Final Report

Health and nutrition information for the berry industry

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Project code:

MT21000

Project:

Health and nutrition information for the berry industry (MT21000)

Disclaimer:

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Public summary

This 2-year project (2022-2024) 'MT21000: Health and Nutrition Information for the berry industry' addresses the ambition '*Demand creation - Grow strong consumer demand in domestic and international markets to support farmgate grower returns.'* (Outcome 1) in the Berries 2022-2026 SIP. Using the investment of the industry's national R&D levy funds to educate health professionals (HPs) about the nutrition and health benefits of berries to support their recommendation to their clients/followers (the end consumer) is a key SIP success pathway.

The project was strategically executed across four pillars; Strategic planning & evaluation, Scientific Research, Resource development, and Communication & Education. Key outputs included the completion of a literature review of berries and health outcomes; development of seven HP resources (fact sheets, infographics, social tiles, educational animation), establishment of an online resource hub and engaged HP database, an engaging communication plan (including eight EDMs), digital outreach campaign and three educational activities (KOL online event, Dietitians' Conference and FOODiQ webinar); and ongoing evaluation via two audience sentiment research (ASR) surveys at baseline and project end.

All intermediate and end-of-project outcomes were successfully met. The project increased HP knowledge of nutrition and health benefits of berries along with their intent to recommend to clients. Specifically:

- The number of HP that were very familiar with the nutrition and health benefits of berries (63% and 69% respectively) increased by over a third during the project.
- Resources were key to HP familiarity and confidence. HP were nearly twice as likely (60% rating top 2 box) to be very confident regarding the nutrition and health benefits of berries if they accessed the resources than if they didn't (45% rating top 2 box).
- Across the board there were 10-30% increases in knowledge on nutrition and health benefits.
- At project end 3 in 4 HPs reported they recommend berries 'always or often' to their clients compared to just over half (58%) at baseline.
- 25% of HP had accessed the resources with 100% finding them useful.

This project clearly demonstrated that the nutrition and health benefits of berries are important drivers of consumption, hence validating efforts to drive awareness of these with HPs, as a valuable strategy to unlocking and driving industry growth. While this project has been a successful first step in educating this important stakeholder influencer group, further consistent investment is recommended to ensure sustained behaviour change. Further investment will maximize the current ROI and help secure berries a stronger position in health promotion.

Future investment is recommended to have short-, medium- and long-term strategic approaches. In the short to medium term, maintaining top-of-mind awareness with the established highly engaged HP database is vital, with opportunities to drive further penetration of key messages to more HPs (including targeting sub-groups e.g. fitness professionals). Medium to longer-term strategies include investment in research to further build the evidence base supporting berries, particularly lesser researched raspberries and blackberries and a focused education campaign on 'Paddock to Plate' to combat key concerns voiced by HPs around production practices, specifically pesticide use.

Keywords

Health professional; Berries; Education; Communication; Health; Nutrition

Introduction

Growth and sustainability for the berry industry is reliant on driving consumption. As part of the Berry Strategic Investment Plan (SIP) 2022-2026, a key ambition is '*Demand creation- Grow strong consumer demand in domestic and international markets to support farmgate grower returns.'* (Outcome 1). One of the key strategies of the SIP includes the investment of the industry's national R&D levy funds into educating health professionals (HPs) about nutrition and health benefits of berries to support their recommendation to their clients and/or followers (the end consumer).

This project, MT21000: Nutrition and health information for the berry industry, commenced in February 2022 and ran over 2 years. Initially tendered as a 3-year project, a contract variation was issued early in the project, following one industry (Strawberry) needing to pull out of the project investment.

One of the highest dietary sources of polyphenols, berries have an impressive nutrition story to tell. Although well known as a healthy food, prior consumer research to this project completed in **RB18000** found that the perceived high price point and short shelf life of fresh berries were key consumer barriers to consumption. While taste will always be king, and together with cost consistently shown in consumer research to be the top two drivers of consumer purchase, food processing, nutrition and sustainability are also shown to be important drivers of purchase and can be important determinants if cost is perceived as high.[1] Consumer research in Asia Pacific supports that consumers are willing to pay premium on products which offer specific benefits such as nutrition and health.[2]

While consumers increasingly seek out the internet for nutrition and health information, health professionals (HPs) are still the preferred source for such information.[3] In an era of information overload and misinformation high, consumers are looking for clear, concise and credible advice.[2] Health Professionals are an important entity to provide that cut through and beacon that compliments and supports any consumer marketing strategies. They are a trusted and key go to source for nutrition information that can increase consumer's awareness and knowledge and ultimately influence consumer purchase behaviour.[3]

Baseline sentiment research conducted at the start of the project showed that overall, while most HPs are quite confident to discuss nutrition and health benefits of berries this appears more in terms of them being perceived as 'generally good for you'. When they were asked about specific nutrition and health benefits, they were not as knowledgeable, particularly health benefits. Significantly, nearly half (42%) of respondents were not regularly recommending berries to their clients and when they do a mix of berries or blueberries most common, with very few specifically recommending blackberries or raspberries. In addition, there is little appreciation of the unique differences between berry types. Nutritional and health benefits, taste and convenience were cited as the key drivers to recommending berries to clients, but not being top of mind and lack of nutritional and health knowledge the key barriers to recommendation. Cost was an issue for only small subset of respondents (15%) which appears lower than the general consumer audience sentiment and may partway be explained by fact that having a heightened appreciation of nutrition and health benefit, the value equation was already understood.

The opportunity for the berry industry to drive consumption is to tap into education of HPs to credibly create a greater value proposition for consumers based in nutrition and health of berries. Specifically the opportunity is to establish a unique health position for berries that makes it memorable and top of mind yet also allows the individual berries (blackberries, blueberries, raspberries and strawberries) to shine.

Methodology

The project targeted Australian HPs with the primary target of Dietitians, Nutritionists & Naturopaths. It was strategically developed and executed across 4 key pillars; Strategic planning & evaluation, Scientific Research, Resource development and Education & Communication. The project was conducted with a continuous improvement mindset with modifications to the project implemented based on learnings from activations and research insights.

Strategic planning & evaluation

The initial phase of the project involved finalisation of key project planning elements in conjunction with Hort Innovation, including the project risk register, program logic, and monitoring and evaluation plan. Communication to Hort Innovation on project progress including outputs and outcomes were provided 6 monthly through benchmarking reports.

As part of the monitoring and evaluation plan, and to help inform strategy and evaluate the effectiveness of the communications plan, a detailed audience sentiment survey (ASR) was designed. The research was planned strategically throughout the project; project start (May 2022), and project end (Jan 2024). The ASR sought to help establish current and changing attitudes, knowledge and propensity to act of health professionals with regards to Australian berries over time.

A snapshot at baseline served to provide a benchmark of HP knowledge, attitudes and behaviour around berries, with the snapshot at project end allowing a comparison and assessment of project effectiveness, insights and learnings. The baseline survey also sought to understand HP needs and preferences around receiving education and resources. The survey consisted of a detailed questionnaire designed to extract both qualitative and quantitative data from the responses. Each question was crafted around a core objective to ensure information collated was robust information to help inform and guide the overall approach. The survey captured knowledge levels of the nutritional properties and health benefits of berries and behaviour around recommending berries, including facilitators and barriers. Each person who participated in the research was incentivised through a chance to win mechanic.

Based on FOODiQ's commitment to continuous improvement, the evaluation of activations including ASR findings, external environmental influences such as the requirement to revise the project due to changes in project investment, planned resource development and educational events, the project strategy was reviewed ongoing, and the plan strategically adjusted accordingly. These strategic changes were aligned with the Hort Innovation R&D Manager, along with the Project Reference Group (PRG) as needed.

Scientific Research

In year 1, a comprehensive literature review was undertaken to provide credible science that could be translated into impactful messaging and utilised in education and communication activations including presentations and developed resources. The approach was designed to focus on synthesised review published research on berries with linkage to Australian growers and international organisations such as the International Blueberry Association.

The literature review was conducted in two parts. In part 1, a systematic search of the scientific literature was conducted to determine 'What are the effects of Australia berries on human health outcomes?' Study types were limited to randomised controlled trials (RCTs), cohort studies, systematic literature reviews (SLRs) and umbrella reviews. Due to the large quantity of data available on the effect of berries on human health, ten health outcomes were strategically selected for data extraction based on the quality of scientific literature available, the leading causes of illness/death in Australia, consumer trends and target audience engagement. All SLRs for each health outcome were selected for inclusion. If a SLR with meta-analysis or narrative synthesis was available, only additional RCT or cohort data not reported in the SLR were extracted. In part 2, a targeted literature search was undertaken to answer specific questions to support resource and education development.

Resource development

Throughout the project, collateral was developed as the key mechanism to educate HPs and increase their knowledge and understanding on the nutrition, health and culinary properties of berries. Along with specific resources to improve HP knowledge, collateral was developed to support the dissemination of this knowledge to their clients. Based on the ASR learnings, different types of collateral were developed to help support engagement and interest including infographics, social tiles, fact sheets and an animation. Strategically developed over the 2 years, the collateral served as new 'news' to maintain interest and an ongoing conversation with the project's owned HP database.

Communication & Education

A **database** was initially established at start of project when people participated in the ASR. The database served as the project's central core target audience with a key objective and outcome to continuously build the database throughout the project. A database growth strategy was developed to continue to build the network during the 2-year period. This was designed to be achieved through specific planned activations that included recruiting HPs attending our own educational events, leveraging paid professional association mailouts and dedicated social media lead generation mechanics.

An **educational activity plan** of events including relevant HP conferences and webinars was originally planned at project start with ambition to target all key HP targets (i.e., GPs, dietitians, nutritionists, and naturopaths, fitness professionals). Specific events were modified throughout the project in response to learnings from ASR, executed activations and changes to project budget. In agreement with the PRG and R&D Manager, a more focused message and target audience was considered the best strategy to meet project outcomes with available budget. Target audience was focused to just dietitians/nutritionists and naturopaths with previous GP activations replaced with an end of project digital activation outreach campaign to drive greater reach and impact with this core group.

An **ongoing periodic communication and end-of-project digital activation** program was developed and executed to target both HPs and growers throughout the 2 years. The communication plan included regular EDMs to the database along with an end of project HP targeted digital activations campaign utilising social media, relevant third-party channels and key opinion leader influencers. For growers, periodic communication to keep them informed on the project progress and milestones was planned, developed and executed in conjunction with Berries Australia via articles in the Australian Berries Journal.

Results and discussion

Educational events

A total of three educational events were held during project, including KOL online event, Dietitian Australia Conference and FOODiQ HP webinar. **See Table 1** for results.

KOL Online event

December 2022

DA Conference Breakfast

July 2023

FOODiQ Webinar

October 2023

TABLE 1: Summary survey results educational events

	Audience	Event 'Excellent or Very good' Overall	Event 'Extremely or Very' Engaging	Event 'Extremely or Very' Informative	Event 'Extremely or Very' Useful	Intend to recommend berries 'Always or often'
KOL Online Event	33 registered; 19 attended	100%	100%	100%	78%	NA
Dietitians Australia Conference breakfast	110 registered; Only 58 could be accommodated	100%	100%	100%	85%	85%*
FOODiQ Webinar	763 register; 169 live	97%	90%	93%	92%	93%*

NA = Not available
Target = >80%
***Target = >75%**

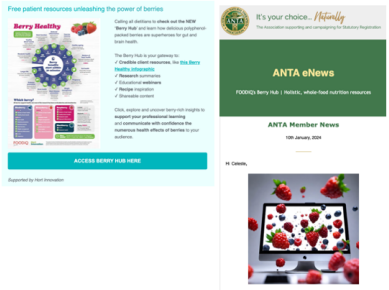
Digital activation campaign

A communications outreach campaign targeted to HP was undertaken at project end in December 2023/January 2024 to drive reach for the awareness of the resources, utilising social media, channel advertising and KOL activation. See **Table 2** for results.

Social media

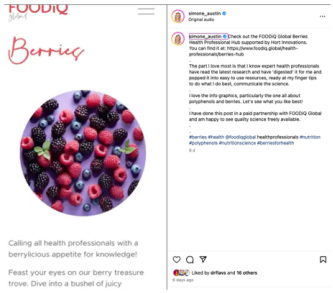
Activation: 4 weeks total split in 2-week blocks over December 2023 and January 2024.

Channel comms



Berry HP Database Direct EDM: 8th January 2024
Australian Naturopath Association Australia solus edm: 10th January
Dietitian Connection e-news: 28th January 2024

KOL Influencers



Activation: January 2024

Over the past 12 months since HP have been directed to the HP hub, there were over 2300 unique visits and 1440 downloads of resources.

TABLE 2: Digital Outreach Campaign Performance

	Audience	Open rate %	Reach	Total clicks	CTR %		Unique Downloads	Cost per contact
Dietitian Connection	11937	49.0%	5823	192	2%	(Average 2%)	129	$26.04
Australian Natural Therapists	7000	30.8%	2154	351	5%	(Above average)	287	$3.50
		Impressions	**Reach**	**Total clicks**	**Av CTR%**	**Sign up database**		
Social media (HP)		236,000	86,653	1531	1.7%	87	319	$1.96
		>1 min view						
Animation		5935	(KPI: 5000)					

Health Professional Database

The HP database was originally commenced at start of project with initial acquisition via the baseline audience sentiment survey. The database has grown throughout the project via targeted strategies at conferences, webinar and the digital outreach campaign. At project end the HP database sits at a total of 1162 subscribers which is 440% increase on baseline (KPI: >30%).

Electronic Direct Mail (EDM)
Eight electronic direct emails were sent to the Berries HP database throughout the project to maintain a connection and keep berries top of mind. The EDMs open rates ranged from 30-50%, consistently performing well above average open rate (25%). See **Table 3** for results.

TABLE 3: EDM open rates

	Topic	Date sent	Open rate
EDM 1 *	Recruitment to ASR	8th June 2022	41%
EDM 2	Welcome & Berry survey	24th August 2022	41%
EDM 3	Infographics	3rd March 2023	33%
EDM 4	Factsheets	29th August 2023	51%
EDM 5	Webinar invite	24th October 2023	37%
EDM 6	Webinar follow up	3rd November 2023	50%
EDM 7	Berries Hub	22nd January 2024	38%
EDM 8	ASR reminder	8th March 2024	39%

*EDM 1 sent to FOODiQ database for recruitment

End of project Evaluation
An audience sentiment research (ASR) survey was undertaken at project start and end. It aimed to assess HP knowledge, awareness and confidence in Australian Berries nutrition and health benefits for project evaluation. Full results are in the full report in **Appendix 2**. See **Figure 1-4** for key results.

FIGURE 1: Health professional confidence nutrition and health benefits baseline Vs project end (accessed versus did not access resources)

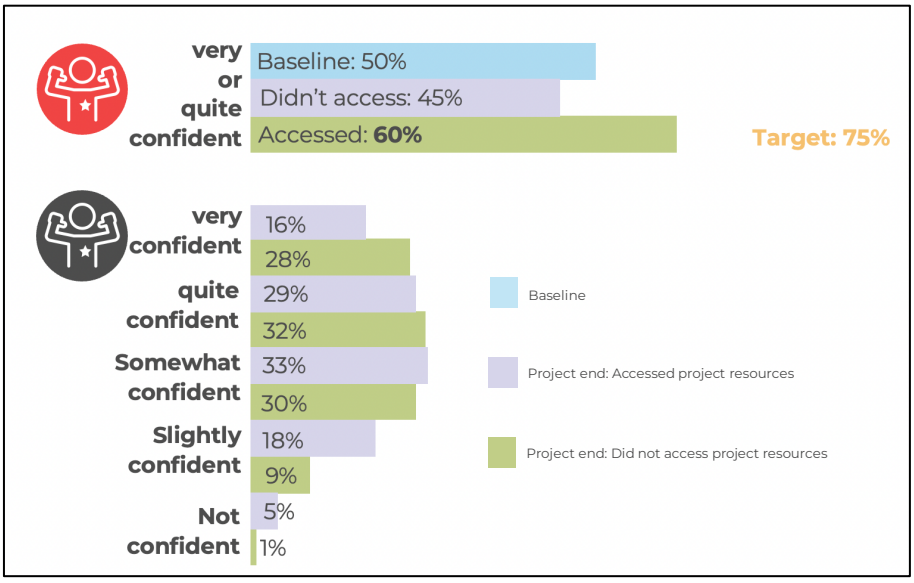


FIGURE 2: Health professionals recommending berries 'Always or Often' at baseline Vs project end (accessed versus did not access resources)

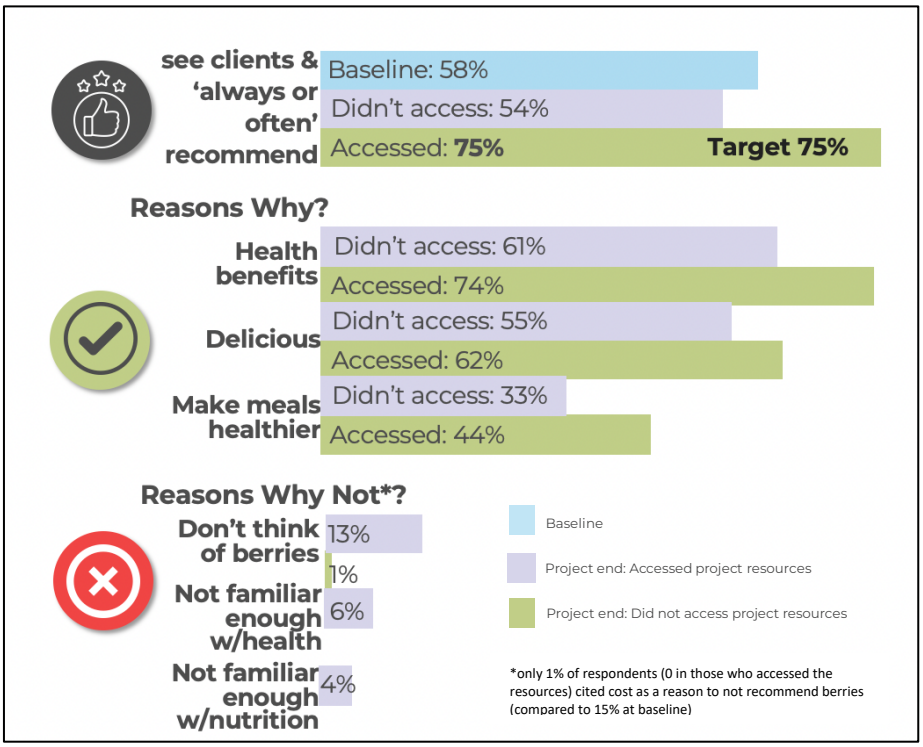


FIGURE 3: Health professional awareness of specific nutrition and health benefits baseline Vs project end

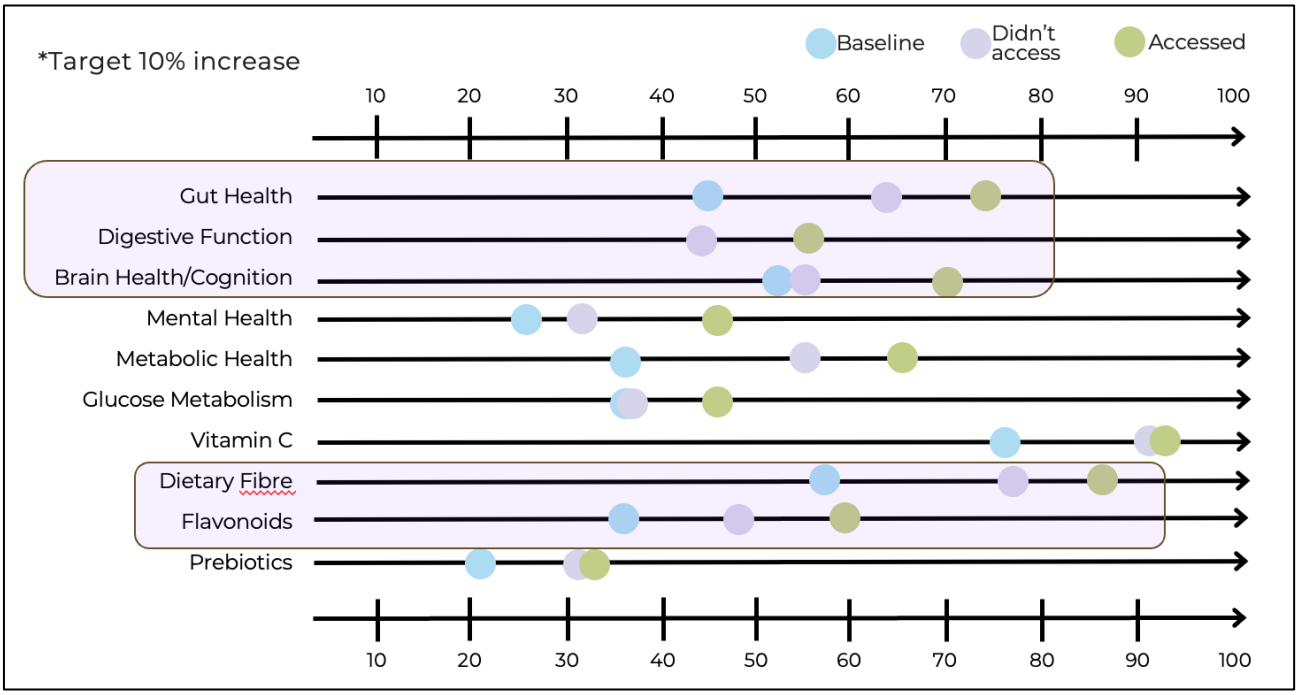
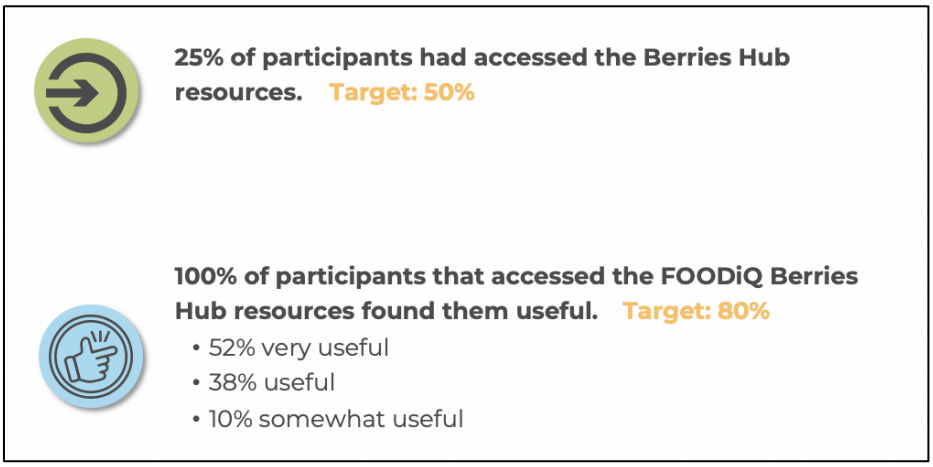


FIGURE 4: Project resources usage and perception by Health Professionals



In summary, HP knowledge regarding the key project education messages increased the most supporting that focused messaging strategy had the intended outcome. The project evaluation supports that HP communications benefit from using focused messaging. Key reasons for not recommending relate to berries not being top of mind or unaware of benefits. Access to resources & education correlates well with increased recommendations, knowledge and confidence. HPs were almost twice as likely to be confident in recommending berries if they accessed resources. Resource access appears to have been powerful for changing knowledge, recommendation and confidence, but the number of participants who had accessed the resources was lower than expected. Increased dissemination is likely to amplify impact and developing a duplicate dedicated HP webpage recommended. Furthermore, ongoing continuous HP communication is recommended to maintain top of mind awareness and continue to build reach.

The educational events were all rated highly for information, usefulness and engagement. They served as a valuable strategy to drive database recruitment to disseminate further resources. Leveraging the digital format offers the benefit of securing an evergreen resource that can be leveraged with future audience acquisitions. While a lower return on investment in terms of absolute reach, face-to-face conferences offer deeper connections with HP and support a more intangible value of developing subset of brand advocates that can amplify project messages with credibility.

Outputs

Output	Description	Detail
Audience Sentiment Research – Baseline	Baseline findings HP knowledge, awareness and confidence in Australian Berries nutrition and health benefits. Baseline findings used to help set M&E targets and direct project strategy. **Target audience:** Hort Innovation	Date conducted: May/June 2022 Survey responses: 214 (KPI: >200) Report **(Appendix 1)** presented at PRG 1 and submitted to Hort Innovation on 27th July 2022
Audience Sentiment Research – Project end	End of project findings HP knowledge, awareness and confidence in Australian Berries nutrition and health benefits for project evaluation. **Target audience:** Hort Innovation	Date conducted: Jan/Feb 2024 Survey responses: 368 (KPI:>200) Report **(Appendix 2)** presented at PRG 4 and submitted to Hort Innovation as part of this final report.
Berries literature review	A comprehensive literature review synthesising the health effects of Australian berries (strawberries, blueberries, raspberries and blackberries). **Target audience:** Hort Innovation and project team	Literature review report **(Appendix 3)** submitted to Hort Innovation on 5th September as part of MS103. The findings were leveraged throughout the project in development of evidence-based key messaging for educational events and resource development.
Berry Hub Webpage	Single webpage serving as digital repository of the project resources on the FOODiQ website for HPs. **Target audience:** HP	A Berry Hub webpage on the FOODiQ Website was developed December 2022 and maintained ongoing.
Infographics	3 x single page, simple infographic resources **(Appendix 4)** showcasing berry nutrition & health benefits to HPs; Berry healthy, Berry nutritious, Berry Polyphenol. **Target audience:** HP	Available on the Berries Hub and sent out via the HP database, distributed to attendees at DA conference and webinar, naturopath and dietitian professional channels and communicated in social media activation.
Factsheets	2 x Factsheets **(Appendix 5)**; 1 x HP Berries & Health and 1 x Consumer facing were developed. An evidence-based summary on the berry science for HP knowledge and a patient friendly resource for HP to support client education. **Target audience:** HP	Available on the Berries Hub and sent out via the HP database, distributed to attendees at DA conference and webinar, naturopath and dietitian professional channels and communicated in social media activation.
Social tiles	Social tiles **(Appendix 6)** of nutrition/health educational content for HP to share with their followers/clients. **Target audience:** HP	Available on the Berries Hub and sent out via the HP database, distributed to attendees at DA conference and webinar, and communicated in social media activation.

Animation	A 2-minute digital animation targeted at HPs, summarising the latest scientific evidence on berries and brain health, breaking it down and presenting it in an easily digestible format. **Target audience:** HP	Available both on the FOODiQ Berries Hub and YouTube channel. The animation was sent out via the HP database and communicated in social media activation.
KOL Event	Online KOL influencer event featuring Dr Flavia Fayet-Moore and Alice Zaslavsky. **Target audience:** HP and HP KOLs	Event took place 5th December 2022. See **Appendix 7** for event evaluation. Recording: https://youtu.be/85guAxmtSa8
KOL event pack	A digital information pack for KOLs comprising event recording, 3 infographics, social tiles, recipes **(Appendix 8)**. A gift pack comprising 2 x Joy of Better Cooking cookbooks by Alice Zaslavsky plus 1 x Robert Gordon pottery berry colander. **Target audience:** HP and HP KOLs	The digital information and gift pack was distributed to the KOLs that attended the KOL event.
Dietitian Australia Conference	Annual conference for professional development and networking for members of the key leading voice for nutrition and dietetics and the regulation of accredited practicing dietitians in Australia. **Target audience:** HP	Dietitian's Australia conference took place in Melbourne on 23-25 July 2023. A breakfast seminar was held along with Berries having a trade display stand. See **Appendix 9** for evaluation. 58 people attended the breakfast (KPI>40). 100% found the event 'excellent' or 'very good' (KPI>80%) 100% found event 'extremely informative' or 'very informative' (KPI>80%) 100% found event 'extremely engaging' or 'very engaging' (KPI>80%) 91.5% found information presented 'extremely useful' or 'very useful' (KPI>80%) 84.5% intend to recommend berries 'always' or 'often' (KPI>80%)
FOODiQ HP Webinar	1-hour professional development webinar. **Target audience:** HP (core target dietitians, nutritionist, naturopaths).	Webinar was held on 30th October 2024. See **Appendix 10** for evaluation. 763 registrations and 169 attended live. 97% found the event 'excellent' or 'very good' (KPI>80%) 90% found event 'extremely informative' or 'very informative' (KPI>80%) 93% found event 'extremely engaging' or 'very engaging' (KPI>80%) 92% found information presented 'extremely

		useful' or 'very useful' (KPI>80%) 93% intend to recommend berries 'always' or 'often' (KPI>80%)
Digital Activation Campaign	Communications outreach campaign targeted to HP to drive reach for the awareness of the resources, utilising social media, channel advertising and KOL activation. **Target audience:** HP	Over December 2023 to January 2024, a 4-week paid social media campaign took place along with advertisement to Dietitian Connection (DC) membership and Australian Natural Therapist Association (ANTA) and influencer campaign involving 7 KOLs. See **Appendix 11** for evaluation. Total reach: 94, 630 Social CTR %: 1.7% (KPI:1-2%) DC CTR %: 2% (KPI: 2%) ANTA CTR%: 5% (KPI: 2%) KOL reach: 365, 387 followers (KPI: 100,000)
Electronic Direct Mail (EDM)	An electronic direct email sent to the Berries HP database ongoing regular basis. **Target audience:** HP	8 x EDMs **(Appendix 12)** were sent to the HP database throughout the project. The EDMs served to keep berries top of mind with HP and communicate nutrition and health benefits. 8th June 2022, 24th August 2022, 3rd March 2023, 29th August 2023, 24th October, 3rd November, 22nd January, 8th March 2024
Health Professional database	A final database built during the project to enable an ongoing conversation with HP. **Target audience:** HP	At project end the HP database (**Appendix 13** sent separately) had 1192 subscribers which was a 480% increase on baseline (KPI: 30% increase).
Project Reference Group (PRG) Meetings	6 monthly meeting with appointed project stakeholders/advisors to inform and consult on project. **Target audience:** HP, Industry, Hort Innovation	4 x Meetings **(Appendix 14)** were held where project deliverable outcomes and learnings discussed and consultation for future plans discussed and aligned. 24th August 2023, 29th March 2023, 4th September 2023, 12th March 2024
Berry Journal News	Project update story published in Berry news Journal communicated to growers. **Target audience: Industry**	3 x articles **(Appendix 15)** were prepared. 7th November 2022, 5th May 2023, 19th March 2024
NiQ Science Summaries	6-monthly summaries on the latest science. **Target audience:** project team, Hort Innovation	3 x Scientific searches **(Appendix 16)** prepared for Hort Innovation every 6 months to stay abreast of the latest clinical developments and advances in berries and health. MS104, MS105 and MS190 reports.

Outcomes

Table 4. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
5935 online views of animation	KPI: ≥5,000 views	The animation was communicated to HP via direct EDM to Berries HP database, and via digital activation outreach campaign. The animation is a key engaging and evergreen resource targeted for the digital arena, increasingly a key channel source of information for HP. This channel was a relevant and purposeful way to get the key messages communicated to the target audience.	Online data analytics
24 KOLs with combined following 534,053 followers (Meta) were actively engaged in the project.	KPI: ~40 KOLs with 100,000 followers	The KOLs were engaged through the project via FOODiQ network and invited to an exclusive KOL event. Further KOLs were engaged in direct one-on-one outreach throughout the project. These KOLs are prominent within the digital space and influencers to their HP colleagues. KOL influencers amplify the reach and awareness of key messages from the project and enable genuine authenticity and credibility that solidifies consideration and trust for the key messages.	Online data analytics
25% of HP aware of the Berry Hub	KPI: 50%	The Berry Hub is the repository for all project resources which aim to increase knowledge and understanding on berries. The berry hub was communicated via direct EDM to the owned database, at conferences, webinars and via digital outreach campaign. The evaluation research supports that when awareness is engaged and knowledge increases, intention for recommendation increases. Increasing HP awareness of hub is key and there is opportunity to further drive this.	Audience Sentiment Survey
100% of HP utilising resources found them useful.	KPI: 80%	The resources are the evergreen and main outputs to increase HP knowledge and understanding. Ensuring they were developed to be	Audience Sentiment Survey

		engaging, relevant and practical was key in the development process. The value in uptake of resources lies in the transference to knowledge acquisition which is key to driving recommendation.	
Hort Innovation and Industry were provided updated information and all resources from the project to leverage accordingly.	KPI: Innovation & industry digital platforms contain updated information and resources from the project.	Project team provided stakeholders regular project updates via PRG process, industry news articles and emails. Regular communication with all stakeholders is valuable in ensuring the project value can be leveraged to its maximum potential.	PRG Feedback
The HP database increased 480% from baseline to achieve 1192 subscribers at project end.	KPI: 30% increase from baseline.	The HP database acquisition commenced via the baseline audience sentiment survey recruitment. The database has grown throughout the project via targeted strategies at conferences, webinar and the digital outreach campaign. The database is a key and central strategy to gain direct line communication with the target audience to a maintain cost effective and ongoing connection that ensures berries remains top of mind to secure recommendation and continue to support long term industry growth.	Database management
68% HP utilizing resources rated themselves as familiar with the nutrition benefits and 62% familiar with the health benefits which was 36% and 26% increase from baseline respectively.	KPI: 65%	HP familiarity with the nutrition and health benefits was driven through the developed resources which were disseminated via channel communications and educational events. Increasing familiarity is key to driving understanding and recommendation.	Audience Sentiment Survey
There was a 10-30% percentage point increase from baseline in knowledge of HP utilizing resources, of the specific nutrition and health benefits of berries.	KPI: 10% increase on baseline	HP knowledge of the nutrition and health benefits was driven through the developed resources and planned educational events. Increasing knowledge is key to driving understanding and recommendation.	Audience Sentiment Survey
60% HP utilising resources rated themselves confident in discussing the nutrition and health benefits of berries which	KPI: 75%	While there was a 20% increase from baseline, the target was not met, however, this may be a result of additional education reducing the “Dunning-Krueger” effect of false	Audience Sentiment Survey

was 20% increase from baseline.		confidence – HPs may now be aware that there is so much more to berries than they thought.	
75% of HP utilizing resources and seeing clients reported that they would 'always' or 'often' recommend berries to clients/followers, equating to 32% increase from baseline.	KPI: 75%	Sentiment to increase recommendation of berries results from increasing HP awareness and knowledge of the nutrition, health and culinary benefits of berries. This was the main strategy for the project which involved development of credible evidence-based resources and educational events that were communicated and disseminated via comprehensive communication plan. HP fulfil an important role in consumer decision-making and purchasing, providing trusted information in an increasingly confusing and overloaded information ecosystem. While less tangible and indirect, they play a pivotal part long term in maintaining and further fueling demand and consumption.	Audience Sentiment Survey

Monitoring and evaluation

Table 5. Key Evaluation Questions

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project improved HCPs specific awareness, knowledge, confidence of the nutrition and health benefits of berries and their recommendation to clients?	At project end over two thirds of HP were aware of the nutrition (68%) and health (63%) benefits of berries compared to only around one in two (58%) at baseline. There was 20% increase in HP reporting they felt confident in talking to the nutrition and health benefits of berries, and knowledge on the specific nutrition and health benefits increased by 10-30 percentage points from baseline., with highest increases on those focused in key messages (Gut health, Brain health, fibre, flavonoids). Nearly ¾ of HP are aware that berries support gut and brain health compared to less than half at baseline. At project end HP recommendation to consume berries to clients/followers increased from baseline by one third with three in every four (75%) HP now reporting that they intend to recommend 'always or often' compared to only around two in four (58%) at baseline. Unfamiliarity with the nutrition and health benefits of berries significantly decreased (92%) as a reason to not recommend. Furthermore, the 'For health reasons' was the number one reason to recommend and it increased by 20% from baseline. Further consolidation of the value of education on recommendation is supported from survey measures at events. Attendees at the webinar and conference were asked to also indicate their intent to recommend post event with 93% and 85% respectively indicating they would 'always or often' recommend berries.	• The project has demonstrated that raising awareness and education of HP increases their confidence, familiarity and knowledge, and ultimately intent to actively recommend. Key reason for not recommending berries from the audience survey is not thinking about berries. Maintaining an ongoing conversation with HP to keep berries top of mind will be paramount to maintain their active recommendation. Development and execution of an ongoing integrated dedicated Berry HP website/digital activation strategy should be high priority.

To drive demand of Australian berries, to what extent - did HPs find the educational events informative? - did HPs find the information and resources provided throughout the project useful?	The educational events and resources have consistently been rated by HP as informative and useful and exceeding KPI >80% with no-one rating bottom 2 box of not informative or useful. From the three events held the average response was: 98% indicated 'extremely or very informative' 83% indicated 'extremely or very useful'. Unprompted survey feedback from all events was extremely complimentary of the resources being practical and useful for clinical practice.	• Survey sentiment indicates that while infographics are unanimously valued, a wide variety of touchpoints to receive the key messages is valued. There is further opportunity to extend these key events to other touchpoints such as podcasts.
To what extent have regular project updates been provided through linkage with the industry?	The project team has provided regular updates to key industry stakeholders via 6 monthly PRG meetings and news articles for the grower's magazine.	• Berries Australia joined the PRG midway through the project. The inclusion of growers' association in a PRG is invaluable and should be a mandatory.
To what extent did the planned HP communication and education activations meet target engagement levels? To what extent were HPs aware of educational resources, using or intending to use them and consider useful?	The educational events and resources have consistently been rated by HP as engaging and exceeding KPI >80% and no-one rating bottom 2 box of not engaging. From the three events held the average response was: 98% indicated 'extremely or very engaging'. Unprompted survey feedback from all events was extremely complimentary of the format of the events and engagement drove overall positive ratings. The audience sentiment survey which randomly sampled 368 HP at project end, showed 25% were aware and using the resources with 100% rating them to be useful.	• From a random survey sample of HP at project end, only 25% of respondents were aware of the resources and hub. There is opportunity to further drive awareness to capitalise on the finding that when HP are aware of the resources, they are likely to find them useful and to increase their active recommendation to clients/followers.

Have project outputs been delivered within timelines, to budget and quality?	All project outputs have been delivered within the required timelines within budget and to high quality as exemplified by feedback at events and from PRG members. The project team operated with an efficiency and continuous improvement mindset. This is evidenced by: • In June 2022 Hort Innovation informed that due to unforeseen circumstances, the Strawberry fund needed to remove its funding to the project which comprised around one third of original budget. The FOODiQ team was agile and responsive in being able to strategically put together a solution to continue with the project delivering required budget savings, while delivering a strong plan that aimed to maintain many of original outcomes. • Our strategic review process throughout the project leading to recommendations by the team to focus only on dietitians and naturopaths, single minded messaging across activations and to drop GPs and re-funnel the budget into digital activation to drive greater reach.	• Nil

Recommendations

Overall, this project successfully achieved the stated aim of increasing HP knowledge about the nutrition and health benefits of berries and thereby increasing the frequency with which HPs recommend the inclusion of berries to their clients or followers. This was evidenced by a significant 30% increase at project end in HP reporting they intend to recommend compared to baseline, with 'health benefits' being a key reason to recommend increasing and 'not knowing nutrition/health benefits' being a key reason for not recommending, going down significantly. It is well regarded that HPs are a key influence on the nutrition and health landscape and consumer food choices and consumption, which is increasingly a confusing and information-overloaded ecosystem. This project validates that efforts to drive awareness of berry benefits with HP is a valuable strategy to unlocking and driving industry growth.

While this project has started to make an important and successful first step into educating and influencing this important stakeholder influencer group, it is recommended that further investment be continued. Success in any behaviour change lies in consistent and long-term focused investment. Further investment will maximise the return on the current investment and help secure berries as an active specific recommendation, particularly when they are managing clients with gut health issues, which is a current trending and focused consideration.

It is recommended that any future investment should have both short-, medium- and long-term strategies. While in the short to medium term, maintaining top-of-mind awareness with the established highly engaged HCP database is paramount, there is opportunity to drive further penetration of the communication messages to reach more HCPs (including targeting other sub-groups such as fitness professionals). Medium to longer-term strategies include investment in research to further build the science for the lesser researched berries such as blackberries and raspberries and new news to keep berries top of mind with HP and HP campaigns that directly address one of the key barriers/concerns relating to production methods and pesticide usage.

The following recommendations are made:

Short term:

- Develop a **dedicated HP webpage** on the Berries Australia website
- Continue to **maintain and build on the currently highly engaged HP database** by **c**reating & implementing an ongoing integrated website-digital HP engagement strategy. Recommend that this needs to be evidenced based and contain engaging and relevant content. At a minimum, communicate quarterly e-news on latest science summaries.
- Extend HP key messaging through to consumer communications to amplify and strengthen uptake of messages and cut through.

Communication considerations:

- **Continue with consistent and repetitive messaging benefits of both taste (natural sweetness) and nutrition (Berry Polyphenols/bioactives)** across HP and consumer communication. Berries are the highest food source of polyphenols that provide them with a unique positioning to other foods. Simple, repetitive messaging of relevant and unique benefits is key to gaining traction and building brand differentiation that is memorable. While nutrition is key, enjoyment of food and taste is always number one. Leveraging taste, cooking and/or meal ideas in HP targeted communications is key for building an emotional connection that will build affinity and keep berries more top of mind.
- **Develop an evidenced-based intake dose for communication (e.g. 1 cup of mixed berries daily)** like other foods have successfully created (i.e., 'handful of nuts', 2 & 5 Fruit and Vegetables and 3/day dairy). Communicate it consistently across both HP and consumer communications long term to help build and drive 'top of mind awareness' and relevancy.

Medium term:

- **Build further HP awareness and database** through further strategic planning leveraging FOODiQ iQ^3 strategy process. This could include digital lead generation strategies and bespoke face-to-face berry events dependent on budget funding.
    - Develop HP endorsed therapeutic recipe book development & leverage in digital comms
    - Undertake FOODiQ 'Bring science to kitchen^{TM}' - berries roadshow in key states.
- **Extend and target other HP audiences** as part of the above strategic plan to build further reach. While continuing to maintain communication with tier 1 HPs (Dietitians & Naturopaths) the opportunity is to extend the target audience to include focus on fitness professionals in short term and Nurses/GPs in

medium term.

- **Widen target audience focus** to education & communications campaigns targeting schools, food service industry

Big ideas:

- **'Paddock to Plate' campaign** to **overcome key barriers to recommendations**. Undertake
    - Targeted research on stakeholders to understand perceptions/needs
    - Connect agricultural practice to food
    - HP tailored 'Paddock to Plate' –research, education & digital campaign to address concerns
- Research iQ – undertake **strategic planning to help identify and prioritise innovative research opportunities** that could be leveraged. For example:
    - Research focused on raspberries & blackberries. While each berry contains polyphenols, they have unique nutritional compositions. Blackberries contain the highest of all nutrients found in berries and are a particular standout for dietary fibre, providing one third of daily intake in a serve.
    - Direct berry microbiome/gut function studies to improve understanding
    - 'Food as medicine' real world feasibility studies – e.g. for aged care incorporating berries into resident's menu to reduce IBS/constipation, improve mood
- With the Norwegian Dietary Guidelines as an inspiration, consider as part of the future long-term strategy, an **advocacy plan to achieve greater recognition** of the nutrition and health benefits of berries in the **Australian Dietary Guidelines** to secure a stronger and more prominent position of influence long-term. As research evolves and to strategically support this effort, **build a dedicated stand-alone Australian Berries website** for health and food industry professionals to more effectively maximise information distribution and build berries unique position in the diet.

Refereed scientific publications

Nil to report

References

1. https://www.foodnavigator-usa.com/Article/2023/10/13/How-do-consumers-perception-of-healthy-drive-their-purchase-habits-and-product-development
2. https://nielseniq.com/global/en/insights/analysis/2022/consumer-health-and-wellness-continues-to-drive-fmcg-growth-in-asia-pacific/
3. Australian Commission on Safety and Quality in Healthcare: 2017. Consumer health information needs and preferences: A rapid evidence review

Intellectual property

No project IP or commercialisation to report

Appendices

Appendix 1 – Audience Sentiment Research (Baseline)

Appendix 2 – Audience Sentiment Research (Project end)

Appendix 3 – Literature review

Appendix 4 – Infographics

Appendix 5 – Factsheets

Appendix 6 – Social Tiles

Appendix 7 – KOL event Evaluation

Appendix 8 – KOL pack

Appendix 9 – Dietitian Australia Conference Evaluation

Appendix 10 – FOODiQ Global Webinar Evaluation

Appendix 11 – Digital Activation Campaign Evaluation

Appendix 12 – EDMs

Appendix 13 – HCP Database (Confidential) – sent separately

Appendix 14 – PRG Meetings

Appendix 15 – Berry Journal News

Appendix 16 – NiQ Science Summary Updates

APPENDIX 1

NRAUS

Berries Market Research: Baseline Report

Prepared for Hort Innovation

July 2022

Background

Project code: MT21000

Project name: Health and nutrition information for the Berry industry

Project leader: Dr Flavia Fayet-Moore

Delivery partner: Nutrition Research Australia Pty Ltd (NRAUS)

Report author: NRAUS

Contact: Flavia Fayet-Moore
flavia@nraus.com | 0415 990 050

Contents

- Objectives & Outcomes
- Methods
- Results
  - Audience demographics
  - HCP familiarity with: Growing practices, nutritional properties, and health effects
  - Resources
  - Other considerations
- Learnings & Recommendations
- Limitations
- Conclusions

Objectives & Outcomes

Objectives

1. Obtain baseline data on perceptions and attitudes to be used as a benchmark for project evaluation at project end as part of monitoring & evaluation plan.

2. Gain market insights to help tailor key message development and adjust the communication plan.

This report describes the findings from the baseline market research survey among health-care professionals (HCPs).

It is the first of two market research reports, with the second due to be conducted at the conclusion of the 2-year project, around November 2023.

Outcomes

The 2-year project has the following outcomes:

Health care professionals to have an increased **awareness, knowledge,** and **confidence** discussing the **health and nutrition benefits** of Australian berries (blueberries, raspberries, and blackberries) and recommending these to clients.

Health care professionals to have **access and used developed resources to educate clients** on the health benefits of Australian berries (blueberries, raspberries, and blackberries).

Health care professionals to have an **increased understanding of berry growing practices**.

Methods

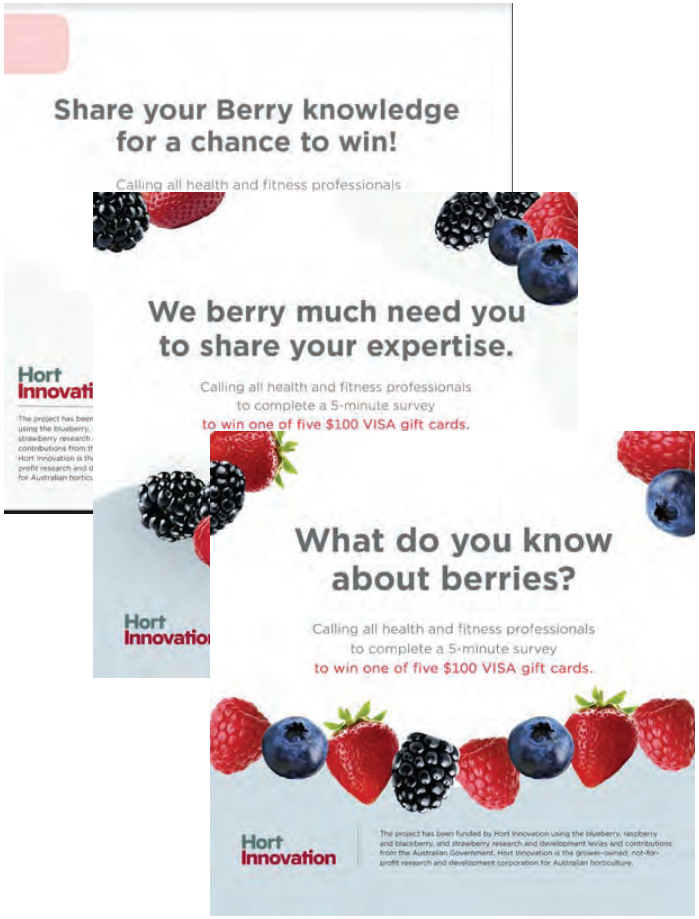
Approach

A digital recruitment campaign was run to recruit a minimum of 200 health care professionals:

- over 4 weeks (May 16th to June 12th, 2022).
- across paid social media channels – Facebook.
- complemented with organic strategies (e.g., sharing via NRAUS employee social media accounts (Facebook, LinkedIn to professional networks).
- dedicated EDM sent to NRAUS owned HCP database
- promoted with the chance to win 1 of 5 $100 Visa gift cards.

To be eligible, participants had to reside in Australia, and either be a health-care professional or studying to become one.

Five separate social media tiles were designed (3 Static, 2 gifs), which allowed us to test and refine the recruitment strategy.



Spend & assets

Social Media	Spend	Impressions	Clicks	Cost per click
Facebook	$ 399.33	42,781	286	$1.40
Total	**$ 399.33**	**42,781**	**286**	**$1.40**

A further 306 clicks were achieved through organic, non-paid strategies.

Facebook (organic)	$ 0	-	48	
LinkedIn	$ 0	-	109	
Other (shares)	$ 0	-	26	
EDM	**Spend**	**Unique opens**	**Total clicks**	
NRAUS EDM	$ 0	803 (39.4%)	123	

Results

Audience demographics

Survey stats

Participant flow:

592 Total views

42.9% of all viewers completed the survey

320 Starts

79.4% of all starters completed the survey

254 Submissions

14 excluded as were not HCPs living in Australia
26 were not HCPs or studying to become HCPs

214 Eligible

Exceeded target of 200

Average time to complete:

Audience Segmentation

Age: 69% were 25-44

- 40% 25-34yrs
- 29% 35-44yrs
- 20% 45-54yrs
- 8% 55+yrs
- 3% 24yrs or younger

Sex: 73% female

- 73% Female
- 23% Male
- 3% Other

State: NSW most popular

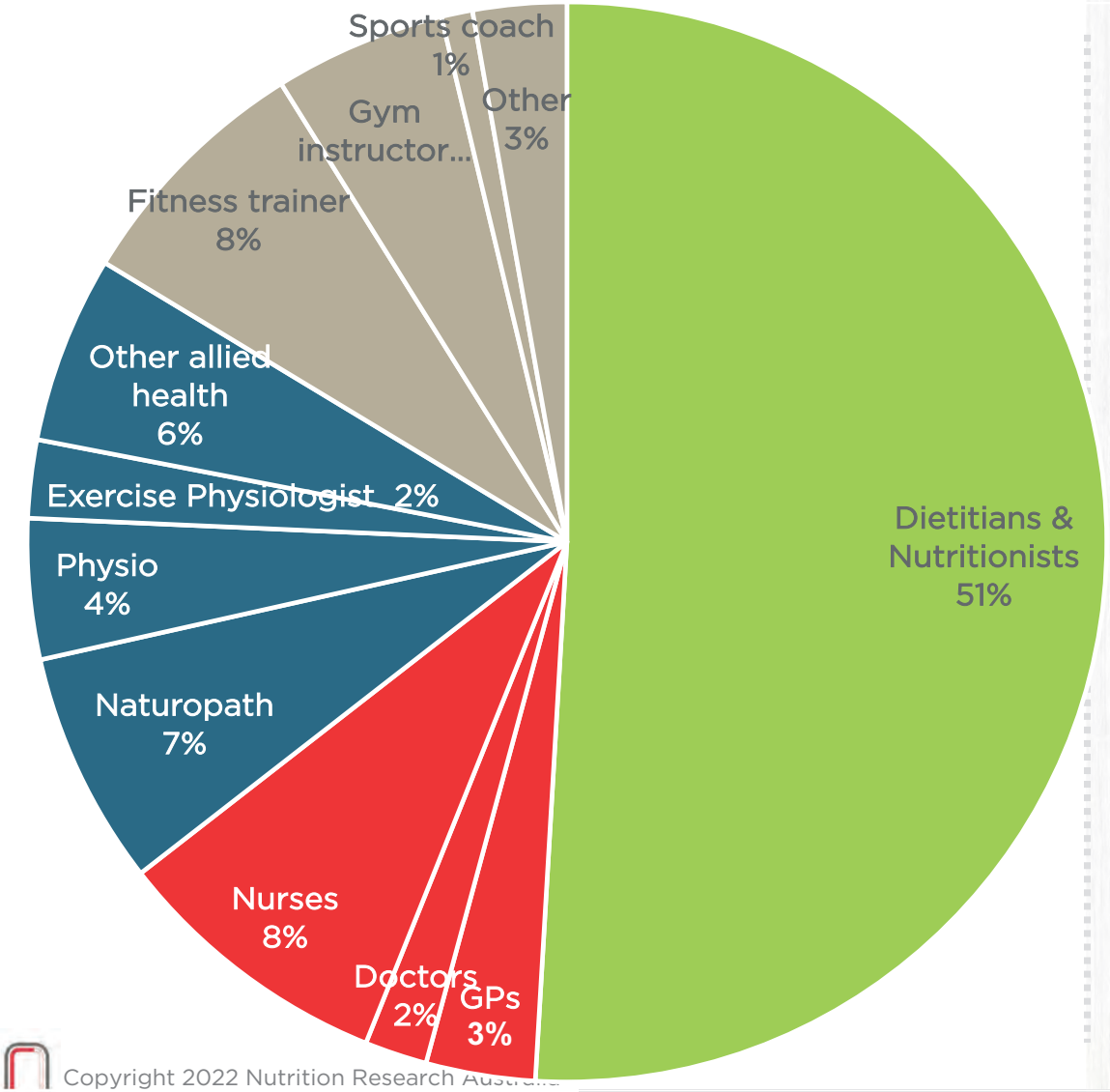
- 31 % NSW
- 19% VIC
- 17% QLD
- 13% WA
- 18% SA
- 8% SA
- 6% ACT, NT, TAS

Students: 1 in 6

- 84% HCPs
- 16% studying

n = 228

Just over half were dietitians or nutritionists, with many (53%) in clinical or private practice



Setting of current practice:

- 27% in private practice
- 26% in clinical
- 15% in gyms
- 10% in public health
- 10% management or other
- 5% currently studying
- 4% in research
- 3% in education/tertiary

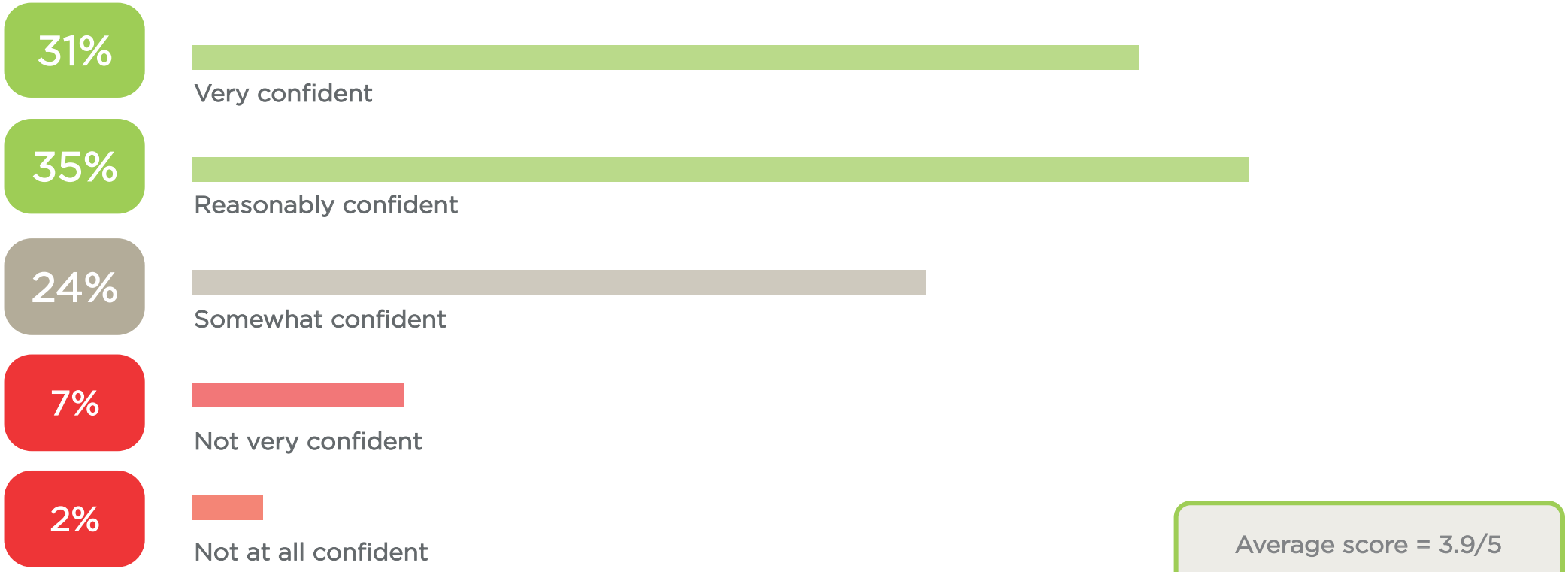
n = 214

Results

HCP familiarity with: Growing practices, nutritional properties, and health effects

The majority (91%) of respondents feel confident in discussing the nutrition and health benefits of Australian berries with 2 in 3 rating themselves very or reasonably confident.

Q. On a scale between 1 and 5, where 1 is 'not confident at all', and 5 is 'very confident', how confident do you feel in discussing the nutrition and health benefits of Australian berries?



n = 214

Dietitians and naturopaths were the professions the highest confidence level, and allied health and nurses the least, in discussing the health effects of berries.

Q. On a scale between 1 and 5, where 1 is 'not confident at all', and 5 is 'very confident', how confident do you feel in discussing the nutrition and health benefits of Australian berries? (by profession)

Profession	n	Mean	SD
Dietitians	72	4.19	0.83
Naturopath	15	4.07	1.03
Sports coach	2	4.00	0.00
Gym instructor	11	4.00	0.89
General Practitioner	7	4.00	1.00
Nutritionists	37	3.97	0.90
Personal (fitness) trainer	16	3.94	1.00
Exercise physiologist	5	3.60	1.14
Other allied health	12	3.33	1.44
Medical doctor other than GP	4	3.25	0.96
Nurse	18	3.22	1.11
Physiotherapist	9	3.00	1.00
Other	6	2.83	0.75

SD = standard deviation

n = 214

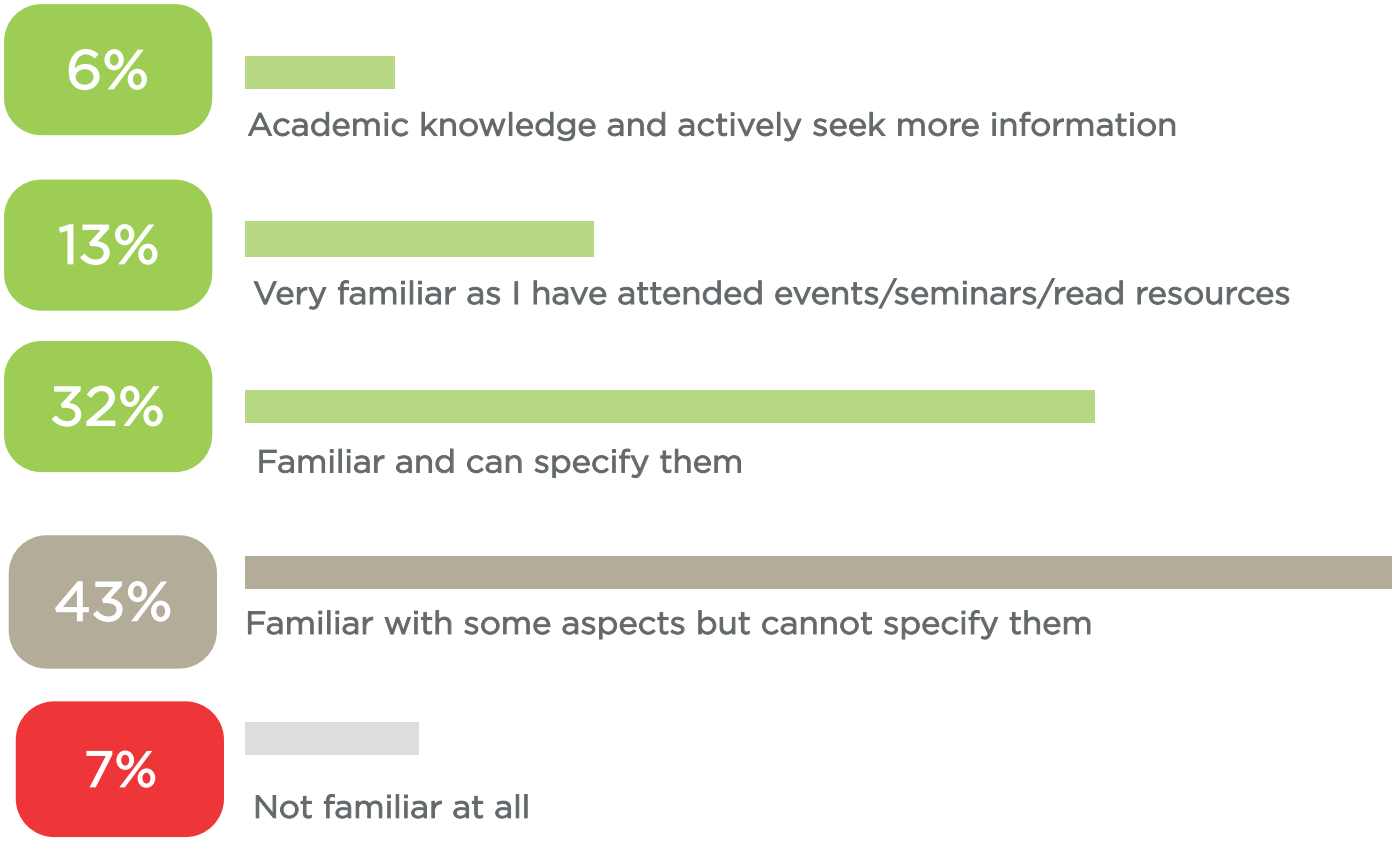
3 in 4 health care professionals are not very familiar with growing practices of Australian berries.

Q. How familiar are you with the growing practices of Australian berries?

n = 214

Half of respondents do not feel able to identify specific nutritional properties of Australian berries

Q. How familiar are you with the different nutritional properties (nutrient content and bioactive components) of Australian berries?

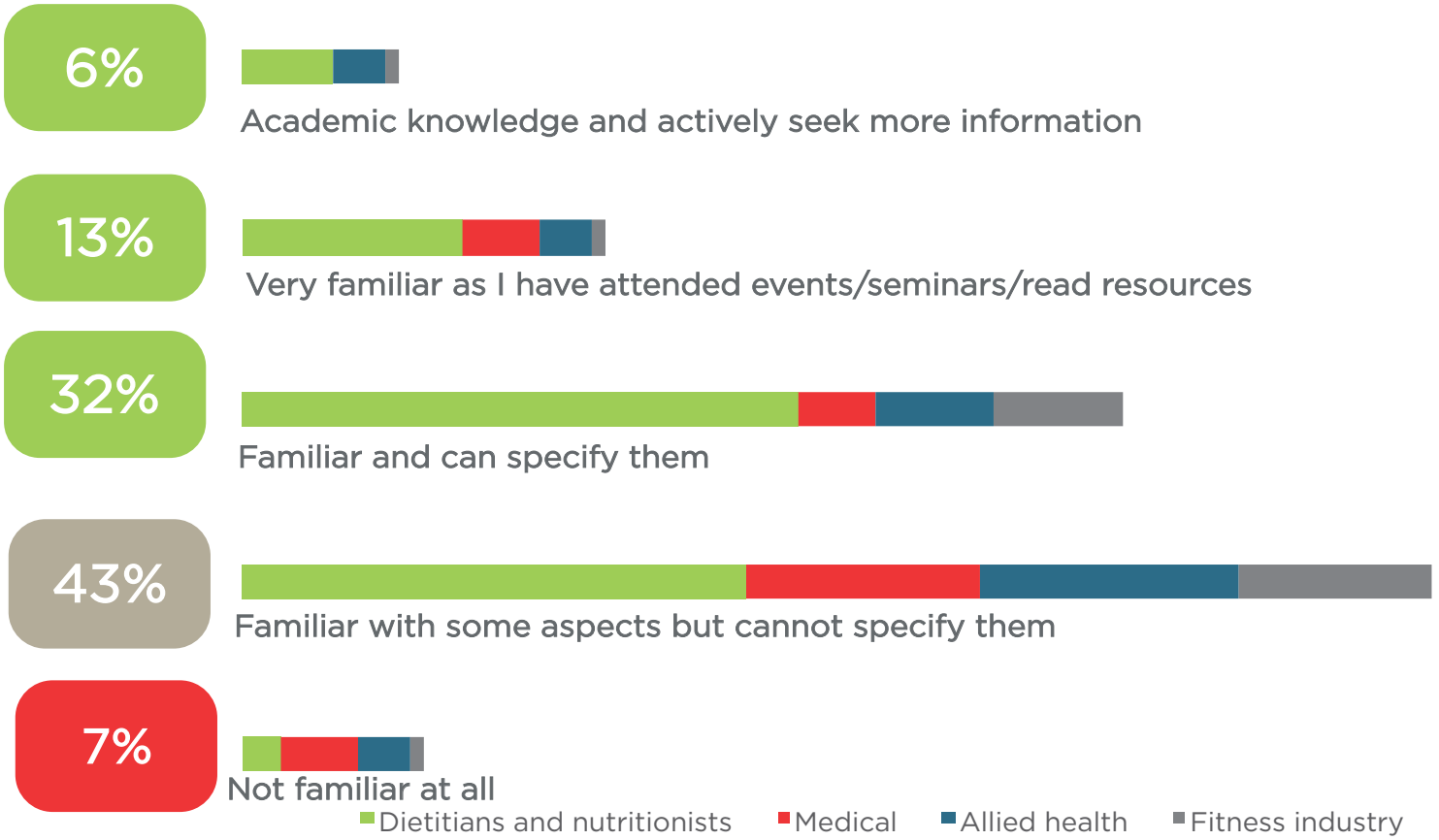


n = 214

Note: Values total >100% due to rounding errors

Dietitian-nutritionists are more likely to specify, while other professions, particularly medical, are more generally familiar.

Q. How familiar are you with the different nutritional properties (nutrient content and bioactive components) of Australian berries?

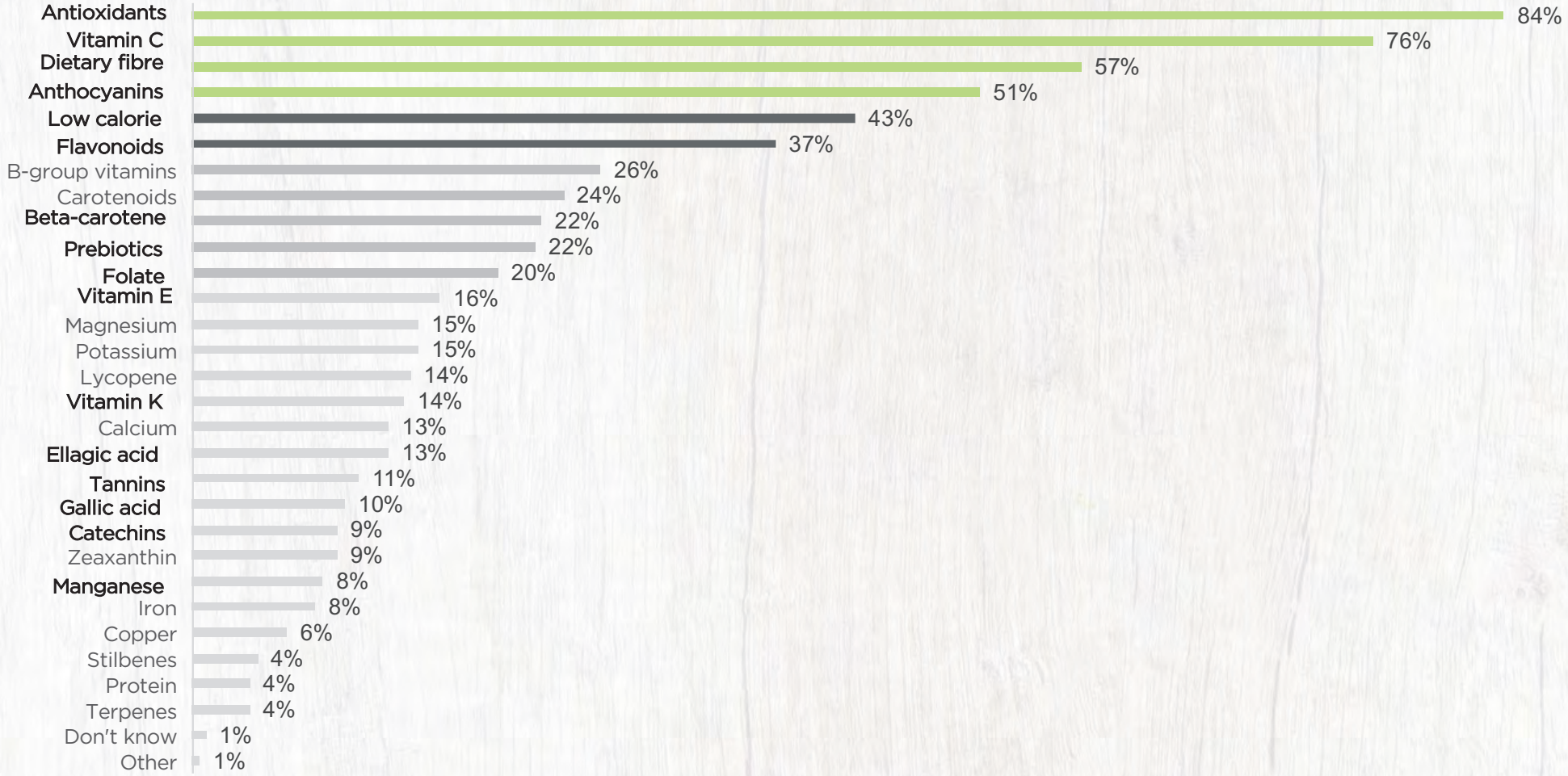


n = 214

Note: Values total >100% due to rounding errors

The majority (>75%)of participants correctly identified antioxidants and vitamin C as key nutritional properties of Australian berries, but only half or less could identify specific bioactives

Q. In your opinion, what are the key nutritional and bioactive properties of Australian berries?

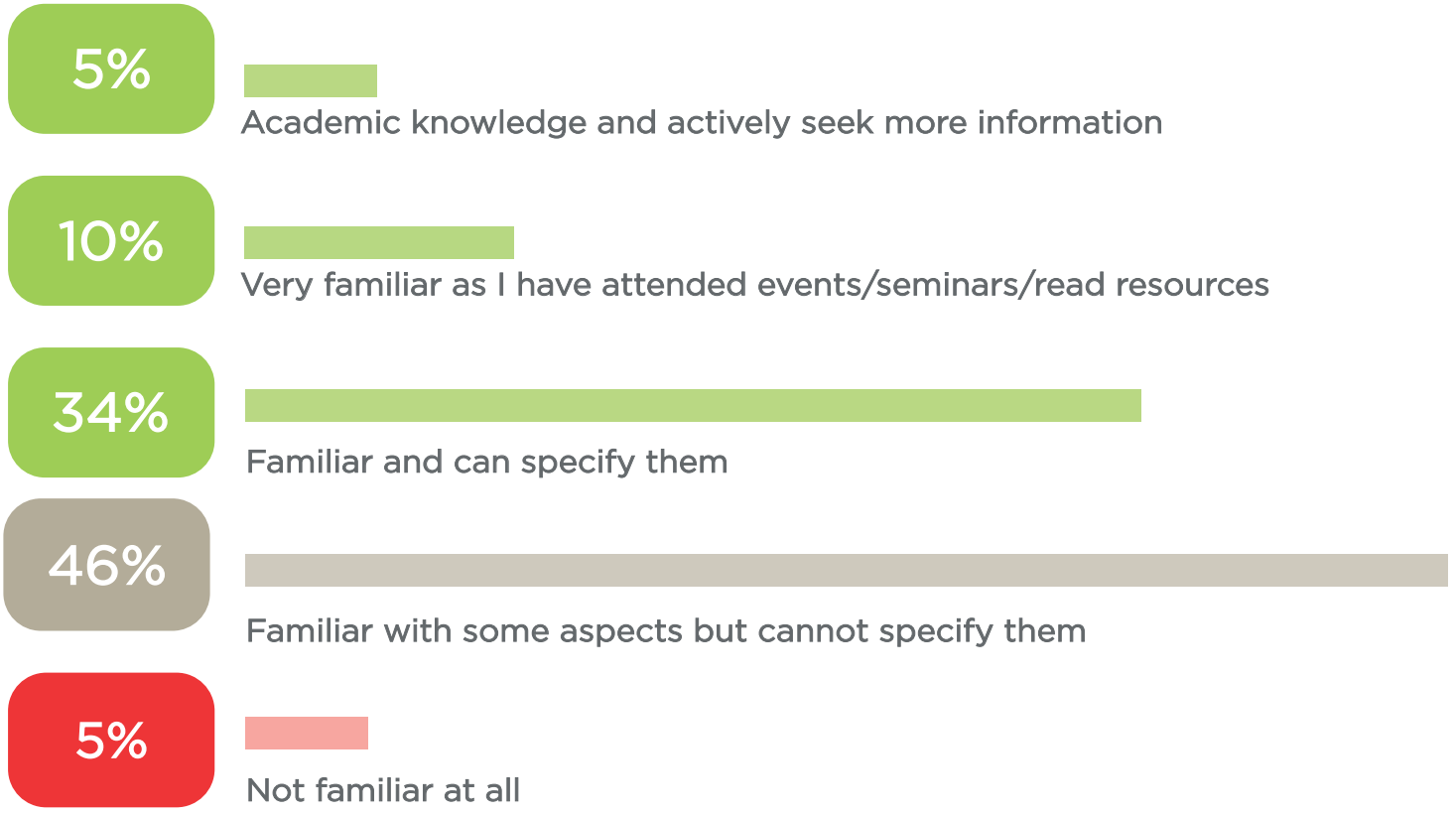


Bold = Key nutritional properties of Berries.

n = 214

Half of respondents do not feel able to identify specific health benefits of Australian berries

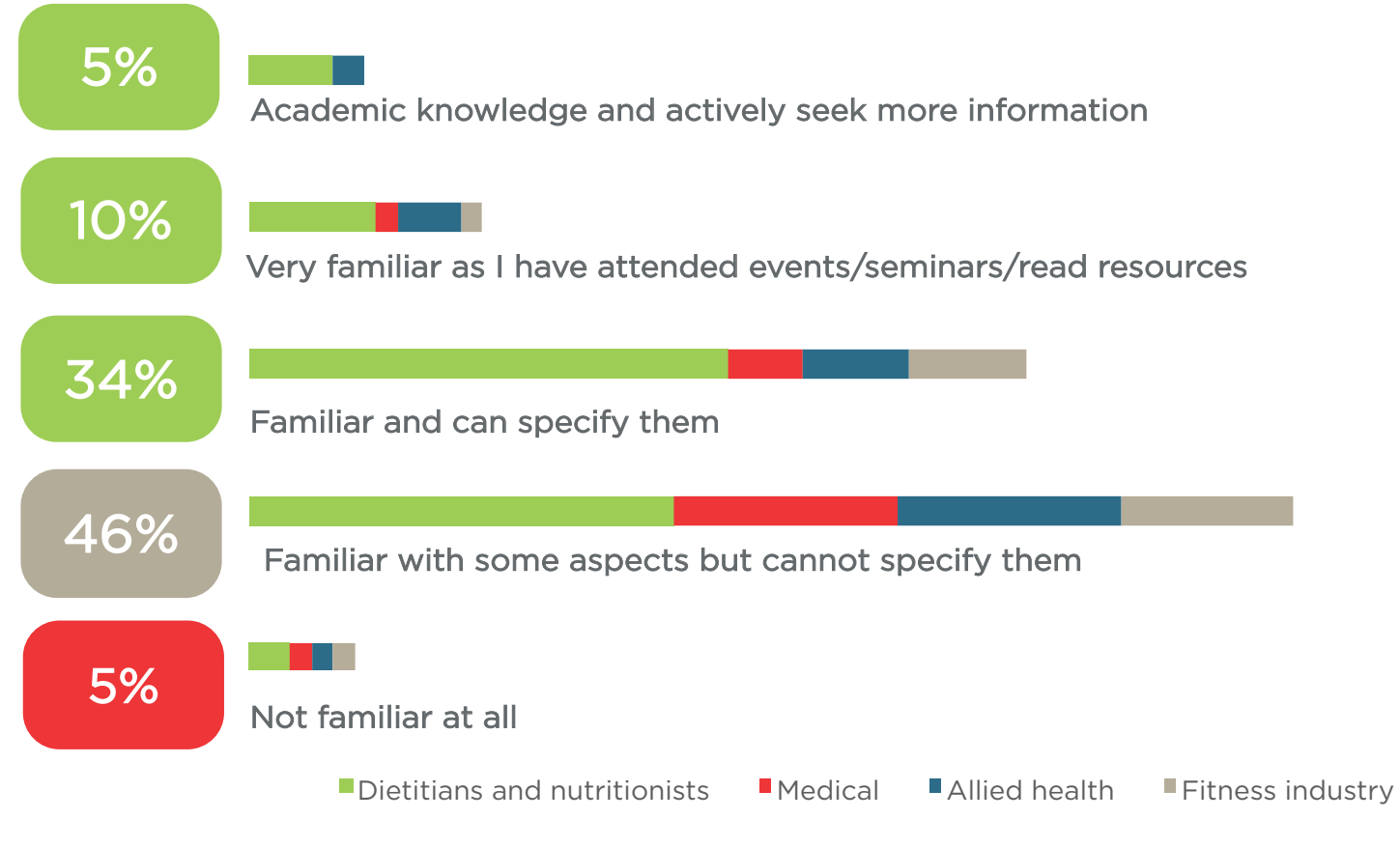
Q. How familiar are you with the different health benefits of Australian berries?



n = 214

Dietitian-nutritionists more likely to be familiar with specific benefits while other professionals, particularly medical, ‘familiar, but can’t specify’.

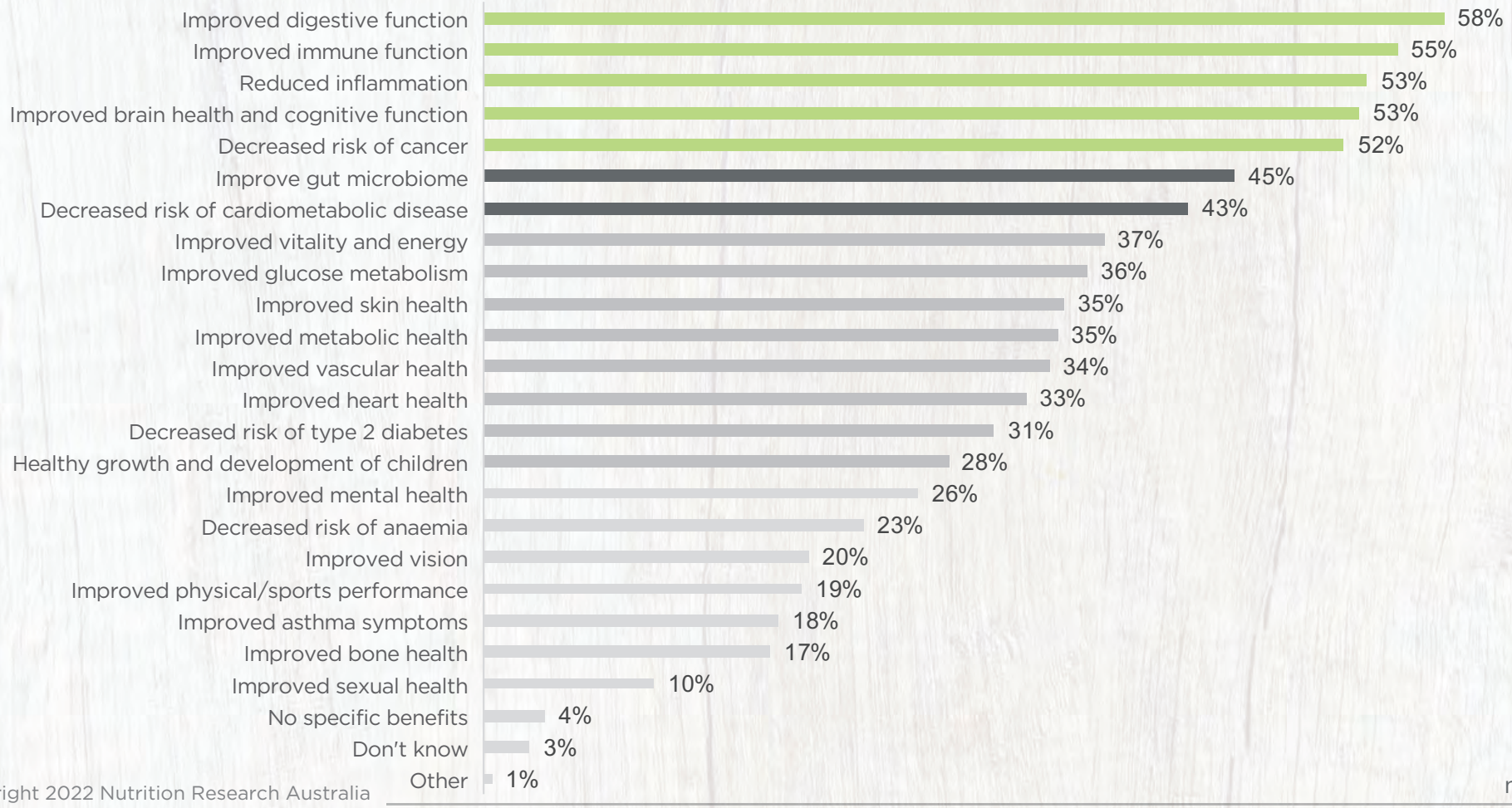
Q. How familiar are you with the different health benefits of Australian berries? (breakdown by profession)



n = 214

The most common health outcomes identified by around half of respondents only included Improved digestion, immunity, and cognition, and decreased inflammation and risk of cancer. Less know about gut health and metabolic benefits.

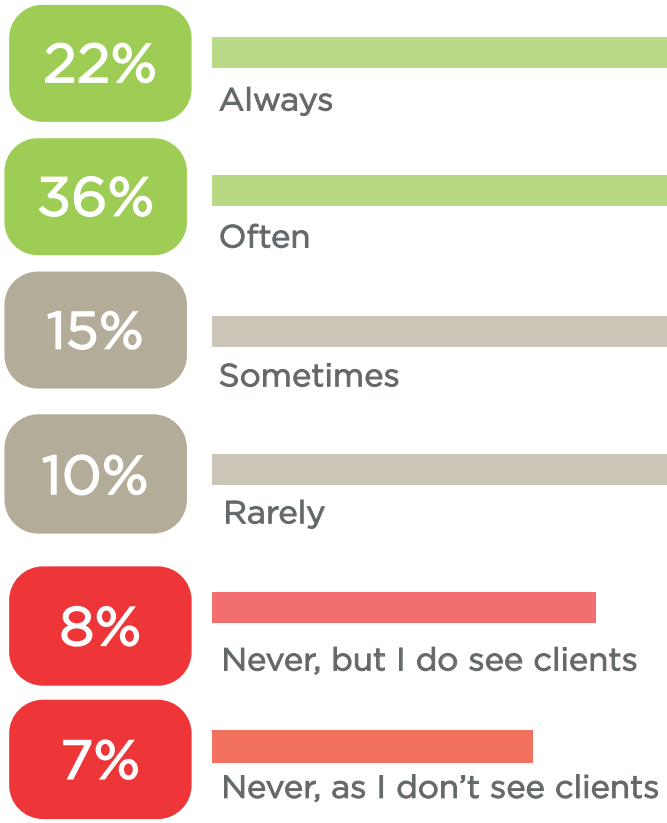
Q. In your opinion, what are the key health properties of Australian berries?



n = 214

Just over half (58%) of respondents regularly recommend berries to their clients

Q. Which statement best describes how often you specifically recommend berries to your clients or patients?

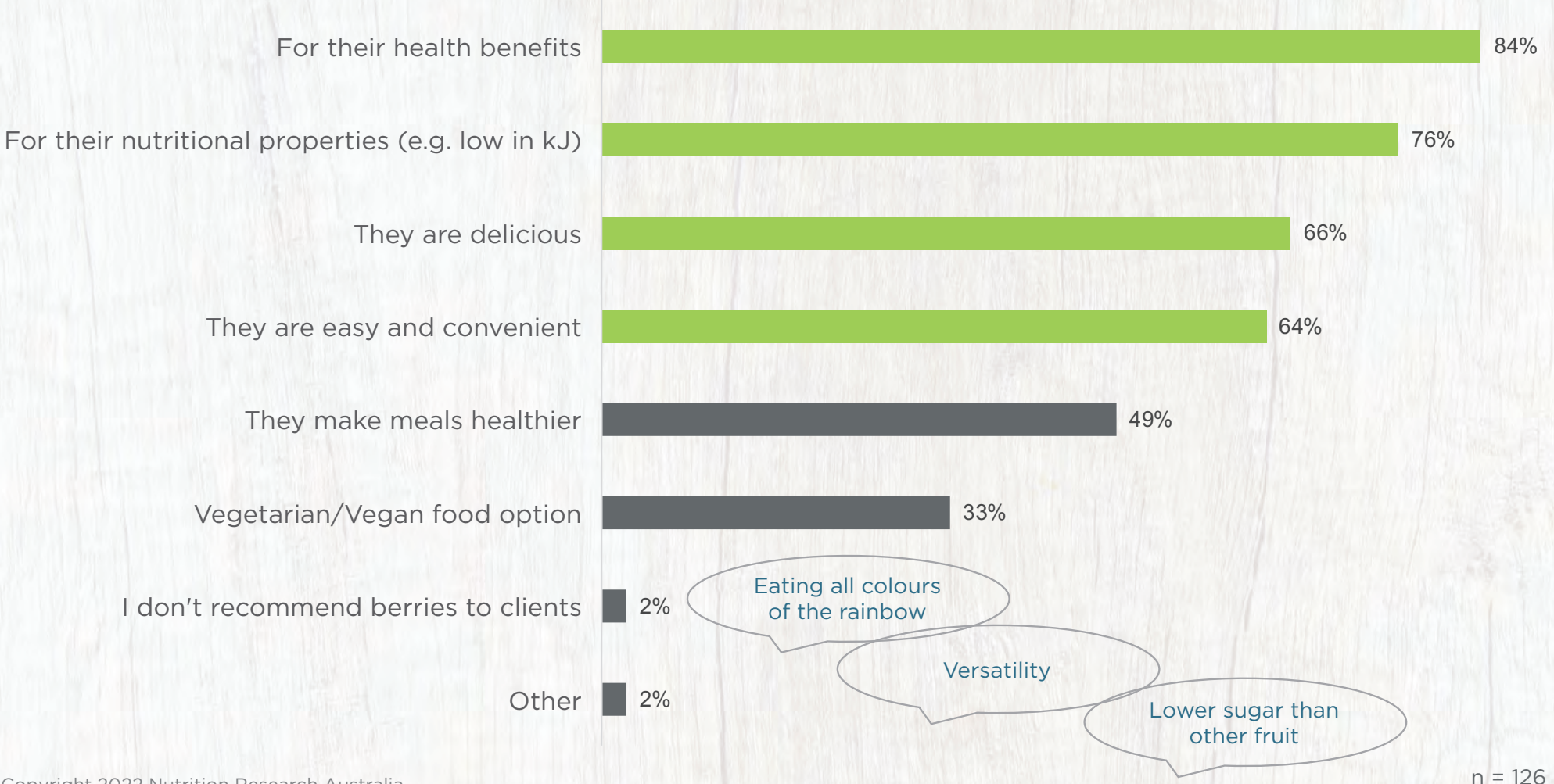


n = 147

Note: Values total <100% due to rounding errors

Health and nutritional benefits, taste and convenience are key drivers to recommending berries to clients.

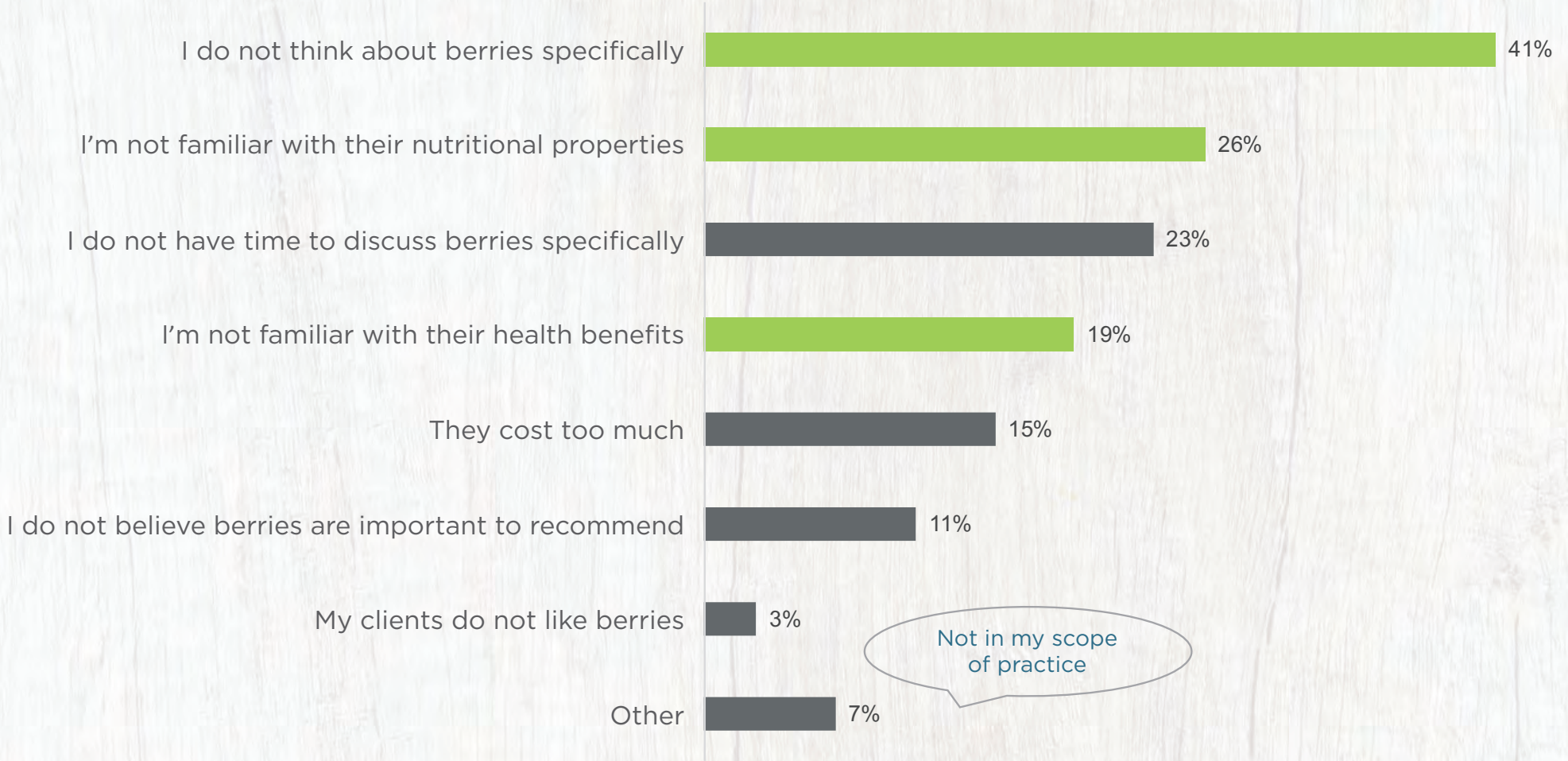
Q. Help us to understand why you recommend berries to your clients



n = 126

Key barriers for why berries are not being recommended include not being top of mind and lack of knowledge about the nutritional and health benefits.

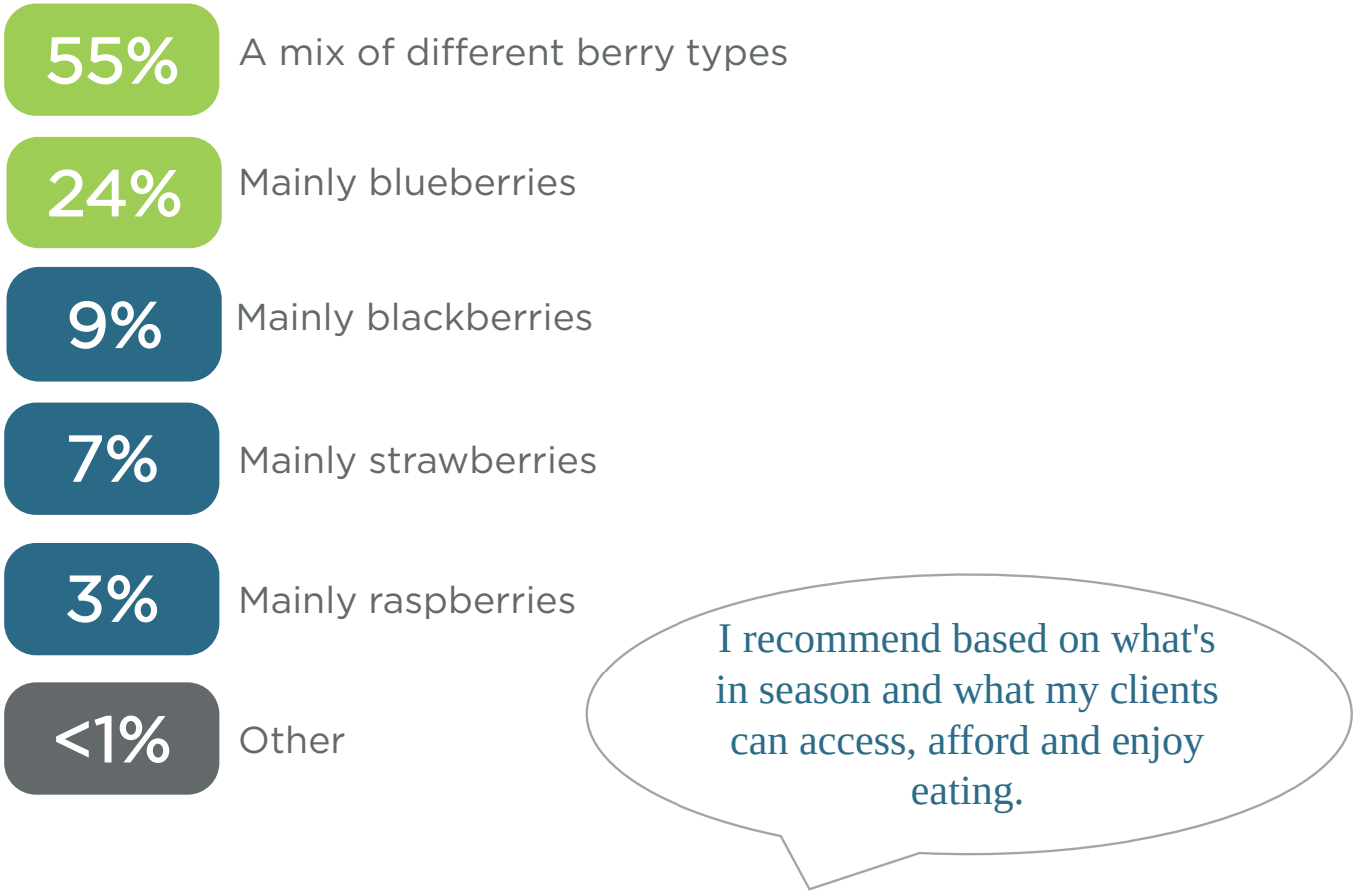
Q. Help us to understand why you do not regularly recommend berries to your clients



n = 73

When recommending berries, a mix of berry types is the most common (55% respondents). Of those who recommend a single berry type, blueberries were the standout.

Q. Which statement best describes your recommendation of berries?



n = 123

Results

Resources

The majority (83%) of respondents were either unaware of resources or do not use them.

Q. Which statement best describes your opinion of the resources available to healthcare professionals on Australian berries?

17%

I have resources and I use them

25%

I have seen resources but am not really interested in them

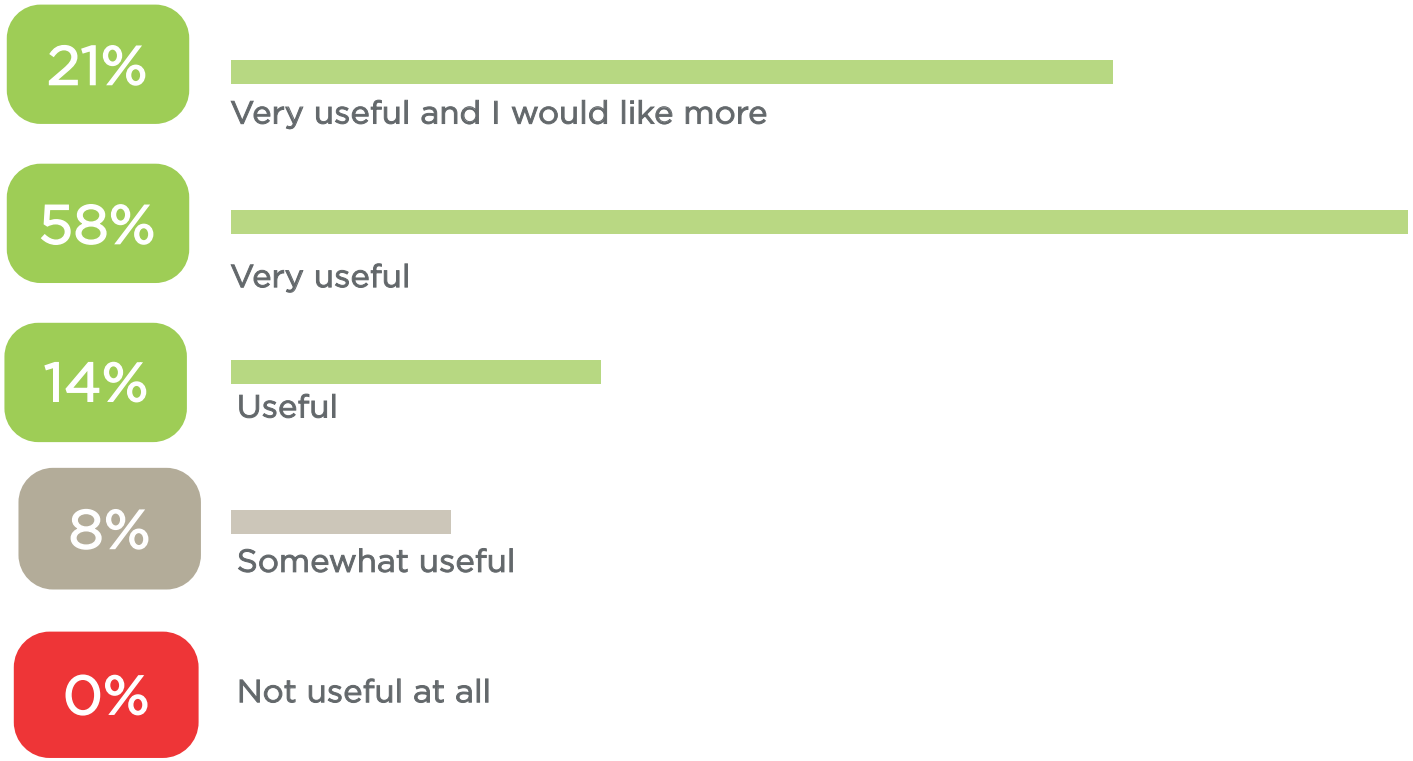
58%

I don't know of any resources

n = 339
n = 214

The majority (93%) of respondents who use or are aware of available resources report finding them useful. One in five who use the resources would like more

Q. Which statement best describes your opinion on the usefulness of Australian berries resources available to healthcare professionals?



n = 36

The main sources of information were work provided resources, internet and social media, and academic sources (e.g. journal articles, conferences)

Q. Please briefly describe where you obtain the Australian berries resources you use.

Dietitians & Nutritionists
Health care(n=8)
Journal articles (n=1)
Dietitian networks (n=1)
Friend (n=1)
Make my own (n=1)
Internet (n=1)
Conferences (n=1)
Books (n=1)
Document authored by Emma Stirling (n=1)

Naturopaths & Allied Health
The internet (n=1)
Berries Australia (n=1)
Kate's Berry Farm (n=1)

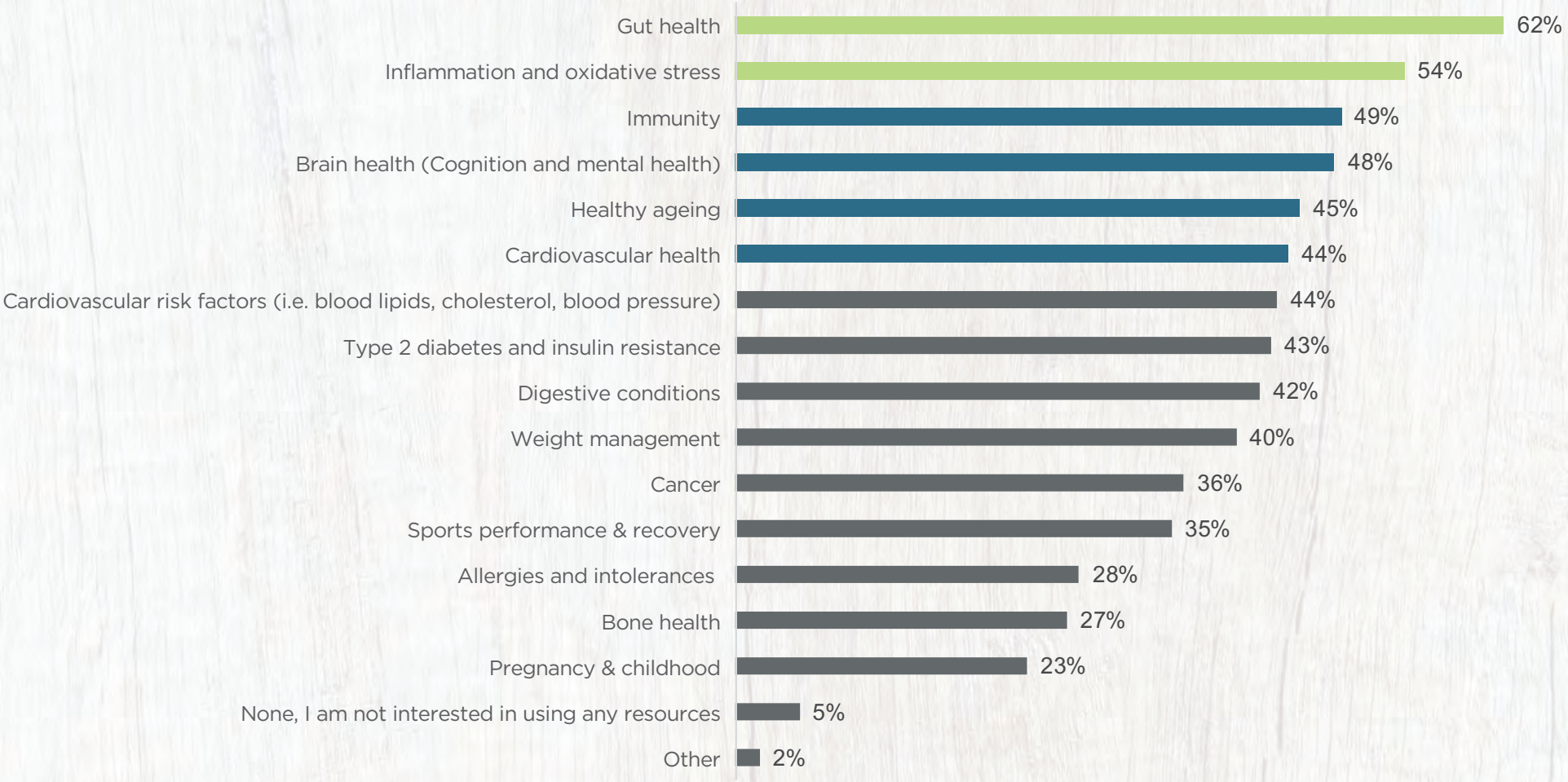
Medical
Breeding base (n=2)
Internet/google (n=1)
Social media (n=1)

Fitness Industry
Breeding base (n=5)
Eat for Health (n=1)
Internet/google (n=1)
Social media (n=1)

n = 32

Gut health and, inflammation & oxidative stress, are key topic areas of interest to HCPs in supporting clients, followed by immunity, brain health, cardiovascular health and healthy aging.

Q. If you were to use educational resources on berries with clients, what topics areas would be of interest?



n = 214

HCPs were most interested in resources that could be shared directly with clients

Q. Which of the following would you find useful to assist you in recommending berries to clients?

54%
simple, infographic style brochures

38%
short videos

31%
podcast

49%
client-friendly fact sheets

34%
webinars

27%
animations

39%
technical scientific brochures

34%
dedicated HCP website

n =199

While printed information is still valued, there is a strong demand for resources to be made also available in digital format

Q. Do you prefer written educational materials to be pre-printed or in digital downloadable format?

47%
Digital + Printed

40%
Digital only

10%
Printed only

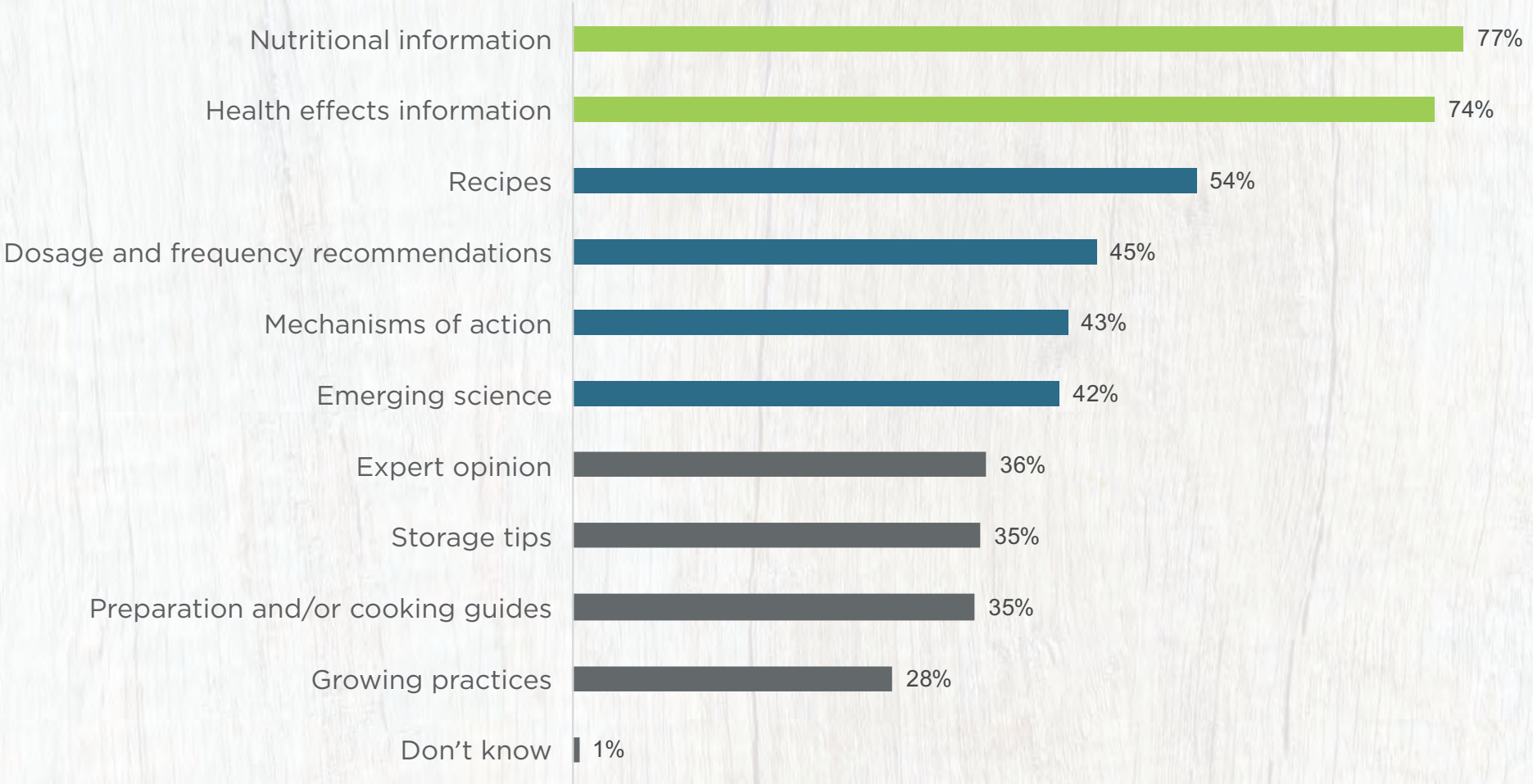
2%
Neither

1%
Unsure

n = 214

While information on nutrition and health effects is key, HCP value information on practical application.

Q. What do you find useful information in resources?



n = 126

Results

Other considerations

HCPs want to know more about soil health and pesticide use, up-to-date credible scientific information, differences in berry types (like nuts), and practical usage information.

Q. Please provide any additional questions or thoughts on the type of information that you would like to see provided about the health or nutritional properties of Australian berries

1. Information on growing practices and the effects on nutrition

"I am interested in the growing practice and the effects of this on the nutritional properties. The use of pesticides and the effects of this on health

"I have been told some berries are quite highly sprayed with pesticides so would be interested in this information too

2. Credible, evidence-based information and differences in berry types

"Recent studies investigating berries in whichever respect and findings

"Authoritative clinical data

"....Australian berries compared to overseas grown as well as specific nutritional or research differences between berries, as we have for nuts

3. Practical usage information

"More on the nutritional benefits and recipes/ways to include them

"Would like best seasons for consumption and growing your own

"Where to find Australian berries vs NZ or other berries in grocery stores, how to stop raspberries going mouldy

"...Nutritional benefits and recipes/ways to include them

Learnings & Recommendations

Survey Q's and promotion

Learnings	Recommendations
• 214 eligible respondents, exceeding the target of 200. • This survey sought to specifically ensure fitness professionals were captured, which was reflected in respondents. Overall, however the number of respondents from professions other than dietitian-nutritionists were small. • Cost per click for LinkedIn was been historically high compared to Facebook. Therefore, in this survey an organic LinkedIn strategy was used to build on existing NRAUS network, which was successful in generating 109 clicks. • Average time to complete was 6:50 minutes, which exceeded 5-minute target. No negative impact was observed with 79% of survey starters completing survey.	• Repeat the same social media promotional strategy for the final survey. • Continue with survey 4 weeks in the field • Ensure grow and broaden database via targeting HCPs via GPCE and upcoming webinar event.

HCP knowledge, understanding and recommendation

Learnings	Recommendations
• Overall, most HCPs are quite confident to discuss nutrition and health benefits of berries, but this appears potentially more in terms of them being 'generally good for you'. • Berries specific benefits are largely not known by around half of HCPs and for those that do, are correctly anchored in containing general antioxidants, vitamin C, and dietary fibre. Not many know of specific bioactives, nor being good source manganese and nearly 1 in 4 incorrectly see them a key source of B-vitamins and carotenoids. • HCPs are not as knowledgeable on health benefits, with improving digestion, immunity, inflammation, cognition and decreased risk of cancer the health benefits most well known but by less than 58% respondents. • Nutritional and health benefits, taste and convenience are key drivers to recommending berries to clients, but not being top of mind and lack of nutritional and health knowledge are the key barriers to recommendation. Cost is issue for only small subset of respondents (15%).	• Drive regular communication about specific nutrition and health benefits about berries and remind about taste and convenience cues to foster engagement and drive top of mind awareness necessary to get HCPs more regularly recommending berries. • Aim to include communication around nutrient:cost benefit ratio to help minimise cost as barrier.

HCP knowledge, understanding and recommendation

Learnings	Recommendations
• Dietitians and nutritionists were most likely to be familiar and know specific benefits, while other professional groups, particularly medical, more likely to be generally familiar. • Dietitians and Naturopaths were the most confident with allied health professionals and nurses the least, in talking about nutrition and health benefits of berries. GPs, gym instructors and personal trainers were not far behind top two. • Nearly half (42%) of respondents are not regularly recommending berries to their clients and when they do a mix of berries or blueberries most common, with very few specifically recommending blackberries or raspberries. • Most are not very familiar with growing practices of Australian berries with large proportion (25%) not familiar at all and yearn specifically for information on how growing affects nutritional quality and effects of pesticides .	• Leverage dietitians as KOLs to communicate, educate and influence other HCP groups via their owned communication channels. This is part of current KOL influencer strategy. • Educate around specific differences of berry types to help increase awareness and support specific recommendation of raspberries and blackberries. • Support greater engagement and interest by educating on 'farm to fork' berry story, specifically highlighting any nutritional and health impacts of growing practices including pesticide use.

Other considerations

Learnings	Recommendations
• HCPs currently are largely unaware of any available resources and mostly value simple infographics and fact sheets they can share with clients. • For their own learning and upskilling ,while technical reports and videos are popular, a variety of formats are key to meet the needs of the broader HCP base. • HCPs are most interested in information around managing gut health, inflammation and oxidative stress, immunity, brain health, cardiovascular health and healthy aging which all align with berries benefits. • While nutrition and health information tops the list, inclusion of practical ways to include berries via recipes are key to support resource usage. • Key supporting information to incorporate in resources includes dosage and frequency intake, mechanisms of action, emerging science and growing practices. • While digital is overwhelming preferred, there is still value in resources also available in printed format.	• Continue with original planned range of educational collateral and event activations as they are in line with HCP preferences. • For the 3 x infographics planned for each berry type (Blueberry, raspberry and blackberry), ensure to highlight specific/unique nutritional and/or health benefits, dosage and frequency intake recommendations, mechanism of action, any emerging science and 'farm to fork' journey that covers pesticide usage in Australia and impact on nutrition and health and practical usage ideas with recipe/s. • In line with available science and HCP preferences recommend 6 planned client friendly fact sheets to cover gut health, Immunity, Inflammation & oxidative stress, brain health, cardiovascular health and healthy aging. • As planned, continue with all materials to be available for digital format and small print quantity for key events.

Limitations

Key Limitations

- The number of respondents from any singular health profession, with the exception of dietitian/nutritionist, was small (<60), limiting conclusions by type of HCP.

Conclusions

The key findings

- While HCPs feel confident in talking to berries, this appears to be around generics with many not able to specify specific nutritional and health benefits.
- Differences between berry types is largely unknown, with specific recommendation of raspberries and blackberries suffering accordingly. Most are not very familiar with Australian growing practices and desire specific information on how growing affects nutritional quality and effects of pesticides.
- Nearly half (42%) HCPs are not recommending berries regularly due to it not being top of mind and lacking knowledge of nutrition and health benefits.
- Besides nutrition knowledge, taste and convenience are important attributes to support their recommendation along with client friendly resources for clients that includes practical ways to include, such as recipes.

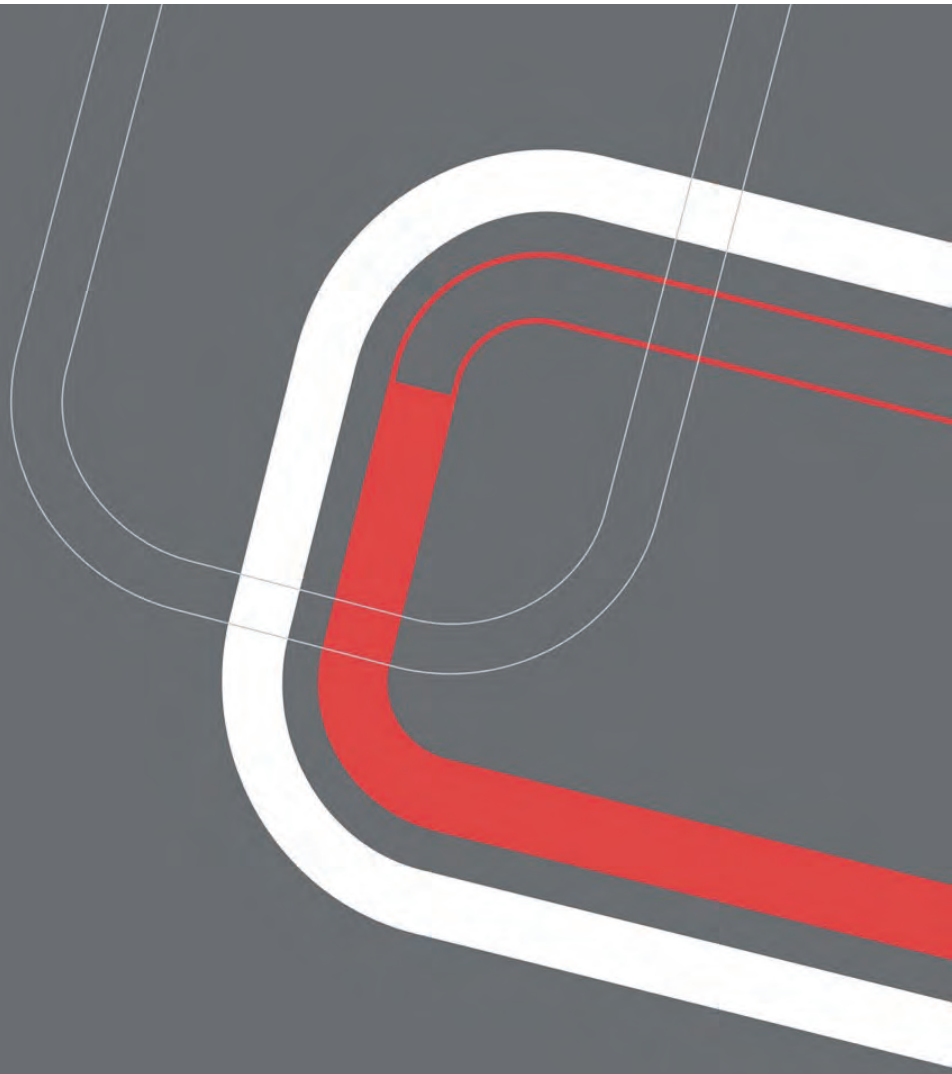
The key recommendations

- Drive regular communication that aims to provide specific nutrition and health benefits about different berry types, reminds about taste and convenience cues and provides practical way to include (recipes) to foster engagement and top of mind awareness necessary to get HCPs regularly recommending berries.
- Support greater engagement and interest by educating on 'farm to fork' berry story, specifically highlighting any nutritional and health impacts of growing practices including pesticide use.

Next Steps

- NRAUS to update the comms plan and key messaging based on these findings.
- NRAUS to update the monitoring and evaluation plan with specific targets based on these findings.

NRAUS



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Thank you

APPENDIX 2

FOODiQ global

MT21000

End of project ASR

March 2024

Background

- **Project code**: MT21000
- **Project name**: Health and nutrition information for the Berry industry
- **Project leader**: Dr Flavia Fayet-Moore
- **Delivery partner**: FOODiQ Global (formerly Nutrition Research Australia)
- **Report author**: FOODiQ Global
- **Contact**: Flávia Fayet-Moore
- flavia@foodiq.global | 0415 990 050

Objectives

1. Help measure the impact of the program on changes in confidence, knowledge and recommendations in those who accessed the program resources, compared to those who did not, with reference to baseline data, where appropriate
2. Gather insights on the current level of knowledge, confidence and recommendations to inform future research.

This report describes the findings from the 2nd market research survey among health professionals (HPs).
It is the 2nd of two market research reports, following on from the baseline data report in July 2022.

Project outcomes

- Target 65% HPs rating themselves as familiar with key nutrition and health benefits of Australian Berries (Baseline 50%).
- Target 10% increase in HPs specifying key nutrient and health benefits Australian Berries as communicated throughout campaign.
- Target 75% HPs rating themselves as ‘very or reasonably’ confident in discussing the nutrient and health benefits of Australian Berries (Baseline 66%).
- Target 70% HPs recommending berries to clients ‘Always or Often’ (Baseline 58%)

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Methods

Approach

A digital recruitment campaign to recruit a minimum of 200 health professionals

- 4 weeks (January 12th to February 12th, 2024).
- across paid social media channels, complemented with organic strategies
- dedicated EDM to berries and FOODiQ Global databases
- promoted with the chance to win 1 of 5 $100 Visa gift cards.

- To be eligible, participants had to reside in Australia, and either be a health professional or studying to become one.

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Results

Survey statistics

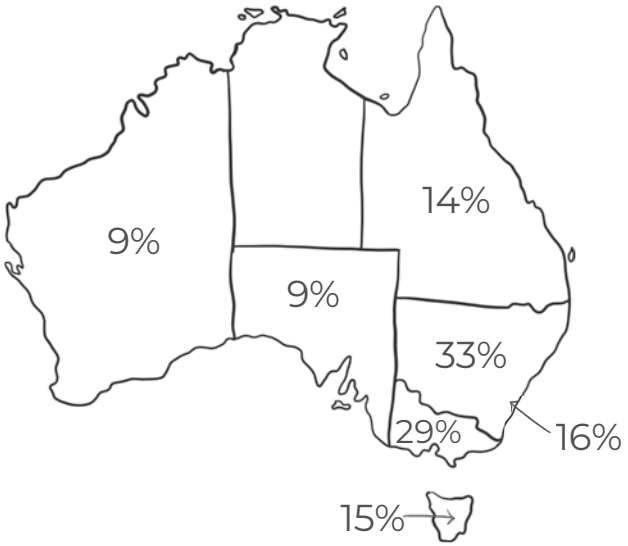
518 surveys completed → 368 eligible

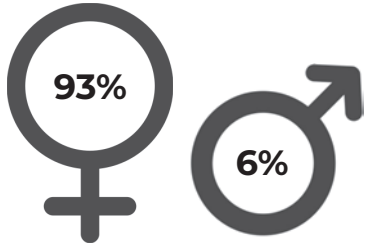
27%	18%	16%	10%	6%	25%
Dietitian	Nutritionist	Nurse	Naturo-path	Drs	Other

83% HPs; 17% students *slightly more students than baseline

31%	28%	16%	25%
Private practice	Clinical	Public Health	Other

29%	27%	19%	11%	10%
25-34	35-44	45-54	55-64	65+





Resource Access & usefulness

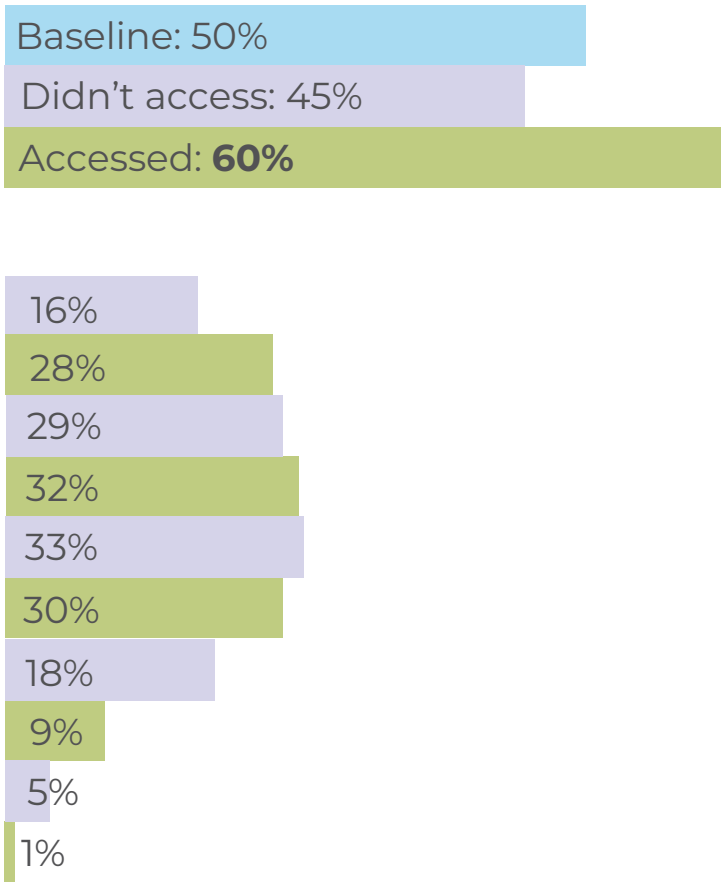
25% of participants had accessed the Berries Hub resources. **Target: 50%**

100% of participants that accessed the FOODiQ Berries Hub resources found them useful. **Target: 80%**

- 52% very useful
- 38% useful
- 10% somewhat useful

Confidence increased with resource access

Confidence in discussing the nutritional benefits of berries.



Target: 75%

Familiarity increased with resource access

Familiarity with the nutritional properties of berries.

familiar or very familiar

Baseline: 50%

Didn't access: 40% (5% very familiar)

Accessed: **69%** (25% very familiar)

Target: 65%

Familiarity with the health properties of berries.

familiar or very familiar

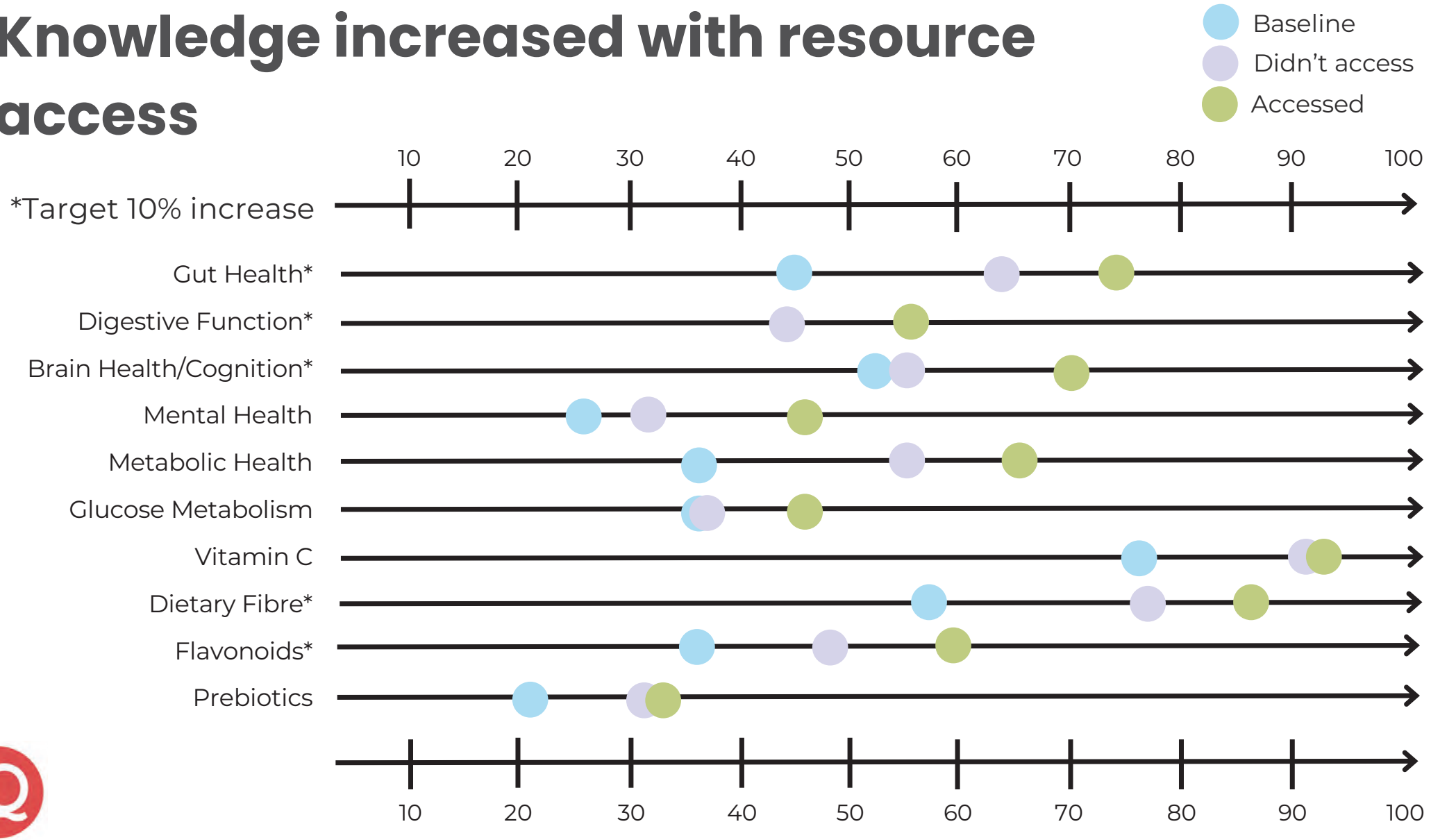
Baseline: 50%

Didn't access: 41% (5% very familiar)

Accessed: **63%** (20% very familiar)

Target: 65%

Knowledge increased with resource access



Frequency of recommending increased

Recommending berries

see clients & always or often recommend

- Baseline: 58%
- Didn't access: 54%
- Accessed: **75%** — **Target 75%**

Reasons Why?

Health benefits

- Didn't access: 61%
- Accessed: 74%

Delicious

- Didn't access: 55%
- Accessed: 62%

Make meals healthier

- Didn't access: 33%
- Accessed: 44%

Reasons Why Not?

Don't think of berries — 13%

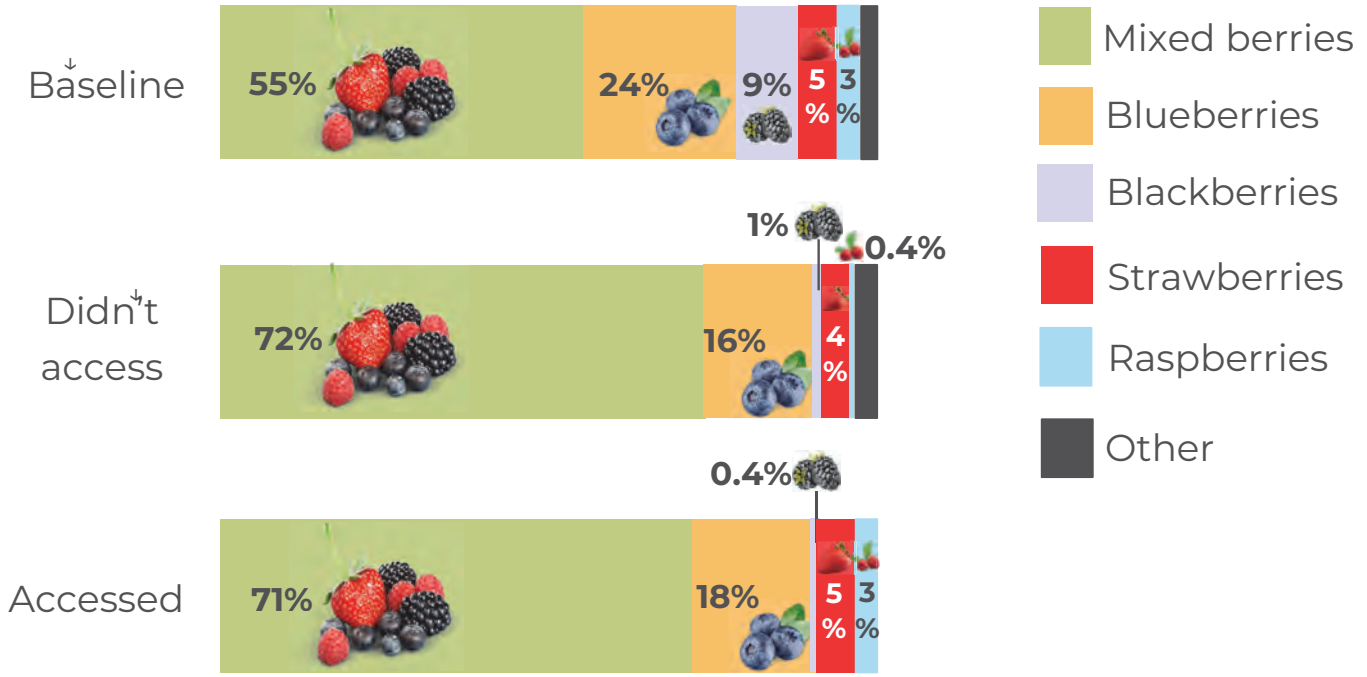
Not familiar enough w/health — 1%

Not familiar enough w/nutrition — 6%

4%

*only 1% of respondents (0 in those who accessed the resources) cited cost as a reason to not recommend berries (compared to 15% at baseline)

Mixed berries are the most common recommendation



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Learnings & recommendations

Survey learnings and recommendations

Learning

- ✓ Participants more diverse in follow-up compared to baseline.
- ✓ Time to complete was >5 mins (target) but did not appear to negatively impact completion rate.
- ✓ Dietitians and nutritionists are most likely to respond (nutrition-focused) but are also most likely to be recommending food/berries. The ratio of dietitians to naturopaths reflects the numbers in practice.
- ✓ Percentage of respondents having accessed the resources was lower than anticipated, limiting opportunities to stratify by profession.

Recommendation

- ✓ Increase recruitment target in follow-up (end of project) relative to baseline recruitment to account for diversity and stratification by accessed vs. did not access.
- ✓ Maintain diverse recruitment techniques for future surveys.
- ✓ Targeted recruitment to match ratios of professions ensures the sample represents the population.
- ✓ Additional survey touch-points at point and time of access may yield additional results. Participants may have accessed the resources, but not recently.

HCP Knowledge & behaviour learnings and recommendations

Learning

- ✓ Resource access appears to have been powerful for changing knowledge, recommendation and confidence, but awareness of the resources was lower than hoped.
- ✓ HP knowledge on the key project education messages increased the most supporting that focused messaging strategy had intended outcome.
- ✓ HPs were almost twice as likely to be confident in recommending berries if they accessed resources.
- ✓ Access to resources & education correlates well with increased recommendations, knowledge and confidence.

Recommendation

- ✓ HP communications benefit from using focused messaging
- ✓ Ongoing continuous HP communication to be maintained to increase reach
- ✓ Resource access improved knowledge and recommendations, but the number of participants who had accessed was lower than expected. Increased dissemination is likely to amplify impact. Housing the same resources in multiple locations could get resources to more stakeholders (e.g. duplicate FOODiQ hub on Berries Australia website.

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Limitations & Considerations

Limitations & Considerations

1. Rebrand (NRAUS to FOODiQ) may have impacted brand recognition of resources in follow-up survey.
2. The number of respondents from singular professions, combined with the lower-than-projected number of participants who had accessed the resources, limited the analysis by type of health profession.
3. The focused (berries for gut-brain health) story appears to have landed with HPs in terms of recommendations increasing but may limit applicability for some HPs looking to address other conditions.

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APPENDIX 3

Berries and Human Health:
A summary of the science

Prepared for:

Hort Innovation- MT21000
September 2022

Prepared by:

Nutrition Research Australia Pty Ltd

Table of contents

Executive Summary

One of the highest dietary sources of polyphenols, berries have an impressive nutrient profile score. There is now compelling evidence for their therapeutic health effects. As part of MT21000, Hort Innovation commissioned NRAUS to undertake a comprehensive review of the literature to investigate the science of Australian Berries (blueberries, strawberries, raspberries and blackberries) and human health. The research will be used to inform key messages in the education campaign.

The methodology

Part 1

We summarised the scientific literature to answer: *What are the effects of Australian berries (strawberries, blueberries, raspberries and blackberries) on human health outcomes?* This included the development and implementation of a systematic search algorithm to identify all systematic literature reviews, randomised controlled trials (RCTs) and cohort studies per health outcome which explored the effect of berries on health. Ten health outcomes were strategically selected based on the quality of literature available, the leading cause of illness or death in Australia, and consumer trends, to ensure project messaging resonates with healthcare professionals.

Part 2

We performed a targeted literature search to gather further evidence to answer the following questions:

- What is the nutritional composition of Australian berries?
- What is the nutrient density to cost ratio of Australian berries?
- How do berry polyphenols impact on gut health and microbiota?
- What are novel uses for Australian berries?
- Does the sustainability of growing practices affect the nutrient composition of berries?
- Does the nutrient composition of Australian berries differ by cooking/processing method?
- What are the consumer trends for Australian berries?

Key findings

Part 1

Berry consumption was associated with positive health effects across 10 health outcomes, and the effects were more pronounced at a daily intake of 125 – 500 g.

- Mixed berry intake reduces total body weight and the risk of all-cause mortality in the long term, and improves total cholesterol (TC), fasting glucose, insulin resistance, and cognitive function in the short term.
- Blueberry intakes reduce total body weight, cognitive decline and risk of type 2 diabetes in the long term, and improves inflammation, reduces oxidative stress post exercise, systolic blood pressure (SBP), high density lipoprotein (HDL) cholesterol, osteoarthritis pain, gestational weight, gestational glucose tolerance and cognitive performance in the short

term. Blueberry intake also improvements in vascular function and exercise induced muscle damage in the short term (acute).

- Strawberry intakes reduce total weight, cognitive decline, risk of coronary heart disease (CHD) and risk of stroke in the long term, and improves vascular function, inflammation, diastolic blood pressure (DBP), oxidised low-density lipoprotein (ox-LDL), malondialehyde, TC, and glucose and insulin responses in postprandial studies in the short term.
- Raspberry intakes improve SBP, inflammation, and glucose and insulin responses in postprandial studies (effects post having a meal) and improves vascular function in the short term.
- Blackberry intakes increase fat oxidation and improves bone density in smokers, insulin resistance, beta-cell functionality, and glucose and insulin responses in postprandial studies.

Part 2

- Berries are low in calories and have a great macro- and micro-nutrient profile (dietary fibre, vitamin C and E, folate, magnesium and manganese), with an abundance of bioactive phytonutrients including anthocyanins, flavanols and phenolic acids, which are mostly retained based on how it is consumed (fresh, frozen, powdered, dried, cooked).
- Growing conditions such as environmental stressors result in more healthful bioactive compounds in berries.
- Berries are more than just fresh snacks or breakfast toppers – they can be freeze dried, processed into jams and juices, used in green salads and more.
- Wastes (from juicing or leaves) can be useful valourisation (given economic value) sources of fibre and bioactive compounds to produce functional foods.

Conclusions

Berries provide unique health benefits that differ between berry type and can be recommended as a healthful dietary modification to increase fruit variety for the general population, elderly, children, and those with type 2 diabetes, risk factors for cardiovascular disease (CVD) and to support exercise recovery. They are low in calories but packed with nutrients and healthful bioactive phytonutrients.

Low doses of berries have been shown to benefit weight outcomes in the general population and pregnancy, reduce risk for CVD, cognitive decline, physical performance and all-cause mortality in longitudinal studies. High level evidence (RCTs) suggests that moderate and high doses (125 – 500 g daily) may reduce risk factors for CVD and type 2 diabetes, improve cognitive functioning and reduce markers of damage following exercise. However, these studies are typically only conducted short term. Results of RCTs are mixed, likely due to diverse doses, timeframes, tests and administration methods used, and populations studied. Research has focused on blueberries and strawberries; further research is needed on raspberries and blackberries, with additional long term prospective cohort studies needed to confirm relationships with long term disease outcomes.

Berries can be added to the diet in a variety of forms (fresh, frozen, powdered, dried, cooked) without dramatical compromising their nutritional content. They can be added as snacks or added to meals. With a range of health outcomes for a range of berries, at achievable intakes, diverse and plentiful enjoyment of berries can be encouraged at a true health food, and without fear of harm.

Background

The brief

Nutrition Research Australia (NRAUS) is the delivery partner for MT21000 Health and Nutrition Information for the Berry Industry, a strategic levy investment under the Hort Innovation blueberry, and raspberry and blackberry funds. As part of MT21000, Hort Innovation commissioned NRAUS to undertake a comprehensive, referenced 'deep dive' literature review to investigate *'What are the health effects of Australian berries (strawberries, blueberries, raspberries and blackberries)?'* The aim of the literature review is to provide an evidence base to inform key messages in the education campaign.

The approach was designed to focus on all high-quality scientific research published, with linkage to Australian growers and international organisations such as the International Blueberry Association. Education materials will look to detail information on research snapshots of health outcome effects, how they are linked to health, dosage and frequency of effect and key reasons that link the nutrient or bioactive content with health benefit.

Research questions

Part 1

- What are the effects of Australian berries (strawberries, blueberries, raspberries and blackberries) on human health outcomes?

Part 2

- What is the nutritional composition of Australian berries?
- What is the nutrient density to cost ratio of Australian berries?
- How do berry polyphenols impact on gut health and microbiota?
- What are novel uses for Australian berries?
- Do growing practices influence the nutrient composition of berries?
- Does the nutrient composition of Australian berries differ by cooking/processing method?
- What are the consumer trends for Australian berries?

Methods

This report has two parts:

1. A summary of the science was undertaken to answer the research questions on page 5. This included the development and implementation of a systematic search algorithm to identify high quality research articles which explored the effect of berries (strawberries, blueberries, raspberries and blackberries) on human health. Detailed methodology is outlined, and findings were reported as key messages to inform the education campaign.
2. A summary of the science was conducted using a targeted literature search to gather any peer-reviewed literature which could answer the specific research questions. Findings were reported narratively.

A summary of overall findings and key messages from this research are then presented.

Part 1

Search strategy

A systematic search strategy was developed for the PubMed database using the key terms listed in **Table 1**. The search was conducted on April 21, 2022, and study types were limited to randomised controlled trials (RCTs), cohort studies, systematic literature reviews (SLRs) of RCTs or cohort studies, and umbrella reviews (i.e., SLR of SLRs).

Table 1. Search terms for the effect of berries on human health outcomes.

INTERVENTION	STUDY DESIGN
Keywords [Title/Abstract]	
Strawberry	Systematic Review [Publication Type]
Strawberries	Review [Publication Type]
Blueberry	Scientific Integrity Review [Publication Type]
Blueberries	Randomised Controlled Trial [Publication Type]
Raspberry	Clinical Trial [Publication Type]
Raspberries	Meta-analysis [Publication Type]
Blackberry	Cohort [Publication Type]
Blackberries	
Berry	
Berries	

Filters
Species: Human
Date: No limits
Final search: 21/04/22

In addition, the following techniques were employed:

- Snowballing techniques within the PubMed database: When a study was identified, the 'relevant titles' listed under each study were screened to check for possible inclusion.
- Targeted searches in Google Scholar: Key terms in **Table 1** were used in an advanced search.
- Berry Health Tool Chest: The Berry Tool Chest is a web-based electronic resource to facilitate Best Research Practices for berry health research (https://berryhealthtoolchest.org/). Berry Health Tool Chest reference lists were screened, and titles assessed for possible inclusion.

Data extraction

Data extracted were study type, berry intervention (dose, duration, delivery), health outcomes measured, population characteristics and key outcome results. Extracted data were synthesised and reported as key messages to inform the education campaign. Extracted data was quality checked for accuracy by a second investigator.

Strength of evidence

When assessing the strength of evidence, we used the highly respected Nutrition Evidence Systematic Review levels of evidence and recommendation grading system (**Table 2**) [1].

Table 2. Nutrition Evidence Systematic Review Grading System

LEVEL	INTERPRETATION
Strong	Evidence is very strong and can be trusted
Moderate	Evidence is strong and can be trusted in most situations
Limited	Evidence provides some support but implement with care
Grade not assigned	Emerging science that must be applied with caution

Part 2

A targeted literature search was undertaken to describe the existing literature, from all sources, to answer the part 2 research questions. Key words relevant to each research question were used and platforms searched included Google Scholar and PubMed databases. Any peer-reviewed article was drawn upon to answer these research questions. No data extraction was performed; instead, key methods and findings were described via narrative synthesis.

Part 1: Results and Key Messages

Search results

The search strategy identified 1373 records, of which 185 studies were relevant for inclusion.

A summary of the number of publications found for each berry type, by study design, are presented in **Table 3**. No umbrella reviews were identified and there were no systematic literature reviews for blackberry and red raspberry.

Table 3. Summary of the number of publications found for each berry type, by study design.

BERRY TYPE	SLR WITH META-ANALYSIS	SLR WITH NARRATIVE SYNTHESIS	NARRATIVE REVIEW	RCT	COHORT	TOTAL
Berries	7	4	26	6	23	**70**
Blackberry				3		**3**
Blueberry	3	3	14	39	1	**61**
Red raspberry			5	5		**10**
Strawberry	2		12	25	2	**41**

Due to the large quantity of data available on the effect of berries on human health, ten health outcomes were strategically selected for data extraction based on the quality of scientific literature available, the leading causes of illness of death in Australia, consumer trends and target audience engagement:

1. Weight management
2. Cardiovascular disease (CVD)
3. CVD risk factors
4. Vascular health
5. Type 2 diabetes (T2DM) and insulin resistance
6. Brain health (e.g., cognitive function, mental health)
7. Inflammation and oxidative stress
8. Exercise performance and recovery
9. Pregnancy and childhood health
10. Ageing health (e.g., physical function, mobility, bone health)

All SLRs for each health outcome were selected for inclusion. If a SLR with meta-analysis or narrative synthesis was available, only additional RCT or cohort data not reported in the SLR were extracted. This led to the inclusion of 59 studies; 2 SLRs with meta-analysis, 48 RCTs and 9 cohort studies (including those with pooled analyses of multiple cohorts).

Weight management

Regular long term berry consumption may help with weight control. Strong quality evidence from epidemiological studies shows that the more fresh berries eaten, the lower the body weight in adults (followed over 24 years). The impact is potentially large, with each daily half cup serve increase in berries (mixed, strawberries and blueberries) associated with a 0.2 – 0.6 kg lower weight at 4-year intervals [2], with additive effects seen with more serves over time.

While reduction of body weight has not been replicated in shorter RCTs (4 weeks to 4 months) even at high doses up to 550 g fresh berry equivalents, positive changes in gut microbiota have been demonstrated. Short term strawberry supplementation in the form of freeze-dried powder (approx. 260 g fresh equivalent) has been demonstrated to increase levels of some gut bacteria linked to weight management, health and longevity, suggesting plausible mechanisms potentially linked to fibre or other components, such as polyphenols modulating microbial populations and functions [3-15]. Importantly, RCTs have not shown increases in weight or other body composition measures (BMI or waist circumference), supporting that berries can be added into the diet without adverse impacts.

The differences in results between long term epidemiological studies and shorter RCTs may be due to short time frames not being long enough to show an effect or the use of freeze-dried berry powders, which may not limit satiety (i.e., fullness) in the same way as whole berries due to their concentrated form. Fruit is relatively low energy and high fibre compared to other potential snack options, which may help people feel fuller for longer, and eat less accordingly. However, berries appear to be even more impactful than other fruit, with blueberries showing the largest effect size. This, along with evidence from RCTs that show changes in gut microbes, suggest that bioactive compounds, unique to berries, particularly flavonoids such as anthocyanins, may have positive impacts on metabolism, potentially via modulation of gut microbes.

Mixed berries

Lower total weight is associated with higher berry (blueberries & strawberries) intake over 4 years

- In a pooled analysis of three prospective cohort studies (n=133,468 adults; 1986-2010; 4-year time intervals), adjusted for other lifestyle factors (i.e., diet, smoking, physical activity) daily berry intake (blueberries and strawberries) was inversely associated with 4-year interval weight change. Effect size per berry serving (half cup) was greater than for fruit [2].
    - For each extra half cup serving of fresh berries consumed daily, weight was reduced by 1.11 lb (equivalent to approx. 0.50 kg; 95% CI -1.45, -0.78 lb).
    - The effect size for berries was greater than the effect size observed for total fruit, where weight was reduced by 0.53 lb (approx. 0.23 kg; 95% CI -0.61, -0.44 lb) for each extra daily serving of total fruits.
- The high fibre and low energy contents of fruits likely explain the relative weight reduction through enhanced satiety and displacement of higher energy foods. However, the enhanced relationship for berries, compared to total fruits, suggests a mechanistic role for bioactive compounds, such as polyphenols, in weight management [2].

No change in BMI or body weight with mixed berry interventions of 4 months or less

- Evidence from meta-analysis of 13 RCTs (including healthy adults and adults with CVD risk factors; n = 498) found supplementation with anthocyanin-rich berries (freeze-dried berry powder/extracts/juice; approx. 200 – 550 g fresh equivalent) for 6 weeks to 4 months had no effect on BMI (WMD = 0.06 kg/m2; 95% CI: −0.03, 0.15 kg/m^2; p = 0.20) [16].
- In an RCT of 5 weeks mixed berry supplementation (450 g/day; n=40; aged 50-70 years; healthy) had no effect on weight (WMD = 0.1kg' p = 0.4) [17].
    - Intervention was a mixed berry beverage (containing 150 g blueberries, 50 g blackcurrant, 50 g elderberries, 50 g lingonberries, 50 g strawberries and 100 g tomatoes), compared to placebo (matched to carbohydrate, pH and volume).

Blueberries

Higher blueberry intake is associated with greater long term weight loss

- In a pooled analysis of three prospective cohort studies (study details above), for each extra half cup serving of blueberries consumed daily, weight was reduced by -1.38lb (approx. 0.63 kg; 95% CI – 1.68, -1.09 lb) [2].
    - The effect size for blueberries was greater than that for mixed berries. Blueberries are particularly high in anthocyanins, compared to other berries. These bioactive compounds may enhance satiety signalling compared to other fruits [2].

No change in BMI with blueberry interventions of 4 months or less

- Evidence from meta-analysis of 7 RCTs (including healthy adults and adults with CVD risk factors; n = 273) found supplementation with blueberries (freeze-dried powder; approx. 200-450 g fresh equivalent) for 6 to 12 weeks had no effect on BMI (WMD = 0.09 kg/m2; 95% CI: −0.18, 0.36 kg/m2; p = 0.52) [16].

Blueberries served with a high carbohydrate meal changes the levels of pancreatic polypeptide

- In a crossover RCT (n=17; healthy adults), a high carbohydrate breakfast meal with 140 g of blueberries or placebo gel (matched for calories, sugars and fibre) increased pancreatic polypeptide levels (a hormone related to appetite levels that increases feelings of fullness) at 30, 60, 90 and 120 minutes after consumption, compared to placebo (P = 0.04) [18].
- Blueberries had no effect on other appetite and satiety hormones (glucagon-like peptide-1 (GLP-1), glucose-dependent insulinotropic peptide (GIP), peptide YY (PYY)) or perceived appetite [18].

Strawberries

Higher strawberry intake is associated with long term weight loss

- In a pooled analysis of three prospective cohort studies (study details above) for each extra half cup serving of strawberries consumed daily, weight was reduced by -0.86 (approx. 0.39 kg; 95% CI -1.41, -0.31 lb) [2].

No short-term effect of strawberry intake on weight loss, BMI or waist circumference

- Evidence from meta-analysis of 8 RCTs (including healthy adults and adults with CVD risk factors; n = 230) found supplementation with strawberries (freeze-dried powder; approx. 200-500 g fresh equivalent) for 8 to 12 weeks had no effect on BMI (WMD = −0.041 kg/m^2, 95% CI: −0.998-0.916; p = 0.9) [19].
- Evidence from meta-analysis of 7 RCTs (including healthy adults and adults with CVD risk factors; n = 170) found supplementation with strawberries (freeze-dried powder; approx. 200-500 g fresh equivalent) for 8 to 12 weeks had no effect on absolute body weight (WMD = −0.070 kg, 95% CI: −1.876-1.735; p = 0.9) or waist circumference (WMD = 0.159 cm, 95% CI: −0.911-1.230; p = 0.8) [19].
- In a parallel RCT (n=15; healthy adults) 4 weeks of freeze-dried strawberry powder (approx. 260 g fresh equivalent) followed by a 2-week washout (no supplementation) had no effect on weight [20].
    - At week 4, there were significant changes in the abundance some "good" gut microbes (*C. Christensenellaceae, C. Mogibacteriacea, V. Verrucomicrobiaceae*, *B. Bifidobacterium, B. Bacteroidaceae*) which have been inversely associated with obesity and metabolic disease, and positively associated with health and longevity [20]. These changes reversed after the supplementation was stopped.

Raspberries

No short term effect of raspberries on BMI, waist circumference or body weight

- In a parallel RCT (n=59; overweight or abdominal obesity with hyperinsulinemia or hyperlipidaemia) 280 g of frozen raspberries daily for 8 weeks had no effect on BMI, waist circumference or body weight, compared to normal diet control group [21].

Blackberries

No data available.

Evidence-based messages

- There is strong prospective evidence for a beneficial dose-dependent relationship between daily berry intake (strawberries and blueberries) and lower total weight over 4 years.
    - For each half cup serving of fresh berries daily, total weight was reduced by 500 g.
    - For each half cup serving of fresh blueberries, total weight was reduced by 630 g.
    - For each half cup serving of fresh strawberries, total weight was reduced by 390 g.
- There is strong evidence that short term berry supplementation (200 – 500 g; mixed berries, blueberries, strawberries and raspberries; < 4 months) has no effect on weight management.
- There is limited evidence that blueberries (140 g) served with a high carbohydrate breakfast meal may increase pancreatic polypeptide levels (hormone that increases feeling of fullness) up to 2 hours after consumption.
- Overall, the evidence suggests effects on weight may only be applicable in the longer term, with shorter RCTs showing no effect on body weight but positive effects on gut microbiota.

Cardiovascular disease risk

Limited evidence shows that higher intake of strawberries (>18 g/day) in the general population, particularly in women, is associated with a 32% lower risk of coronary heart disease (CHD) and stroke. Mixed berry intake was not related to the risk of CVD mortality.

The evidence is limited to mixed berries and strawberries, and to cohort studies due to the long-term timeline of disease progression. More research is needed to understand the differential benefits of berry types and to clarify dose. Mechanisms of action may include micronutrients with antioxidant function, bioactives, fibre and low energy contents. Berry consumption may also be a marker of healthy diet and/or lifestyle choices.

Note: CVD incidence and deaths with long term development of risk – this means large numbers are required for statistical studies. Even in long term prospective studies dietary data collection is representative of fixed points in time. Separating berries in general, and specific berries from other fruits can be difficult. Studies have been conducted in diverse populations (UK, Japan, Scandinavia) but remain limited. CVD is a diverse set of diseases and complicates estimates.

Mixed berries

No association between mixed berries and CVD mortality (CHD or stroke) in UK women

- In a large UK prospective study (n=30,458 women) total fruit intake was associated with lower risk of CVD and CHD mortality (6-7 % reduction in risk for each 80 g/day fruit portion consumed), but specific fruit types including berries, had no significant effect [22].

Strawberries

Lower risk of CHD with higher strawberry intake

- In a large prospective cohort study (n=87,177; aged 44-75 years; Japan; free of CVD & cancer at baseline) risk of CHD was reduced by 32% in those with the highest quintile of strawberry consumption (18 g/day), compared to the lowest (0 g/day; HR = 0.68, 0.58-0.81) in age adjusted models [23].
- No effect was found in models adjusted for study areas, sex, occupation, BMI, use of medication for hypertension and hypercholesterolaemia, history of diabetes, smoking status, alcohol use, physical exercise, coffee intake, green tea intake, and quintile intakes of total energy, seafood, red meat, processed meat, milk, soya foods, vegetables and other fruits [23].
- Findings may indicate that berry consumption is a marker of healthy diets and lifestyles, or that a threshold effect exists that means the impacts of berries are stronger in poorer quality diets or lifestyles [23].

Lower risk of stroke with higher strawberry intake in woman

- In the same Japanese cohort described above, strawberries were associated with a 32% lower risk of stroke in women (HR = 0.68; 95 % CI 0.59-0.79; 27 g/day compared to 0 g/day), but not in men (HR = 0.84; 95 % CI 0.69-1.02; 27 g/day compared to 0 g/day) [24].

Blueberries, Raspberries and Blackberries

No data available.

Evidence-based messages

- Research is limited to a few population-based epidemiological studies due to the long-term timeline of disease progression.
- There is limited epidemiological evidence that strawberries (> 18 g per day) may reduce the risk of CHD and stroke by 32% in the general population, particularly women.
- There is limited epidemiological evidence that mixed berries have no association with CVD or CHD mortality.
- Mechanisms of action may include micronutrients with antioxidant function, bioactives, fibre and low energy contents.
- No evidence for blueberries, raspberries or blackberries has been published.

Risk factors for Cardiovascular Disease

The CVD risk factors summarised in this section include: total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), oxidised-LDL (ox-LDL), triglycerides (TG), systolic and diastolic blood pressure (CSBP & DBP).

Strong evidence from RCTs (including meta-analyses) shows that moderate to high mixed berry consumption (15 – 430 g per day) may lower TC (by up to 4.5 mg/dL) and LDL-C levels (by up to 3.3 mg/dL), but had no effect on HDL-C, TG or blood pressure [16]. Blueberries (110 – 450 g per day) may improve HDL levels by 1.5mg/dL [16], but had no effect on other lipid levels or blood pressure, other than attenuating the rise in SBP caused by smoking [25]. Short term strawberry supplementation (250 – 500 g per day) may improve TC (6.5 mg/dL reduction), ox-LDL (5.8 ng ml^{-1} reduction), TG levels (5.322 mg dL reduction) and DBP (2.22 mmHg reduction) [19, 26]. Regular raspberry intake (400 g per day) in patients with type 2 diabetes may reduce SBP by 10 mm Hg. While blackberries had no effect on lipids or blood pressure, but did increase fat oxidation by 6.5% [27]. The magnitude of changes seen for blood pressure and blood lipids are clinically relevant.

However, these positive findings are mixed with multiple null results, which may indicate that berry variety, diversity and/or regular long-term consumption is needed for benefits. As data only exist from short term RCTs, further epidemiological research studies are required to fully understand the relationships between berry type and CVD risk factors. Importantly, there is no evidence that regular berry consumption does harm regarding CVD risk factors. Modulation may occur through (i) the impacts of fibre on cholesterol absorption and acting as a satiety trigger (leading to improved weight management), and (ii) bioactive compounds, such as polyphenols, which may act on gut microbiota or vascular function.

Mixed berries

Mixed berry intake may reduce TC but has no effect on LDL-C and HDL-C

- Pooled RCT evidence found short term supplementation (3 weeks – 6 months) with anthocyanin-rich berries (15 – 430 g fresh per day) reduced TC by -4.48 mg/dL (WMD -4.48 mg/dL; 95% CI: -8.94 to -0.02; 20 RCTs, n=895), but had no effect on LDL-C (WMD -3.34 mg/dL; 95% CI: -7.39 to 0.71; 14 RCTs, n=620) or HDL-C levels (WMD 0.5 mg/dL; 95% CI: -0.64 to 1.65; 14 RCTs, n=620), compared to controls [16].
    - Effects were greater in adults at high risk of developing CVD (WMD -6.09 mg/dL; 95% CI: −11.09, −1.08) [16].
    - Treatments included anthocyanin-rich berry powders, extracts, juices and fresh berries (types not specified) [16].
    - Effects were not influenced by study duration, health status of participants, anthocyanin dose, study quality or funding source [16].
- In a RCT (n=40; 50-70 years), short term supplementation (5 weeks) with a mixed berry beverage (150 g blueberries, 50 g blackcurrant, 50 g elderberries, 50 g lingonberries, 50 g strawberries and 100 g tomatoes) reduced TC levels by 3.4% (p=0.004) and LDL-C levels by 4.6% (p=0.006), compared to placebo [17].
    - No effect was found on HDL-C and ox-LDL levels [17].
    - In a RCT (n=32; mean age 53 years; participants abdominal obese and majority slightly dyslipidemic and hypertensive), 12-week supplementation with mixed berries (300 g = 100 g

strawberry purée, 100 g frozen raspberries, 100 g frozen cloudberries) had no effect on blood lipid profiles, compared to control group asked to restrict berries for 12 weeks [28].

No short-term effect of mixed berries on blood pressure

- In a RCT (n=32; mean age 53 years), supplementation (12 weeks) with mixed berries (details above) had no effect on SBP or DBP [28].
- Evidence from 20 RCTs (n=883) found short-term supplementation (3 weeks - 6 months) with anthocyanin-rich berries (95-430g fresh per day) had no effect on SBP (WMD -0.65 mmHg; 95% CI: −1.82 to 0.53) or DBP (WMD = −0.96 mmHg; 95% CI: −2.13 to 0.21), when compared to controls [16].
- Treatments included anthocyanin-rich berry powders, extracts, juices and fresh berries [16].
- Effects were not influenced by study duration, health status of participants, anthocyanin dose, study quality or funding source [16].

No short-term effect of mixed berries on TG

- Evidence from 20 RCTs (n=895) found short term supplementation (3 weeks - 6 months) with anthocyanin-rich berries (15 – 430g fresh per day) had no effect on TG levels (WMD −6.02 mg/dL, 95% CI: -0.37 to 12.40), compared to controls [16].
- Treatments included anthocyanin-rich berry powders, extracts, juices and fresh berries [16].
- Effects on TG levels were not influenced by study duration, health status of subjects, anthocyanin doses, study quality, and funding source [16].

Blueberries

No short-term effect of blueberries on blood pressure

- Evidence from 11 RCTs (n=456) found short term supplementation (3 weeks - 6 months) with anthocyanin-rich blueberries (110 – 430g fresh equivalent per day) had no effect on SBP (WMD= 0.78 mmHg; 95% CI -0.44, 2.00; p = 0.2) or DBP (WMD= -1.16 mmHg; 95% CI -2.61, 0.29; p = 0.2) [16].
- Treatments included freeze-dried blueberry powder & fresh berries [16].

No acute effect of blueberries on blood pressure

- In a crossover RCT (n=21 males), acute consumption of a blueberry drink (240 – 560 g fresh equivalent) showed no effect on SBP or DP, compared to a nutrient-matched control drink (0 mg total blueberry polyphenols) [29].
- In a crossover RCT (n=12; males), 300g blueberries compared to water with sugar showed no effect on SBP or DBP [30].
- In a parallel double blind RCT (n=45; mean age 63 years; metabolic syndrome), consumption of an energy dense beverage either with or without freeze-dried blueberries (150g fresh equivalent), showed no effects on SBP or DBP over 24 hours [31].

Blueberries counteract the rise in SBP but not DBP or heart rate triggered by smoking

- In a crossover RCT of male smokers (n=16; 20-30 years), blueberry consumption attenuated the rise in SBP induced by smoking (+8.48±0.02% rise in the smoking with 300 g blueberries

group vs 13.1±0.02% in the smoking only and 13% smoking control (water and sugar) group; p = 0.008 and 0.01, respectively) [25].

- No effect was observed after blueberry intake for DBP among the three treatments [25].

No effect of blueberries on TC, TG or LDL-C, but increased HDL-C

- Evidence from 7 RCTs (n=309 adults) found short term supplementation (4 weeks - 6 months) with blueberries (110 – 430 g fresh equivalent per day) increased HDL-C (WMD= 1.46 mg/dL, 95% CI: 0.20, 2.72 mg/dL), but had no effect on TC (WMD= 0.43mg/dL, 95% CI: -5.00, 5.85 mg/dL) or LDL-C (WMD= -3.34 mg/dL; 95% CI: −7.39, 0.71 mg/dL), compared to controls [16].
- Evidence from 8 RCTs (n=353 adults) found short term supplementation (4 weeks - 6 months) with blueberries (110 – 430 g fresh equivalent per day) had no effect TG (WMD= 9.06mg/dL, 95% CI: -0.87, 19.00 mg/dL), compared to controls [16].
- Treatments included freeze-dried blueberry powders & fresh berries [16].
- Participants included healthy, obese, and/or with risk factors for CVD [16].

Strawberries

Short term strawberry supplementation improves DBP but not SBP

- Evidence from 11 RCTs (n=272 adults; including healthy, obese, metabolic syndrome and/or with risk factors for CVD) found short term supplementation (4 weeks – 12 weeks) with strawberries (250 – 500g fresh equivalent per day) improved DBP only (WMD= −2.22 mmHg, 95% CI: −4.26, −0.18), compared to controls [19].
    - Subgroup analyses found DBP decreased with supplementation for more than 12 weeks (WMD -2.15, 95% CI -3.82, -0.47), at doses of ≥ 50g freeze-dried strawberries (500 g fresh equivalent; WMD -1.99 mmHg, 95% CI -3.37, -0.61) and in dyslipidemia subjects (WMD -1.79 mmHg, 95% CI –3.23, -0.35) [19].
- In a parallel RCT (n=28; male adolescents), supplementation with freeze-dried strawberry powder (500g fresh equivalent) for 1 week showed no acute or short-term effects on blood pressure, compared to isocaloric control powder [32].

Short term strawberry supplementation improves ox-LDL, malondialdehyde and TC, but had no effect on LDL-C, HDL-C or TG levels

- Evidence from 4 RCTs (n=86 adults with risk factors for CVD) found short term supplementation (4 weeks – 12 weeks) with freeze-dried strawberries (250 – 500 g fresh equivalent per day) improves malondialdehyde levels (a marker of lipid peroxidation) (WMD= 0.309 µmol L^{-1}, 95% CI -0.50, -0.118) and ox-LDL (linked to atherosclerosis risk) (WMD = −5.8 ng ml^{-1}, 95% CI: −10.34, −1.26; 3 RCTs n=56), compared to controls [19].
- Evidence from 15 RCTs (n=326 adults with risk factors for CVD) found short term supplementation (4 weeks – 12 weeks) with freeze-dried strawberries (250 – 500 g fresh equivalent per day) reduced TC (WMD = −6.49 mg dL^{-1}; 95% CI: −11.91, −1.074), compared to controls. There was no effect on LDL-C, HDL-C or TG, compared to controls [19].
    - TC was improved among adults with baseline levels >5 mmol/l (WMD= −0·52 mmol/l; 95% CI −0·88, −0.15) [19].

- However, high dose of ≥50 g day of strawberry supplementation (500 g fresh equivalent) improved LDL-C (WMD= -1.84; 95% CI -7.25, 3.56) and TG (WMD = -5.322; 95% CI= -9.950, -0.694) [19].
- Meta-regression analysis showed a linear relationship between strawberry dose and the absolute changes in TG levels (p = 0.041) [19].

Acute strawberry supplementation reduces ox-LDL after a high fat meal, but had no effect on TG

- In a RCT (n=31 adults), freeze-dried strawberry powder (250 g fresh equivalent) with a high fat meal showed no effect on ox-LDL or TG levels after 0.5, 1, 2 or 4 hours, compared to the meal only control [33].
- In a RCT (n=21 adults), strawberry powder beverage (100g, 200g or 400g) with a high fat meal revealed a significant reduction in baseline normalised ox-LDL after the 200 g dose (-3.0 ± 0.8 U/L) and the 400 g dose (–0.7 ± 0.8 U/L) compared to the no strawberry group [26].

Raspberries

Acute raspberry supplementation had no effect SBP or DBP

- In a crossover RCT (n=10 males), 400 g of raspberries blended in water had no acute effect on SBP or DBP, compared to an isocaloric, micro- and macronutrient matched control drink [34].

Short term raspberry supplementation may reduce SBP but not DBP

- In a crossover RCT of adults with type 2 diabetes (n=21), acute raspberry supplement phase (meal with or without 250 g raspberries), followed by a one-week washout, followed by a 4-week supplement phase with 250 g raspberries daily, or control diet with no raspberries, found SBP was reduced after 4 weeks of supplementation (144±7 vs 154±7 mmHg; $p < 0.001$), compared to the control [35].
  - No effect on DBP was observed (84.5±5 vs 88±6 mmHg; $p>0.05$) [35].
- In a parallel RCT (n=59; overweight/obesity with hyperinsulinemia or hyperlipidaemia), 280 g raspberries daily for 8 weeks found no changes in blood pressure [21].

Blackberries

Short term blackberry supplementation does not impact blood lipid profiles or blood pressure

- In a parallel RCT (n=72 dyslipidemic adults), 300mL of blackberry juice with pulp for 8 weeks had no effect on SBP, DBP, TC, TG, LDL, compared to usual diet [36].

Short term blackberry supplementation had no effect TG, but increased fat oxidation

- In a RCT (n=24, mean age 54 years), supplementation of 600 g blackberries per day for 1-week had no effect on TG levels (mean difference -0.0004 mg/dL, 95% CI −0.0011, 0.0003) but increased fat oxidation at 24 hours as measure via calorimetry (mean difference 8.47 g, 95% CI -0.35, 16.59), compared to an isocaloric flavoured gelatin control [27].

Evidence-based messages

- Strong evidence that short term mixed berry supplementation (3 weeks – 6 months; 15 – 430 g per day) reduces TC by 4.48 mg/dL, but had no effect on LDL-C, HDL-C, TG or blood pressure.
- Strong evidence that acute and short-term blueberry supplementation (single dose – 6 months; 15 – 560 g per day) has no effect on blood pressure, but may counteract the rise in SBP induced by smoking and increase HDL-C.
- Strong evidence that short term strawberry supplementation (4 – 12 weeks; 250 – 500 g per day) improves DBP, ox-LDL, malondialdehyde and TC in people with metabolic syndrome and/or risk factors for CVD, but had no effect on SBP, LDL-C, HDL-C and TG.
- Strong evidence for a linear relationship between strawberry dose and the absolute changes in TG levels.
- Emerging evidence that short term raspberry supplementation (4 weeks; 250 g daily) reduces SBP by 6.5% but had no effect on DBP or acute blood pressure.
- Emerging evidence that short term blackberry supplementation has no effect on blood lipid profiles or blood pressure (300 mL juice for 8 weeks) but increases fat oxidation (600 g daily for 1 week).
- Evidence only exists from short term RCTs, thus further epidemiological research studies are required to fully understand the relationships between berry type and CVD risk factors.
- Mechanisms of action may occur through (i) the impacts of fibre on cholesterol absorption and acting as a satiety trigger (leading to improved weight management), and (ii) bioactive compounds, such as polyphenols, which may act on gut microbiota or vascular function.

Vascular health

There is strong evidence that moderate to high berry consumption (240 – 560 g in single doses or daily) has positive effects on vascular function in the general population, smokers and those with CVD risk factors. There is evidence that flow mediated dilation (FMD) & reactive hyperemia index (RHI) responses are acutely improved by high blueberry intake (300 g), but not low doses of blueberries (150 – 250 g), and high raspberry intake (400 g). Data for strawberries suggests that responses are varied and may depend on other underlying characteristics of participants. The diversity in study design and tests acting as markers of vascular function explain some of the inconsistency in results.

The observed changes in vascular health are linked to changes in levels of polyphenol metabolites (vanillic acid, ellagic acid, urolithin A-3-glucuronide and urolithin A-sulfate), plasma nitrate/nitrite levels and markers of DNA damage, which suggests an active role for bioactive compounds.

Mixed berries

Short term mixed berry supplementation does not influence vascular function

- Evidence from 6 RCTs (n=263 adults; healthy, obese, and/or with risk factors for CVD) showed short term supplementation (3 weeks – 6 months) with anthocyanin-rich berries (95 – 430 g fresh equivalent per day; type not reported) found no change in flow mediated dilation (WMD: 1.20 %, 95% CI: −0.21, 2.60 %) [16].

Blueberries

Acute blueberry supplementation improves some features of vascular function

- In a parallel RCT (n=21 males), consumption of a blueberry drink (240 – 560 g) improved FMD one hour after drinking in a dose dependent manner, compared to a nutrient-matched control drink (0 mg total blueberry polyphenols) [29].
    - For each 60 g of fresh equivalent blueberry consumed, FMD improved by 0.5% [29].
    - FMD was increased compared to the control (2.4 ± 0.5%; $p < 0.01$) and remained elevated compared to control at two (1.5 ± 0.4%; $p < 0.01$) and six hours (1.2 ± 0.6%; $p < 0.01$) [29].
    - The plasma metabolites vanillic acid ($R^2 = 0.25$ for the model, $P = 0.02$) and benzoic acid ($R^2 = 0.25$ for the model, $p = 0.04$) predicted the magnitude of FMD increase at one and two hours, suggesting that these metabolites may be, at least in part, involved in mediating the observed increases in endothelium-dependent vascular function between one to two hours [29].
    - No differences were found in pulse wave velocity, augmentation index, DVP stiffness index or DVP reflexion index between treatment and control groups [29].
- In a crossover RCT (n=10 males; mean age 20.8 years), eating 300g of blended blueberries reduced H_2O_2 DNA damage (-18%; $p < 0.01$) 1 hour after consumption compared to the isocaloric, sugar and colour matched control jelly [37].
    - Other markers of vascular function (plasma nitric oxide, peripheral arterial function) were unchanged [37].
- In a crossover RCT (n=16 male smokers; 20-30 years), 300g blueberries attenuated the vascular disfunction induced by smoking [25].

    - Blueberry consumption counteracted the impairment of endothelial function (RHI) induced by smoking (−4.4 ± 0.8% blueberry treatment *vs.* −22.0 ± 1.1% smoking treatment, $p < 0.01$), Framingham reactive hyperemia (+28.3 ± 19.2% blueberry treatment *vs.* −42.8 ± 20.0% smoking treatment, $p < 0.001$), and the increase of SBP (+8.4 ± 0.02% blueberry treatment *vs.* +13.1 ± 0.02% smoking treatment, mmHg, $p < 0.05$) after cigarette smoking [25].
    - No effect was observed for arterial stiffness (a determinant of pulse pressure and elasticity of the blood vessels) [25].
    - Groups were: (i) smoking only (single cigarette challenge), (ii) smoking with blueberries and (iii) smoking with control (300 mL water and sugar) [25].
- In a crossover RCT (n=12 males; 20-30 years), acute supplementation (single dose) with 300g of blueberries improved endothelial function (measured as RHI) in young smokers and non-smokers with endothelial dysfunction [30].
    - In smokers, mean percentage change pre- to post-treatment was +8.38% (95% CI: −4.57%, +21.3%) following the smoking treatment, +34.6% (95% CI: +10.6%, +58.7%) following the control plus smoking treatment and +35.2% (95% CI: +20.2%, +50.3%) following the blueberry plus smoking treatment (p = 0.02) for RHI. In post-hoc analyses, a single serving of blueberry reversed the impairment of RHI when compared to the smoking only treatment group (p = 0.023; data not reported) [30].
    - In non-smokers, mean percentage change pre- to post-treatment was +54.8% (95% CI: +37.9%, +71.7%) following blueberry treatment, compared to control (28.2%; 95% CI: +11.5%, +44.9%; p = 0.01) [30]. 83% of non-smokers reversed their RHI impairment following blueberry treatment, compared to 58% following control treatment [30].
    - No effect was observed for markers of arterial stiffness or heart rate [30].
- In a parallel RCT (n=20), acute blueberry supplementation (single dose 250g) had no effect on ACE enzyme activity, compared to placebo [38].
- In a parallel double blind RCT (n=45; mean age 63 years; metabolic syndrome), an energy dense beverage with freeze-dried blueberries (150g fresh equivalent) had no effect on FMD, PWV or Aix over 24 hours [31].

Short term blueberry supplementation does not improve vascular function

- Evidence from three RCTs (n=15 adults; including healthy or with risk factors for CVD) showed that short-term supplementation (4 weeks - 6 months) with blueberries (95 – 230 g fresh equivalent per day) does not influence FMD (WMD = 1.10 %, 95% CI: −0.83, 3.04) [16].
- In a parallel RCT (n=25), 6 weeks supplementation with blueberries powder (250 g fresh equivalent) reduced augmentation index (AIx) (14.66 +/- 13.8 m/s^2 vs. 24.58+/-10.15 m/s^2) but had no effect on FMD, compared to placebo powder [39].
- In a parallel RCT (n=20), 3 weeks supplementation (250 g per day) did not change ACE enzyme activity, compared to placebo powder [38].

Strawberries

Incorporating freeze-dried strawberry powder into a high-fat meal does not alter postprandial vascular function

- In a RCT (n=30 adults) testing a high fat meal with strawberry powder (400 g fresh equivalent) compared to a control meal (no strawberry powder) found no differences in central arterial pressures, wave characteristics (augmentation pression and augmentation index normalised to heart rate) or pulse wave velocity after 30 mins, 1, 2 or 4 hours [33].

Short term strawberry supplementation improves vascular function

- In a RCT (n=28 male adolescents), supplementation with freeze-dried strawberry powder (500 g fresh equivalent) for one week improved vascular function, compared to isocaloric control powder [32].
    - Acute plasma nitrate/nitrite levels after one week were higher in the strawberry group, compared to control (mean difference 0.89; 95 % CI 0.01, 0.17; p<0.001) [32].
    - For those individuals where fasting nitrate levels increased after short-term freeze-dried strawberry powder intake compared to controls, an increase in RHI was observed (p=0.014), whereas RHI was unchanged in those individuals who did not have a significant increase in nitrate (p=0.396) [32].
    - There was no main or interaction effect of treatment on the RHI or the Framingham RHI (fRHI) [32].
    - Data suggests strawberries can provide vascular health benefits to heavier adolescent males [32].

Raspberries

Acute raspberry supplementation improves vascular function

- In a RCT (n=10; healthy males), drinking 400 g raspberries blended in water, or 200 g raspberries blended in water with fibre and vitamin C added to match the 400 g drink, both improved FMD at 2 hours (400 g drink: 1.6%; 95%CI 1.2, 1.9; 200 g drink: 1.2%; 95% CI 0.8, 1.5) and 24 hours (400 g drink: 1.0%; 95% CI 0.6, 1.2; 200 g drink: 0.7%; 95%CI 0.2, 0.9) post-consumption, compared to an isocaloric, nutrient matched control [34].
    - Raspberry polyphenol metabolites were analysed in plasma and urine [34].
    - Plasma ellagic acid, urolithin A-3-glucuronide and urolithin A-sulfate correlated with the improvements in FMD at 2- and 24-hours post-consumption, respectively (p<0.05) [34].
    - No changes were found in central arterial blood pressure, pulse wave velocity or aortic augmentation index [34].

Blackberries

No data available.

Evidence-based messages

- Strong evidence that acute blueberry intake (240 – 560 g) improves vascular function via increased FMD, reduced H_2O_2 DNA damage, improved endothelial function and attenuating the vascular disfunction induced by smoking**.**
- Moderate evidence that short term blueberry supplementation (3 weeks – 6 months; 95 – 250 g per day) has no effect on vascular function.
- Emerging evidence that short term strawberry supplementation (500 g fresh equivalent for 1 week daily), and acute raspberry supplementation (400 g single dose) improves vascular function in males.
- The diversity in study design and tests acting as markers of vascular function explain some of the inconsistency in results.
- Mechanisms that may explain the observed changes in vascular health are linked to changes in levels of polyphenol metabolites (vanillic acid, ellagic acid, urolithin A-3-glucuronide and urolithin A-sulfate), plasma nitrate/nitrite levels and markers of DNA damage, which suggests an active role for bioactive compounds.
- No evidence for blackberries has been published.

Type 2 diabetes & insulin resistance

Moderate evidence suggests higher blueberry intake (≥ 3 serves per week) is associated with a 26% reduced risk of type 2 diabetes in the general population. For other berries (strawberries, raspberries and blackberries), moderate evidence supports a relationship between berry intake (≥ 250 g for each) and modulation of glucose and insulin responses in post-prandial studies. Long term epidemiological studies are needed to determine the role of berries in the prevention of type 2 diabetes. However, regular modulation of post-prandial responses may have additive consequences in the long-term. Impacts are likely linked to weight modulation, and impacts of polyphenols and other bioactives.

Mixed Berries

Short term mixed berry supplementation improves glucose control

- In an RCT (n=40; aged 50-70 years; healthy) short-term supplementation (5 weeks) with a mixed berry beverage (150 g blueberries, 50 g blackcurrant, 50 g elderberries, 50 g lingonberries, 50 g strawberries and 100 g tomatoes) reduced fasting blood glucose levels by 18% (32.4± 2.7 vs 39.2±3.6) and HOMA-IR by 19% (1.3±0.1 vs. 1.6±0.2), compared to control (matched to carbohydrate, pH and volume) [17].

Blueberries

Higher blueberry intake is associated with a reduced risk for type 2 diabetes

- Pooled analysis from three prospective cohort studies (n=952,382; commenced in 1976, 1986 and 1989 with dietary information collected every 4 years; total of 3,464,641 person years follow up) found blueberries reduced the risk of type 2 diabetes by 26% for every 3 serves per week (serve size not defined) (HR 0.74; 95% CI 0.66, 0.83) [40].
    - Blueberries were the fruit that provided the largest reduction in risk for type 2 diabetes [40] .
    - Reductions in risk for other fruits were: whole fruit (HR 0.98; 95% CI 0.96, 0.99), grapes and raisins (HR 0.88; 95% CI 0.83, 0.93), prunes (HR 0.89; 95% CI 0.79, 1.01), apples and pears (HR 0.93; 95% CI 0.90, 0.96), bananas (HR 0.95; 95% CI 0.91, 0.98), oranges (HR 0.99; 95% CI 0.95, 1.03), strawberries (HR 1.03; 95% CI 0.96, 1.10) [40].

No short-term effect of blueberry supplementation on blood glucose or insulin levels

- Evidence from 6 RCTs (n=175 adults; including healthy and/or with risk factors for CVD and/or insulin resistance) found 4 – 8 week supplementation with blueberries (215 g – 430 g fresh equivalent) had no effect on blood glucose (MD 0.00 mmol/l; 95% CI −0.17, 0.17) or fasting insulin (MD -5.49 pmol/l; 95% CI −12.35, 1.36) [41].
- In a parallel RCT (n=115; overweight/obese males, mean age 63 years), consumption of blueberries (5-150 g fresh equivalent) daily for 6 months had no effect on HOMA-IR, compared to placebo [42].

Blueberry supplementation may influence blood glucose responses over 24 hours

- In a crossover RCT (n=17; young males, mean age 24 years), supplementation with blueberry powder (235 – 555 g fresh equivalents) in a 500 mL beverage containing both sugar matched

controls and no added sugar forms, had no effect on blood glucose curves (area under the curve) of the sugar containing drinks nor the timing of peak glucose levels for 2.5 hours post ingestion [43].

- In a crossover RCT (n=17; adults), a high carbohydrate breakfast treated with 140 g of blueberries had no effect on glucose and insulin responses when monitored post-prandially for 2 hours, compared to a placebo gel matched for calories, sugars and fibre [18].
- In a parallel double blind RCT (n=45; mean age 63 years; metabolic syndrome), drinking an energy dense beverage with freeze-dried blueberries (150 g fresh equivalent) favourably affected glucose and insulin concentrations over 24 hours post meal, compared to control [31].
    - After a transient higher peak glucose concentration at 1 h after blueberry intake (8.2 mmol/L, 95% CI: 7.7, 8.8 vs placebo 6.9 mmol/L, 95% CI: 6.4, 7.4), blueberries significantly attenuated 3 h glucose (4.3 mmol/L, 95% CI: 3.8, 4.8 vs placebo 5.1 mmol/L, 95% CI: 4.6, 5.6) and insulin concentrations (blueberry: 23.4 pmol/L, 95% CI: 15.4, 31.3 vs placebo 52.9 pmol/L, 95%CI: 41.0, 64.8) [31].

Strawberries

Acute strawberry intake improves post meal insulin responses

- In a crossover RCT (n=24; overweight adults), a high-carbohydrate, moderate-fat meal accompanied by either a strawberry (340 g fresh equivalent) or an isocaloric placebo beverage showed that the strawberry group had a reduced postprandial insulin response compared to the control group at 6 hours (402.8 ±13.9 vs 458.4 ± 13.9 pmol/L) [44].
    - Blood glucose levels were similar between groups (5.5 ±0.1 vs 5.5 ±0.1 pmol/L) [44].
- In a crossover RCT (n=21; adults with insulin resistance), a high-carbohydrate, high-fat meal and beverage with freeze dried strawberry powder at low (10 g), moderate (20 g) and high doses (40 g; equivalent to 100 g, 200 g and 400g fresh), showed that the high dose strawberry group (400 g fresh equivalent) reduced the postprandial insulin response by 12% compared to the control group at 6 hours (56.3 ±5.6 vs 63.9 ±5.6 µIU/mL) [26].
    - Blood glucose levels were similar between groups [26].
    - Repeated measures correlational analysis revealed significant inverse associations within subjects between pelargonidin-glucuronide (PG), an anthocyanin metabolite and insulin [26].

Raspberries

Acute raspberry intake improves post meal glucose responses but not short-term glucose control

- In a crossover RCT (n=21; type 2 diabetes), 250 g raspberry supplementation per day reduced postprandial glucose levels, but had no effect on fasting blood glucose levels, compared to control [35].
    - RCT involved an acute raspberry supplement phase (meal with or without 250 g raspberries), followed by a 1-week washout, followed by a 4-week supplement phase with 250 g raspberries daily, or control diet [35].
    - Postprandial glucose levels at 2 and 4 hours were lower in the acute raspberry challenge group compared the control (176±21 vs 206 ±16 and 154±10 vs 187 ±12 mg/dL, respectively) [35].

- Postprandial insulin levels did not differ, nor did fasting blood glucose levels after 4 weeks of supplementation or control [35].

- In a crossover RCT (n=21 prediabetes and insulin resistance; n = 11 healthy), trial arms included: 0 g of frozen red raspberries (control), 125 g of frozen red raspberries (RR-125), or 250 g of frozen red raspberries (RR-250), with a challenge breakfast meal (high carbohydrate/moderate fat) on three separate days, samples collected over 24 hours [45].
    - 250 g raspberries in the challenge breakfast meal reduced postprandial 30-minute peak glucose concentrations in the pre-diabetes/insulin resistance (PreDM-IR) group compared with the control (7.2 ± 0.2 vs. 8.1 ± 0.2 mmol/ L, respectively; $p<0.001$) and remained lower than control at 1 hour post meal (6.8 ± 0.2 vs. 7.3 ± 0.2 mmol/L, respectively; $p=0.03$). Two-hour post meal glucose AUC was also lower after RR-250, compared with control [45].
    - Like the glucose results, 250 g of raspberries lowered mean insulin responses in the PreDM-IR group over the 24-hour period compared with control (228.0 ± 19.2 vs. 308.4 ± 18.0 pmol/L, respectively; $p<0.001$) [45].
    - Peak insulin in the PreDM-IR group occurred at 1 hour post-raspberry meals (647.4 ± 38.4 pmol/L for 125g raspberries and 537.6 ± 40.2 pmol/L for 250g raspberries), whereas insulin peaked sharply after the control breakfast meal at 30 minutes (804.6 ± 38.4 pmol/L) and was higher than peak insulin concentrations observed after 250 g ($p<0.01$) [45].
    - The 2-hour AUC analysis indicated that the PreDM-IR group, but not the healthy group, had lower total insulin after both RR-125 and RR-250 meals compared with the control meal ($p = 0.02$ and $p = 0.0002$, respectively).

Raspberry supplementation for 8 weeks does not change metabolic profiles

- In a parallel RCT (n=59; hyperinsulinemia or hyperlipidaemia), 280 g frozen raspberry supplementation for 8 weeks had no effect on plasma fasting insulin, glucose, or HOMA-IR, compared to a normal diet control [21].
- 43 genes were differentially expressed with enrichments in several functional pathways, a major portion of which were involved in the regulation of cytotoxicity, immune cell trafficking, protein signal transduction, and interleukin production. In addition, 10 serum metabolites were found significantly altered, among which β-alanine, trimethylamine N-oxide, and bioactive lipids – so potentially these would have impacts with longer supplementation [21].

Blackberries

Short-term blackberry supplementation improves insulin responses to glucose tolerance testing and long-term markers of blood glucose control

- In a RCT (n=24, mean age 54 years), 1 week with 600 g of blackberries per day improved (smoother) insulin levels in response to the glucose tolerance test (0.47 (0.24, 0.70) vs. 9.02 (8.77, 9.26) iAUC µU.min/mL), compared to isocaloric flavoured gelatin control [27].
    - Glucose kinetics were unchanged (8.16; 95% CI 7.90, 8.41 vs. 8.31; 95% CI 8.05, 8.57) iAUC mg.min/dL) [27].

- The berry group had lower HOMA-IR (0.47; 95% CI 0.24, 0.70 vs. 0.57; 95% CI 0.34, 0.80) and HOMA-B levels (80.32; 95% CI 61.30, 99.34 vs. 91.24; 95% CI 72.22, 110.26) [27].

Evidence-based messages

- Moderate evidence that blueberry intake (≥ 3 serves per week) is associated with a 26% reduced risk of type 2 diabetes in the general population.
- For other berries (strawberries, raspberries and blackberries), moderate evidence supports a relationship between berry intake (≥ 250 g for each) and modulation of glucose and insulin responses in post-prandial studies.
- Emerging evidence that short term mixed berry supplementation (350 g per day) improves fasting blood glucose levels by 18% and HOMA-IR by 19% over 5 weeks in older adults.
- Emerging evidence that short term blackberry supplementation (600 g per day for 1 week) improves insulin resistance by 18% and beta-cell functionality by 12% in adults.
- Long term epidemiological studies are needed to determine the role of other berries (except blueberries) in the prevention of type 2 diabetes.
- Mechanisms of action are likely linked to weight modulation, and impacts of polyphenols and other bioactives.

Brain health

Limited evidence from long term cohort studies and short term RCTs shows those who eat more berries (particularly strawberries and blueberries; ≥1 cup per week) had lower levels of cognitive decline in aging.

Effects are consistent and more pronounced for high doses of berries (≥2 cups or 300 g per day). High doses of mixed berries (300 – 350 g) reduced cognitive fatigue in young adults and improved cognitive performance in older adults, while 500 mL blueberry juice improved cognitive outcomes in those undergoing surgical anaesthesia and 300 g blueberries (fresh equivalent) improved cognitive performance in healthy children.

However, demonstration of these effects in short term RCTs has been mixed, which is partly due to the vast array of cognitive function tests available and the diversity of populations tested. Different berries and consumption patterns may be associated with different outcomes, or it may represent false positives due to repeat testing.

Mixed berries

Short term mixed berry supplementation may reduce cognitive fatigue in young adults

- An RCT (n=40; aged 20-30 years; healthy) tested a single dose of 400 mL mixed berry smoothie (containing 75 g each of blueberry, strawberry, blackberry and raspberry) or a carbohydrate and vitamin C matched placebo. Testing commenced at baseline then 2-, 4- and 6-hours post-dosing. As expected, following placebo intervention, performance decreased across the day as participants became cognitively fatigued. However, berry intervention participants maintained accuracy on both cognitive tasks up to and including 6 hours, and demonstrated quicker response times on the MANT at 2 and 4 h, and TST at 6 hours [46].
    - MANT accuracy at 4 hours about 96% for both groups, at 6 hours dropped to 94% for placebo, but did not drop for berry. MANT accuracy for incongruent trials was 94% in both groups at 4hrs but dropped to about 91% at 6 hrs in the placebo group. MANT response time was higher in placebo group at 2 (435 ms vs 445 ms), 4 (430 ms vs 440 ms), and 6 hours (433 ms vs 441 ms) all $p<0.05$ [46].
    - Task switching tests 94% to 92% in placebo from 2-6 hours, berries stayed same throughout. Accuracy following switching was higher in the berry throughout by about 3%. Reaction time decreased for switching task at 6 hours (from 770 ms to 730 ms) [46].

Short term mixed berry supplementation may improve cognitive performance in older adults

- An RCT (n=40; aged 50-70 years; healthy) tested a mixed berry beverage (containing 150g blueberries, 50g blackcurrant, 50g elderberries, 50g lingonberries, 50g strawberries) or placebo matched to carbohydrate, pH and volume daily for 5 weeks showed that subjects performed better in the working memory test after the berry beverage compared to after the control beverage [17].
    - No differences in selective attention and psychomotor reaction time were found [17].

Blueberries

Higher blueberry intake is associated with reduced cognitive decline in aging

- In a longitudinal study (n=16,010, aged ≥70 years) greater intakes of blueberries (based on average intakes every 4 years from 1980 to 2001) were associated with slower rates of cognitive decline (based on global score averaging of 6 cognitive tests given twice, two years apart between 1995 and 2001) after adjustment for multiple confounders [47].
    - Mean difference 0.04 (95% CI 0.01-0.07; p = 0.014) comparing extreme levels of intake (women who ate ≥1 serving of blueberries per week to those who ate <1 serving per month). These effect estimates where equivalent to the differences normally attributable to 1.5-2.5 years of aging in the cohort [47].
    - Berries were the primary food contributing to anthocyanidin intake. Greater intakes of anthocyanidins and total flavonoids were associated with slower rates of cognitive decline (p-trends = 0.015 and 0.053, respectively, for the global score). Flavonoids Q1 = 145.4 mg/day Q4 = 684.1 mg/day [47].

Short term blueberry supplementation has no effect on cognitive test performance

- In a parallel RCT (n=37; >60 years), freeze dried blueberry supplementation (2 x 12 g/day) for 90 days resulted in fewer repetition errors in the CVLT-II (p = 0.031; Cohens d=0.759) and a reduction in switch trial errors (task-switching test) over the test visits (p = 0.033; Cohens d=0.629), compared to isocaloric blueberry flavoured powder [48, 49].
    - No differences were found in the digit span task, virtual version of the Morris Water Maze and Attention Network Task.
- In a parallel RCT (n=20; >60 years), frozen blueberry supplementation (2 cups, 300 g fresh equivalent) for 6 weeks did not improve performance on cognitive tests (reaction time, trail making), compared to carrot juice placebo [49, 50].
- In a parallel RCT (n=112; >65 years), blueberry powder supplementation (0.5 g and 1 g/day; 5 g and 10 g fresh equivalents) did not show improvement in cognitive tasks (E-prime V2, Rey's Auditory Verbal Learning Task, object recognition task, Corsi Blocks task, serial subtractions and Sternberg memory scanning, The Sternberg memory scanning task, Modified Attention Network Task and Stroop task) at 12 or 24 weeks, compared to placebo [49, 51].
- In a crossover RCT (n=26, >60 years) comparing 12 weeks of 30 mL blueberry concentrate (details of fresh equivalents not given but estimated to be about 130 g based on reported anthocyanin content) per day vs placebo (synthetic blackcurrant and apple cordial with sugar added to match blueberry energy content), there were no differences in a panel of cognitive tests (detection task, the Groton maze timed chase test, delayed recall, identification task, 1-back and 2-back, reaction time, working memory, numerical Stroop test) [49, 52] .
    - Increases in brain activation responses were found in a number of task-associated regions following blueberry supplementation compared with placebo relative to the baseline visits (Brodman areas 4, 6, 10, 21, 40, 44, 45, precuneus, anterior cingulate, insula and thalamus; $p < 0.001$) [52].
    - No increases in brain activity were observed following placebo compared with blueberry supplementation relative to baseline [52]. This may mean that longer

periods of testing are needed to see differences in performance or that there is a threshold effect not seen in healthy individuals.

Short term blueberry supplementation improves cognitive performance in older adults with mild cognitive impairment at high doses

- In a crossover RCT (n=16; >56 years; with reported "forgetfulness"), 12 weeks of daily blueberry juice (6-9 mL/kg doses of blueberry juice; 1kg of fresh berries made 735mL of juice; equivalent to 570 – 857 g of fresh berries in a 70 kg adult) resulted in higher verbal paired associate learning test scores compared to the isocaloric grape juice with no polyphenols placebo (13 vs 7.5, Cohen's effect size, f = 0.48) [53].
    - No differences were found in the California Verbal Learning test scores (p = 0.12, Cohen's f = 0.32) [53].
- In an RCT (n=16; over 68 years; age related memory decline), freeze dried blueberry powder supplementation (150 g fresh equivalent) for 16 weeks found no improvements in cognitive performance (relative working memory) compared to isocaloric, colour and flavour matched placebo powder [54].
    - There was higher blood oxygen level dependent brain signalling seen on fMRI in the left inferior parietal and left pre-central gyri in the blueberry group during some tasks (p <0.0001) [54].
- In a double blind RCT (n=19; >62 years; with perceived cognitive decline) supplementation with 25 g freeze-dried blueberry (daily dose equivalent 1 cup) led to fewer reported cognitive symptoms on the dysexecutive questionnaire (11.9 vs 15.9, p < 0.05; Cohens d=0.68) compared to macronutrient matched placebo powder [55].
    - There was an effect indicating improved discrimination in recognition memory with higher Hopkins Verbal learning test discrimination scores (11.2 vs 10.8p = 0.04; cohens D = 0.68) after 24 weeks of treatment and 24 weeks of washout [55].
- In a double blind parallel RCT (n=38; >60 years), 90 days of supplementation with freeze-dried blueberry powder (24 g/day; 1 cup fresh equivalent) found no differences in task-switching test or California verbal learning test outcomes, compared to control [56].
    - Improvements were associated with changes in postprandial levels of plasma ferulic acid-glucuronide, syringic acid, and malvidin-3-galactoside (R^2 = 0.521, p < 0.05) for the task-switching test and postprandial levels of ferulic acid-glucuronide, syringic acid, and hippuric acid (R^2 = 0.807, p < 0.001) for the verbal learning test. This may suggest that supplementation does not have a uniform response and may be dependent on baseline diets or genetics [56].

Blueberry supplementation may attenuate the loss of cognitive performance associated with surgical anaesthesia

- An RCT (n=26; patients undergoing major elective surgeries) showed that 500 mL/day of blueberry juice for 14 days before their procedure attenuated the decline in neuropsychological scores on tests performed 3 and 24 hours after surgery, that occurred in the control group following surgery [57].
    - The control group showed a decrease in performance on the Prose Memory test, at 3 hours and 24 hours (p <0.01), in the Trail Making Test Part B at 24 hours (p <0.01);

and the Attentional Matrices test at 24 hours (p <0.001). The blueberry juice group did not show any decrease in the performance of the three tests [57].

Short term blueberry supplementation may improve cognitive performance in healthy children

- In an RCT (n=21; 7-10 years), a single supplementation of 15 or 30 g of freeze-dried blueberry powder in 30 mL of fruit squash was compared to fruit squash only as the placebo with cognitive testing after 1.5 and 3 hours. The 30 g blueberry powder group showed a strong association with improvements in final acquisition performance (p = 0.023; cohens d= 0.940), and weak associations with word recognition (p = 0.016; cohens d=0.245) and incongruent flanker trials at 3-hour timepoint (p = 0.035; cohens d=0.2). The 15 g dose showed small improvements for the incongruent flanker test at 3 hours (p = 0.019 d=0.245), compared to placebo [58].
- A similar RCT (n=21; 7-10 years), with 3 repeated 30 g blueberry powder dosing and testing sessions over 2 weeks found that the supplementation group was significantly faster on high visual load/congruent (540 ms vs 580 ms p = 0.026), high visual load/incongruent (600 ms vs 650 ms; p =0.029) and medium visual load/incongruent trials (590ms vs 640ms; p = 0.021; cohens d=0.940), compared to placebo [59].
    - Response times were also faster following intervention for central (560ms vs 600ms; p = 0.033) and spatial cues (550ms vs 590ms; p = 0.041), compared to placebo [59].
- In an acute crossover RCT (n=14; 8-10 years) of 200 g fresh blueberries in a smoothie (compared to milk only) there were no differences in attention, response inhibition or visuospatial memory tests (o-NoGo, Rey's auditory-verbal learning test, Word-colour Stroop, Visuospatial n-back task, object location task or delayed recall tasks), compared to control [60].

Strawberries

Higher strawberry intake is associated with reduced cognitive decline in aging

- In a longitudinal study (n=16,010, aged ≥70 years; details above) strawberries were associated with slower rates of cognitive decline (based on global score averaging of 6 cognitive tests given twice, two years apart between 1995 and 2001) after adjustment for multiple confounders (MD= 0.03 (95% CI 0.00-0.06; p = 0.022) comparing extreme levels of intake (women who ate ≥2 servings of strawberries per week to those who ate <1 serving per week) [47].
    - Effect estimates were equivalent to the differences normally attributable to 1.5-2.5 years of aging in the cohort [47].

Strawberry supplementation improves performance in virtual spatial navigation and verbal learning tests

- In a blinded RCT (n=37; ages 60-75; able to walk minimum 20 mins unaided), freeze dried strawberries supplementation (24 g/day; equivalent to 2 cups fresh) lead to improvements in cognition relative to controls (colour matched isocaloric powder) [61].
    - Strawberry group displayed shorter latencies in virtual spatial navigation tasks following 45 days of supplementation - spending more than 40% of the test time in the right quadrant of the maze, while those in the placebo group spent less than

30% of their time searching in the right quadrant. These differences were lost by 90 days of treatment, potentially due to the impact of test repetition on learning [61].
    - Strawberry group displayed a small increased difference in word recognition in the California Verbal Learning Test in visit 4 compared to visit 2 [61].
    - No improvements were seen in gait or balance tests, attention network test, task switching test, digit span or geriatric depression indicator or profile of mood states.

Raspberries, Blackberries

No data

Evidence-based messages

- There is limited epidemiological evidence that greater intakes of blueberries and strawberries (≥1 cup per week) is associated with slower rates of cognitive decline over 20 years.
- Effects are consistent and more pronounced for high doses of berries.
    - Mixed berries (≥300 g per day) may have beneficial effects on cognition through reducing cognitive fatigue in young adults acutely and improving working memory in older adults over the short term (5 weeks).
    - Blueberry juice (500 mL) may prevent a decline in cognitive performance on neuropsychological tests up to 24 hours after surgical anaesthesia.
    - In healthy children, blueberry supplementation (300 g; single dose – 2 weeks daily) may improve cognitive performance through improvements in final acquisition performance, word recognition, special cues, high visual load/congruent, high visual load/incongruent and medium visual load/incongruent trials.
    - In older adults with mild cognitive decline, blueberry supplementation (570 – 857 g) may improve cognitive performance through increasing verbal paired associate learning test scores (13 vs 7.5 score).
- In healthy older adults, highly consistent evidence that short term (6 weeks – 3 months) blueberry supplementation (24 – 300 g) has no effect on cognitive test performance.
- Inconclusive evidence of effects in short term RCTs, which is partly due to the vast array of cognitive function tests available and the diversity of populations tested, different berries and consumption patterns, or may represent false positives due to repeat testing.
- More research is required to confirm the effects of individual berries in different parts of the brain, including measuring the polyphenolic compounds in different brain regions following supplementation, as different polyphenolics may localise or concentrate in different brain regions.
- No evidence for raspberries and blackberries has been published.

Inflammation & oxidative stress

Limited evidence from RCTs suggests that berries can reduce inflammation and oxidative stress markers in general populations, sedentary populations and those with type 2 diabetes. However, results are inconsistent, which may be due to the non-specific nature and multiple functions of the inflammation markers used (e.g., C-Reactive Protein (CRP) is responsive to multiple factors and cytokines like IL-6 have complex and multifaceted roles).

Consumption of ≥ 250 g blueberries daily may improve inflammatory and immune outcomes by increasing natural killer (NK) cell levels and decreasing inflammatory oxidase activity. Strawberries (≥ 100 g per day) may improve inflammatory outcomes through reducing IL-6 and CRP levels, while raspberries (250 g) may lower inflammatory markers in those with type 2 diabetes. Drinking blackberry juice (300 mL) daily for 8 weeks had no effect on CRP levels.

Mixed berries

Mixed berry supplementation does not influence inflammatory markers

- In an RCT (n=40; 50-70 years; healthy), both a mixed berry beverage (containing 150 g blueberries, 50 g blackcurrant, 50 g elderberries, 50 g lingonberries, 50 g strawberries) and placebo (matched to carbohydrate, pH and volume) consumed daily for 5 weeks had no effect on circulating levels of IL-6, IL-18 or MDA, compared to control [17].

Blueberries

Short term blueberry supplementation increases NK cell levels in sedentary participants

- In an RCT (n=25; adults; sedentary), 6 weeks supplementation with blueberry powder (250 g fresh equivalent) found that absolute NK cell counts were increased in the blueberry group (260 vs 210 counts/mm^3) compared to the control powder [39].

Acute blueberry supplementation can reduce inflammatory oxidase activity

- In a double blind RCT (n=21 males), acute supplementation of a blueberry drink containing 240 – 560 g of blueberries resulted in 30% reductions in neutrophil NADPH oxidase activity were measurable at 1–2 and 6 hours (p = 0.001), compared to baseline and a nutrient-matched control (0 mg total blueberry polyphenols) [29].
    - Smaller reductions were also found at 4 h (22%; p = 0.05) [29].
    - No differences in plasma concentrations of soluble-gp91phox (catalytic core of phagocyte NADPH oxidase, partly reflecting NADPH oxidase expression) were found [29].

No effect of short-term blueberry supplementation on inflammatory markers or microbial profiles

- Evidence from four RCTs (n=208; adults; including healthy and/or with risk factors for CVD) found that 6 weeks to 4 month blueberry supplementation (95-430 g fresh equivalent) had no effect on CRP (WMD = 0.04; 95% CI -0.30, 0.39) or TNF-α (WMD = -0.039; 95% CI -0.138, 0.061) [16].

- In a parallel RCT (n=17 adults), freeze-dried blueberry powder (310 g fresh equivalent per day) for 6 weeks compared to baseline did not change microbiota diversity in women, however FRAP responses correlate with changes [62].
- Alterations in the abundance of some gut bacteria weakly but significantly correlated with increased antioxidant activity in blood (OTU-level microbiota R^2 =0.04, p = 0.01; CAG-level microbiota R^2= 0.06, p = 0.05).

Strawberries

Acute strawberry supplementation may positively influence inflammation

- In a crossover RCT (n=24; overweight adults), participants consumed a high-carbohydrate, moderate-fat meal accompanied by either a strawberry (100g fresh equivalent) or an isocaloric placebo beverage found that the strawberry beverage significantly attenuated the postprandial inflammatory response as measured by high-sensitivity C-reactive protein (2.7±0.1 vs 3.1±0.1 mg/L) and IL-6 (2.6±0.2 vs 3.1±0.2 mg/L) compared to the control [44].
    - TNF-α did not differ between groups [44].
- In a crossover RCT (n=21; overweight adults with insulin resistance), a high-carbohydrate, high-fat meal and a beverage with low (100g fresh equivalent) or moderate (200g fresh equivalent) levels of freeze-dried strawberry powder (described earlier) was positively correlated with changes in IL-6 and anthocyanin metabolites (P3G, and PG and C3G), despite IL-6 not varying by treatment (p < 0.02) [26].

Short term strawberry supplementation reduces inflammation

- Evidence from 7 RCTs (n= 259) found strawberry supplementation (100-3200 g fresh equivalent) for 3-12 weeks lowered levels of inflammation marker CRP (WMD = -0.472 mg/L; 95% CI -0.777, -0.166) [19].

Raspberries

Short term raspberry supplementation positively impacts inflammation

- In a crossover RCT (n=21; type 2 diabetes), an acute raspberry supplement phase (meal with or without 250 g raspberries) was given, followed by a 1-week washout, followed by a 4-week supplement phase with 250 g raspberries daily, or control diet with no raspberries. Results found that post-meal IL-6 and TNF-α were lower in the raspberry group than the control (7.2±5.5 vs 10.5 ±6.5 and 3.2±2.1 vs 5.3 ±3.3, respectively; p < 0.05) at 4 weeks of supplementation [35].
- In a parallel RCT (n=59; hyperinsulinemia or hyperlipidaemia), 280 g frozen raspberry supplementation for 8 weeks showed no changes in inflammation markers in the blood [21].

Acute raspberry supplementation does not impact inflammation

- In a crossover RCT (n=21 prediabetes/insulin resistance; n=11 healthy) no differences in oxidative stress or inflammatory biomarkers were found after consumption of 0 g, 125 g or 250 g frozen red raspberries with a high carbohydrate meal (as previously described) [45].

Blackberries

Short term blackberry supplementation does not impact inflammation

In an RCT (n=72; dyslipidemic adults), 300 ml blackberry juice per day for 8 weeks compared to usual diet control (as previously described) showed no differences in CRP-levels [36].

Evidence-based messages

- Research on berry intake and inflammation is mixed, which may be due to the non-specific nature and multiple functions of the inflammatory markers assessed.
- Eating ≥250 g of blueberries per day may have beneficial effects on inflammation through increasing natural killer cell activity over the short term (6 weeks) and reducing neutrophil NADPH oxidase activity acutely.
- There is limited evidence that ≥250 g raspberries per day have beneficial effects on inflammation through lowering IL-6 and TNF-α over the short term (4 weeks).
- Consistent evidence that >100 g strawberries per day have acute and short-term beneficial effects on inflammation.
- Mechanisms of action may include alterations in the abundance of some gut bacteria which are weakly but significantly correlated with increased antioxidant activity.

Exercise performance & recovery

Blueberries have been the focus of exercise related studies. Moderate evidence suggests that high doses of blueberry supplementation (500 g per day) may improve some markers of exercise induced damage, stress and recovery by reducing blood lactate, and markers of inflammation, oxidative stress and nucleic acid damage. Results were found during treadmill-based exercise challenges in recreational runners, well trained runners, and untrained people with pre-diabetes and insulin resistance. Reduced declines in reactive strength post-challenge and higher blood glucose levels were also seen. There was no evidence of improved overall performance.

Findings may occur through modulation of glucose responses or antioxidant functions of micronutrients or bioactive compounds. Other berries may have similar impacts but have not been studied in this context.

Mixed berries

No data

Blueberries

Short term blueberry supplementation reduces signs of muscle damage following an exercise challenge

- In a crossover RCT (n=11; recreational runners), supplementation with blueberry powder (500 g fresh equivalents) as a single challenge prior to a treadmill challenge in normobaric hypoxic conditions reduced blood lactate levels by 12 – 18%, compared to isocaloric placebo powder [63].
    - Following the time trial treadmill challenge, blood lactate concentration was lower in the blueberry group, compared to the placebo (7.2 ±1.9 vs. 8.9 ±2.7; Cohen's d showed a moderate effect size (d = 0.76)) [63].
    - No differences in heart rate, oxygen saturation, reported perception of exertion, salivary stress hormones or inflammatory markers ($p > 0.05$) were found [63].
- In a crossover RCT (n=14; prediabetes and insulin resistance), blueberry powder supplement (500 g fresh equivalents) daily for 4 days, or 2 days of blueberry powder followed by 2 days of placebo powder, or 4 days of placebo powder (isocaloric) prior to an 8 km treadmill challenge showed no differences for time to complete the time trial, heart rate, ratings of perceived exertion, vertical jump height, or any of the salivary markers [64].
    - An interaction effect was observed for blood lactate, which was lower in those supplemented for 4 days (5.4 ± 2.0 mmol/L), compared to the placebo (6.6 ± 2.5 mmol/L) and 2-day supplementation groups (7.4 ± 3.4 mmol/L) [64].
    - Decline in reactive strength index was less following 4 days of supplementation (-6.1% ± 13.5%) than placebo or 2-day treatments (-12.6% ± 10.1% and -11.6% ± 11.5%, respectively) [64].

Short term blueberry supplementation reduces inflammation following an exercise challenge

- In a parallel RCT (n=25; well-trained runners), 250 g blueberries per day for 6 weeks and 375 g given 1 h prior to 2.5 hours of running at approximately 72% maximal oxygen, found that

blueberry consumption counters oxidative stress, inflammation, and immune changes, compared to controls following their usual diet [65].

- Increases in F_2-isoprostanes (an oxidative stress marker) and 5-OHMU (RNA damage marker) were less in the blueberry group compared to the control [65].
- Plasma F2-isoprostanes (129% immediately postexercise in the control group compared to just 55% in the blueberry group ($p = 0.016$) [65].
- 5-OHMU Blueberry 4.9±4.2 vs control 6.4±3.0 ($mg.g^{-1}$ creatine; $p = 0.028$) [65]
- Plasma IL-10 (an anti-inflammatory cytokine) and NK cell counts were higher in the blueberry group compared to the control [65].
  - 1L-10 blueberry 15.5±1.9 vs control 10.8±1.9. $p < 0.0001$ [65].
  - NK cell count was 96%, 122%, and 76% greater, pre-exercise, immediately post-exercise and one hour post exercise, respectively, compared to the control group ($p = 0.003$) [65].
- No differences in cortisol, other cytokines, homocysteine, T-cell function, and lymphocyte cell counts for inflammation and immune system activation, ferric reducing ability of plasma (for antioxidant capacity) and urine 8-OHDG (a marker of DNA damage) [65].

- In a crossover RCT (n=9), involving one week per treatment (with one week washout); neither blueberry or vitamin C consumption for 1 week were effective in suppressing exercise-induced increases in F_2-isoprostanes or lipid hydroperoxides (ROOH; a primary product of oxidative stress). However, blueberry supplementation reduced the increase in post exercise ROOH concentration compared to placebo (15 mins post exercise; placebo = 73.5 ± 3.2 $\mu mol.L^{-1}$, blueberry = 40.1 ± 4.6; vitamin C = 48.9 ± 6.1), but had no effect on F_2-isoprostanes [66].
  - Treatment groups included 150 g per day (fresh) blueberry in a milkshake, blueberry flavoured milkshake with vitamin C, blueberry flavoured milkshake. Fasting subjects were then tested by running at 70% VO_{2max} in a hyperthermic environment (35°C, 70% RH) until a core temperature of 39.5°C was reached [66].
  - The combination of exercise and heat stress significantly increased plasma concentrations of F_2-isoprostanes and ROOH. The increase in these lipid markers indicates that participants underwent significant oxidative stress from exercising in the heat [66].
  - No effects were seen between treatment groups for IL-6, IL-10, IL-8, and IL-1 [66].
  - Results indicate that blueberry supplementation may be beneficial for athletes exercising in hot environments [66].
- In a parallel RCT (n=63; adults aged 40-79; with symptomatic knee osteoarthritis), when freeze-dried blueberry powder (330 g fresh equivalents) was consumed daily for four months, compared to maltodextrin placebo (isocaloric, carbohydrate matched) [67], the outcomes found after a walking trial were:
  - WOMAC (a scale used to assess pain, stiffness, and quality of life in arthritis) total score and sub-groups, including pain, stiffness, and difficulty to perform daily activities decreased by 25% in the blueberry group, but not in the placebo group. However, post treatment values were similar between groups [67].
  - No changes were observed in plasma concentrations of inflammation markers (tumour necrosis factor (TNF)-α, interleukin (IL)-1β, IL-6, IL-10, IL-13, matrix

metalloproteinases (MMP)-3, MMP-13, and monocyte chemoattractant protein-1 (MCP-1) in both groups [67].
    - Besides baseline differences in systolic blood pressure, there was no difference between the blueberry and the placebo group in regard to weight, height, BMI, or systolic and diastolic blood pressure, at any time point [67].

Short term blueberry supplementation increases fasting glucose and HDL-C levels following an exercise challenge

- In a crossover RCT (n=32; mean age 28 years), 150 g per day (fresh) blueberry supplementation on exercise days (4 weeks of running/jogging 5 km five times per week) led to fasting glucose levels that were 3% higher in the blueberry group compared to the control (instructed to keep eating habits unchanged) after 4 weeks of exercise (5.32 ± 0.29 mmol/L vs 5.17 ± 0.23 mmol/L; p =0.04) [68].
    - HDL-C increased by 8% in the blueberry group, compared to the control (1.64 ± 0.33 mmol/L vs 1.51 ± 0.29 mmol/L; p =0.006)
    - TG were lower in the control group compared to the blueberry group (1.10 ± 0.49 mmol/L vs 0.93 ± 0.31 mmol/L; p=0.02).
    - No differences in insulin levels were found [68].

Strawberries, Raspberries, Blackberries

No data

Evidence-based messages

- There is limited evidence that acute blueberry supplementation (500 g fresh equivalents) prior to a treadmill challenge may lower blood lactate concentration by 20%.
- There is limited evidence that blueberry supplementation (150 – 375 g) may reduce oxidative stress when consumed for more than 1 week, with reductions in F_2-isoprostanes (57% reduction), 5-OHMU (23% reduction) and lipid hydroperoxides (45% reduction) being reported after an exercise challenge.
- There is emerging evidence that blueberry supplementation (250 g per day for 6 weeks and 375 g prior to challenge) may have an anti-inflammatory effect with a 30% increase in plasma IL-10 (an anti-inflammatory cytokine) and a 96%, 122% and 76% increase in NK cell counts pre-exercise, immediately post-exercise and one hour post exercise, respectively being reported after an exercise challenge.
- There is emerging evidence that blueberry supplementation (330 g fresh equivalents) daily for 4 months may decrease pain, stiffness and difficulty to perform daily activities by 25% in adults with symptomatic knee osteoarthritis.
- There is emerging pilot evidence that blueberry supplementation (150 g) may induce differential effects on cardio-metabolic risk factors during exercise, including increased levels of both fasting glucose (3% increase) and HDL-cholesterol (8% increase).
    - However, evidence is of low quality and further studies are needed to confirm findings.
- No evidence for mixed berries, strawberries, raspberries or blackberries has been published.

Pregnancy & childhood health

There is limited evidence from observational data that maternal mixed berry intake during pregnancy may improve offspring outcomes including a 10% reduced risk of developing advanced β-cell autoimmunity and no effect on risk of asthma, allergic rhinitis or wheeze up to 5 years of age. In observational studies berries may serve as a marker of a healthy diet, and fibre and bioactives may influence metabolic outcomes.

Limited evidence from one RCT shows that maternal consumption of 280 g fresh blueberries daily for 18 weeks during pregnancy improved gestational weight control by 43% and blood glucose control by 24%. No effects were found for blood lipids or infant birthweight. Importantly, berries do not appear to pose any risks for pregnancy. Further research in large population-based cohorts and RCTs are required to confirm findings.

Mixed berries

Maternal mixed berry intake is inversely associated with the development of advanced β-cell autoimmunity in offspring

- Prospective Finnish birth cohort (n=3,723), mean follow up time of 4.4 years found a 10% reduction in risk of developing advanced β-cell autoimmunity for each doubling of consumption (HR = 0.90; 95% CI 0.83–0.98) (adjusted for genetic risk group and familial diabetes) [69].

Maternal berry consumption is not associated with risk for asthma, allergic rhinitis or wheeze in offspring

- In a prospective birth cohort study (n=2,441), maternal berry consumption measured by food frequency questionnaire during pregnancy did not influence risk for asthma, allergic rhinitis or wheeze in offspring at 5-year follow up [70].

Blueberries

Maternal blueberry consumption leads to improved weight and glucose control

- In an RCT (n=34; overweight), pregnant women supplemented with 280 g of fresh blueberries and 12 g of soluble fibre per day for 18 weeks during pregnancy (up to 32-36 weeks' gestation) gained 6.8 ± 3.2 kg, compared with 12.0 ± 4.1 kg in the usual care controls ($p = 0.001$) [71].
    - Blood glucose based (Glucose Challenge Test) was lower in the intervention (100 ±33 mg/dL) compared with the control (131 ± 40 mg/dL; $p < 0.05$).
    - C-reactive protein was lower in the intervention group (5.5 ± 2.2 mg/L) compared with the control group (9.5 ± 6.6 mg/L $p = 0.002$) [71].
    - Conventional lipids (total, LDL, and HDL cholesterol and triglycerides) did not differ between groups over time. No differences were noted in infant birth weight [71].

Strawberries, Raspberries, Blackberries

No data

Evidence-based messages

- There is limited emerging evidence that berry intake in pregnancy may improve maternal and offspring health outcomes.
    - A 2011 epidemiological study reported maternal mixed berry intake during pregnancy (7 – 33 g) was inversely associated (weakly) with the development of advanced β-cell autoimmunity in offspring at 4 – 5 years of age.
    - A 2012 epidemiological study reported maternal mixed berry intake during pregnancy was not associated with risk for asthma, allergic rhinitis or wheeze in offspring at 5-years of age.
    - A 2021 RCT reported maternal intake of 280 g fresh blueberries daily for 18 weeks during pregnancy improved gestational weight control by 43% and blood glucose control by 24%.
- No evidence found that maternal blueberry intake during pregnancy effects blood lipids or infant birthweight.
- No evidence for strawberries, raspberries or blackberries has been published.

Ageing health

Limited evidence suggests lower berry intake (28 – 45 g per day) may be associated with higher physical function and performance, bone mineral density and longevity in elderly populations, indicating potential for improved outcomes of aging. Whereas higher intakes of blueberries (2 cups per day) may benefit the elderly in movement tasks.

In a longitudinal cohort study, eating berries regularly (> 14 times per month) was associated with a 23% reduced risk of all-cause mortality over 40 years. Whereas, in a cross-sectional analysis of a longitudinal cohort study, eating as little as 28 g of mixed berries per day was associated with higher physical function scores compared to the lowest quartile of intake (8 g berries per day; 85.9±5.6 vs 22.5±10.6).

Single study RCT evidence shows that low doses of blackberries (45 g per day) improved bone density in smokers (value not reported) and higher doses of blueberries (2 cups/day) for six weeks improved dual-task adaptive gait tests with 30% fewer errors compared to the carrot juice control.

(Note: cognitive function is addressed in the brain health section.)

Mixed berries

Mixed berry consumption is associated with reduced risk of dying from any cause

- A population-based prospective Norwegian cohort study of 10,000 men followed from 1968 through 2008 found that berry consumption (type unknown) is inversely associated with all-cause mortality [72].
    - Men who consumed berries more than once per month had a 5–7% decreased risk of dying during follow-up compared with men who consumed berries more than once per month. (HRR = 0.91; 95 % CI 0.85–0.96) highest quartile of consumption (>8 times per month) compared to lowest quartile of consumption (≤1 time per month) in crude analysis. However, results were not significant in the fully adjusted model [72].
    - Consumption of garden berries >14 times per month was associated with a 23% reduced risk of all-cause mortality (HRR = 0.77; 95 % CI 0.67–0.88), while those who ate wild berries >14 times per month had a 16% reduced risk of all-cause mortality (HRR = 0.84, 95 % CI 0.74–0.94) [72].

Mixed berry intake is positively associated with physical function in the elderly

- In a cross-sectional analysis of a longitudinal cohort study of the oldest men (n=130; >81 years) from the Helsinki Businessmen cohort, physical function scores (calculated using the RAND-36 health-related quality of life instrument) were positively associated with berry intake, but not total intake of fruits or vegetables [73].
    - Those with the lowest quartile of physical function scores (mean = 22.5, SD ±10.6) consumed an average of 8 g (SD 17) berries per day, and those with the highest physical function scores (mean = 85.9, SD = 5.6) consumed an average of 28 g (SD ±41) berries per day (p = 0.04) [73].

Blueberries

Blueberry supplementation may improve performance in complex movement tasks in the elderly

- In an RCT of elderly participants (n=20; 60 years; independently mobile, without cognitive impairment), blueberry supplementation (2 cups per day for 6 weeks) resulted in improvements in dual-task adaptive gait tests with 30% fewer errors compared to the carrot juice control (mean 4.26 errors (SE = 0.48) in the blueberry group, and 6.09 errors (SE = 0.66) in placebo [50].
    - This was independent of gait speed (adjusted mean of 4.25 errors (SE = 0.49) in the blueberry group, and 6.08 errors (SE = 0.68) in the placebo) [50].
    - Measures improved in the blueberry group from baseline, with no effect in the placebo. No differences were found in grip strength, reaction time, gait speed, single gait tasks or trail making test results [50].

Strawberries

No data available.

Raspberries

No data available.

Blackberries

Blackberry supplementation may protect against loss of bone mineral density in smokers

- In an RCT of smokers (n=45) and non-smokers (n=20), both smoking controls and smokers in the blueberry supplementation group (45 g/day) reported a loss of total body bone mineral density after 9 months (p = 0.0284; value of reduction not reported).
    - No change in total body bone mineral density was found after 9 months in non-smokers and those in the blackberry supplementation group (45 g/day) [74].
    - No difference in bone mineral content, urinary deoxypyridinoline, bone alkaline phosphate, osteocalcin, thiobarbituric acid reactive substances and high sensitive C-reactive protein and difference between groups at 9 months were reported [74].

Evidence-based messages

- There is limited emerging evidence that mixed berry intake may improve ageing health in men.
    - A 2015 population-based cohort study reported mixed berry intake in men (>14 times per month) was associated with a 23% reduced risk of all-cause mortality after 40 years.
    - A 2018 cross-sectional study reported mixed berries intake in men (28 g per day) was associated with almost 4 times higher physical function scores compared to those that consumed 8 g per day.
- There is limited emerging RCT evidence that low doses of blackberries (45 g per day) may improve bone density in smokers (value not reported) after 9 months.
- There is limited emerging RCT evidence that high doses of blueberries (2 cups/day) for six weeks may improve complex movement tasks in the elderly by 30%.
- No evidence for strawberries or raspberries has been published.

Part 2: Supporting Evidence

What is the nutritional composition of Australian berries?

Summary

Berries are a low energy food or ingredient as they are low in major macronutrients (carbohydrate, fats, protein) (**Table 4**) but relatively high in micronutrients and bioactives.

One serve (150g) of berries contributes less than 4% of the energy allowance in the reference 8700kJ diet. Despite this, they are high in fibre – contributing 12.5-36.6% of the adequate intake for adults in one 150g serve (depending on berry, age and sex; **Table 5**).

Berries, particularly strawberries and blackberries, are an excellent source of vitamin C (**Table 4**), with contributing over 100% RDI in one 150g serve (Table 5). Berries are also good sources of folate (with the exception of blueberries). Sodium levels are nil or negligible, especially when considered relative to potassium levels.

Berries are also high in phenolics and polyphenols, including anthocyanins, flavanols and phenolic acids (**Table 6**). These bioactive compounds are thought to be responsible for the healthful properties of berries, above and beyond their micronutrient and macronutrient contents.

Table 4: Energy and key essential nutrients per 100g (fresh) berries.

	STRAWBERRY	BLUEBERRY	RASPBERRY	BLACKBERRY
Energy kJ	109	194	203	211
Carbohydrate g	3.9	9.6	6.8	7.5
Sugars g	3.8	9.2	6.5	7.5
Starch g	0.1	0.4	0.2	0
Fats g	0.2	0	0.2	0.3
Protein g	0.7	0.5	1.1	1.4
Fibre g	2.5	3.5	5.6	6.1
Water g	92.1	83.6	85.8	84.6
Vitamin C mg	45	2	29	38
Vitamin E mg	0.32	0.55	0.7	1.4
Vitamin B6 mg	0.02	0	0.05	0.02
Niacin eq	0.1	0.1	0.53	0.3
Folate µg	39	0	34	34
Thiamine mg	0.02	0.03	0.035	0.02
Riboflavin mg	0.05	0	0.025	0.03
Vit A eq	0	0	5	53
Sodium mg	0	2	1	0
Potassium mg	185	83	156	114
Magnesium mg	8	6	20	30

Manganese mg	0.356	0.082	0.505	0.55
Calcium mg	22	11	26	30
Phosphorus mg	24	11	34	29
Iron mg	0.55	0.35	0.540	0.42
Zinc mg	0.18	0.07	0.320	0.24
Selenium µg	1	0	1	2
Iodine µg	0	0	0	0

Data from Foodworks 10.

Table 5: Percentage contribution to reference values (% DI, %RDI/AI) per serve (150g; fresh)

	STRAWBERRY	BLUEBERRY	RASPBERRY	BLACKBERRY
Energy %DI*	1.9	3.3	3.5	3.6
Carbohydrate %DI*	1.9	4.6	3.3	3.6
Fats %DI*	0.4	0	0.4	0.6
Protein %DI*	2.1	1.5	3.3	4.2
Fibre AI#	12.5-15	17.5-21	28-33.6	30.5-36.6
Vitamin C %RDI	150.0	6.6	96.6	126.6
Vitamin E %RDI#	4.8-6.8	8.3-11.7	10.5-15	21-30
Vitamin B6 %RDI#	1.8-2.3	0	4.4-5.7	1.8-2.3
Niacin %RDI#	0.9-1.1	0.9-1.1	5-5.7	2.9-3.2
Folate %RDI	14.6	0.0	12.8	12.8
Thiamin %RDI#	2.6-2.7	3.8-4.1	4.4-4.7	2.6-2.7
Riboflavin %RDI#	5.7-6.8	0	2.9-3.5	3.5-4.1
Vit A %RDI	0	0	0.9	8.9-11.4
Sodium %AI	0	0.3-0.6	0.2-0.3	0
Potassium %AI#	7.3-9.9	3.3-4.4	6.2-8.4	4.5-6.1
Magnesium %RDI#	2.9-3.9	2.1-2.9	7.1-9.7	10.7-14.5
Manganese % RDI#	9.7-10.7	2.2-2.5	13.8-15.2	15-16.5
Calcium %RDI#	2.5-3.3	1.3-1.7	3-3.9	3.5-4.5
Phosphorus %RDI	3.6	1.7	5.1	4.4
Iron %RDI#	4.6-10.3	2.9-6.5	4.5-10.1	3.5-7.9
Zinc %RDI#	1.9-3.4	0.8-1.3	3.4-6	2.6-4.5
Selenium %RDI#	2.1-2.5	0	2.1-2.5	4.5-5
Iodine %RDI	0	0	0	0

Based on 8700kj/day reference diet; #Ranges for varying needs of males & females (adults – not pregnant or lactating)

Table 6: Key bioactives per 100g (fresh) berries.[1]

	STRAWBERRY	BLUEBERRY	RASPBERRY	BLACKBERRY
Anthocyanins (mg)	73.01	133.64	72.47	172.59
Flavanols (mg)	11.45	39.8	21.99	26.64
Phenolic acids (mg)	12.74	139.63	112.78	57.44
Stilbenes (mg)	0.35	-	-	-

[1] Data are means from http://phenol-explorer.eu/ from chromatography analyses. For blueberries, highland and rabbit eye were averaged as the most common types in Australia. Note ranges of data occur due to growing conditions, ripeness and storage.

What is the nutrient density to cost ratio of Australian berries?

Summary

- The nutrient density to cost ratio tells us which foods provide the most nutrition for the lowest cost. Foods with a higher nutrient density to cost ratio are the best sources of affordable nutrition.
- Among Australian berries, strawberries have the highest nutrient density to cost ratio, followed by blackberries, blueberries, and raspberries. This indicates that strawberries provide the most nutrition, for the lowest cost, compared to other Australian berries.
- When it comes to nutrient density alone, strawberries and blackberries rank the highest depending on whether the berries are scored per unit weight (blackberries) or per 100 calories (strawberries). This is because strawberries are lower in calories than blackberries (per 100 g) leading to a greater quantity of strawberries, and therefore nutrients, per 100 calories.
- When it comes to cost alone, strawberries were the cheapest berry per 100 g, but blueberries were the cheapest berry per 100 kcal. This is because blueberries are higher in calories than strawberries (per 100 g), leading to a lower quantity of blueberries, reducing cost, per 100 calories.
- Bioactive density is not captured in this ratio and thus findings need to be interpreted with caution.

What is the nutrient density to cost ratio and what does it tell us?

The nutrient density to cost ratio is a measure of affordable nutrition. It is the ratio between the nutrient density of a set amount of a food, and how much that amount of food costs, which provides an indication of a food's healthiness and affordability at the same time. Recent research in Australia [75] and New Zealand [76] has shown that diets containing foods with a high nutrient density to cost ratio are both healthier and more affordable than diets containing foods with a lower nutrient density to cost ratio. By choosing high nutrient density to cost foods, we can eat healthier, for less.

How is it calculated?

The nutrient density to cost ratio is the ratio between two separate values: the nutrient density of a food, and the cost of a food.

- Nutrient density is calculated using the NRF9.3 nutrient density index score (NRF9.3), which tells us how tightly packed the nutrition within a food is, developed by Drewnowksi et al in 2010 [77]. A food with a higher NRF9.3 provides a greater amount of healthy nutrition within a smaller quantity.
    - The NRF9.3 is based on the presence of 9 favourable nutrients (protein, fibre, vitamin A, vitamin C, vitamin E, calcium, iron, magnesium, and potassium) and 3 nutrients to avoid (added sugar, saturated fat, and sodium) [77].
    - The overall NRF9.3 score is the difference between the quantity of favourable nutrients and nutrients to avoid.
    - The NRF9.3 can be calculated per 100 g, per serving size, or per 100 calories.
- The cost of a food is the cost in dollars per 100 g, per serving size, or per 100 calories. Cost is usually determined as an average cost across several different supermarkets.

- To determine the nutrient density to cost ratio of a food, the NRF9.3 score of that food is divided by its cost, keeping the unit measure of both nutrient density and cost the same (that is, per 100 g, per serving, or per 100 calories).

How do Australian berries fare?

The nutrient density score (NRF9.3) and cost (each per 100 g, per 150 g serving, and per 100 kcal) for each of blackberries, blueberries, raspberries, and strawberries, as well as the nutrient density to cost ratio for each, is shown in **Table 7.**

Strawberries and blackberries scored the highest for nutrient density (NRF9.3), depending on which unit measure was used for comparison. While strawberries had the highest nutrient density per 100 calories (478.2), blackberries ranked the highest per 100 g (142.3) and per 150 g serving (213.5). The reason for this difference is that strawberries are lower in calories (per 100 g) than blackberries, resulting in a greater quantity of strawberries per 100 calories, containing a greater quantity of nutrients. The high NRF9.3 of strawberries was largely due to a high level of vitamin C, iron, and potassium, while blackberries had the highest protein, fibre, vitamin A, vitamin E, calcium, and magnesium. In contrast, blueberries had the lowest NRF9.3 lowest for all unit measures, with the lowest levels of all favourable nutrients except vitamin A. Nutrients to avoid were negligible for all berries.

Cost was lowest for strawberries ($2.30 per 100 g), and highest for blackberries and raspberries ($5.52 per 100 g each), when expressed based on weight. When expressed per 100 calories, blueberries and raspberries had the lowest ($7.21) and highest ($11.37) cost among the berries, respectively. As for the NRF9.3, the reason for this difference is based on calorie content; blueberries are higher in calories than strawberries (per 100 g), leading to a lower quantity of blueberries, costing less, per 100 calories.

Overall, the Australian berry that provides the best source of affordable nutrition is the strawberry, at least double that of the other berries. The nutrient density to cost ratio of strawberries was 53.7, followed by blackberries at 25.8, raspberries at 19.3, and blueberries at 12.2. As the nutrient density to cost ratio is a ratio, it is the same regardless of which unit measure is used for calculation, provided the unit measure is equivalent for both NRF9.3 and cost.

Table 7. Nutrient density (NRF9.3), cost, and nutrient density to cost ratio for each Australian berry.

BERRY TYPE	CALORIES PER 100 G	NUTRIENT DENSITY SCORE[1]			COST ($AUD)			RATIO[2]
		PER 100 G	PER SERVING[1]	PER 100 KCAL	PER 100 G	PER SERVING[3]	PER 100 KCAL	
Blackberry	50.5	142.3	213.5	282.0	5.52	8.28	10.94	25.8
Blueberry	52.2	45.8	68.8	87.9	3.76	5.64	7.21	12.2
Raspberry	48.6	106.5	159.7	219.2	5.52	8.28	11.37	19.3
Strawberry	25.8	123.6	185.3	478.2	2.30	3.45	8.90	53.7

[1] NRF 9.3. [2] Nutrient density to cost ratio. [3] One serving is equivalent to 150 g for whole fruit, based on the Australian Dietary Guidelines [78]. $AUD, Australian dollars; g, grams; kcal, calories.

How do berry polyphenols impact on gut health and microbiota?

Data on the impact of berries and berry polyphenols on gut health and microbiota remains mixed and complex to interpret.

The microbiome influences polyphenol metabolism

Polyphenols need to be broken down to be absorbed – this can be done by enzymes in saliva or the intestines, or by the microbes' resident in the gut. This may explain why polyphenol bioavailability differs between individuals [79].

Berry polyphenols may positively influence microbial balance linked to weight

After 8 weeks supplementation with a berry extract (including blueberry) with a blend of prebiotics, adults with uncomplicated obesity had reduced levels of Firmicutes bacteria ("bad" bacteria – linked to obesity and poor diet) and increased levels of Bacteroidetes bacteria ("good" bacteria – linked to healthy weight) [80]. Improvements were also reported in gastrointestinal symptoms (bloating, gas and abdominal pain) and stool consistency. Results suggest that regular consumption of the berry-prebiotic blend supplement may positively modulate the intestinal ecosystem. However, multiple other studies have failed to show modulation of overall diversity. This may be due to individual population differences (e.g., baseline microbial populations and diets) [62, 80, 81].

Berry polyphenols may inhibit bacterial populations linked to Inflammatory Bowel Disease (IBD) in animal studies

Raspberry ellagitannins inhibit *Staphylococcus* [82] and gallic acid (a metabolite of anthocyanin) inhibits *Clostridium histolyticum* [83]. In a mouse model of IBD, control diet supplemented with 10% blueberry extract decreased *C. perfringens, Enterococcus spp.* and *E. coli* populations [83]. However, clinical studies are required to establish whether blueberry consumption can alter the composition and metabolism of large intestine microbiota and promote colon health in humans.

Berry polyphenols may have a prebiotic like effect

In culture systems, berry extracts and the anthocyanin malvidin-3-glucoside (one of the main anthocyanins in blueberries) enhanced the growth of "good" bacteria (Bifidobacterium and Lactobacillus) [82, 84]. Similar results have been found in rats fed blueberry extracts [85, 86]. In diabetic mice, supplementation with strawberry extract (2.35% freeze-dried strawberry) increased the abundance of beneficial bacteria Bifidobacterium which play a pivotal role in the metabolism of anthocyanins [87].

In humans, 6-week supplementation with a wild blueberry drink, increased "good" Bifidobacterium [88]. No differences were found for *Bacteroides spp., Prevotella spp., Enterococcus spp*, and *Clostridium coccoides*. Results suggest regular consumption of a wild blueberry drink can positively modulate the consumption of the intestinal microbiota.

What are novel uses for Australian berries?

Summary

- Dried berries are becoming increasingly available – alone as snacks or in mixes with nuts, seeds and other snack items. These are now available in major supermarkets. (e.g., https://shop.coles.com.au/a/national/product/dried-strawberries)
- Berry powders are frequently used in research to allow for large volumes, reduce variation and to maintain nutrient profiles. These powders are increasingly available from speciality stores and can be used in cooking and food preparation. (e.g., https://berryfresh.com.au/shop/mixed-berry-powder/)
- Berry leaves are a potential additional source of nutritional and medicinal compounds [89].
    - Berry leaves can be an agribusiness by-product.
    - Phenolics and other phytonutrients (including phenolic acids, flavonoids and tannins) may be extracted for utilisation in functional foods, nutraceuticals or pharmaceuticals.
    - Raspberry, blackberry, and blueberry leaves can be consumed as teas; strawberry leaves are less common.
- Extracts of berries and their leaves may have anti-microbial properties [90].
    - Phenolic compounds found in berries, such as ellagitannins and flavonol myricetinare antibacterial agents – they disrupt microbial membranes, inhibit the function of microbial enzymes and disrupt microbial metabolism.
    - There may be applications in reducing the growth of microbes in foodstuffs or opportunities for extraction to product new antimicrobial products.
- Novelty berries in new varieties may enhance consumer awareness and interest https://www.abc.net.au/news/rural/2022-07-26/pink-white-strawberries-new-varieties-developed-pina-colada/101259808
- Berries are typically eaten at breakfast – with yoghurt, cereals or in smoothies – berries are also great in salads (not just fruit salads!) – green salads with berries and nuts pack a tasty and nutritional punch. (e.g., https://www.tasteofhome.com/recipes/green-salad-with-berries/)
- As a form of waste valorisation fibres from berry pomace (waste from juicing) can be used in baked (e.g., cookies and cakes) and extruded cereal-based foods (e.g., breakfast cereals) [91] to add fibre and phytonutrients, improving their nutritional properties, reducing waste and potentially appealing to health and environmentally conscious consumers [91].

Do growing practices influence the nutrient composition of berries?

Summary

Berries produce bioactive compounds including flavonoids and other antioxidants in response to sunlight, temperature, water, nutrient and salinity stress. Therefore, berries grown in controlled, indoor, soilless and hydroponic conditions may contain lower levels of healthful bioactive compounds.

It is becoming increasingly common for blueberries in Australia to be grown in polytunnels to protect them from varying environmental conditional and to better control inputs of water and fertilizers. Compared to open-field growth, blueberries grown in poly-tunnels have lower polyphenol levels, as they are under less environmental stress. The application of mild and selective stress may improve the bioactive properties of blueberries grown under controlled conditions [92].

Ways to improve the bioactive properties of berries include:

- Light-emitting diodes (LEDs), photo-selective films and exposure of plants to mild stresses could be used to optimise blueberry fruit characteristics and nutrient composition [93].
- Mild water stress improves bioactive levels without compromising firmness, acidity or soluble solids) [94, 95].
- Thinning of foliage can improve berry size, quality and composition of blueberries [96].
- Lower levels of fertilizer (nutrient stress) [97, 98], blue LED light [99], water deficit irrigation[100, 101] and salt stress [102] improve strawberry phenolic and vitamin C content and antioxidant activity. However, over exploitation can favour the production of anti-nutritional compounds.
- Soilless growth conditions can lead to lower sugars and acids in strawberries [103].
- White weed matting, or even newspaper and cardboard mulch may improve berry sugar levels compared to black weed matting [96].

Does the nutrient composition of Australian berries differ by cooking/processing method?

Summary

Berries can be eaten fresh, frozen, dried, cooked in foods, processed into jams or juiced. All berry products remain good sources of bioactive compounds.

Freezing does not compromise the nutritional properties of berries compared to fresh
(Comparisons made in Foodworks 10)

- Generally, polyphenolic compounds are not prone to degradation by freezing [104-106] and some even report a small (less than 5%) increase in the phenolic compounds content after freezing, likely due to relative moisture loss [107, 108].
- Vitamin C and anthocyanin levels are maintained in slow and quick-frozen strawberries [104] and remain relatively stable even during long term frozen storage (4 months) [109]. While some declines are seen after 6 months, the range of these losses are less than the natural levels of variation seen in fresh fruit [105].

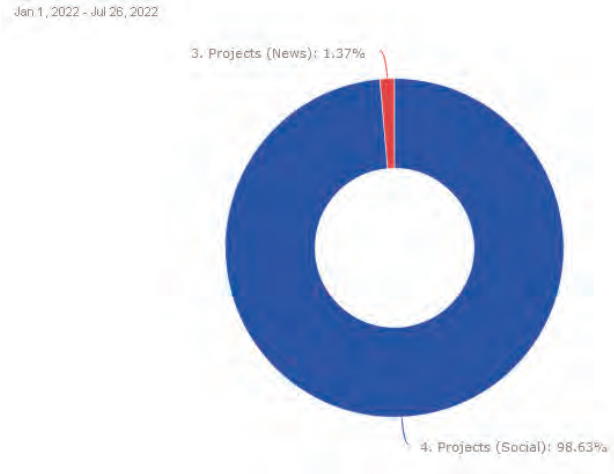
The level of bioactives in dried berries depends on the drying method

- Solar and convective drying may reduce levels of bioactive compounds by approximately 40% due to long drying times required [110]
- Vacuum-drying and freeze-drying conserves almost all bioactives and micronutrients with minimal loss compared to fresh [110]
- Cold-pressing is superior at conserving flavanols compared other juicing methods (including heat pasteurisation method) [111]; losses of ~45-50% compared to up to 85%.
- Bioactives are slightly (~18%) reduced when processed into jams [111].
- Anthocyanin levels are decreased by cooking, proving, and baking by 30-60% [111, 112].

What are the consumer trends for Australian berries?

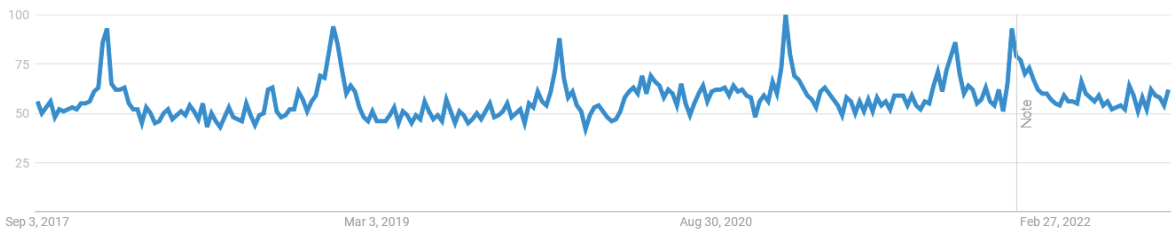
Meltwater Summary

Meltwater, a media monitoring and social listening platform, was searched for both traditional media and social media between Jan 1st 2022 and July 22nd, 2022. Search terms included: (berry OR raspberry OR blueberry OR strawberry OR blackberry OR berries OR raspberries OR blueberries OR strawberries OR blackberries) AND (food OR fruit) AND (nutrition OR nutrient OR science OR taste OR flavour OR health OR antioxidant OR risk OR disease OR illness OR wellness). The search was then further refined by excluding any articles or posts which mentioned the word 'recipe'. Traditional (print and online) media was restricted to articles published within Australia and New Zealand. Social media covered Twitter, YouTube, and Facebook, and could not be restricted by region.



Between Jan 1st 2022 and Jul 26th 2022, most of the information related to berries was shared via social media. Trends on social media show the most used words related to berries are all related to recipes, and no references to health effects were picked up.

When 'recipe' was specifically excluded from the search, some references to health and nutritional properties was detected, including body weight, health, calories, diet, protein. To enhance dissemination of project resources, it is recommended to use a social media strategy and consider inclusion of recipes or practical usage information to enhance resource uptake.



Using Google trends, searches for Berries tend to peak in summer, with the highest number of searches recorded for December-January each year. This doesn't appear to be a global trend – while in the USA there is a slight peak during their northern summer (i.e., June/July), England's search patterns also peak during December. To optimise reach in the Australian market, consider timing events and social media outreach strategies to be timed within the Australian Summer months.

How are berries being talked about in the consumer landscape?

The following are examples of what is being said in the consumer landscape around berries:

- Good for your heart and a brain booster
- High in fibre
- Helps fight inflammation
- May be good for skin
- May help keep arteries healthy
- May help lower blood pressure
- Improves blood sugar levels and insulin to prevent or manage diabetes
- Loaded with antioxidants
- Provides many nutrients
- May improve blood cholesterol
- May protect from cancer
- Keeps you mentally sharp
- Prebiotic for digestive health
- Tiny but powerful from head to heart

How are berries being talked about by dietitians to consumers?

Overall, berries are positively talked about by dietitians. Blueberries are mainly highlighted as a super food, nutrition powerhouse or great all-rounder, that provides a lot of nutrients for not many calories and lower sugar. Health benefits commonly mentioned include a reduced risk of heart disease and diabetes, and excellent for cognitive function and memory ("brainberries"). Blueberries are also showcased as the fruit to provide the blue colour or anthocyanins pigments, in the 'eat a rainbow' concept to increase fruit variety. They are often recommended as the healthiest snack straight from their punnet.

What are the consumer trends for berries consumption in Australia?

- 75% of Australian households buy berries [113].
- 21.7% of berry buyers buy 4 types of berries, and these buyers contribute to 46% of the value of berry sales [114].
- Per capita consumption in 2019/2020 was 3.8kg [113].
    - Strawberry 2.6kg/capita
    - Blueberries 0.78kg/capita
    - Raspberries and blackberries 0.353kg/capita
- All Australian berries saw significant growth from 2012/2013 to 2019/2020 [113].
    - Strawberries 494% export volume increase over the total period.
    - Blueberries 9% year-on-year volume increase.
    - Blackberries and raspberries 458% increase in the total volume produced over the total period.
- All Australian berries saw sales growth in the 12 months to April 2020 [113].
    - Strawberries – 4% sales growth
    - Blueberries – 6% sales growth
    - Raspberries – 6% sales growth
    - Blackberries – 92% sales growth

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Appendices

Supplementary Tables

Table S1. Berries: The number of publications found for each identified health outcome.

OUTCOME	UMBRELLA REVIEW	SYSTEMATIC REVIEW WITH META-ANALYSIS	SYSTEMATIC REVIEW WITH NARRATIVE SYNTHESIS	RCT	COHORT	TOTAL
Cognition, vascular function & CVD risk factors			1			**1**
CVD risk factors		4	1	1		**6**
Cardiovascular			1			**1**
Heart health			1	1	2	**4**
Metabolic syndrome			1	4		**4**
Glycaemic response				1		**1**
Inflammation				1		**1**
Cognitive function				1	2	**3**
T2DM / insulin resistance		2		1	2	**5**
Weight management					1	**1**

Pregnancy					4	**4**
Mortality					3	**3**
Physical function					1	**1**
Cancer		1			3	**4**
Infant health					2	**2**
Respiratory health					1	**1**
Gastrointestinal health					1	**1**

Table S2. Blackberry: The number of publications found for each identified health outcome.

OUTCOME	UMBRELLA REVIEW	SYSTEMATIC REVIEW WITH META-ANALYSIS	SYSTEMATIC REVIEW WITH NARRATIVE SYNTHESIS	RCT	COHORT	TOTAL
Weight management				1		**1**
Bone health				1		**1**
CVD risk factors				1		**1**

Table S3. Blueberry: The number of publications found for each identified health outcome.

OUTCOME	UMBRELLA REVIEW	SYSTEMATIC REVIEW WITH META-ANALYSIS	SYSTEMATIC REVIEW WITH NARRATIVE SYNTHESIS	RCT	COHORT	TOTAL
Exercise			1	5		**6**
Metabolic syndrome		1				**1**
Cognitive function			2	8		**10**
CVD risk factors		1		8		**8**
T2DM/ insulin resistance			1	1	1	**3**
Blood pressure		1				**2**
Gestational diabetes*				1		**2**
Postprandial effects				3		**3**
Vascular function				2		**2**
Osteoarthritis & juvenile idiopathic arthritis				2		**2**
Inflammation & oxidative stress				5		**5**
Eye health				1		**1**
Mental health				1		**1**

Gastrointestinal health	1	**1**
Mobility	1	**1**
*Blueberry intervention includes soluble fibre		

Table S4. Red raspberry: The number of publications found for each identified health outcome.

OUTCOME	UMBRELLA REVIEW	SYSTEMATIC REVIEW WITH META-ANALYSIS	SYSTEMATIC REVIEW WITH NARRATIVE SYNTHESIS	RCT	COHORT	TOTAL
Metabolic syndrome				1		**1**
Cardiovascular				1		**1**
Inflammation				1		**1**
T2DM/ insulin resistance				2		**2**

Table S5. Strawberry: The number of publications found for each identified health outcome.

OUTCOME	UMBRELLA REVIEW	SYSTEMATIC REVIEW WITH META-ANALYSIS	SYSTEMATIC REVIEW WITH NARRATIVE SYNTHESIS	RCT	COHORT	TOTAL
CVD risk factors		2		11		**13**
Inflammation & oxidative stress				6	1	**7**
Cancer				1		**1**
Cardiovascular				1		**1**
Weight management				1		**1**
Cognitive function				1		**1**
T2DM / insulin resistance				2		**2**
Exercise performance				1		**1**
Immunity				1		**1**
Stroke					1	**1**

APPENDIX 4

Berry Nutritious

All berries are nutritious, with fibre and bioactives. But each offers a unique nutrition package.

	Strawberry 170% of vitamin C needs Vitamin C Superstar	Blueberry #1 in polyphenols Polyphenol Punch	Raspberry Source of 5 nutrients Nutrient All-rounder	Blackberry Highest in fibre, vitamin E & magnesium Big Boss
Nutrients[1]				
Energy kJ	164	291	305	317
Sugars g	5.7	13.8	8.4	11.3
Fibre g (DI%)	3.8 (13%)	5.3 (18%)	8.4 (28%)	9.2 (31%)
Vitamin C mg (DI%)	68 (170%)	3 (8%)	44 (110%)	57 (143%)
Vitamin E mg (DI%)	0.5 (5%)	0.8 (8%)	1.1 (11%)	2.1 (21%)
Folate µg (DI%)	59 (30%)	0 (0%)	51 (26%)	51 (26%)
Magnesium mg (DI%)	12 (4%)	9 (3%)	30 (9%)	45 (14%)
Manganese mg (DI%)	0.5 (10%)	0.1 (2%)	0.8 (16%)	0.8 (16%)
Bioactives				
Total polyphenols mg[2]	390	806	310	374
Highest in bioactive type	✓ Resveratrol (a polyphenol)	✓ Lutein (a carotenoid)	✓ Ellagitannin (a polyphenol)	✓ Lignan (a polyphenol)

Enjoy now, or freeze for later

	Strawberry	Blueberry	Raspberry	Blackberry
Store in fridge	✓ 5 days	✓ 5–7 days	✓ 1–2 days	✓ 2 days
Freeze	✓ 6 months	✓ 3 months	✓ 12 months	✓ 6 months
Rinse	✓ Gentle	✓ Gentle	✗ Dip in water	✓ Gentle
Enjoy	Room temp	Chilled	Room temp	Room temp

Data based on a standard serve (150g). DI = Daily intake.

1. Foodworks 10. 2. Perez-Jimenez et al. EJCN. 2010

Farming berries

Australian berry growers use a 3-step approach to manage pests and keep berries fresh:

BIOLOGICAL

- Some insects, mites and spiders encouraged.
- Rid pests without affecting quality.

CULTURAL

- Proven techniques that reduce pests.
- E.g. rain covers, tillage, rolling, irrigation & crop rotation.

CHEMICAL

- Registered pesticides used as a third resort only when required.
- Broken down over time and by environmental factors such as rain and sunlight.

NRAUS NUTRITION RESEARCH | Hort Innovation

The project has been funded by Hort Innovation using the blueberry, raspberry and blackberry research and development levies and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Berry Healthy

Snapshot of findings across 185 studies from a literature review on berries and health[1].

Brain function
Improved measures of cognitive performance

Reduced inflammation
Reductions in inflammatory markers

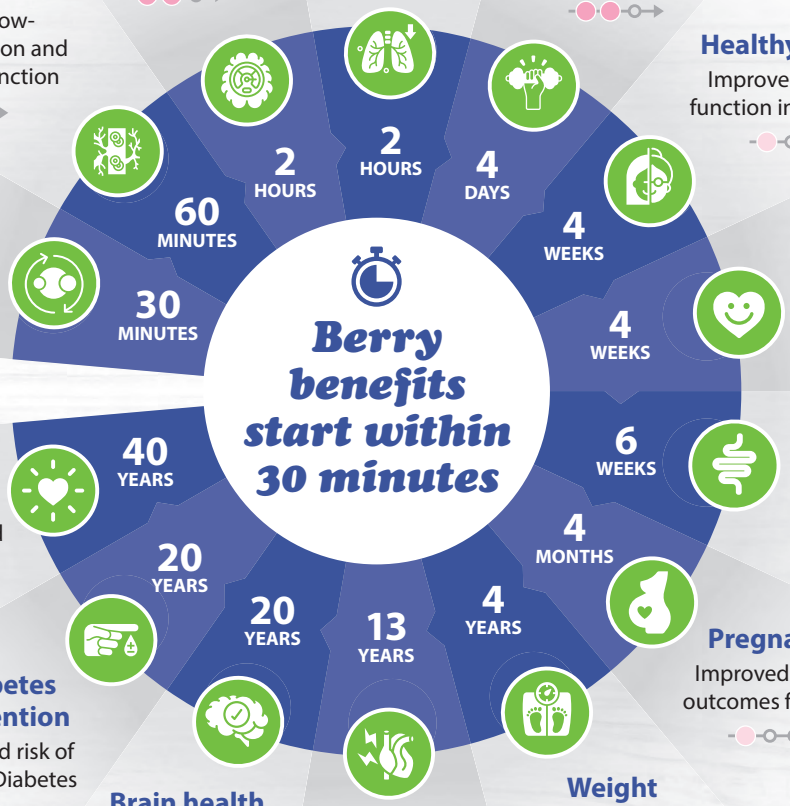
Exercise recovery
Reductions in markers of muscle damage

Healthy blood vessels
Improved flow-mediated dilation and endothelial function

Healthy ageing
Improved physical function in the elderly

Metabolic health
Improved glucose and insulin response

Markers of heart health
Improved cholesterol, blood pressure, and triglycerides



Gut health
Favourable changes to the gut bacteria

Longer life
Associated with reduced all-cause mortality

Pregnancy
Improved health outcomes for mum

Diabetes prevention
Reduced risk of Type 2 Diabetes

Weight management
Associated with less weight gain

Brain health
Reduced cognitive decline in ageing

Heart disease prevention
Reduced risk of coronary heart disease

Which berry?

All berries support health, but most of the research has been on blueberries and strawberries

Blueberry
- Markers of heart health
- Healthy blood vessels
- Brain health
- Diabetes prevention
- Exercise recovery
- Brain function
- Weight management
- Reduced inflammation
- Pregnancy

Strawberry
- Markers of heart health
- Metabolic health
- Weight management
- Reduced inflammation
- Healthy blood vessels
- Brain health
- Heart disease prevention

Raspberry
- Markers of heart health
- Healthy blood vessels
- Metabolic health
- Reduced inflammation

Blackberry
- Metabolic health

Limited – Implement with care, e.g., singular small study.

Moderate – Evidence can be trusted in most situations, e.g., consistent evidence in prospective cohort studies; numerous RCTs but with some inconsistent results.

Strong – Evidence can be trusted, e.g., Consistent effects across well designed RCTs.

How much? Benefits most commonly seen at 125–500 grams (about 1–3 cups) a day. **1 serve = 1 cup (150 grams)**

1. Nutrition Research Australia. Berries and Human Health: A summary of the Science. 2022. (Unpublished).

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Berry Polyphenol

Nutrition science shows that non-nutrient components of plant foods improve health

WHAT?

- Polyphenols are the main type of bioactives (non-nutrients) in plant foods
- Protects plants from environmental stressors & pathogens
- Contributes to their colour, flavour & smell

KEY CLASSES?

- Flavonoids
- Phenolic acids
- Lignans
- Stilbenes

KEY SOURCES?

- Fruits & vegetables
- Grains
- Legumes
- Nuts & seeds
- Oils
- Tea, coffee & wine

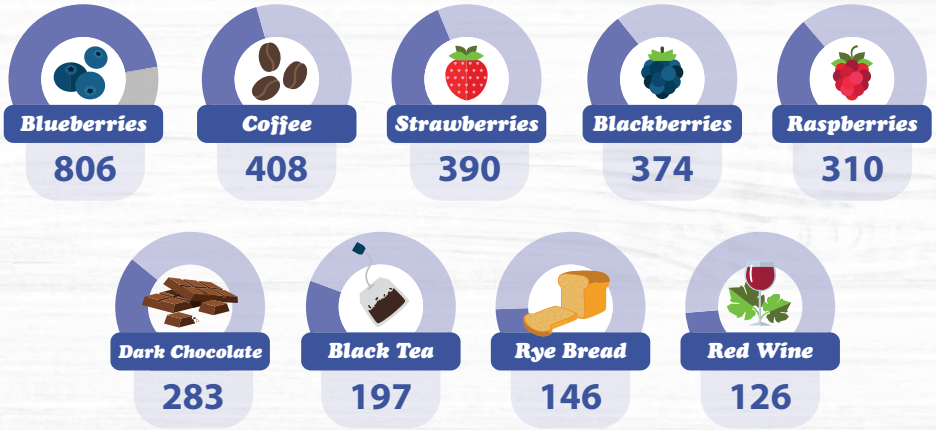
The rise of polyphenols

- **2800 BC** — Evidence of plant foods being used as medicine
- **1912** — Vitamins first discovered to explain health benefits of food
- **1980s** — Many polyphenols in plants first identified as health promoting
- **1990s** — Antioxidant capacity in fruits shown to correlate to their polyphenol content
- **TODAY** — Health benefits established with 8000+ polyphenol compounds identified

Common sources of polyphenols

Total polyphenol content per serve (mg)[1]

- Berries are the highest food source of polyphenols per serve[1]
- Anthocyanins represent up to 70% of their total polyphenol content[2]
- Some berries have been associated with lower Type 2 Diabetes risk[3] and weight gain[4] than for total fruits, possibly due to their high polyphenol content



Polyphenols are much more than antioxidants

CARDIOPROTECTIVE

- Anti-platelet effects
- Anti-inflammatory effects
- Inhibits LDL oxidation
- Lowers incident of CVD

ANTI-DIABETIC

- Can enhance insulin production
- Improves insulin sensitivity

PREBIOTIC

- Prebiotic-like effects
- Increases Bifidobacterium & Lactobacilllus

ANTI-CANCER

- Protective effect in human cancer cell models

ANTI-AGEING

- Antioxidant & anti-inflammatory effects may result in anti-ageing benefits

NEUROPROTECTIVE

- Improves brain plasticity
- Supports memory
- May reduce cognitive decline

1. Perez-Jimenez et al. EJCN. 2010 2. Olas. Front. Pharmacol. 2018 3. Bertoia et al. PLoS Med. 2015 4. Muraki et al. BMJ. 2013

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APPENDIX 5

Nourish Your GUT, Feed Your BRAIN

With Australian berries

Berries are a powerful little fruit that support the gut-brain axis.

Interest in gut & brain health is strong & growing. It is emerging that gut health is about more than just fibre, with bioactive polyphenols also important. *Berries are enjoyable all-rounders, rich in nutrients, polyphenols and fibres that nourish the gut & feed the brain.*

Brain Health

Brain health includes full cognitive, sensory, social, emotional, behavioural, and motor function throughout life irrespective of disorders[1].

A HEALTHY BRAIN INCLUDES[1]:

- **Short-term** - good memory, mood, movement, cognitive performance, sensation, and executive function.
- **Mental health** – reducing anxiety, depression, stress.
- **Long-term** – reducing neurodegenerative disease and cognitive decline.

Gut Health

50% of Australians experience gut health problems, with 1 in 7 experiencing distressing gut health symptoms[2].

A HEALTHY GUT INCLUDES:[3,4]

- effective digestion and absorption of food.
- the absence of gastrointestinal illness.
- effective immune status.
- the absence of gastrointestinal symptoms (e.g. abdominal pain, constipation, bloating, diarrhoea).
- normal, stable and diverse microbiota[5].

The Gut Brain Axis

The gut-brain axis is a constantly interacting, bidirectional communication system connecting the central nervous system (CNS) and the gastrointestinal (GI) tract[6].

- Can influence memory, mood, digestion, metabolism, immunity, mood regulation, motivation, cognitive functions and pain[6,7].
- Dysbiosis (microbiome imbalance) occurs in cognitive, neurological, and mood disorders[8].

HORMONES
VAGUS NERVE
METABOLITES

What's in berries that PACKS A PUNCH?

Berries are jam-packed full of health promoting nutrients & fibre. The power of berries also comes from polyphenols.

MICRONUTRIENTS

Vitamins C & E, Folate, Magnesium & Manganese – **levels vary by berry**.

POLYPHENOLS

- Bioactive compounds – they aren't essential to survive but have health-promoting actions[9].
- **Abundant in berries** – they give berries their vibrant colours, flavours, and aromas[5].
- Act like prebiotics in the gut – they help the 'good' bacteria to flourish[10].

FIBRE

Berries contain insoluble & soluble fibres – these promote gut health and feed the 'good' gut bacteria that produce compounds to nourish the brain[5].

IMPROVE BRAIN HEALTH

IMPROVE GUT HEALTH

IMPROVE GUT-BRAIN AXIS

Berries & Brain Health - the evidence

SYSTEMATIC REVIEWS (11 STUDIES EACH)

Consumption of whole berries and their products can improve[11]

- resting brain perfusion
- memory and learning
- executive function
- processing speed
- attention
- psychomotor function

Berry fruits and their components can facilitate[11]

- neuroplasticity
- neurotransmission
- neuronal calcium homeostasis

Blueberry fruit, juice and powder intake linked to[12]

- improvements in short and long term memory

PROSPECTIVE COHORT STUDIES

Higher blueberry and strawberry intakes are linked to slower cognitive decline[23].

- In a study of over 16,000 elderly people the improvements seen were the equivalent of being 1.5-2.5 years younger[23].

BERRIES & THE GUT

- 4 weeks of freeze-dried strawberry powder (~260g fresh equivalent) led to significant changes in the levels of some gut microbes associated with health and longevity (Christensenellaceae, Mogibacteriacea, Verrucomicrobiaceae, Bifidobacterium, Bacteroidaceae)[24].

INTERVENTION STUDIES - BERRY SUPPLEMENTATION

Mixed berries may reduce cognitive fatigue in young adults[13].

- In 40 healthy young adults accuracy on cognitive tasks was maintained over time, and response times were quicker when a 400mL mixed berry smoothie (75g each of blueberry, raspberry, blackberry and strawberry) was consumed[13].

Mixed berries may improve cognitive performance in older adults.

- In 40 healthy older adults working memory was better after a mixed berry drink (150g blueberries, 50g blackcurrant, 50g lignonberries and 50g strawberries)[14].

Blueberries may improve cognitive performance in older adults with mild cognitive impairment.

- In 4 randomized controlled trials,[15, 16-18] ranging from 12 to 24 weeks, cognitive performance was improved across a variety of tests.

Blueberries may limit the loss of cognitive performance after anaesthesia.

- In 26 patients undergoing major surgery 500mL/day blueberry juice for 14 days before surgery improved cognitive function after anaesthesia[19].

Blueberries may improve cognitive performance in children.

- In 21 children (7-10 years old) a single supplement of 15g or 30g of blueberry powder, and repeat dosing over 3 weeks both lead to improve cognitive performance[20,21].

Strawberries may improve spatial navigation and verbal learning performance.

- In 37 older adults supplementation with freeze dried strawberries (equivalent to 2 cups fresh) improved cognition[22].

Many of these benefits are thought to be due to the high polyphenol content of berries.

HIGH IN POLYPHENOLS

Polyphenols: What are they and what do they do?

Polyphenols are bioactive compounds in plant foods

Classified into flavonoids and nonflavonoids based on their chemical structure.

Flavonoids are the most abundant subgroup[9].

Have anti-inflammatory, antioxidant, anti-aging, anti-tumor, antimicrobial, immunomodulatory, and lipid and glucose-lowering effects[9].

Berries are the highest food source of polyphenols per serve:

PHENOLIC ACIDS & FLAVONOIDS	Strawberries	Blueberries	Raspberries	Blackberries
Phenolic acid esters	2.5	89.4	0.9	8.5
Anthocyanins	72.2	187.3	72.5	172.6
Flavonols (glucosides)	2.2	38.6	16.3	12.8
Flavonols (catechins)	9.1	1.1	5.8	13.9
Tannins	173.7	334.2	156.5	75.9
TOTAL PHENOLICS	**209-443**	**154-585**	**192-529**	**411-678**

From Komarnytsky et al 2023[5].

How Berry Polyphenols Improve Brain Health

DIRECT EFFECTS ON THE BRAIN

- Berry polyphenols may support brain health by improving[11] vascular health, neuro-synthesis and glucoregulation.
- Berry polyphenols can reduce oxidative stress and tissue damage in the brain helping to prevent neurodegenerative diseases, reduce neuronal apoptosis and improve memory, learning and cognitive functions[25].

INDIRECT EFFECTS VIA THE GUT

- 90-95% of berry polyphenols reach the colon to interact with the microbiota[5,26].
- Potential mechanisms include[12,27] direct inhibition of bacterial overgrowth and microbial metabolism to produce and enhance bioavailability of compounds that support brain health .
- Berry polyphenols can have a prebiotic-like effect by increasing beneficial bacteria reducing inflammation[5,26] which can impact brain health[10].
- Complex carbohydrates and polyphenols in berries can rebalance Firmicutes: Bacteroidetes ratios[5], which can be unbalanced in cognition-related health conditions[28].
- Berries can increase anti-inflammatory butyrate producing bacteria in the gut[5].

Berry polyphenols can directly protect the brain through anti-oxidant, anti-inflammatory and other modulatory functions.

Through nourishment of beneficial microbes metabolites may support brain health via the gut brain axis.

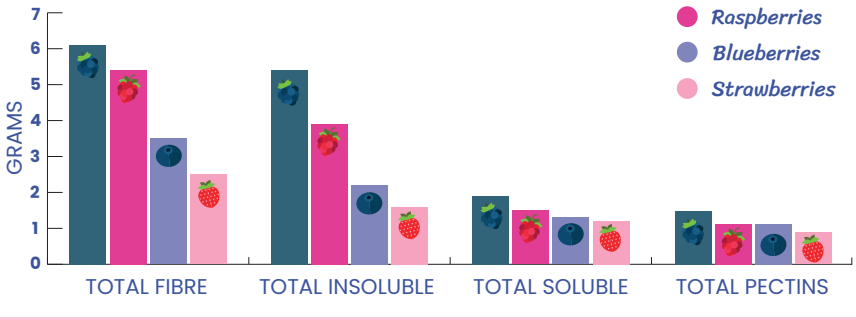
BRAIN RELATED BERRY BENEFITS START WITHIN 30 MINUTES FROM CONSUMPTION

- 30 MINS — Improved glucose and insulin response.
- 60 MINS — Improved flow-mediated dilation and endothelial function.
- 2 HRS — Improved measures of cognitive performance and reduction of inflammatory markers.
- 4 WEEKS — Improved physical functioning in the elderly.
- 6 WEEKS — Favourable changes in gut bacteria.
- 20 YEARS — Reduced cognitive decline in ageing.

Types of dietary fibre in berries

Berries have insoluble fibre (cellulose), insoluble fermentable fibre (hemicellulose), soluble but less fermentable fibres (arabinoxylans), and soluble fermentable fibres (beta-glucans, inulins, pectins) that can benefit the microbiome[5].

BERRY FIBRE FACTS (1 CUP)[29,30]



PREBIOTIC FIBRES Specific abundant pre-biotic fibres

Blueberries	Strawberries	Raspberries	Blackberries

FOS

INULIN

PECTIN

Fructooligosaccharides (FOS): A type of oligosaccharide. FOS acts as a prebiotic by selectively stimulating the growth of beneficial bacteria in the gut, such as Bifidobacteria.

Pectin: Another type of soluble fibre. It has prebiotic properties and helps nourish beneficial gut bacteria.

Inulin: A type of soluble fibre that acts as a prebiotic. Inulin passes through the digestive system intact and serves as a food source for beneficial bacteria in the colon, promoting their growth and activity.

Berry Nutricious

Berries are low in energy and sugars, while tasting sweet, and jam packed with important micronutrients.

NUTRIENTS (per 150 g)[30]	Strawberry 170% of vitamin C needs — Vitamin C Superstar	Blueberry #1 in polyphenols — Polyphenol Punch	Raspberry Source of 5 nutrients — Nutrient All-rounder	Blackberry Highest in fibre, vitamin E & magnesium — Big Boss
ENERGY KJ	164	291	305	317
SUGARS G	5.7	13.8	8.4	11.3
VITAMIN C MG (DI%)	68 (170%)	3 (8%)	44 (110%)	57 (143%)
VITAMIN E MG (DI%)	0.5 (5%)	0.8 (8%)	1.1 (1%)	2.1 (21%)
FOLATE µG (DI%)	59 (30%)	0 (0%)	51 (26%)	51 (26%)
MAGNESIUM MG (DI%)	12 (4%)	9 (3%)	30 (9%)	45 (14%)
MANGANESE MG (DI%)	0.5 (10%)	0.1 (2%)	0.8 (16%)	0.8 (16%)

Berry Unique

Eating a variety of berries offers health benefits above consuming a single type of berry. All berries offer unique health benefits individually, consuming mixed berries can:

1. Enhance nutritional and bioactive diversity - providing a broader spectrum of nutrients, antioxidants, and prebiotics for overall health and wellbeing.
2. Facilitate potential synergistic effects by enhancing functions of different components.

References:

1. World Health Organisation. Brain health (2023) https://www.who.int/health-topics/brain-health. **2.** The Gut Foundation https://gutfoundation.com.au/. **3.** Bischoff (2011) https://doi.org:10.1186/1741-7015-9-24. **4.** Staudacher (2021) https://doi.org:https://doi.org/10.1016/S2468-1253(21)00071-6. **5.** Komarnytsky (2023) https://doi.org:10.1007/s13668-023-00449-0. **6.** Mayer (2011) https://doi.org:10.1038/nrn3071. **7.** Cryan (2012) https://doi.org:10.1038/nrn3346. **8.** Rogers (2016) https://doi.org:10.1038/mp.2016.50. **9.** Zhang (2023) https://doi.org:https://doi.org/10.1016/j.phrs.2023.106787. **10.** Drljača (2023) https://doi.org:https://doi.org/10.1111/cns.14076. **11.** Bonyadi (2022) https://doi.org:10.1038/s41598-022-07302-4. **12.** Travica (2020) https://doi.org:10.1016/j.bbi.2019.04.001. **13.** Whyte (2019) https://doi.org:10.3390/nu11112685. **14.** Nilsson (2017) https://doi.org:10.1371/journal.pone.0188173. **15.** Krikorian (2010) https://doi.org:10.1021/jf9029332. **16.** Boespflug (2018) https://doi.org:10.1080/1028415x.2017.1287833. **17.** McNamara (2018) https://doi.org:10.1016/j.neurobiolaging.2017.12.003. **18.** Rutledge (2021) https://doi.org:10.1039/d0fo02125c. **19.** Traupe (2018) https://doi.org:10.23736/s0375-9393.18.12333-9. **20.** Whyte (2016) https://doi.org:10.1007/s00394-015-1029-4. **21.** Barfoot (2019) https://doi.org:10.1007/s00394-018-1843-6. **22.** Miller (2021) https://doi.org:10.1017/s0007114521000222. **23.** Devore (2012) https://doi.org:10.1002/ana.23594. **24.** Ezzat-Zadeh (2021). https://doi.org:10.1016/j.nutres.2020.12.006. **25.** Subash (2014). https://doi.org:10.4103/1673-5374.139483. **26.** Lavefve (2020). https://doi.org:10.1039/C9FO01634A. **27.** Flanagan (2018). https://doi.org:10.1007/s13668-018-0226-1. **28.** Białecka-Dębek, (2021) https://doi.org:10.3390/nu13082514. **29.** Cosme (2022). https://doi.org:10.3390/foods11050644. **30.** Foodworks online.

SCAN FOR MORE INFO

This brochure is intended for educational purposes only.

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Nourish Your GUT, Feed Your BRAIN

With Australian berries

Be berry well.

What you eat impacts gut health as well as mood, brain function and brain health.

A healthy brain and gut can help us to live our *berry* best lives.

Brain & Gut 101

A HEALTHY BRAIN regulates our emotions, moods, behaviours and senses[1], supporting mental performance, and memory - helping us to live well now and as we age[2].

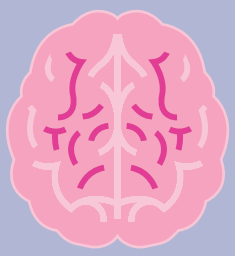
A HEALTHY GUT means regular bowel movements, gut symptoms that don't interrupt your quality of life, and the microbes that live in your gut are in balance[3].

THE GUT-BRAIN AXIS is the two-way communication between your brain and your gut[4] with each influencing the other's functions[4,5].

Berries feed the brain.

Studies show that eating more berries can:

- Improve memory, learning, attention[6-8], & executive function – the mental processes that help us to plan, focus, remember and juggle tasks[6,9].
- Improve the flow of oxygen & energy to the brain[6] and transport information between brain cells[6,9].
- Improve neuroplasticity - the forming of new connections in the brain to help us learn, grow, and form memories[6].
- Reduce cognitive fatigue[10] and slow cognitive decline[11].



What's in berries that packs a POWERFUL PUNCH?

Berries are jam-packed full of health promoting nutrients including fibre. The power of berries also comes from bioactive polyphenols.

MICRONUTRIENTS

Vitamin C, Vitamin E, Folate, Magnesium & Manganese – **in different levels across each berry type**.

POLYPHENOLS

- **Abundant in berries** – giving their vibrant colours, flavours, and aromas[3].
- **Bioactives** – health promoting compounds[12].
- **Act like prebiotics in the gut** – help the 'good' bacteria to flourish[13].

FIBRE

Contain insoluble and soluble fibres – these promote gut health and feed the 'good' gut bacteria that produce compounds to nourish the brain[3].

IMPROVE BRAIN HEALTH

IMPROVE GUT HEALTH

SUPPORT GUT-BRAIN AXIS

How berry polyphenols improve brain health

DIRECTLY

- Improve blood flow to the brain[6].
- Increase synthesis of brain & nerve cells[6].
- Regulate glucose levels - the main energy source for the brain[6].
- Protect the brain through antioxidant actions[14].

INDIRECTLY BY NOURISHING THE GUT

90-95% of berry polyphenols reach the large intestine where they interact with the gut microbiota[3,15]:

- inhibiting the growth of 'bad' bacteria[8,16]
- supporting the growth of 'good' bacteria that produce compounds that support brain health[8,16].

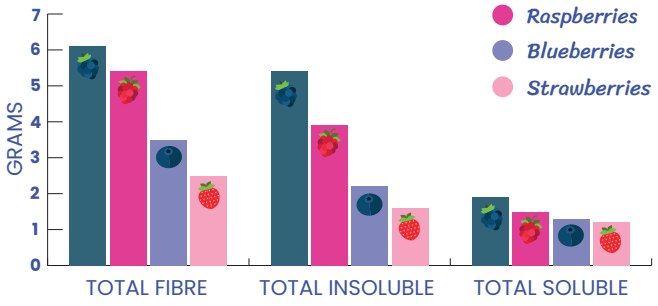
TOP TIP: Each berry has their own unique profile of **polyphenols** – so choosing a variety of berries ensures you get a range of polyphenols & benefits.

How berries improve gut health

BERRIES CONTAIN:

- **Insoluble fibres** - help transport nutrients and polyphenols to support the 'good' gut microbes[3].
- **Soluble fermentable fibres** - feed the 'good' gut bacteria[3].
- **Pectins** - particular soluble fibres that stimulate the growth of health promoting bacteria and their production of anti-inflammatory & anti-oxidant compounds[17].
- **Polyphenols** - help the 'good bacteria' to grow.

BERRY FIBRE FACTS (1 CUP)[18,19]



Berrylicious...

Berries are good for brain and gut health and they also make other gut and brain-healthy foods like wholegrains and fish tasty!

Try these culinary and practical tips to eat berry well...

MAKE ICE CUBES

MIXED BERRY & CHIA SEED PUREE

ADD TO WHOLEGRAIN PANCAKES OR TOAST

BERRIES AND LEMON JUICE IN COMPOTE

WITH MEAT, FISH & CHICKEN DISHES

IN DRESSINGS

Take home message:

Berries NOURISH THE GUT and FEED THE BRAIN in a sweet, delicious way!

To maximise the power of berry polyphenols, nutrients, and fibres, eat a mix of blackberries, blueberries, raspberries, and strawberries to nourish the gut and feed the brain.

References:

1. National Institute on Aging. Cognitive health and older adults, <https://www.nia.nih.gov/health/cognitive-health-and-older-adults> (2023). **2.** World Health Organisation. Brain health, <https://www.who.int/health-topics/brain-health#tab=tab_1> (2023). **3.** Komarnytsky (2023). https://doi.org:10.1007/s13668-023-00449-0. **4.** Mayer (2011). https://doi.org:10.1038/nrn3071. **5.** Cryan (2012). https://doi.org:10.1038/nrn3346. **6.** Bonyadi (2022). https://doi.org:10.1038/s41598-022-07302-4. **7.** Nilsson (2017). https://doi.org:10.1371/journal.pone.0188173. **8.** Travica (2020). https://doi.org:10.1016/j.bbi.2019.04.001. 9. Bell (2021). https://doi.org:10.1080/09637486.2020.1852192. 10. Whyte (2019). https://doi.org:10.3390/nu11112685. **11.** Devore (2012). https://doi.org:10.1002/ana.23594. **12.** Zhang (2023). https://doi.org:https://doi.org/10.1016/j.phrs.2023.106787. **13.** Drljača (2023) https://doi.org:https://doi.org/10.1111/cns.14076. **14.** Subash (2014). https://doi.org:10.4103/1673-5374.139483. **15.** Lavefve (2020). https://doi.org:10.1039/C9FO01634A. **16.** Flanagan (2018). https://doi.org:10.1007/s13668-018-0226-1. **17.** Pascale (2022). https:// 10.3390/nu14173629. **18.** Cosme (2022). https://doi.org:10.3390/foods11050644. **19.** Foodworks online.

SCAN FOR MORE INFO

This brochure is intended for educational purposes only.

NRAUS
www.nraus.com

Hort Innovation

The project has been funded by Hort Innovation using the blueberry, raspberry and blackberry research and development levies and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

APPENDIX 6

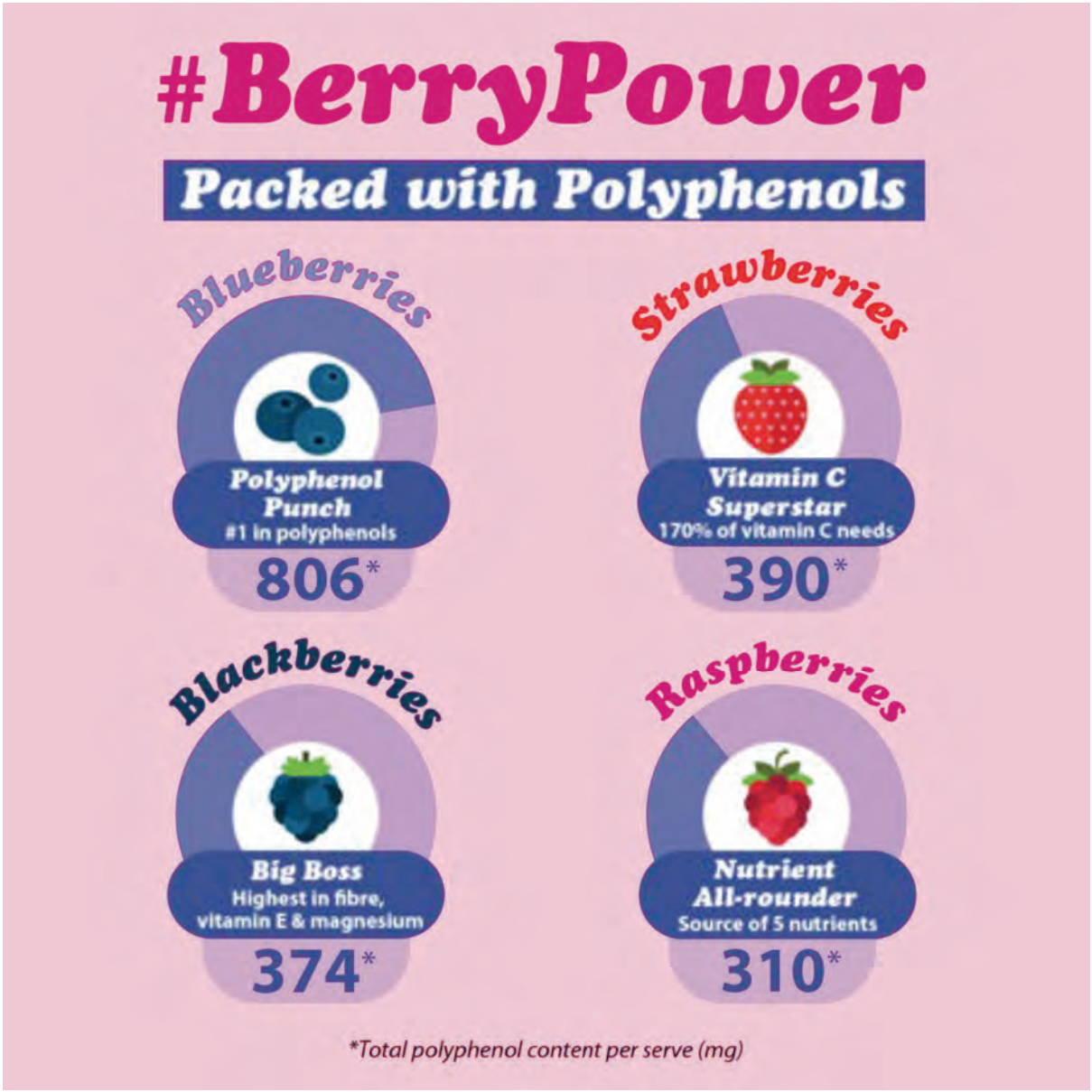
MT21000 SOCIAL MEDIA TILES

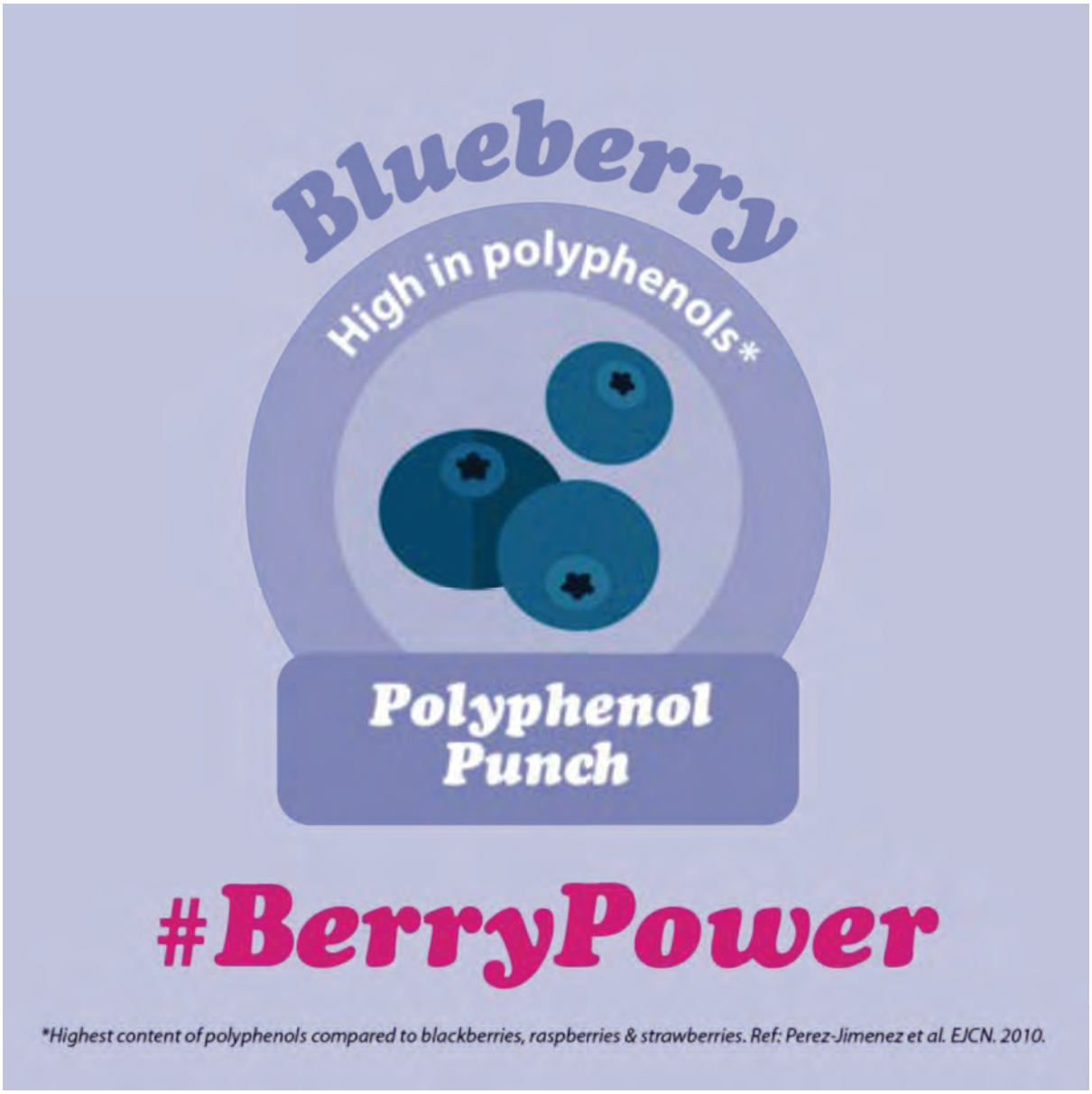
Prepared for:

Hort Innovation
September 2023

Prepared by:

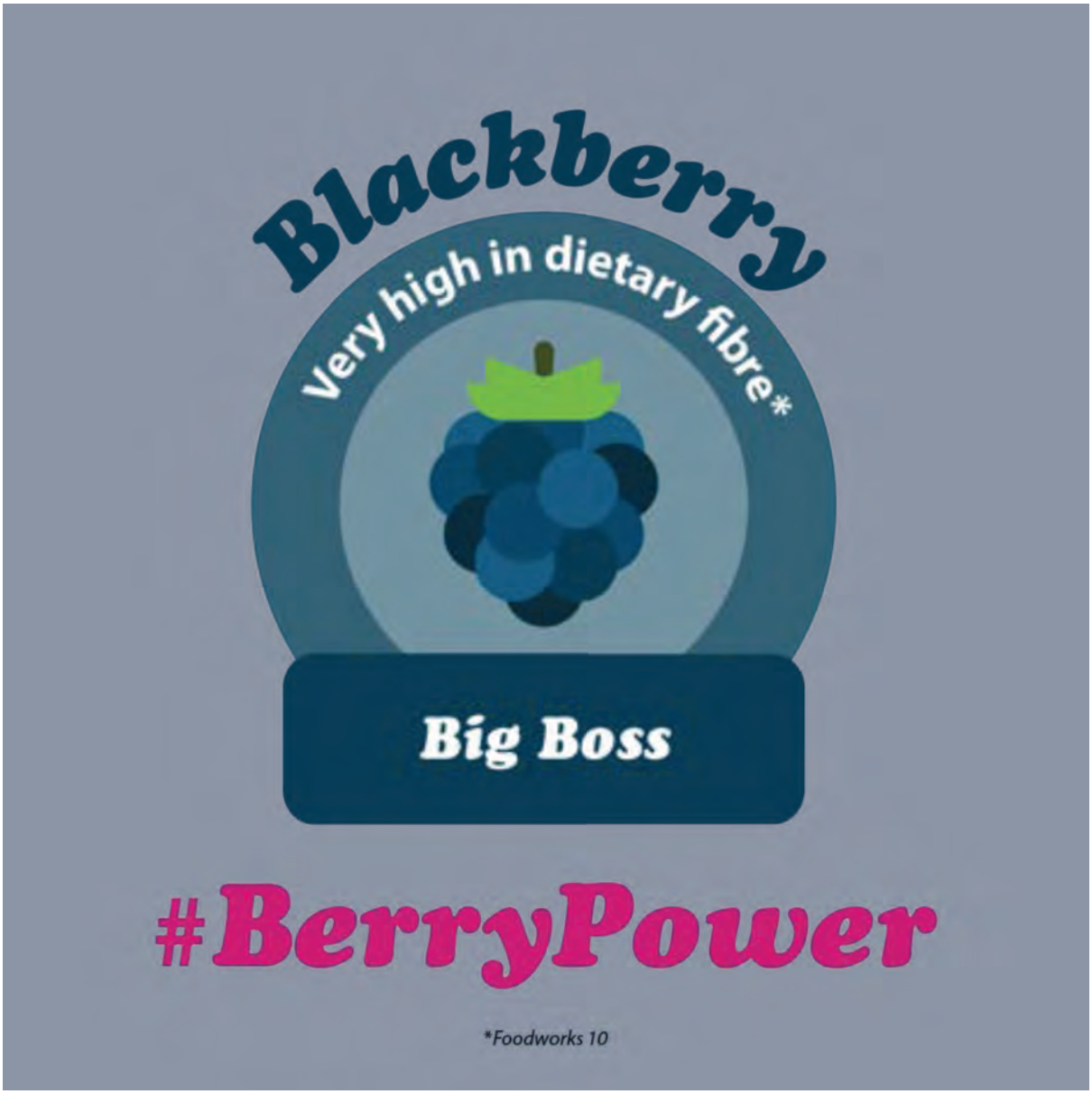
Nutrition Research Australia Pty Ltd


#BerryPower
Packed with Polyphenols
Blueberries
Polyphenol Punch
#1 in polyphenols
806*
Strawberries
Vitamin C Superstar
170% of vitamin C needs
390*
Blackberries
Big Boss
Highest in fibre, vitamin E & magnesium
374*
Raspberries
Nutrient All-rounder
Source of 5 nutrients
310*
*Total polyphenol content per serve (mg)


Blueberry
High in polyphenols*
Polyphenol Punch
#BerryPower
*Highest content of polyphenols compared to blackberries, raspberries & strawberries. Ref: Perez-Jimenez et al. EJCN. 2010.


Strawberry
170% of vitamin C needs*
Vitamin C
Superstar
#BerryPower
*Foodworks 10


Raspberry
Fibre, vitamin C, E, manganese and folate*
Nutrient
All-rounder
#BerryPower
*Foodworks 10


Blackberry
Very high in dietary fibre*
Big Boss
#BerryPower
*Foodworks 10

APPENDIX 7

NRAUS

Berries KOL Event: Evaluation Report

Prepared for Hort Innovation

January 2023

“Berry Well Tribe” – exclusive online KOL event

"Berry Well Tribe" – exclusive online KOL event
Summary Results

Attendance

101 invited
33 registered to attend
19 attended live
14 completed feedback (74%)

Follower count of attendees

Instagram: 7,631 (103 – 31,900)
Twitter: 1,608 (503 – 24,200)

(median, range)

Information related to the event was shared by **11/19 attendees (57%)**

Top posters (Insta reach: 108K):

- Ebony Crameri
- Karen Kingham
- Monique Cormack
- Michelle McCraken
- Dr Emma Beckett
- Natalie Hayllar
- Sarah Gray
- A/Prof Sara Grafenauer
- Prue Mynard
- Millie Padula
- Nicole Dynan

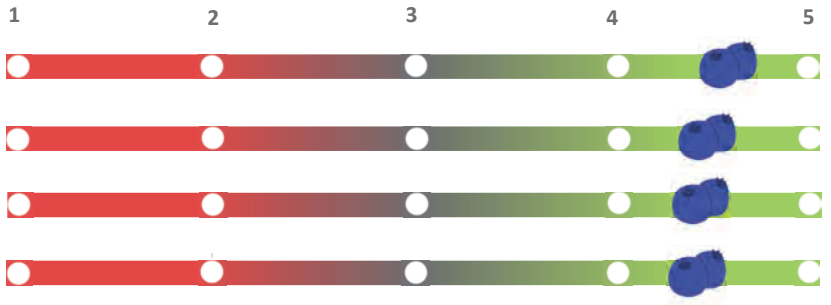
100% (14/14) rated the event as "Excellent" or "Very Good"

85% (12/14) rated **informativeness** as "Extremely" or "Very Informative"

85% (12/14) rated **engagement** as "Exceptional" or "Above Average"

78% (11/14) rated **usefulness** as "Extremely Useful" or "Very Useful"

Overall, how would you rate the event?	**4.64**
How **informative** did you find the event?	**4.42**
How **engaging** did you find the event?	**4.35**
How **useful** do you feel the information presented to you was?	**4.21**



What attendees said about the online KOL event format:

"Loved the meeting vs webinar format"

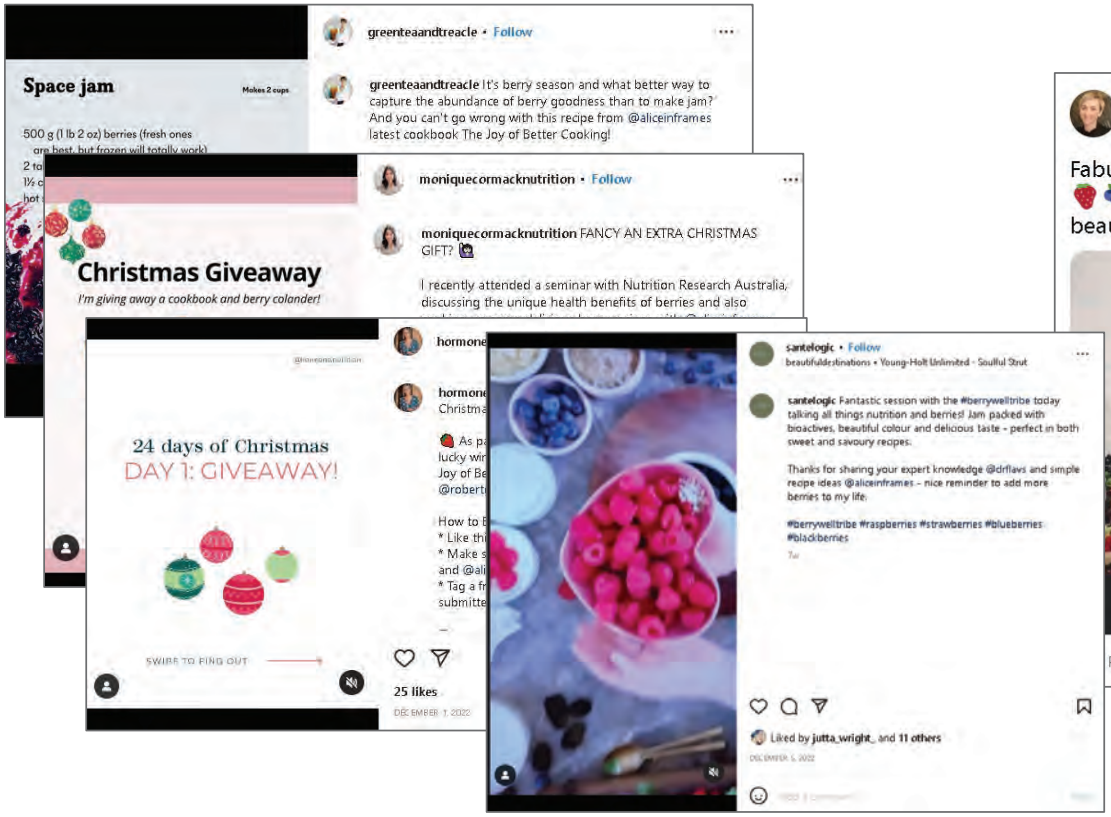
"I preferred this style of interactive event vs. a typical webinar, it was nice to discuss the culinary aspects of nutrition as well as talk about health benefits."

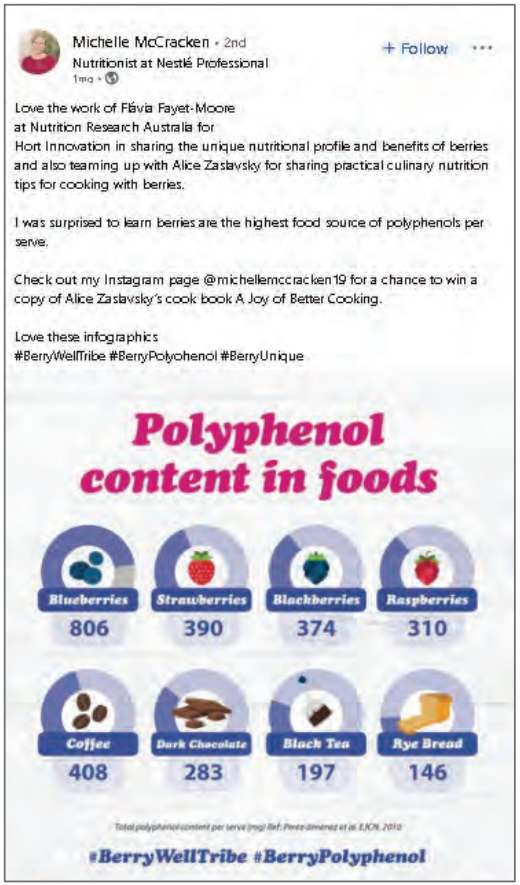
"Being divided into the 'break-out' rooms was a really nice way to break the ice and learn more about other professionals in the industry."

"I would have loved if the event was in person, as it would have been great to be able to chat to other members of the audience and interact with the hosts more, which would probably need it to be a slightly longer event."

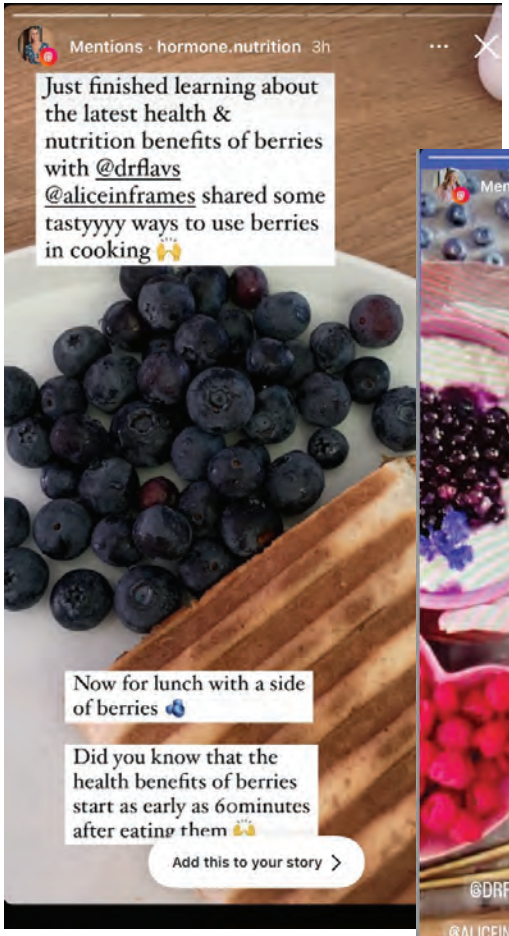
“Berry Well Tribe” – exclusive online KOL event
#BerryWellTribe

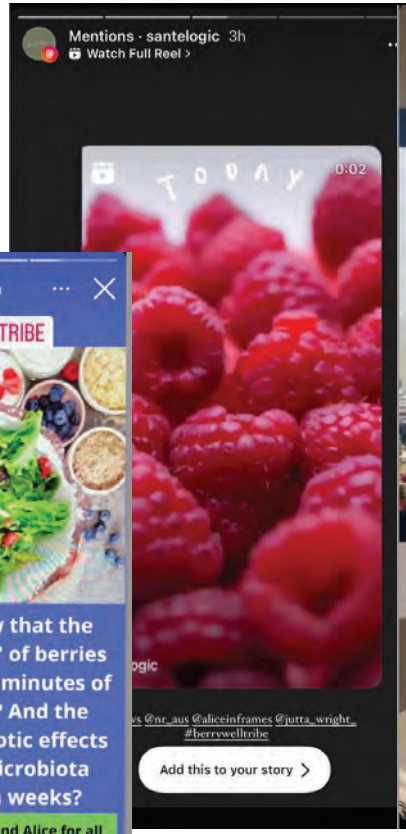
The hashtag **#BerryWellTribe** was used 11 times on Instagram, once on Facebook, and once on LinkedIn. The information posted to Facebook was cross-posted from Instagram, and the information shared on LinkedIn was unique to that platform, as well as linked back to the user’s Instagram accounts. One Instagram reel was created from footage at the event.

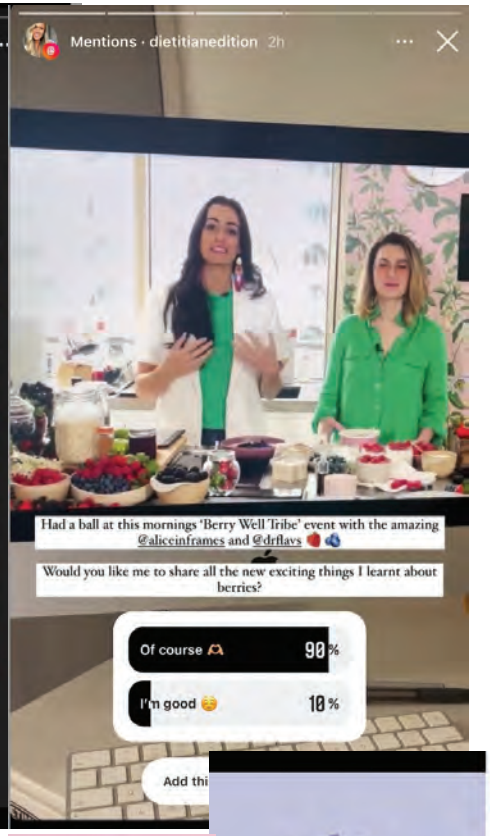


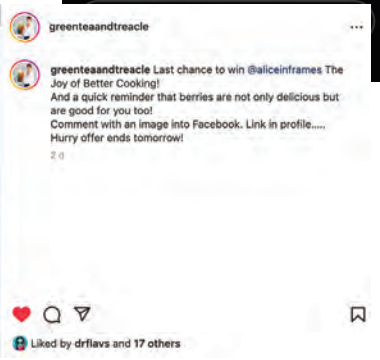


“Berry Well Tribe” – exclusive online KOL event
#BerryWellTribe

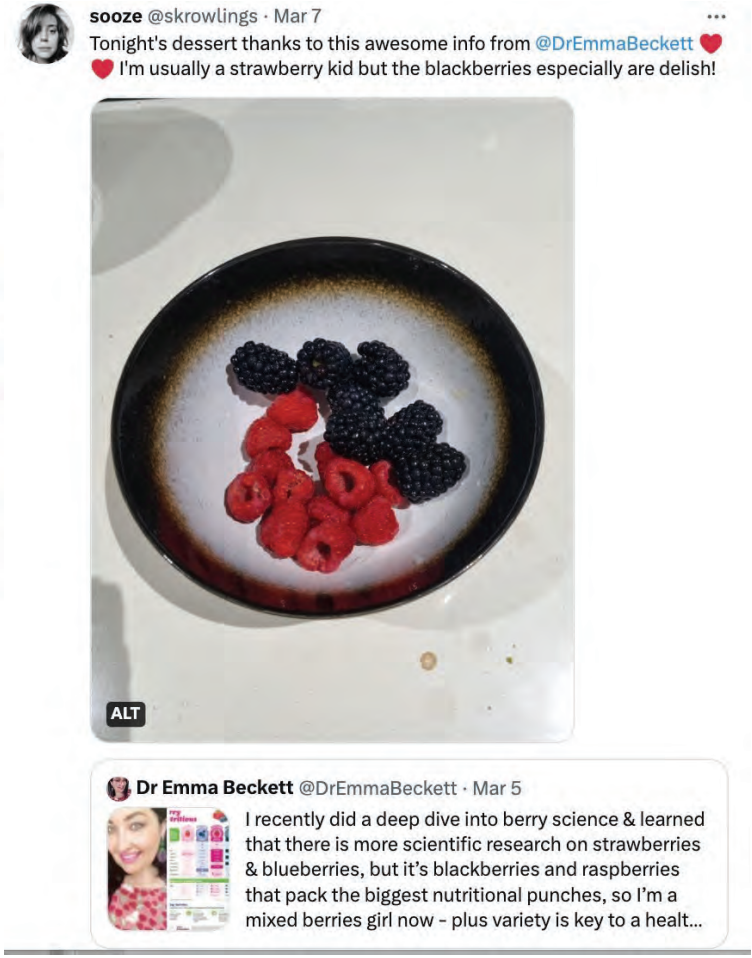




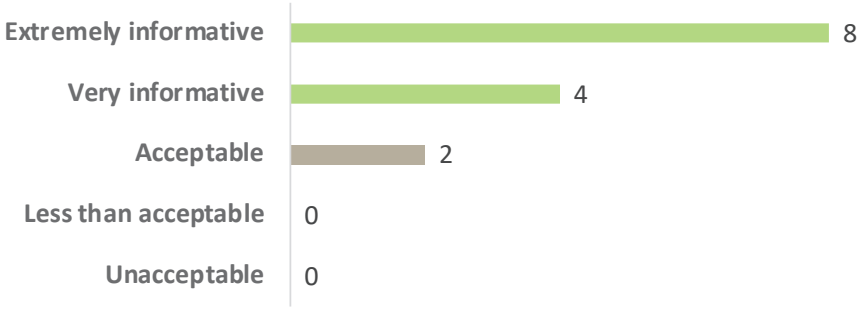




“Berry Well Tribe” – exclusive online KOL event
#BerryWellTribe



How informative did you find the event? Why or why not?



"Loved the facts shared, especially about practical kitchen tips"

"Personally I find online events a little less engaging, summary slides or a reference document/powerpoint would also be helpful to ensure I get all key takeaways"

"I have some "bite-size" points committed to memory"

"I thought the level of evidence/information provided was fantastic - above and beyond the usual standard. I picked up a few new facts and found the event engaging."

"Dr Flav has some great insight into the nutritional benefits of berries and Alice's simple and practical tips on how to use these beautiful fruit was great."

"Really interesting facts about berries, recipe/culinary nutrition tips and key nutritional profile/benefits of the different berries."

"Lots of fun facts, great presenting, great dialogue between presenters"

"I learnt lots of new facts which I have already started sharing with clients, friends & family!"

"It was great to hear about 'bioactives' as a new focus from Dr Flav and some innovative recipe ideas from Alice"

"Greta mix of info and beautiful food and recipes."

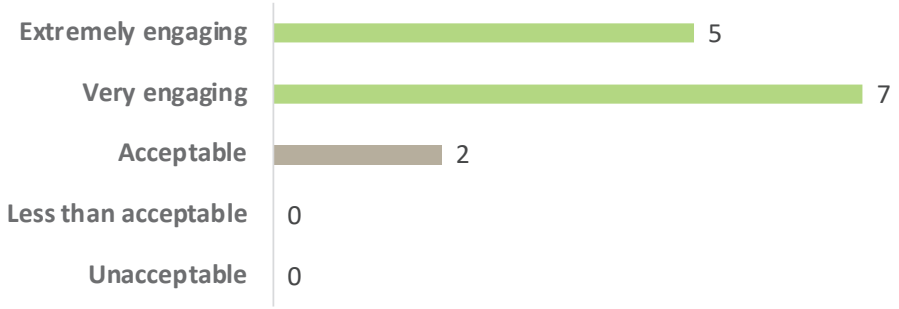
"I thought I knew a lot about berries, until this event. I particularly loved the 'fun-facts' integrated throughout the session content."

"I loved the nutritional biochemistry information shared! The research is so fascinating and informative!"

"Lots of fun culinary facts, could have used more evidence base"

"Great new facts weaved in with practical culinary tips"

How engaging did you find the event? Why or why not?



"the polls were good"

"Not particularly engaging, once again, hard to acheive in the online format."

"The Q&A was great"

"Loved the breakout rooms and the polls."

"I loved the breakout rooms at the start and thought that the true/false conducted throughout really provided engagement and interaction."

"Great interaction for an online event. Break out room and questions throughout were good. No Powerpoint was great - Flavia knows her content and the interaction with Alice was good."

"As per previous answer" *(Lots of fun facts, great presenting, great dialogue between presenters)*

"Excellent presenters, I loved the cooking demonstrations & audience polls"

"Great to have the fun quizzes throughout"

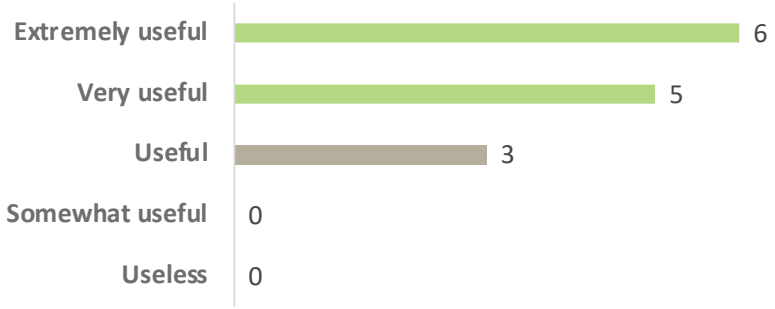
"Very positive hosts. Engaged chat group."

"Being divided into the 'break-out' rooms was a really nice way to break the ice and learn more about other professionals in the industry. I also found the polls/quizzes was a nice way to keep me engaged. I don't think I picked up my phone once!"

"Time in breakout rooms too short, would have been good to return to them. Alice and Flavia were polished presenters and overall very joyful"

"Loved the meeting vs webinar format and small group breakout"

How useful do you feel the information presented to you was? What did you consider to be the most valuable learning/s?



"the facts that I can share in my work (practical kitchen tips)"

"Don't wash berries before going into the fridge haha"

"Folate & DF tips"

"Unique facts about each type of berry e.g. specific antioxidants and how they are linked to health benefits."

"The need to talk more about the bioactives in berries and to communicate them."

"The key nutritional profile of the different berries, how they provide a good source of key bioactives not found in many other foods. The recommendation to use "bioactives" as a term with consumers and how to explain this. Practical tips for preparing, storing and cooking with berries."

"New Ways to use berries and research facts"

"Practical tips around eating/cooking berries. Nutritional benefits/profile of individual berries"

"I would say the valuable differences between the different berries as well as the delicious recipes"

"Understanding some of the killer facts around berries. Key nuggets of truth for each one. The easy recipes. Although it went so fast I couldn't get it all down. I'd love some notes."

"A combination of the most up-to-date research on berries and how to incorporate berries into both sweet & savoury dishes."

"Culinary tips"

"Practical advice we can share with consumers to them. Alice and Flavia were polished presenters and overall very joyful"

"Loved the meeting vs webinar format and small group breakout"

Key recommendations for future KOL events

Consider delivering a face-to-face event for KOLs

- Although the format rated well for engagement and enjoyment for most attendees, several expressed a desire to attend a similar event in a face-to-face format, with a longer session and more time to have ice breaker activities.

Provide a summary evidence document of information provided, with references

- Compared with a traditional webinar, which is supported by visual guides and references, several attendees mentioned they would like to review the evidence or look up the references of the systematic literature reviews mentioned in the presentation. Recommendations for the future would be to provide a list of resources used to all participants at the conclusion of the presentation.

Alert attendees ahead of time that they may be asked to turn cameras on

- Participants were not aware ahead of time that they would be split into breakout rooms and would have their cameras turned on. The feedback for the breakout rooms was overwhelmingly positive, and was mentioned frequently as an enjoyable experience for attendees. One participant provided feedback that they did not feel camera ready. Recommendations for future events would be to inform attendees prior to the event that there would be activities that will require them to turn on their camera (if possible), and to remind attendees as housekeeping at the beginning of the event.

Consider short-form video content as a method of disseminating information

- Short-form video and live videos on video-sharing platforms (e.g. tiktok, youtube shorts, Instagram reels) – consider using short-form videos to engage and excite.

APPENDIX 8:

Berry Nutritious

Strawberry

170% of vitamin C needs^

Vitamin C Superstar

Blueberry

High in Polyphenols*

Polyphenol Punch

Blackberry

Very high in dietary fibre^

Big Boss

Raspberry

Fibre, Vitamin C, E, manganese and folate^

Nutrient All-rounder

*^Foodworks 10 *Highest content of polyphenols compared to Strawberry, Raspberry & Blackberries. Ref: Perez-Jimenez et al. EJCN. 2010*

#BerryWellTribe #BerryUnique

Blackberry

^Foodworks 10

#BerryWellTribe #BerryUnique

Blueberry

High in Polyphenols*

Polyphenol Punch

**Highest content of polyphenols compared to Strawberry, Raspberry & Blackberries. Ref: Perez-Jimenez et al. EJCN. 2010*

#BerryWellTribe #BerryUnique

Raspberry

Fibre, Vitamin C, E, manganese and folate^

Nutrient All-rounder

^Foodworks 10

#BerryWellTribe #BerryUnique

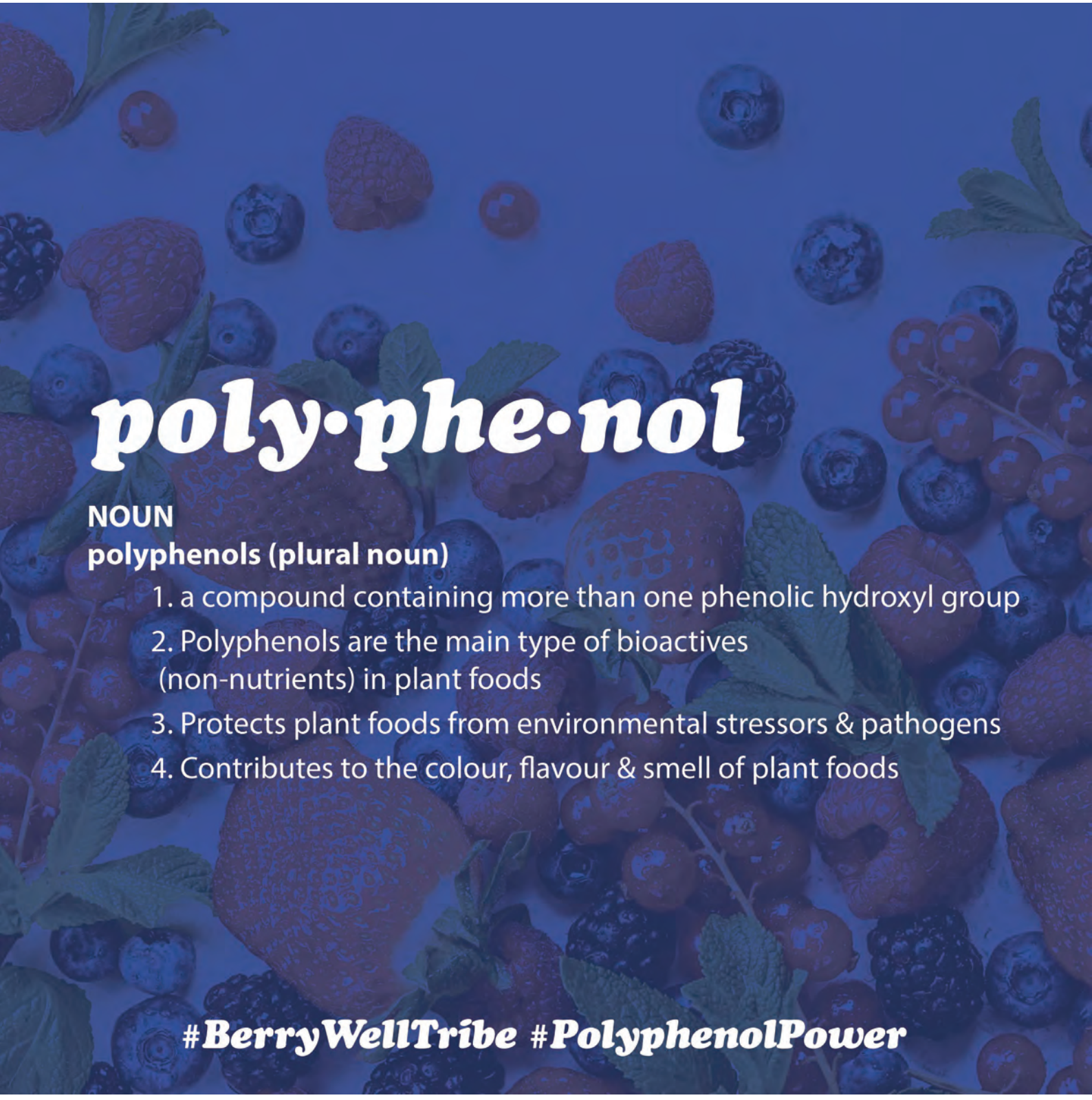
Strawberry

170% of vitamin C needs^

Vitamin C Superstar

^Foodworks 10

#BerryWellTribe #BerryUnique


poly·phe·nol
NOUN
polyphenols (plural noun)
1. a compound containing more than one phenolic hydroxyl group
2. Polyphenols are the main type of bioactives (non-nutrients) in plant foods
3. Protects plant foods from environmental stressors & pathogens
4. Contributes to the colour, flavour & smell of plant foods
#BerryWellTribe #PolyphenolPower

Polyphenol content in foods

Blueberries

806

Strawberries

390

Blackberries

374

Raspberries

310

Coffee

408

Dark Chocolate

283

Black Tea

197

Rye Bread

146

Total polyphenol content per serve (mg) Ref: Perez-Jimenez et al. EJCN. 2010

#BerryWellTribe #BerryPolyphenol

Berry Nutritious

All berries are nutritious, with fibre and bioactives. But each offers a unique nutrition package.

	Strawberry 170% of vitamin C needs Vitamin C Superstar	Blueberry #1 in polyphenols Polyphenol Punch	Raspberry Source of 5 nutrients Nutrient All-rounder	Blackberry Highest in fibre, vitamin E & magnesium Big Boss
Nutrients[1]				
Energy kJ	164	291	305	317
Sugars g	5.7	13.8	8.4	11.3
Fibre g (DI%)	3.8 (13%)	5.3 (18%)	8.4 (28%)	9.2 (31%)
Vitamin C mg (DI%)	68 (170%)	3 (8%)	44 (110%)	57 (143%)
Vitamin E mg (DI%)	0.5 (5%)	0.8 (8%)	1.1 (11%)	2.1 (21%)
Folate µg (DI%)	59 (30%)	0 (0%)	51 (26%)	51 (26%)
Magnesium mg (DI%)	12 (4%)	9 (3%)	30 (9%)	45 (14%)
Manganese mg (DI%)	0.5 (10%)	0.1 (2%)	0.8 (16%)	0.8 (16%)
Bioactives				
Total polyphenols mg[2]	390	806	310	374
Highest in bioactive type	✓ Resveratrol (a polyphenol)	✓ Lutein (a carotenoid)	✓ Ellagitannin (a polyphenol)	✓ Lignan (a polyphenol)

Enjoy now, or freeze for later

	Strawberry	Blueberry	Raspberry	Blackberry
Store in fridge	✓ 5 days	✓ 5–7 days	✓ 1–2 days	✓ 2 days
Freeze	✓ 6 months	✓ 3 months	✓ 12 months	✓ 6 months
Rinse	✓ Gentle	✓ Gentle	✗ Dip in water	✓ Gentle
Enjoy	Room temp	Chilled	Room temp	Room temp

Data based on a standard serve (150g). DI = Daily intake.

1. Foodworks 10. 2. Perez-Jimenez et al. EJCN. 2010

Farming berries

Australian berry growers use a 3-step approach to manage pests and keep berries fresh:

BIOLOGICAL

- Some insects, mites and spiders encouraged.
- Rid pests without affecting quality.

CULTURAL

- Proven techniques that reduce pests.
- E.g. rain covers, tillage, rolling, irrigation & crop rotation.

CHEMICAL

- Registered pesticides used as a third resort only when required.
- Broken down over time and by environmental factors such as rain and sunlight.

NRAUS NUTRITION RESEARCH | Hort Innovation

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Berry Polyphenol

Nutrition science shows that non-nutrient components of plant foods improve health

WHAT?

- Polyphenols are the main type of bioactives (non-nutrients) in plant foods
- Protects plants from environmental stressors & pathogens
- Contributes to their colour, flavour & smell

KEY CLASSES?

- Flavonoids
- Phenolic acids
- Lignans
- Stilbenes

KEY SOURCES?

- Fruits & vegetables
- Grains
- Legumes
- Nuts & seeds
- Oils
- Tea, coffee & wine

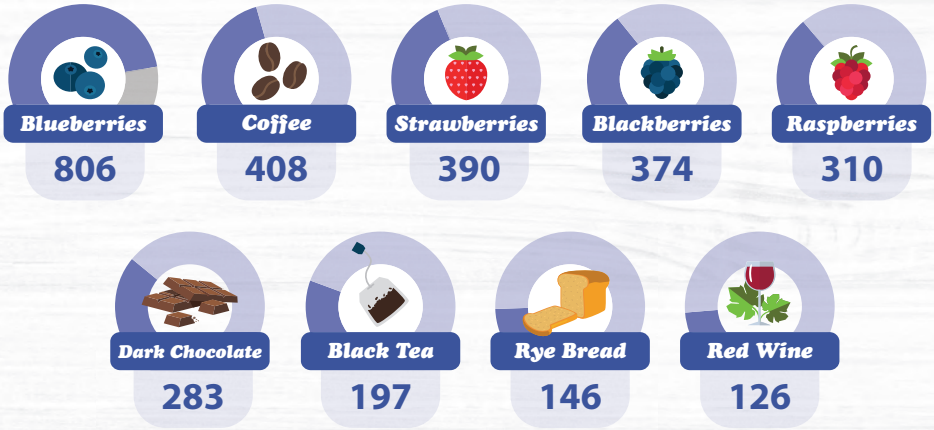
The rise of polyphenols

- **2800 BC** — Evidence of plant foods being used as medicine
- **1912** — Vitamins first discovered to explain health benefits of food
- **1980s** — Many polyphenols in plants first identified as health promoting
- **1990s** — Antioxidant capacity in fruits shown to correlate to their polyphenol content
- **TODAY** — Health benefits established with 8000+ polyphenol compounds identified

Common sources of polyphenols

Total polyphenol content per serve (mg)[1]

- Berries are the highest food source of polyphenols per serve[1]
- Anthocyanins represent up to 70% of their total polyphenol content[2]
- Some berries have been associated with lower Type 2 Diabetes risk[3] and weight gain[4] than for total fruits, possibly due to their high polyphenol content



Polyphenols are much more than antioxidants

CARDIOPROTECTIVE

- Anti-platelet effects
- Anti-inflammatory effects
- Inhibits LDL oxidation
- Lowers incident of CVD

ANTI-DIABETIC

- Can enhance insulin production
- Improves insulin sensitivity

PREBIOTIC

- Prebiotic-like effects
- Increases Bifidobacterium & Lactobacilllus

ANTI-CANCER

- Protective effect in human cancer cell models

ANTI-AGEING

- Antioxidant & anti-inflammatory effects may result in anti-ageing benefits

NEUROPROTECTIVE

- Improves brain plasticity
- Supports memory
- May reduce cognitive decline

1. Perez-Jimenez et al. EJCN. 2010 2. Olas. Front. Pharmacol. 2018 3. Bertoia et al. PLoS Med. 2015 4. Muraki et al. BMJ. 2013

NRAUS NUTRITION RESEARCH | Hort Innovation

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Berry Healthy

Snapshot of findings across 185 studies from a literature review on berries and health[1].

Brain function
Improved measures of cognitive performance

Reduced inflammation
Reductions in inflammatory markers

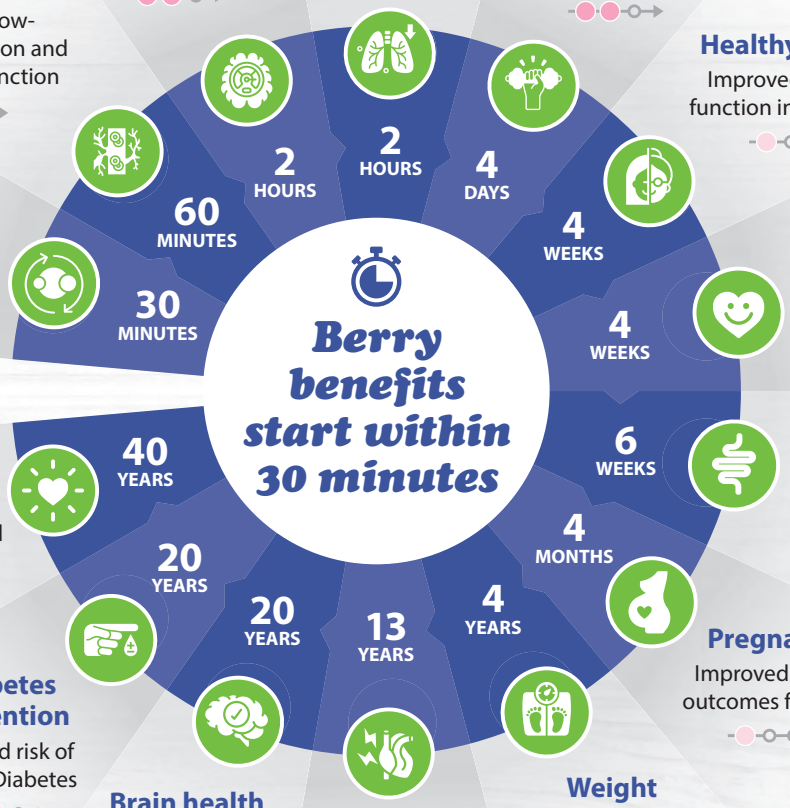
Exercise recovery
Reductions in markers of muscle damage

Healthy blood vessels
Improved flow-mediated dilation and endothelial function

Healthy ageing
Improved physical function in the elderly

Metabolic health
Improved glucose and insulin response

Markers of heart health
Improved cholesterol, blood pressure, and triglycerides



Berry benefits start within 30 minutes

Gut health
Favourable changes to the gut bacteria

Longer life
Associated with reduced all-cause mortality

Pregnancy
Improved health outcomes for mum

Diabetes prevention
Reduced risk of Type 2 Diabetes

Weight management
Associated with less weight gain

Brain health
Reduced cognitive decline in ageing

Heart disease prevention
Reduced risk of coronary heart disease

Which berry?

All berries support health, but most of the research has been on blueberries and strawberries

Blueberry
- Markers of heart health
- Healthy blood vessels
- Brain health
- Diabetes prevention
- Exercise recovery
- Brain function
- Weight management
- Reduced inflammation
- Pregnancy

Strawberry
- Markers of heart health
- Metabolic health
- Weight management
- Reduced inflammation
- Healthy blood vessels
- Brain health
- Heart disease prevention

Raspberry
- Markers of heart health
- Healthy blood vessels
- Metabolic health
- Reduced inflammation

Blackberry
- Metabolic health

Limited – Implement with care, e.g., singular small study.

Moderate – Evidence can be trusted in most situations, e.g., consistent evidence in prospective cohort studies; numerous RCTs but with some inconsistent results.

Strong – Evidence can be trusted, e.g., Consistent effects across well designed RCTs.

How much? Benefits most commonly seen at 125–500 grams (about 1–3 cups) a day. **1 serve = 1 cup (150 grams)**

1. Nutrition Research Australia. Berries and Human Health: A summary of the Science. 2022. (Unpublished).

NRAUS NUTRITION RESEARCH | Hort Innovation

The project has been funded by Hort Innovation using the blueberry, raspberry and blackberry research and development levies and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

APPENDIX 9:

Dietitians Australia Conference

23-25th July 2023

Dietitian's Australia Conference Evaluation – Summary results

- Over 600 delegates attended conference
- Team educated dietitians who came to the stand in their morning tea, lunch and afternoon tea breaks on nutrition & health benefits of berries and the berries hub, converting **113 people to register** for the competition.
- From both the NRAUS edm, breakfast and trade display we recruit **166 new subscribers** to the database and **48 unique users** checked out #berrieshub during conference.
- Berry sampling was KEY winner, attracting visitors with word-of-mouth buzz circulating to ‘check out the berry stand for the best tasting berries’.

Dietitian's Australia Berry Breakfast Evaluation – Summary results

On Tuesday 25th July, **Nutrition Research Australia** hosted a Breakfast Seminar on behalf of **Australian Berries** at the **Dietitians Australia 2023 Conference**.

*"**Berries – a powerful solution to support the gut-brain axis**"*

Featuring:

Nicole Dynan
Emma Stirling
Dr Emma Beckett

- Extremely popular event
- Largest waiting list of all the conference activities (**110** on the waiting list for **48** places).
- All registrants attended, and an additional 10 people were accommodated on the day.

- A high proportion of attendees (81%) completed the evaluation survey.
- Feedback on the presenters and information provided was unanimously positive, with numerous comments speaking to an engaging and vibrant presentation.

Dietitian's Australia Berry Breakfast Evaluation – Registration

Registrations via NRAUS direct networks

- An EDM containing an invitation to register was distributed to the Nutrition Research Australia's owned audience of healthcare professionals on Tuesday July 11th, 2023.
- Included in the email:
  - ✓ Link to register for the seminar
  - ✓ Link to the Berries Hub
  - ✓ Link to subscribe to the database
- The EDM had a high open rate (53%) and click-through rate (4.6%).
  - ➢ Twenty-three new subscribers were added to the Berries HCP database.

Dear << Test First Name >>,

Will you be attending the **Dietitians Australia 2023** Conference in Melbourne?

We invite you to join us for a delicious and educational breakfast with leading culinary nutritionist **Emma Stirling**, food & nutrition scientist **Dr Emma Beckett** and gut health dietitian **Nicole Dynan**, to discuss the **powerful benefits of berries for gut & brain health**.

Berries – A powerful solution to support the gut-brain axis.

Spaces are limited, so register early to secure your place!

Register for the breakfast seminar

Dietitian's Australia Berry Breakfast Evaluation – Summary results

ATTENDEES

58 Attended
(KPI: >40 attendees)

47 (81%)Completed Survey
(KPI: >30%)

REGISTRATIONS

48 Registered
10 additional attendees accommodated on the day
110 on waiting list

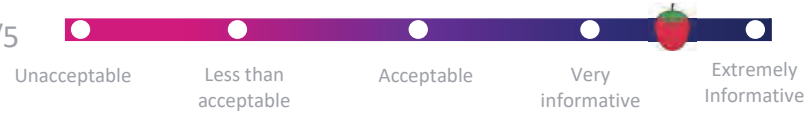
Target KPIs were achieved for: attendance, evaluation completion, and for all outcomes measured in the participant evaluation.

100% found event '**Excellent**' or '**very good**'
(KPI: >80% ✓)

Mean **4.8**/5

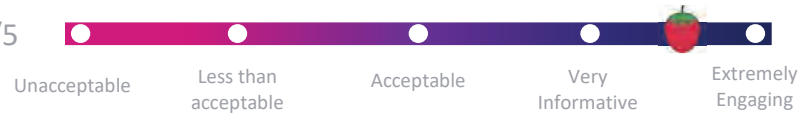
100% found event '**extremely informative**' or '**very informative**'
(KPI: >80% ✓)

4.5/5



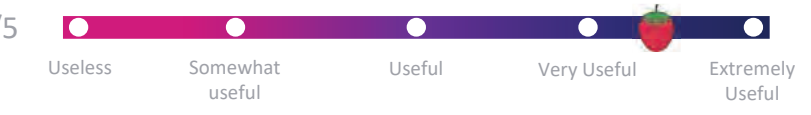
100% found event '**extremely engaging**' or '**very engaging**'
(KPI: >80% ✓)

4.6/5



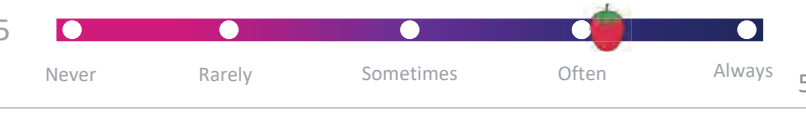
91.5% found information presented '**extremely useful**' or '**very useful**'
(KPI: >80% ✓)

4.4/5



84.5% intend to recommend berries '**always**' or '**often**'
(KPI: >80% ✓)

4.1/5



Dietitian's Australia Berry Breakfast Evaluation – Comments

Overall Sentiment:

informative, knowledgeable, engaging and loved the energy of the presenters

"Vibrant and knowledgeable presenters and delicious food"

"Food is the best way to bring people together and engage - just like the kitchen is the heart of the home and best place to have a meaningful conversation"

"Great speaking ability and engaging activities"

"Loved the engagement. Such vitality and passion."

"Could not ask for a more engaging and passionate and knowledgeable team"

"Presenters were very energetic and passionate"

"The content and the energy of the presenters!"

High engagement scores driven by:

Mix of scientific information with practical, as well as the caliber of presenters and interactive nature of the session

"Good mix of science and how to apply in an appetizing way"

"The session highlighted the importance for dietitians to upskill in describing the sensory properties of food in our nutrition comms"

"It was creative, inspiring, and educational"

"Lots of scientific information in an easy to digest format (especially at 8am in the morning!), engaging audience, encouraging creativity… the list goes on!"

"Very interesting to know that berries can decrease the cognitive decline"

"Great presenters; fun vibe; delicious berries and food!"

"The interactive session really brought it all together"

Dietitian's Australia Berry Breakfast Evaluation – Comments

Most valuable out-takes:

Health benefits and different ways to use and recommend

"Practical Application and sound evidence-based messaging"

"Encourage regular berries consumption"

"Thinking of unconventional pairings, the whole eating experience (aroma, mouthfeel etc)"

"Thinking about how berries can be used beyond just eating them"

"Different fibre types in various berries and roles in brain health"

"Many different ways to use berries to recommend to patients and so much fibre!"

"Brain health studies"

"Versatile ways to use berries."

What was done best:

Energy, engagement of the presenters and science/practical format

"Breakfast and the variety/fit/relevance of content"

"Education, food, entertainment"

"Tasting and recipe idea, food provided were delicious"

"Engagement of presenters"

"Speakers and audience involvement"

"Delicious food! And excellent presenters"

"Good mix of talk and activity"

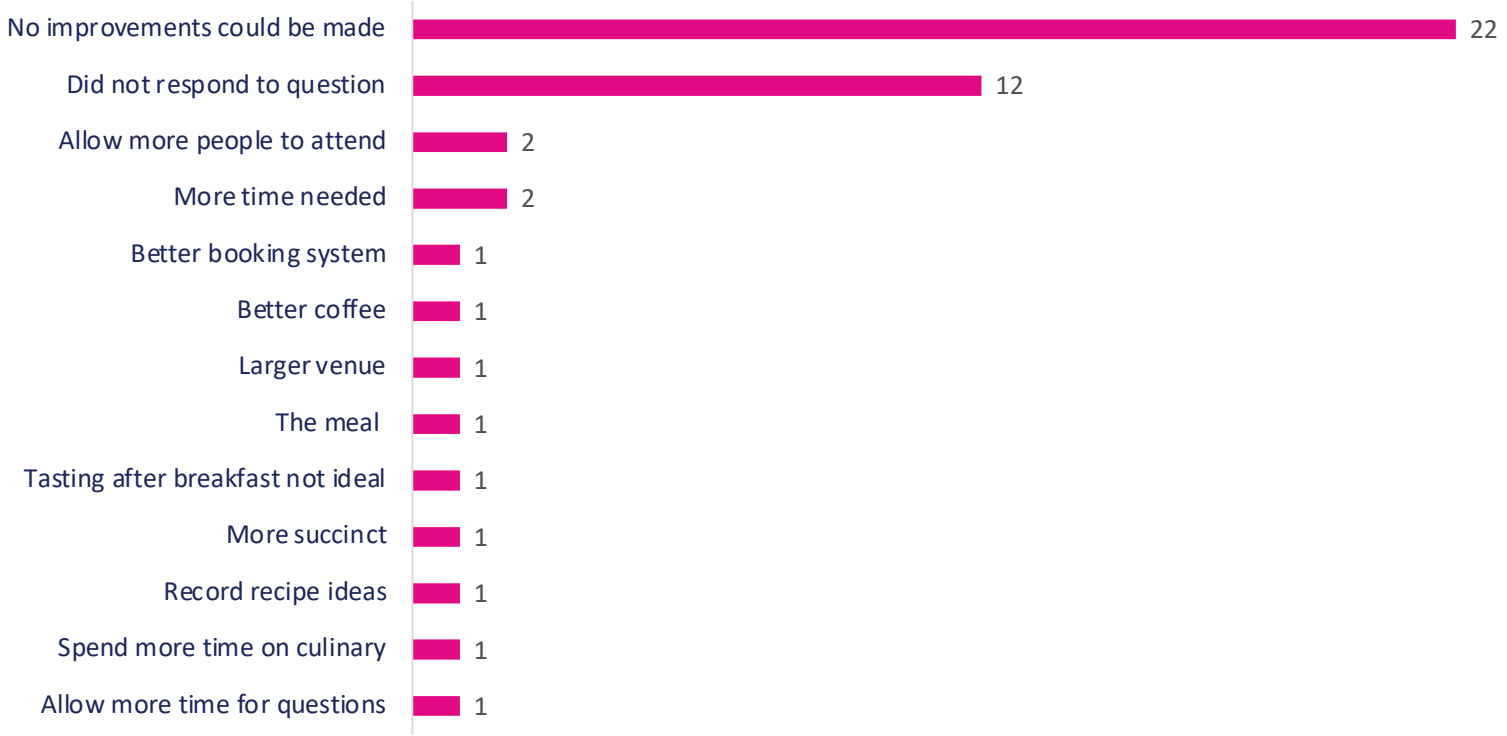
"Different presenters with practical recommendations"

"All of it! Wouldn't change a thing!"

"Everything!"

Dietitian's Australia Berry Breakfast Evaluation – Recommendations

Overall, attendees satisfied with nearly half respondents stating no improvements needed.



Dietitian's Australia Berry Breakfast Evaluation – Social Media

#BerryPower #DA2023

Twitter, Instagram, and LinkedIn were actively monitored during and after the breakfast seminar for mentions of the breakfast. Monitoring involved:

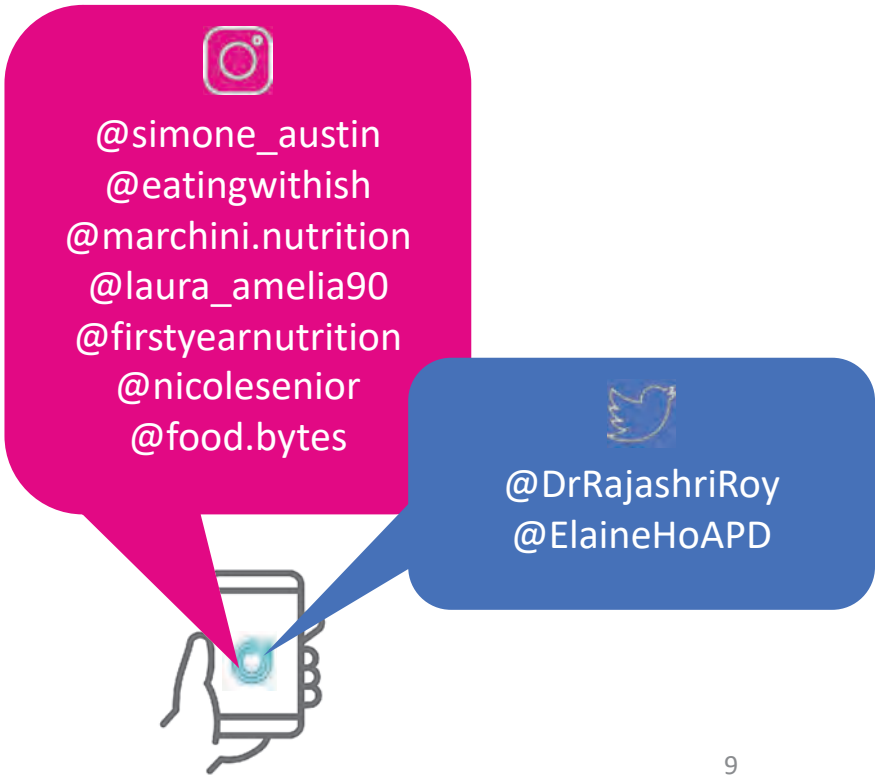
- Reviewing posts where NRAUS had been tagged
- Searching for the #BerryPower hashtag
- Searching the #DA2023 hashtag
- Reviewing stories reshared by the presenters or DA

Note that posts which did not tag NRAUS or use the #DA2023 hashtag have been missed.

- **10** attendees posted about, mentioned, or endorsed the breakfast via their social media platforms.
- Multiple posts from the three presenters from their professional profiles, and reshares from the DA account. These were not counted in the evaluation.
- Main platform used by attendees was **Instagram**, with stories the most popular content format. LinkedIn had lowest social media activity
- Three attendees shared information via their social media feed, with all three being regarded as highly professional and credible sources of nutrition information (Sally Marchini, Nicole Senior, Teri Lichtenstein).
- No matter what platform, every post was accompanied by pictures of or from the event, with several featuring the resources printed.

10 unique posters from 58 attendees (17.2%)

(KPI: >25%)



Dietitian's Australia Berry Breakfast Evaluation – Social Media

Key Observations

- The most active time for posting conference-related material was after the final session for the day
- Compared with the stories, posts directly to the Instagram feed tended to more information-based. Likewise, Twitter was used to share information.
- Conference-related activity on Twitter was much lower than it had been in previous years, likely reflective of recent changes to the platform.
- Content on Instagram is highly curated, particularly when compared with Twitter, which tends towards conversational, which might account for some of the lower-than-anticipated activity across social media platforms
- Disruptions to the social media industry have resulted in multiple new platforms emerging (e.g. Mastodon, BlueSky) which have not been captured here

Trends* in messaging style across platforms and content formats from #DA2023

Instagram Stories

Twitter

Instagram Post

Situational and responsive

Curated and informational

*Selected images representative of typical content across platforms

Dietitian's Australia Berry Breakfast Evaluation – Learnings

Recommendations for future events

- There were very few suggestions from participants for improvements to the event. Information regarding culinary uses of berries was highly valued by participants and should be included in future events
- Continue relationship building with KOLs including Nicole Senior, Sally Marchini, and Teri Lichtenstein, to further establish and elevate project-related messaging
- Review strategy and approach for engaging healthcare professionals on social media – consider incorporation of incentives or gamification to increase engagement
- Recommend holding future face-to-face event as an independent breakfast/event rather than as part of conference. Event highly successful format to deliver conversion but had a low reach. Significant structural costs and limitations in doing such an event within a conference with exhibitor fees, additional breakfast costs not originally visible. An independent event would likely have less cost and greater flexibility in extending reach with greater numbers and/or videoing allowed.

Dietitian's Australia Evaluation – KPIs

KPI	Status
Educate ≥100 people at trade display on the nutrition and health benefits of berries and resource hub	Exceeded
Recruit ≥50 people to the Berries database	Exceeded
≥40 registrants to breakfast session	Exceeded
≥30% survey evaluation responses	Exceeded
≥80% attendees rating the event ‘excellent or very good’	Exceeded
≥80% of attendees finding the event ‘engaging’	Exceeded
≥80% of attendees finding the event ‘useful’	Exceeded
≥80% intend to recommend consumption berries ‘always or often’	Met
Secure posts, mentions, endorsements from more than 25% HCPs that attend the event.	Did not meet

APPENDIX 10:

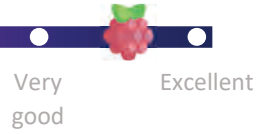

Berry Webinar
30th October 2023

Berry webinar Evaluation – Summary results

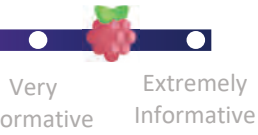
763 registered
(KPI >100 registered)
169 attended live
35.5% attendees completed evaluation (KPI >80%)

All KPIs met and exceeded

96.6% found event 'Excellent' or 'very good'
(KPI: >80%)



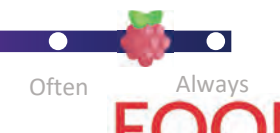
93.3% found event 'extremely informative' or ' very informative'
(KPI: >80%)



90% found event 'extremely engaging' or 'very engaging'
(KPI: >80%)

91.6% found information presented 'extremely useful' or 'very useful'
(KPI: >80%)

93.3% intend to recommend berries 'always' or 'often'
(KPI: >80%)



Berry webinar Evaluation – Comments

High informative score driven by:
Attendees learning something new about berries

"I did not realise the full value of blueberries for your gut health"

"Great look at the multiple nutritional and biomedical benefits. Loved the integration of gut health and recipes as well"

"I thought I knew a lot about berries, but now I know more!"

"I never knew the benefits that berries contain for overall health"

"I loved the informative nature of the webinar and that I learnt some new information"

"Enjoyed the culinary options - especially how to use berries in savoury dishes"

"Learnt about polyphenols & their importance"

"This has been amazing and very informative"

High engagement score driven by:
Highly knowledgeable and engaging speakers

"many different and knowledgeable speakers presented and contributed to the webinar"

"Speakers were knowledgeable and passionate"

"The way host conducted the discussion is very much interesting as all three other speakers joined to the discussion at the same time."

"Speakers were knowledgeable and passionate"

"All presenters were engaging, providing information in their areas of expertise"

"Each panelist was straight to the point and yet brought their own unique perspective"

"Everyone came across as passionate and knowledgeable."

Berry Evaluation – Most valuable out-takes

Learning about Polyphenol content & health benefit

"Polyphenols excellent for brain and gut health."

"Polyphenol content, diversity, prebiotics, diabetes and brain health benefits"

"The latest science on polyphenols and culinary benefits"

"Contribution and structure of polyphenols and how they contribute to out gut health"

"Benefits of berries within gut and brain."

Learning about unique benefits of everyday berries

"The nutrient comparison between the berries to highlight their unique benefits"

"Readily available berries are just as beneficial as "super" berries"

"Normal berries as good as superfoods"

"Nutritional differences between the berries"

"Readily available berries are just as beneficial as "super" berries"

Getting information in concise way to help in clinical practice

"I enjoyed how it summarised all the research and benefits into 1 seminar, so it was all valuable and a great summary of what's out there"

"More so the raw information I need in order to justify the importance of berries to my clients"

"Ways of cooking/eating supported by evidence about why and dose"

"The practical ways of how to add into the diet that aren't necessarily just as a sweet dessert"

Berry webinar Evaluation – Best Aspects

Easy to follow format and great speakers and host

"All the discussion, engagement, presentation are very attractive, informative and interesting. The event is wonderful"

"Included a number of speakers with different perspectives. Appealed to different audiences.

"Whole presentation, Dr Emma was bright & bubbly made for a great presentation"

"Multiple speakers meant it wasn't stale or boring. and incorporation of the host (Dr Emma Beckett) who added personality"

Great format, slide presentation & organisation

"Easy to follow format, slides easy to read and followed information presented."

"Great enthusiastic facilitator, smooth transition between presenters and clear slides"

"Presentation slides were great - colourful and engaging"

"Slides were good, event flowed well, presenters were genuinely interested"

"Duration and organisation"

Great resources & practical content

"Free resources were relevant and helpful. Engaging presentation"

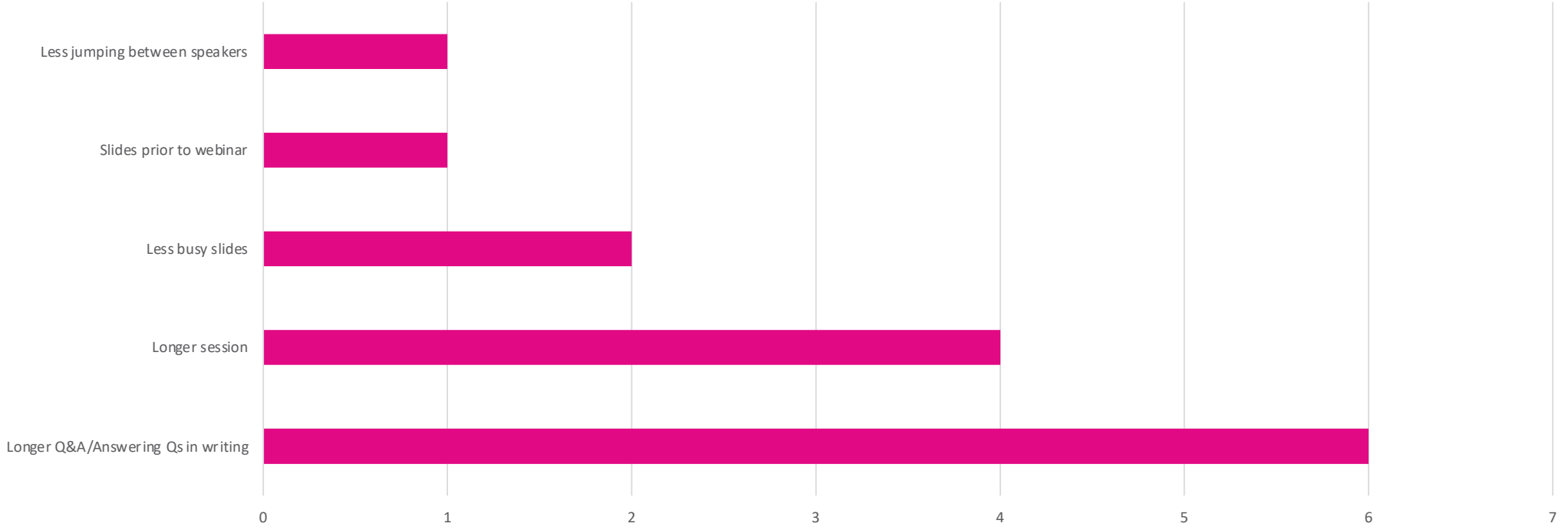
"All aspects. The overall presentation was excellent & the attached resources very beneficial. Well done to all involved!"

"I liked the practical suggestions of what can be done with berries eg berries roasted in EVOO and the dessert option"

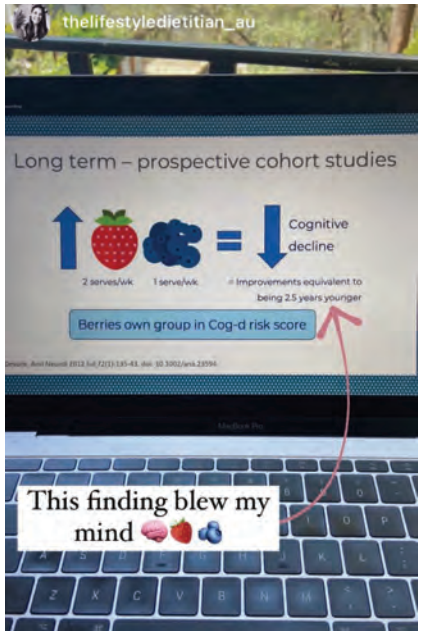
"The content was applicable to my clinical practice"

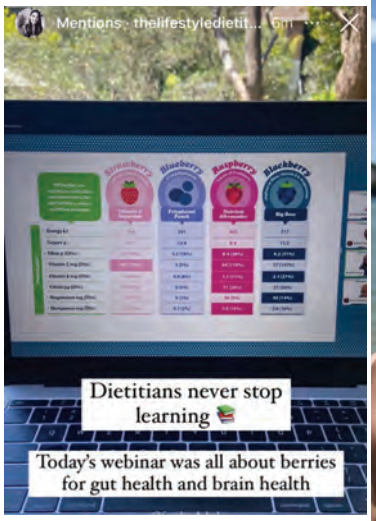
Berry webinar Evaluation – Recommendations

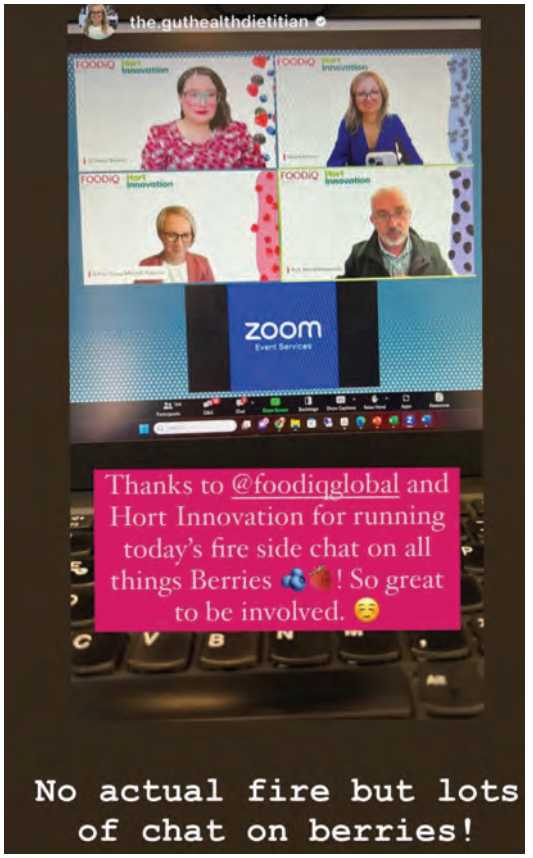
Overall attendees were satisfied with the webinar with the main recommendation being longer Q&A time



Berry webinar Evaluation – Social media







APPENDIX 11:

FOODiQ global

MT21000

Digital Activation Outreach

March 2024

FOODiQ global

Objective

Drive awareness of the hub and project resources with HP.

Activity

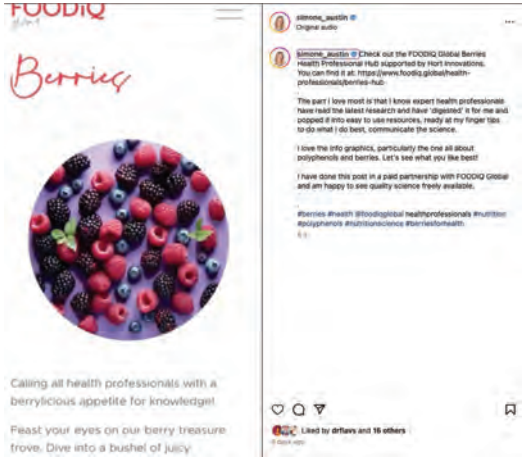
Social media

Activation: 4 weeks total split in 2-week blocks over December 2023 and January 2024.

Channel comms

Berry HP Database Direct EDM: 8th January 2024
Australian Naturopath Association Australia solus edm: 10th January
Dietitian Connection e-news: 28th January 2024

KOL Influencers



Activation: January 2024

FOODiQ global

Results

Channel & social media results

	Audience	Open rate %	Reach	Total clicks	CTR %		Unique Downloads	Cost per contact
Dietitian Connection	11937	49.0%	5823	192	2%	(Average 2%)	93	$26.04
Australian Natural Therapists	7000	30.8%	2154	351	5%	(Above average)	287	$3.50

	Impressions	Reach	Total clicks	Av CTR%	Sign up database		
Social media (HP)	236,000	86,653	1531	1.7%	87	186	$1.96

	>1 min view	
Animation	5935	(KPI: 5000)

Berry HP Database EDMs - Summary

	Topic	Date sent	Open rate
EDM 1 *	Recruitment to ASR	8th June 2022	41%
EDM 2	Welcome & Berry survey	24th August 2022	41%
EDM 3	Infographics	3rd March 2023	33%
EDM 4	Factsheets	29th August 2023	51%
EDM 5	Webinar invite	24th October 2023	37%
EDM 6	Webinar follow up	3rd November 2023	50%
EDM 7	Berries Hub	22nd January 2024	38%
EDM 8	ASR reminder	8th March 2024	39%

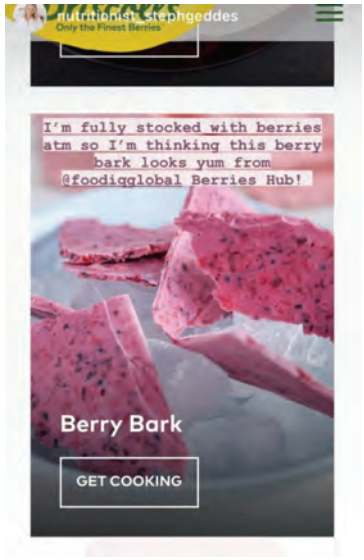
*EDM 1 sent to FOODiQ database for recruitment

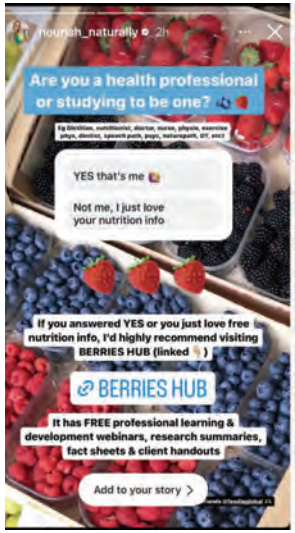
KOL activation - Summary

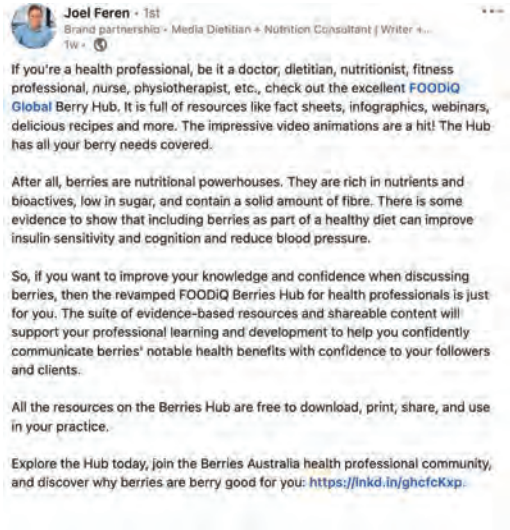
7 KOLs with combined following **365, 387 followers** were engaged to communicate the Berry Hub to their followers in their own authentic voice.

	Profession	Followers
Nicole Dynan	Dietitian	21,100
Steph Geddes	Nutritionist	21,500
Simon Austin	Dietitian	6857
Prue Mynard	Dietitian	14,000
Rebecca Gawthorne	Dietitian	257,000
Tara Leong	Nutritionist	35,000
Joel Feren	Dietitian	9930
TOTAL REACH		365 ,387

KOL activation - posts







FOODiQ global

Learnings and recommendations

Learnings & Recommendations

Learning

- ✓ Overall digital activation was effective in driving reach awareness of 94,630 HPs
- ✓ Solus EDM (ANTA) performed better than e-news item in EDM (DC).
- ✓ Video/animation content tends to drive greater engagement than static. Social content moving towards shorter bite sized video content.
- ✓ KOL influencers cost effective and credible way to amplify comms.

Recommendation

- ✓ A solus ad is preferable when cost possible. DC solus ad is very expensive and not recommended unless comms very newsworthy such as whitepaper or new research published.
- ✓ Future development of video/animation assets should be designed for social media delivery from outset – 3 x 30 second content rather than 1 x 2-minute asset development.
- ✓ KOL influencers should always be included as part of the strategy.

Learnings & Recommendations

Learning

- ✓ Dietitians are costly to reach @ $26/contact compared to Naturopaths @ $3.5/contact. While social media is a cost-effective way to drive reach @$2/contact, the quality of leads with professional body comms is high and bullseye.
- ✓ Building owned database is key long-term strategy as this is most cost-effective comms channel. Subscribers are highly engaged with 33-50% open rates and are ultimately at no cost.

Recommendation

- ✓ Work with professional body channels to experiment with creatives/hooks to drive better engagement.
- ✓ Develop an ongoing recruitment strategy to continue to build database long term.
- ✓ Move towards developing an 'always on' digital communication strategy with owned database to maintain top of mind awareness to drive recommendation.

FOODiQ global

Thank **YOU!**

foodiqglobal

@foodiqglobal

foodiqglobal

info@foodiq.global

www.foodiq.global

APPENDIX 12:

Hi Jutta Wright,

We *berry* much need your expertise!

Nutrition Research Australia are currently undertaking research for Berries Australia to find out what health and fitness professionals understand about the growing practices, nutritional properties, and health benefits of Australian berries (strawberries, blueberries, raspberries and blackberries).

We would greatly appreciate if you could take 5 minutes to answer a short survey on berries.

WIN ONE OF FIVE $100 VISA GIFT CARDS

By completing the survey, you could win one of five $100 VISA gift cards to spend on whatever you like!

Start Survey

Thank you in advance for your time.

LOVE WHAT YOU SEE?
Join our social channels or share this with a friend.

Share to your profile | Tweet to your followers | Forward to a friend

A berry good welcome to our new friends! We'd like to thank you for completing our recent healthcare professional survey on Australian Berries and joining our e-newsletter updates. In return, we would love to give you a brief snapshot with what we found.

Most HCPs are regularly recommending berries for nutrition and health benefits.

Berries are well known for their antioxidant content, as well vitamin C and fibre. Less is known, however, about the specific bioactives and health benefits of individual berries.

Convenience and taste are also winners.

While nutrition and health benefits are the most important driver to recommendation, taste and convenience are also valued.

HCPs want to know more!

Healthcare professionals want to know more about:

- The unique nutrition and health effects of different types of berries
- How berries are grown in Australia
- The best way to wash and store berries to maintain their nutrition and flavour
- Fresh and innovative ideas for incorporating berries into everyday diets

We look forward to sharing with you in future e-newsletters more on what you want to know about, including useful resources and upcoming educational events. Stay tuned.

NRAUS and Berries Australia

Berry FUN Facts!

BERRY AVAILABLE
Fresh Australian berries are available all year round, grown in warmer climates during winter, and cooler climates during summer.

BERRY POPULAR
Berries are purchased by around 75% of Australian households.

BERRY UNIQUE
Blueberries have a high antioxidant capacity.
Raspberries are a source of lutein.
Blackberries are high in vitamin C and fibre.

HUNGRY FOR MORE?

VISIT OUR BERRIES HUB

www.nraus.com/berrieshub

For all the latest healthcare professional resources in one place

Hort Innovation

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For more information on the fun and strategic levy investment visit horticulture.com.au

Hello!

We have been busy looking into all things berry-related and are excited to share our newly released infographics with you to download and share.

Did you know that every berry has its own **unique bundle of health-promoting nutrients and bioactives**?

^ Foodworks 10 (Xyris Software). * In comparison to strawberries, raspberries, and blackberries. Perez-Jimenez et al. EJCN. 2010

And berries work hard for you from the very beginning - improvements in metabolic health can be detected in as little as 30 minutes, and cognition in just 2 hours. Download our **Berry Healthy** infographic for a snapshot of berries' health effects.

Finally, did you know that berries are the highest food source of polyphenols per serve? Polyphenols are the main type of bioactives in plant foods and much more than just antioxidants. They are also ✓ *Cardioprotective* ✓ *Anti-cancer* ✓ *Anti-diabetic* ✓ *Anti-ageing* ✓ *Prebiotic* ✓ *Neuroprotective.* Find out more in this **Berry Polyphenol** infographic.

Visit our Berries Hub today to download and share!

HUNGRY FOR MORE?

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Hello << Test First Name >>,

We would like to welcome our newest members to our Berries community of healthcare professionals.

Some of the NRAUS team recently attended the Dietitians Australia 2023 conference on behalf of the Australian Berries industry, and loved speaking with like-minded colleagues and sharing our love for berries! Read on to find out our favourite fun facts from our ***Nourish the Gut-Feed the Brain*** berry breakfast event.

We also launched our newest berry resources at the conference, which you can **access**, **download**, and **distribute for free** from our **Berries Hub** anytime:

Informative brochure for healthcare professionals

This educational 4-page brochure presents the latest evidence on the nutritional and health benefits of berries in relation to gut and brain health, so you can communicate confidently with clients.

For instance, **did you know** berries contain a variety of soluble and non-soluble fibres with pre-biotic functions?

Client-facing brochure

There are lots of reasons to enjoy berries in almost every healthful diet! Benefits to health and cognition accumulate over days, weeks, even years, so now is a great time to start adding berries everyday.

This easy-to-follow, printable handout contains **nutrition and health-based information** alongside **practical tips** and culinary suggestions, to help support your clients.

Social Media Pack

We have develop five informative **#BerryPower** social media tiles that you can use on your own social media channels.

Download Here

#DA2023 Berry Good Breakfast Highlight

Emma Stirling (Scoop Nutrition), Nicole Dynan (The Gut Health Dietitian), and Dr Emma Beckett (Nutrition Research Australia) gave an extremely interesting and engaging presentation on Berries at one the most popular breakfast sessions at the Dietitians Australia conference. Here are some of our favourite fun facts that they shared!

Berries: Feed the Gut, Nourish the Brain

The unique blend of fibres and bioactives make berries a great choice to support gut health, even on a low FODMAP diet. One FODMAP-friendly serve of berries is:

- 🍓 65g (5 medium) strawberries
- 🫐 125g (1 cup) blueberries
- 🍒 58g (1/3 cup) raspberries

- 1 small blackberry

The taste and flavour profile of berries gives them great culinary versatility. Attendees were encouraged to consider inspired flavour pairings and culinary tips in their client education as a way to engage and support behaviour change. Some of the delicious and creative flavour pairings included:

- Raspberry and goat's cheese
- Blueberry and coriander
- Blackberry and basil

We would like say a special thank you to **Driscoll's Berries** for providing us with magnificently fresh, plump and delicious berries for the breakfast session and sampling throughout the conference. They were an absolute hit!

You can visit our **Berries Hub** anytime to download these brochures, to get some recipe inspirations provided by Driscoll's Berries, or to download and share our informative Berry Infographics series and social tiles for you to share the #**BerryPower** love via your own community.

We look forward to sharing with you more fun facts and berry news. Stay tuned!

NRAUS and Berries Australia

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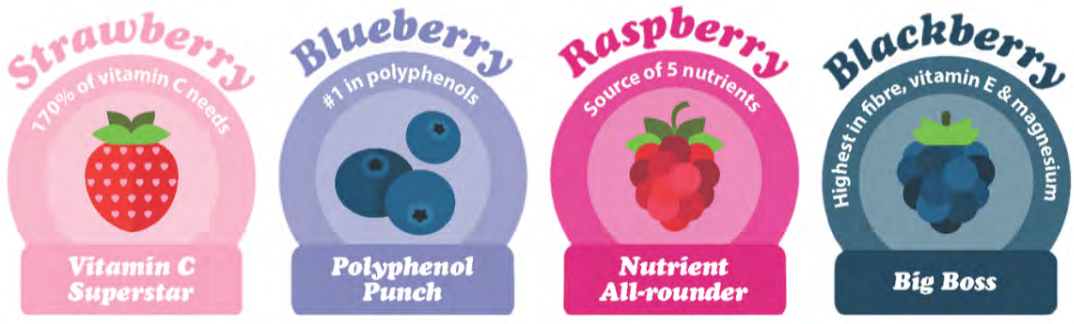

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Dear << Test First Name >>,

As a valued member of our Berries community of healthcare professionals, we invite you to attend this **FREE** educational webinar. Hear the latest scientific evidence around polyphenols, and how berries - the **highest food source of polyphenols** - support gut and brain health.

Register Now

FREE WEBINAR

Berries - A powerful solution to support the gut and brain health: Perspectives from a researcher, a dietitian, & naturopath

Monday 30th October, 2023
11:00 - 12:00 AEDT *(Syd/Melb/ACT time)*

Interest and research around the gut-brain axis and related health outcomes is strong & growing. It is emerging that gut health is about more than just fibre, with bioactive polyphenols emerging as key players with direct and indirect (via the gut) links to brain health. Berries are a potentially powerful player - supporting the healthy function of the gut-brain axis offering dietary fibre, polyphenols and key micronutrients in an easy to prepare

whole food.

Hosted by **Dr Emma Beckett**, this webinar session will deliver the latest scientific evidence around polyphenols and the nutrition and health benefits of berries, the highest food sources of polyphenols with **Dr Nenad Naumovski**. Attendees will also gain clinical insights, culinary tips and other practical pearls of incorporating berries into everyday diets to support both short- and long-term health conditions relating to the gut and brain, from gut health dietitian **Nicole Dynan** and Naturopath and academic **A/Prof Teresa Mitchell-Paterson**.

The diverse panel will offer a unique view of the science and practice. Participants will be provided with resources on the health benefits of berries free to use in their professional practice.

REGISTER FOR YOUR CHANCE TO WIN

Everyone who registers will have a chance to
win 1 of 5 copies of *Alice Zaslavsky's* cookbook
"The Joy of Better Cooking"

What you'll learn about:

- Polyphenols (including those in berries) and the latest science on their health effects.
- The unique nutrition attributes of blackberries, blueberries, raspberries and strawberries.
- The culinary benefits of berries and how they can support health.
- The importance and value of complexity, food synergy, and food-first approaches to health.
- The gut-brain axis and its importance of treating the gut as a central strategy.
- Clinical pearls of using berries in practice for managing GIT and brain health.

Register Now

We hope to see you there!

FOODiQ Global (formerly Nutrition Research Australia) and **Berries Australia**

NOTE: Nutrition Research Australia has exciting news - we have rebranded to become FOODiQ Global! You can read more about our journey here:

THE FOODIE NERDS HAVE GONE GLOBAL

This means that emails from us will now come from a FOODiQ Global email address - info@foodiq.global. Be sure to add this to your 'safe' list!

CONTACT US | MEDIA ENQUIRIES | FOODiQ WEBSITE

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Dear << Test First Name >>,

We were pleased this week to host Professor Nenad Naumovski, Nicole Dynan, and Associate Professor Teresa Mitchell-Paterson in our webinar **Berries as a powerful solution to support the gut and brain health: Perspectives from a researcher, a dietitian, & a naturopath**.

Hosted by our very own Dr Emma Beckett, we had a great time and loved learning some new things about berries!! **Thank you** to everyone who was able to join us live for the event.

In case you missed it, you can catch up on the webinar recording and download our informative resources from the **Berries Hub**.

WATCH the webinar

DOWNLOAD the slides

FREE DOWNLOADABLE AND PRINTABLE RESOURCES

INFOGRAPHICS SERIES

Every berry has a unique nutritional package packed full of nutrients and bioactive.

This infographic series covers the latest in berry science in an easily digestible format.

EDUCATIONAL BROCHURE FOR CONSUMERS AND CLIENTS

Printable handout for clients with easy to understand information and practical tips on berries' nutritional content and how they can support gut and brain health.

EDUCATIONAL BROCHURE FOR HEALTHCARE PROFESSIONAL

Increase your knowledge and confidence when discussing berries with clients with this fully referenced evidence summary.

Visit the Berries Hub

UPCOMING FOODiQ EVENTS

Citrus is well known for vitamin C, but that is only one small part of the story. Two and half centuries after citrus was shown to prevent and treat scurvy, we now know **there is much more to citrus fruits than just vitamin C!** Citrus is a great example of the research illuminating the importance of bioactives in addition to nutrients, and the marvel of food synergy, for health.

Join us for an engaging and insightful webinar that explores the **latest science on bioactives and food synergy,** and specifically empower you with the knowledge you need to make citrus fruits a top-of-mind choice to **support long term immunity, cardiovascular health and brain health.**

Register now

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Dear << Test First Name >>,

There's lots to love about berries!!

Not only are they delicious, versatile, and available all year round in Australia, they are rich in fibre, vitamins, minerals and are the highest food source of polyphenols, a potentially powerful player in supporting **the healthy functioning of the gut-brain axis.**

Each berry has its own unique nutritional package, so adding a mix of berries, to the daily diet is an easy way to help your clients reap their benefits. And one thing we have learnt, is clients LOVE learning about berries!

Looking for a way to improve your knowledge and confidence when talking about Berries? **Introducing the revamped FOODiQ Berries Hub for health professionals.**

Here, you'll find an assortment of evidence-based resources and shareable content to support your own professional learning and development, plus help you communicate the various health effects of berries with confidence to your followers and clients.

All the resources provided on the Berries Hub are FREE to download, print, share, and use in your practice.

READ ON to learn how you can be in the running to **win one of five $100- gift cards**

EXPLORE THE BERRIES HUB

What you'll find on the hub

PROFESSIONAL LEARNING AND DEVELOPMENT RESOURCES

EDUCATIONAL WEBINAR – BERRIES AS SOLUTION FOR GUT & BRAIN HEALTH

Hosted by our very own **Dr Emma Beckett**, join **Professor Nenad Naumovski**, gut health dietitian **Nicole Dynan**, and naturopath and clinical nutritionist, **Associate Professor Teresa Mitchell-Paterson** as they discuss the latest scientific evidence around polyphenols, and the health and nutrition benefits of berries (the highest food source of polyphenols).

RESEARCH SUMMARY FACT SHEET

Increase your **knowledge** and **confidence** when discussing berries with clients with this fully referenced **evidence summary** covering the latest scientific evidence on **berries to support gut and brain health**.

INFOGRAPHICS SERIES

Simplify your message with scientifically supported facts provided in these engaging and informative infographics, communicating the latest in berry science in an easily digestible format.

Berry Nutritious: Discover the unique nutritional package found in each berry.

Berry Polyphenol: Uncover the potency of berries as supreme polyphenol sources. Delve into their definition, food sources, and health impacts.

Berry Healthy: Explore the **14 health outcomes** improved by berries, with benefits measured from as little as **30 minutes** after consumption.

CLIENT-READY RESOURCES AND SHAREABLE CONTENT

EDUCATIONAL BROCHURE FOR CLIENTS

Printable handout for clients with **easy-to-understand information** and **practical tips** on berries' nutritional content and how they can support gut and brain health.

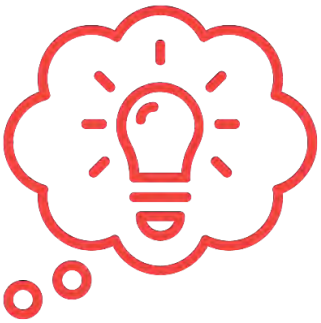
SOCIAL MEDIA PACK to Spread the Word #BerryPower

People look to social media for health information, and in the age of misinformation, it is important that health professionals are sharing credible content. **Educate your audience in the power of berries** using these social media tiles, which highlights the key health and nutrition benefits of berries **#BerryPower**

NOURISH YOUR GUT, FEED YOUR BRAIN EDUCATIONAL ANIMATION

This engaging short video simplifies the complex nutrition science in clear, concise language, helping you to communicate with confidence and ensuring the #BerryPower message can be easily understood by your clients and followers.

We want to know what you think!! - your chance to WIN



As a valued member of our community, we'd like to ask for **5 minutes** of your time to complete a **short survey**, to help us understand what you have learnt and get valuable feedback on the resources.

Everyone that completes the survey will have the chance to enter the draw to win **one of five $100- gift cards.**

COMPLETE THE SURVEY

Thank you for being part of our berry community!!

Warmest regards,
FOODiQ Global and **Berries Australia**

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Dear << Test First Name >>,

We are completing research to understand what health professionals know about the health and nutritional properties of berries and what they think of the current resources available.

As a member of our vibrant **Berries Community of Health Professionals**, we'd love it if you could spare **5 minutes** to complete this short survey, and in doing so have a chance to **WIN**!

COMPLETE THE SURVEY

As a thank you for your time, everyone that completes the survey will have the chance to enter a draw - **five lucky winners will receive a $100- gift card!**

Survey closes 16th February, 2024.

Thank you for being part of our berry community!!

Warmest regards,
FOODiQ Global and **Berries Australia**

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APPENDIX 13:

APPENDIX 14:

MT21000 Health and nutrition information for the Berry industry

PRG Meeting 1

24th August 2022

Agenda

1. Introductions
2. Project Overview
3. Audience Sentiment Research
4. Upcoming deliverables
5. Feedback/Discussion

Introductions

Business Lead & Spokesperson

Dr Flavia Fayet-Moore
PhD, MNutrDiet, APD, FASLM
CEO

Flavia will oversee the project and ensure that overall project objectives and levy payer needs are met.

- ✓ 15+ years experience in business, research & communications.
- ✓ 50+ published papers and conference abstracts, specialising in dietary modelling.
- ✓ Australia's first CEO to establish an independent research, translational science, and education company.
- ✓ Australia's first dietitian to be board-certified Lifestyle Medicine practitioner.
- ✓ Well recognised and highly regarded by industry and health care professionals.

Scientific expertise

Dr Michelle Blumfield
PhD, BND(Hons), APD
Project Manager (Research)

Michelle is co-project manager of the project with Jutta. She is key lead for the science and research strategy and execution.

- ✓ PhD-qualified Accredited Practising Dietitian with extensive management and mentoring experience.
- ✓ 70+ published manuscripts and conference abstracts, specialising in maternal and childhood nutrition.
- ✓ Exceptional data analysis, scientific writing, and publication skills.

Strategy Expertise

Jutta Wright
APD, BAppSc MNutrDiet GDipHerbMed
Senior Dietitian

Jutta is co-lead in management of the project together with Michelle and is the project lead for communication strategy and execution.

.

- ✓ Experience across dietetics including clinical, food industry, corporate health, community health, and private practice.
- ✓ Experience in identifying food trends and insights, strategic marketing, communication and product development guidance to food and health industries.
- ✓ Excellent communication skills, strategic thinking and consumer insights means Jutta delivers the highest quality nutrition science in a manner with real-world impact.

Our esteemed PRG

Jacqui Simpson
R & D Manager
Hort Innovation

Melinda Simpson
NSW DPI
Development officer

Sonia Gabauer
Marketing Manager
Driscolls

Emma Beckett
Senior Lecturer &
Science Communicator
Uni Newcastle

Leanne Bates
Certified personal
trainer

Dr Jill Gamberg
GP & Lifestyle Medicine
Practitioner

Jemma O'Hanlon
Senior Food & Nutrition
Advisor NHF

Project overview

The project: MT21000

Supports the **Strategic Investment Plan** of the Blueberry, and Raspberry and Blackberry Funds to increase domestic consumption of fresh Australian Berries.

End of project outcomes:

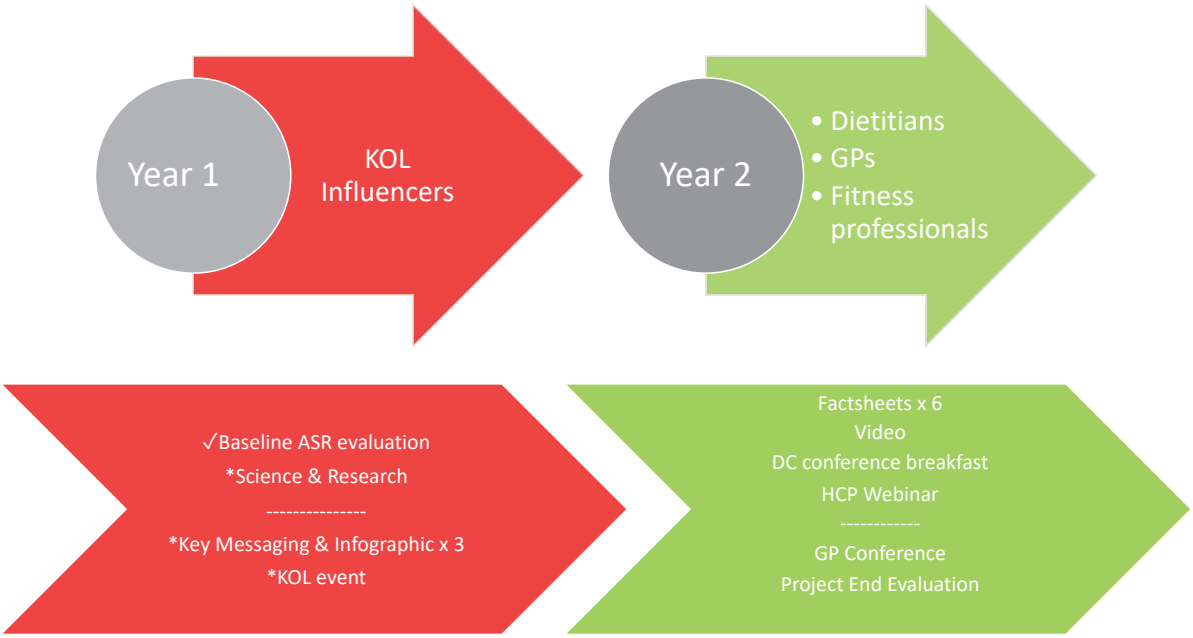
1. Health care professionals to have an **increased awareness** and knowledge and **confidence in discussing** with clients the health and nutrition benefits of Australian berries.
2. **Increase** health care professional **recommendations for the consumption** of fresh blueberries, raspberries, and blackberries.

The project

Intermediate outcomes:

1. **HCPs** to **access and use developed resources** to educate clients on the health benefits of Australian berries.
2. **Berry growers** to have an **increased awareness of health and nutrition benefits** of Australian berries.
3. **Hort Innovation and industry's digital platforms** to be **updated with contemporary research and resources** that can be shared and used by the berry industry and health professionals and their stakeholders.
4. **HCP** electronic **database increased** by a minimum of **30%**.

Top-line approach & Target Audiences



Audience Sentiment Research - Baseline

Objectives

1. Obtain baseline data on perceptions and attitudes to be used as a benchmark for project evaluation at project end as part of monitoring & evaluation plan.

2. Gain market insights to help tailor key message development and adjust the communication plan.

First of two market research reports, with the second due to be conducted at the conclusion of the 2-year project, around November 2023.

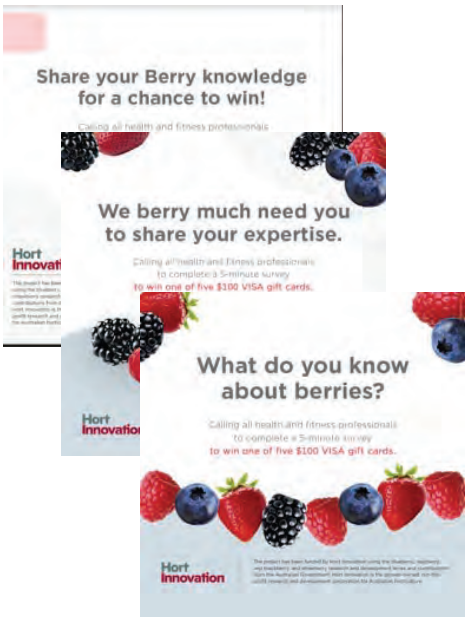
Approach

A digital recruitment campaign was run to recruit a minimum of 200 health care professionals:

- over 4 weeks (May 16th to June 12th, 2022).
- across paid social media channels – Facebook.
- complemented with organic strategies (e.g., sharing via NRAUS employee social media accounts (Facebook, LinkedIn to professional networks).
- dedicated EDM sent to NRAUS owned HCP database
- promoted with the chance to win 1 of 5 $100 Visa gift cards.

To be eligible, participants had to reside in Australia, and either be a health care professional or studying to become one.

Five separate social media tiles were designed (3 Static, 2 gifs), which allowed us to test and refine the recruitment strategy.



Survey stats

Participant flow:

592 Total views

42.9% of all viewers completed the survey

320 Starts

79.4% of all starters completed the survey

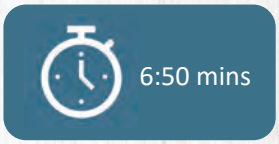
254 Submissions

14 excluded as were not HCPs living in Australia
26 were not HCPs or studying to become HCPs

214 Eligible

Exceeded target of 200

Average time to complete:



Audience Segmentation

Age: 69% were 25-44

- 40% 25-34yrs
- 29% 35-44yrs
- 20% 45-54yrs
- 8% 55+yrs
- 3% 24yrs or younger

Sex: 73% female

- 73% Female
- 23% Male
- 3% Other

State: NSW most popular

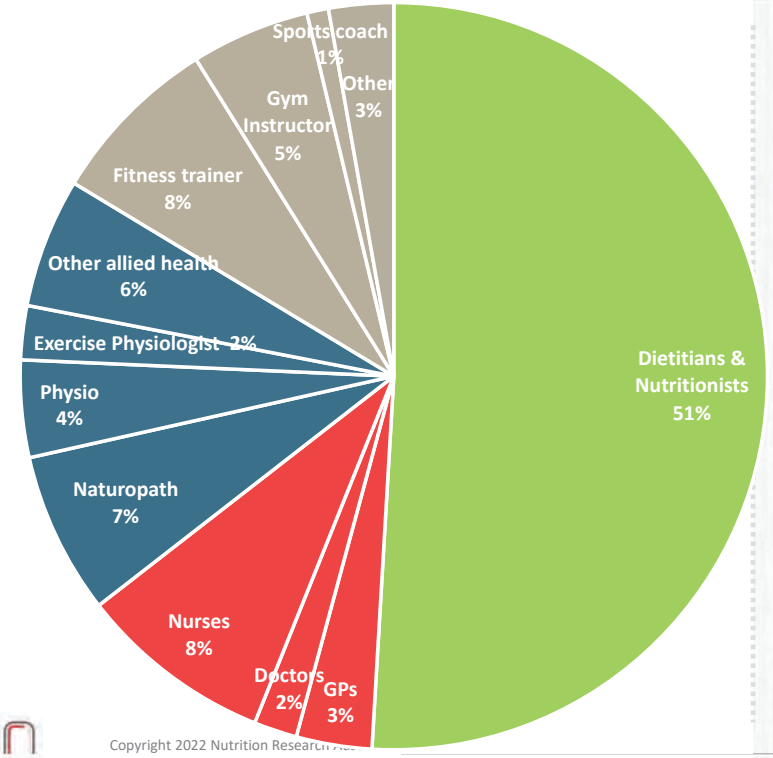
- 31 % NSW
- 19% VIC
- 17% QLD
- 13% WA
- 18% SA
- 8% SA
- 6% ACT, NT, TAS

Students: 1 in 6

- 84% HCPs
- 16% studying

n = 228

Just over half were dietitians or nutritionists, with many (53%) in clinical or private practice



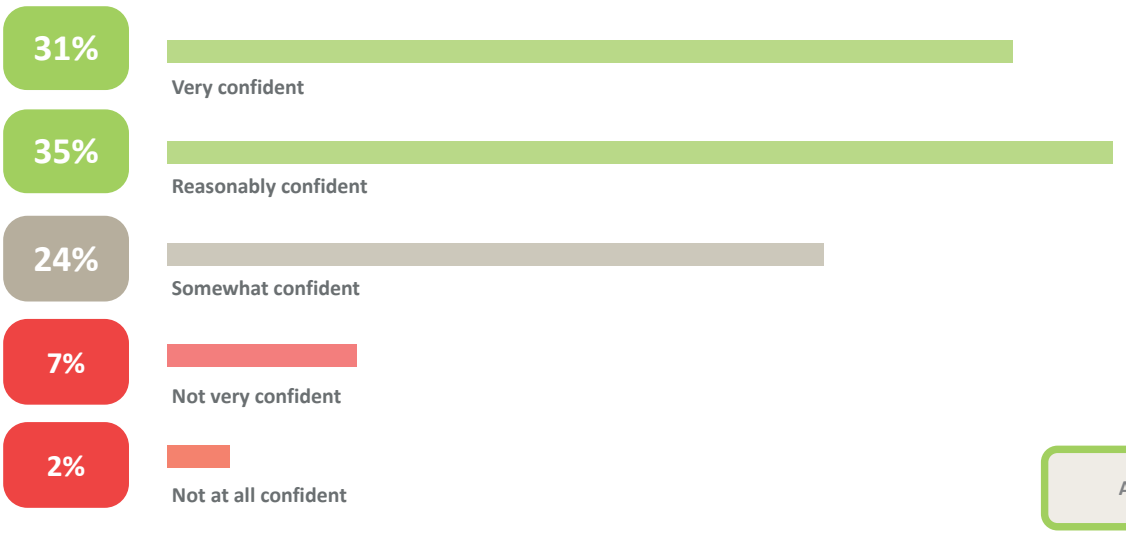
Setting of current practice:

- 27% in private practice
- 26% in clinical
- 15% in gyms
- 10% in public health
- 10% management or other
- 5% currently studying
- 4% in research
- 3% in education/tertiary

n = 214

Findings

Majority HCPs feel confident in discussing the nutrition and health benefits of Australian berries with 2 in 3 rating themselves very or reasonably confident.

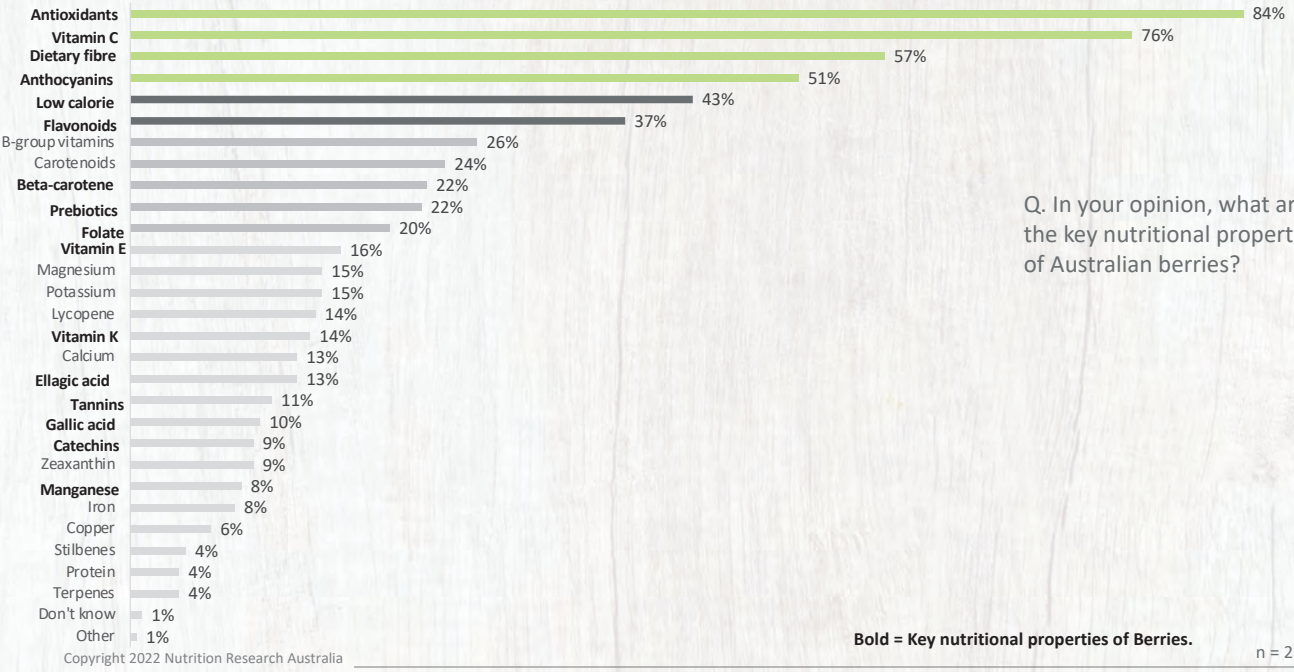


Dietitians and naturopaths had the highest confidence level, and allied health and nurses the least.

Average score = 3.9/5

n = 214

The majority (>75%) correctly identified antioxidants and vitamin C as key nutritional properties, but only half or less could identify specific bioactives .

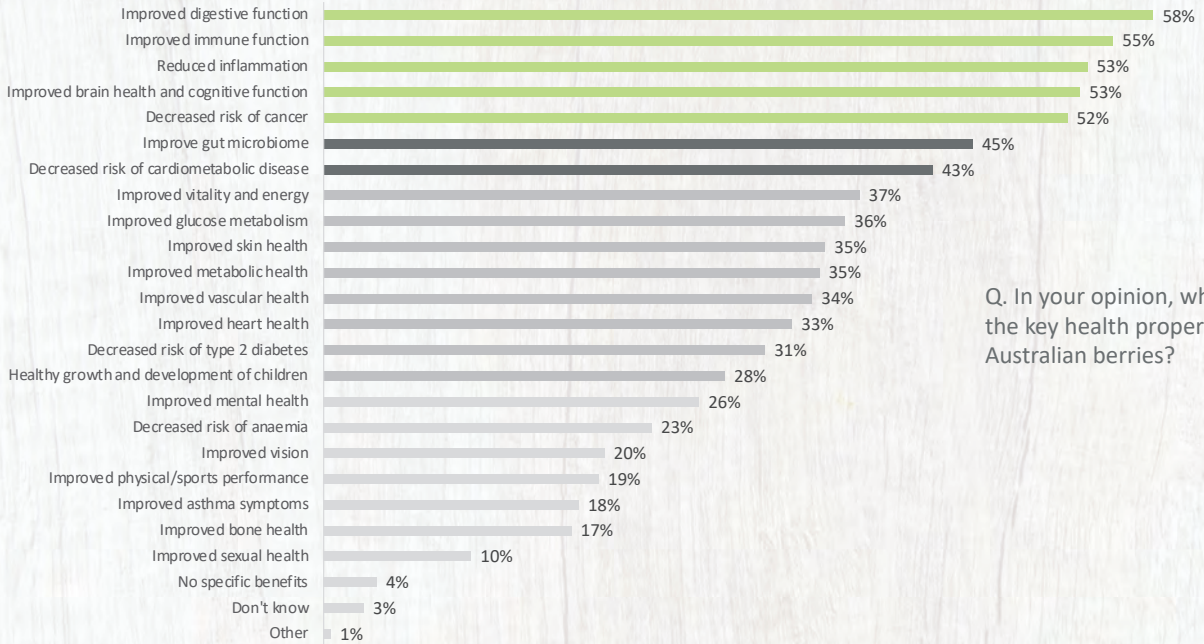


Q. In your opinion, what are the key nutritional properties of Australian berries?

Bold = Key nutritional properties of Berries.

n = 214

Most common health outcomes identified by around half included Improved digestion, immunity, and cognition, and decreased inflammation and risk of cancer. Less know about gut health and metabolic benefits.

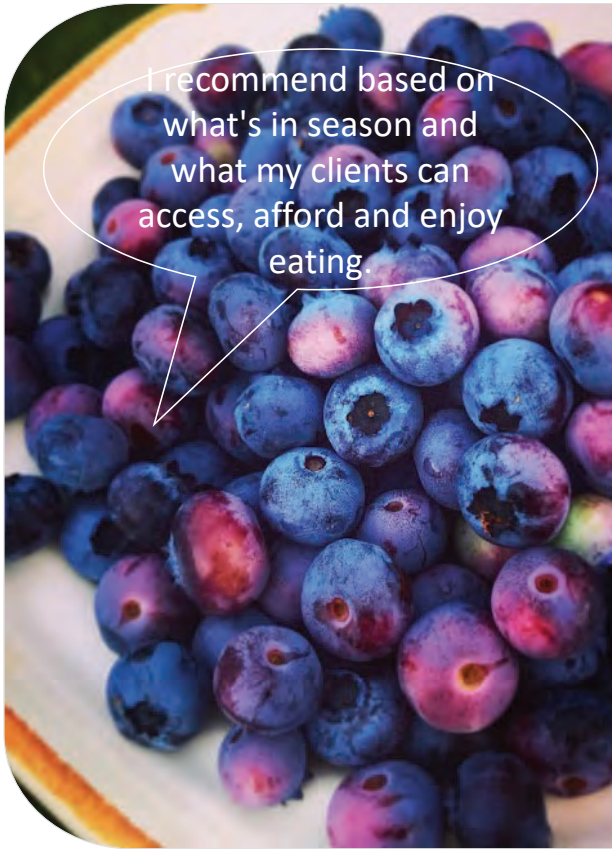


Q. In your opinion, what are the key health properties of Australian berries?

n = 214

58% HCPs regularly recommending berries to clients

- Mixed berries or blueberries most common, with very few specifically recommending blackberries or raspberries.
- Nutritional and health benefits, taste and convenience are key drivers.
- Not being top of mind and lack of nutritional and health knowledge are the key barriers.
- Cost issue for only small subset of respondents (15%).
- 3 in 4 not familiar with growing practices of Australian berries and yearn for information on how growing affects nutritional quality and effects of pesticides.



Most HCPs (60%) unaware of resources

- While technical reports and videos are popular, a variety of formats are key to meet the needs of the broader HCP base.
- Mostly value simple infographics and fact sheets they can share with clients. While digital is overwhelming preferred, there is still value in resources also available in printed format.
- Most interested in information around managing gut health, inflammation and oxidative stress, immunity, brain health, cardiovascular health and healthy aging.
- While nutrition and health information tops the list (75%), inclusion of practical ways to include berries via recipes are key to support resource usage (55%)
- Other key supporting information: dosage and frequency intake, mechanisms of action, emerging science (45%) and growing practices (25%).

HCPs want to know more about soil health and pesticide use, up-to-date credible scientific information, differences in berry types (like nuts), and practical usage information.

1. Information on growing practices and the effects on nutrition

"I am interested in the growing practice and the effects of this on the nutritional properties. The use of pesticides and the effects of this on health

"I have been told some berries are quite highly sprayed with pesticides so would be interested in this information too

2. Credible, evidence-based information and differences in berry types

"Recent studies investigating berries in whichever respect and findings

"Authoritative clinical data

"….Australian berries compared to overseas grown as well as specific nutritional or research differences between berries, as we have for nuts

3. Practical usage information

"More on the nutritional benefits and recipes/ways to include them

"Would like best seasons for consumption and growing your own

"Where to find Australian berries vs NZ or other berries in grocery stores, how to stop raspberries going mouldy

"…Nutritional benefits and recipes/ways to include them

Strategy recommendations

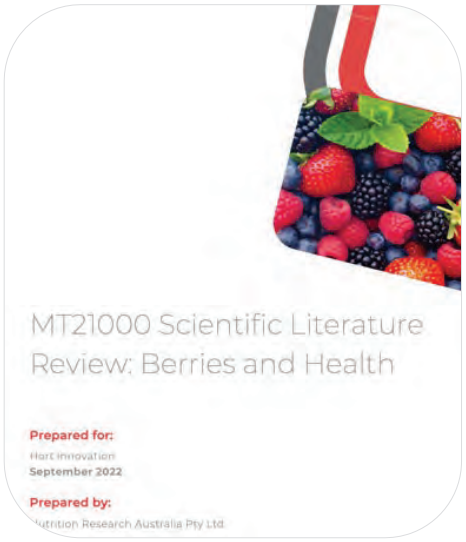
- Regular communication to drive top of mind awareness.
- Leverage dietitians as KOLs to communicate, educate and influence other HCP groups via their owned communication channels.
- Continue with original planned range of educational collateral and event activations.
- Continue with all materials to be available for digital format and small print quantity for key events.
- Recommend 6 planned client friendly fact sheets to cover gut health, immunity, inflammation & oxidative stress, brain health, cardiovascular health and healthy aging.

Messaging recommendations

- Overall provide specific nutrition and health benefits about different berry types, remind about taste and convenience cues and provides practical usage ideas including recipes.
- Support with dosage and frequency intake recommendations, mechanism of action, any emerging science.
- Educating on ‘farm to fork’ berry story, specifically highlighting any nutritional and health impacts of growing practices including pesticide use.
- Aim to include communication around nutrient:cost benefit ratio to help minimise cost as barrier.

Upcoming deliverables

Berries Literature Review



What are the health effects of Australian berries?

Role:

- Provide an evidence base to inform the education campaign
- Focus on emerging research published since 2016
- Additional information collected on:

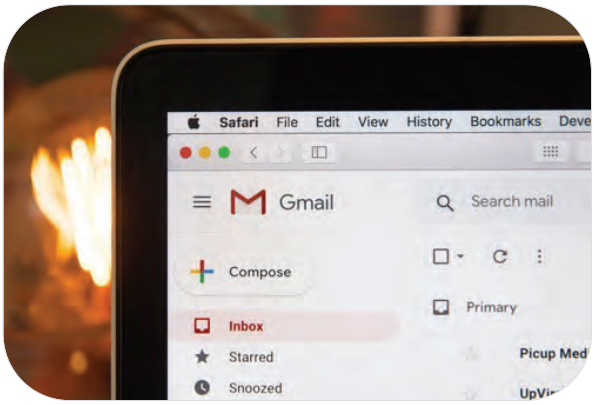
Nutritional composition, nutrient density-to-cost ratio, novel uses, sustainability of growing practices, impact of cooking/processing method and consumer trends

*E.g., Blueberries can reduce the risk of type 2 diabetes, with every 3 serves a week reducing the risk by 26%**

**where 1 serve equals ½ cup fresh blueberries*

Status: Undertaking final peer review and will be completed 5th September 2022

EDMs



Role: Ongoing communication (2-3 per year) to Berries HCP database utilised to educate on berries nutrition and health, disseminate educational materials and communicate upcoming events.

EDM 1 (August 22) – Welcome, Feedback on ASR, Fun Facts.

EDM 2 (November 22) – Infographics

EDM 3 (March 23) – KOL event lowdown

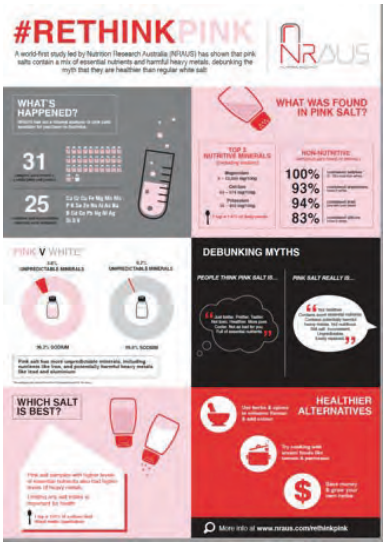
EDM 4 (May 23) – Factsheets

EDM 5 (July 23) – Webinar invite

EDM 6 (Oct 23) – End of project

Status: First EDM gone out this week

Infographics



- 3 x A4 6 panel – Blueberry, Blackberry, Raspberry
- Include: what, why & how
  - Fun facts about
  - Growing practices
  - Nutrition benefits
  - Health benefits
  - Intake recommendations - dosage
  - Practical usage ideas

Next Steps: Confirm messaging and commence development outline.

KOL Event

Co-ordinated online, free, live event inviting 30 Tier 1 KOL and nutrition influencers to a "#BerryMuch" event.

Featuring a virtual cooking demonstration by **Alice Zaslavsky** and scientific fun facts presentation by **Dr Flav.**

We will leverage the relationship and trust built with the KOLs to distribute information through-out the campaign.

Role: Build KOL ambassador and influencer network that can communicate and amplify project key messages throughout the project.

Timing: Aiming early December

Status: Planning stages

Feedback & Discussion

PRG feedback

Influencer event

- Suggestion by Jemma to hold culinary masterclass and get involvement of attendees by sending kit they can use to prepare along with Alice to foster engagement. Friendly competition could be encouraged to foster creativity and translation of the messages they hear, by getting them to post their creation with one or two facts they learned.

General messaging

- Jemma highlighted that having just a few specific (one or two so better remembered) and memorable messages for each berry type should be created that helps communicate their uniqueness. Consider also using visual elements to bring messages to life and make them simple and memorable – e.g., blueberries in heart ramekin for heart health. Also consider the consumer as the end receiver of the message and what resonates.

PRG feedback

General messaging continued

- Sonia highlighted importance of ensuring messaging is tailored to the HCP target audience specific needs (noting Dietitians different to GP or fitness professional) to ensure they will leverage.
- Jemma noted that many people often use frozen berries, while this project aims to raise consumption of fresh berries. Will be important to create a value proposition for fresh rather than frozen. Sonia highlighted that the application of fresh berries would be the way to action this. Most common occasions berry consumption 1. Snacking. 2. Breakfast. 3. Dessert. Fresh berries have texture advantages to frozen. Showcasing the culinary benefits and usage/recipe ideas for occasions that support fresh consumption will be key.
- Discussion around HCP desire to understand more about growing practices and pesticide use. Real opportunity to debunk myths in this area. Similarly, HCPs desired information on how to store/maintain shelf life. Sonia to support with information in areas growing/pesticides/how to select/store that can be leveraged in communication.

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Thank you

NRAUS

MT21000 Health and nutrition information for the Berry industry

PRG Meeting 2

29th March 2023

Agenda

1. Introduction new team member
2. Project Overview
3. Review project achievements to date
4. Strategy refinement & proposed plan
5. Feedback/Discussion

Introductions

Dr Emma Beckett

Senior Food & Nutrition Scientist (RNutr, PhD)

- ✓ an award-winning food and nutrition scientist, communicator, and media personality
- ✓ PhD (Food Science & Human Nutrition), Masters (Science Management), Grad. Dip (Epidemiology), Grad Cert (Nutrition), Bachelor of Biomedical Science.

Project overview

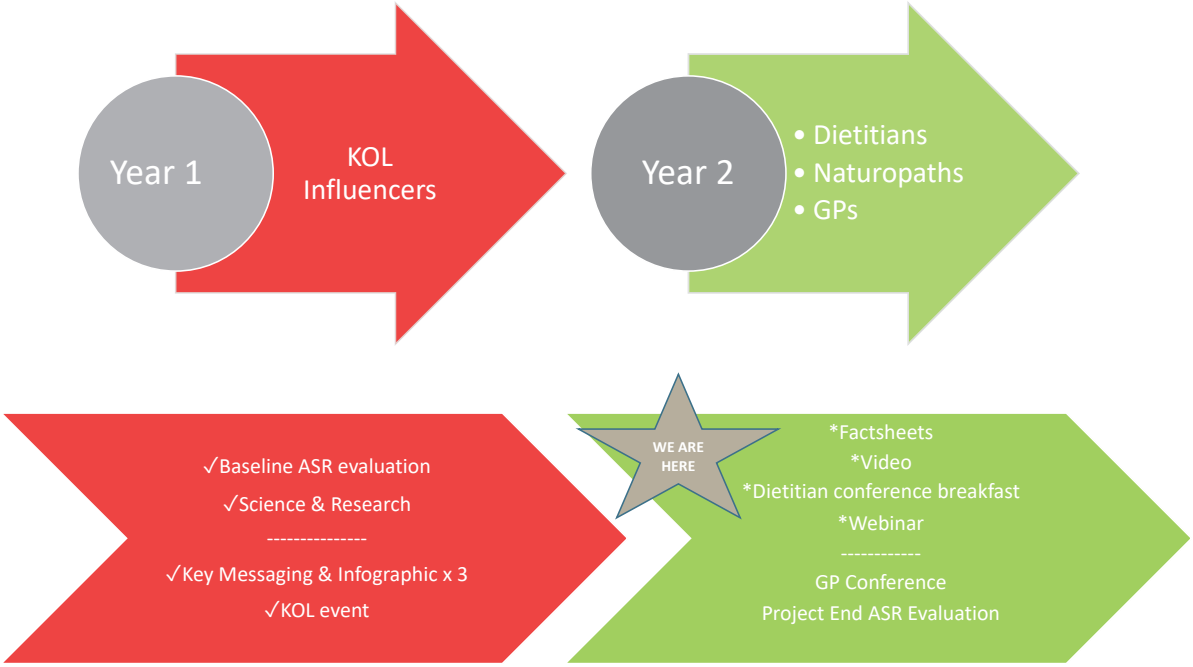
The project: MT21000

Supports the **Strategic Investment Plan** of the Blueberry, and Raspberry and Blackberry Funds to increase domestic consumption of fresh Australian Berries.

End of project outcomes:

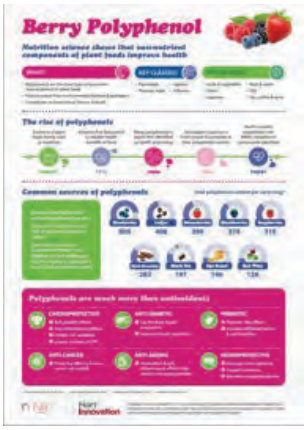
1. Health care professionals to have an **increased awareness** and **knowledge** and **confidence** in discussing with clients the health and nutrition benefits of Australian berries.
2. **Increase** health care professional **recommendations for the consumption** of fresh blueberries, raspberries, and blackberries.

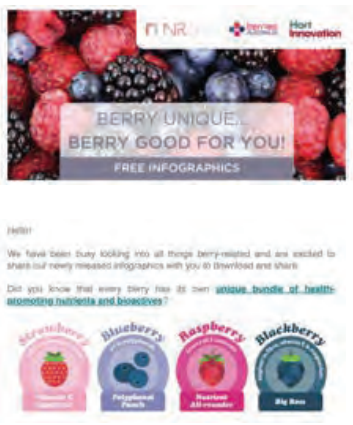
Top-line approach & Target Audiences



INFOGRAPHICS

3 infographics produced – part of KOL information kit and sent out to Berry database.

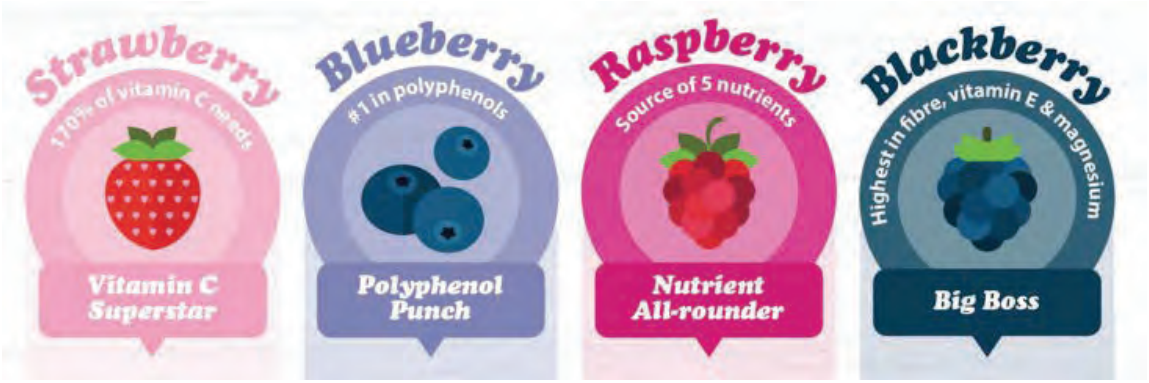




KOL EVENT

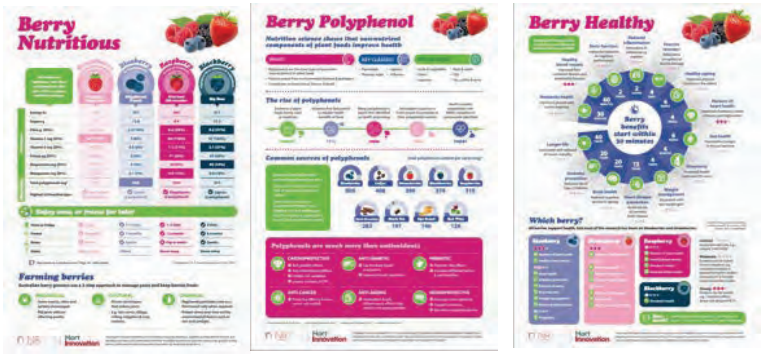
“Berry Well Tribe” – exclusive online KOL event

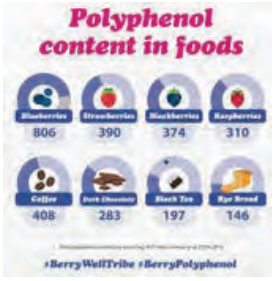
“Berry Well Tribe” – exclusive online KOL event

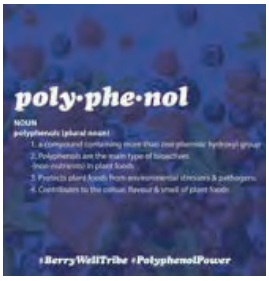


Bringing to life the unique positioning for each of the berries

KOL information kit: infographics and social tiles.







"Berry Well Tribe" – exclusive online KOL event
Summary Results

Attendance

101 invited
33 registered to attend
19 attended live

Follower count of attendees

Instagram: 7,631 (103 – 31,900)
Twitter: 1,608 (503 – 24,200)

(median, range)

Information related to the event was shared by nearly two-thirds of attendees **(11/19)**

100% (14/14) rated the event as "Excellent" or "Very Good"

85% (12/14) rated **informativeness** as "Extremely" or "Very Informative"

85% (12/14) rated **engagement** as "Exceptional" or "Above Average"

78% (11/14) rated **usefulness** as "Extremely Useful" or "Very Useful"

		1	2	3	4	5
Overall, how would you rate the event?	**4.64**					
How **informative** did you find the event?	**4.42**					
How **engaging** did you find the event?	**4.35**					
How **useful** do you feel the information presented to you was?	**4.21**					

What attendees said about the online KOL event format:

"Loved the meeting vs webinar format"

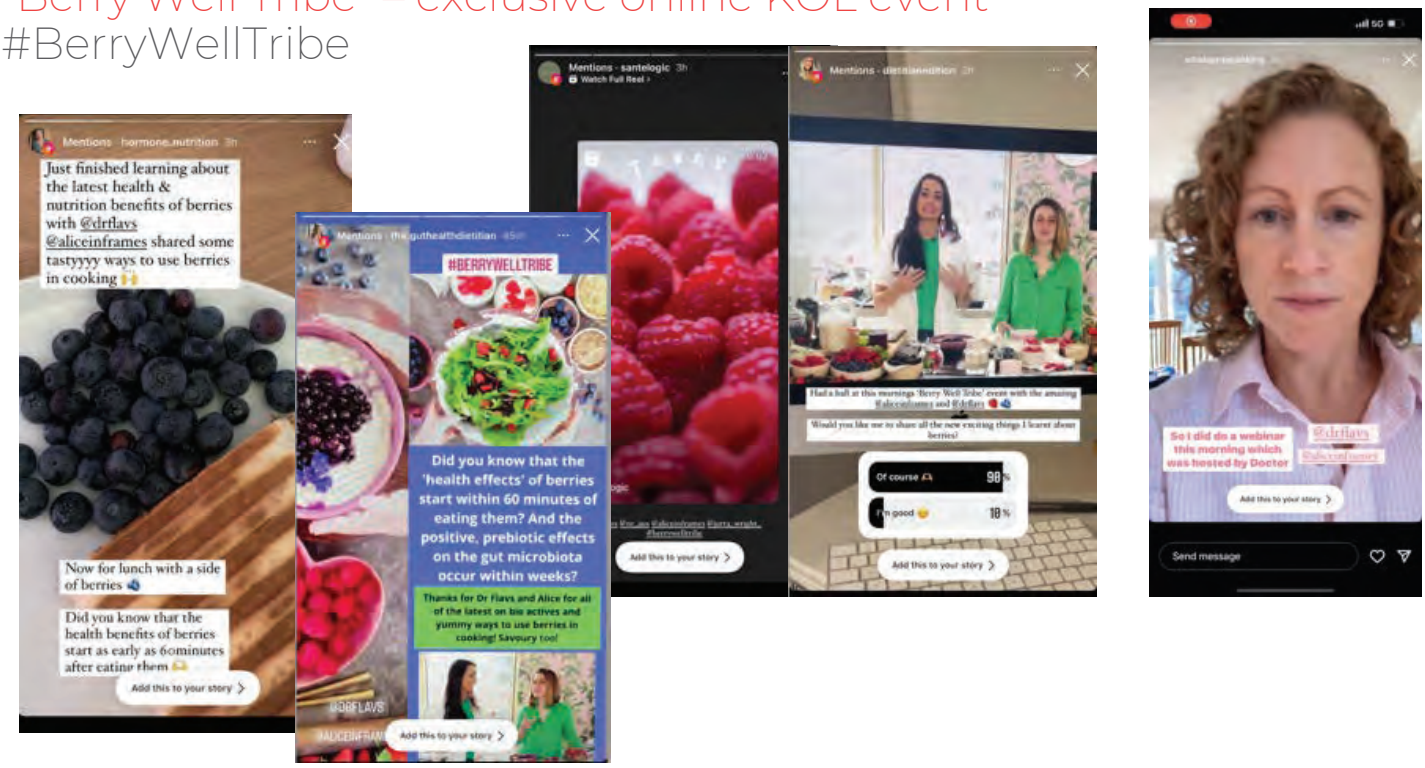
"I preferred this style of interactive event vs. a typical webinar, it was nice to discuss the culinary aspects of nutrition as well as talk about health benefits."

"Being divided into the 'break-out' rooms was a really nice way to break the ice and learn more about other professionals in the industry."

"I would have loved if the event was in person, as it would have been great to be able to chat to other members of the audience and interact with the hosts more, which would probably need it to be a slightly longer event."

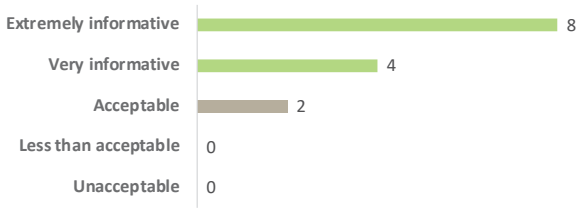
"Berry Well Tribe" – exclusive online KOL event
#BerryWellTribe

“Berry Well Tribe” – exclusive online KOL event
#BerryWellTribe



“Berry Well Tribe” – exclusive online KOL event
#BerryWellTribe

How informative did you find the event? Why or why not?



"Loved the facts shared, especially about practical kitchen tips"

"Personally I find online events a little less engaging, summary slides or a reference document/powerpoint would also be helpful to ensure I get all key takeaways"

"I have some "bite-size" points committed to memory"

"I thought the level of evidence/information provided was fantastic - above and beyond the usual standard. I picked up a few new facts and found the event engaging."

"Dr Flav has some great insight into the nutritional benefits of berries and Alice's simple and practical tips on how to use these beautiful fruit was great."

"Really interesting facts about berries, recipe/culinary nutrition tips and key nutritional profile/benefits of the different berries."

"Lots of fun facts, great presenting, great dialogue between presenters"

"I learnt lots of new facts which I have already started sharing with clients, friends & family!"

"It was great to hear about 'bioactives' as a new focus from Dr Flav and some innovative recipe ideas from Alice"

"Greta mix of info and beautiful food and recipes."

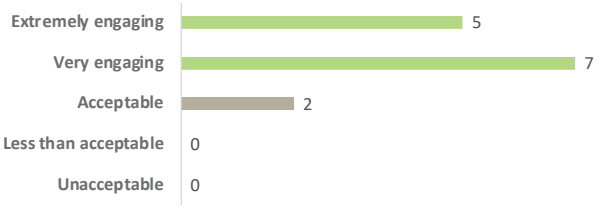
"I thought I knew a lot about berries, until this event. I particularly loved the 'fun-facts' integrated throughout the session content."

"I loved the nutritional biochemistry information shared! The research is so fascinating and informative!"

"Lots of fun culinary facts, could have used more evidence base"

"**Great new facts weaved in with practical culinary tips"**

How engaging did you find the event? Why or why not?



"the polls were good"

"Not particularly engaging, once again, hard to acheive in the online format."

"The Q&A was great"

"Loved the breakout rooms and the polls."

"I loved the breakout rooms at the start and thought that the true/false conducted throughout really provided engagement and interaction."

"Great interaction for an online event. Break out room and questions throughout were good. No Powerpoint was great - Flavia knows her content and the interaction with Alice was good."

"As per previous answer" *(Lots of fun facts, great presenting, great dialogue between presenters)*

"Excellent presenters, I loved the cooking demonstrations & audience polls"

"Great to have the fun quizzes throughout"

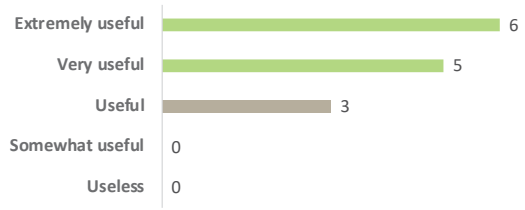
"Very positive hosts. Engaged chat group."

"Being divided into the 'break-out' rooms was a really nice way to break the ice and learn more about other professionals in the industry. I also found the polls/quizzes was a nice way to keep me engaged. I don't think I picked up my phone once!"

"Time in breakout rooms too short, would have been good to return to them. Alice and Flavia were polished presenters and overall very joyful"

"Loved the meeting vs webinar format and small group breakout"

How useful do you feel the information presented to you was? What did you consider to be the most valuable learning/s?



"the facts that I can share in my work (practical kitchen tips)"

"Don't wash berries before going into the fridge haha"

"Folate & DF tips"

"**Unique facts about each type of berry e.g. specific antioxidants and how they are linked to health benefits."**

"The need to talk more about the bioactives in berries and to communicate them."

"The key nutritional profile of the different berries, how they provide a good source of key bioactives not found in many other foods. The recommendation to use "bioactives" as a term with consumers and how to explain this. Practical tips for preparing, storing and cooking with berries."

"New Ways to use berries and research facts"

"Practical tips around eating/cooking berries. Nutritional benefits/profile of individual berries"

"I would say the valuable differences between the different berries as well as the delicious recipes"

"Understanding some of the killer facts around berries. Key nuggets of truth for each one. The easy recipes. Although it went so fast I couldn't get it all down. I'd love some notes."

"A combination of the most up-to-date research on berries and how to incorporate berries into both sweet & savoury dishes."

"Culinary tips"

"Practical advice we can share with consumers to them. Alice and Flavia were polished presenters and overall very joyful"

"Loved the meeting vs webinar format and small group breakout"

STRATEGY REFINEMENT

SWOT analysis

Strengths

- Highest in polyphenols (per serve)
- Strong health perceptions
- On trend
- Some awareness on anthocyanins and brain health
- Strong nutritional profile and evidence for many (10+) health outcomes

Weaknesses

- Limited evidence for raspberries, blackberries
- HCPs see as healthy but lack knowledge in the specificity as to why
- Lots of health outcomes means generally healthy but not top of mind when discussing any key health concerns (e.g., gut health)
- Pesticides and cost, for a subset of HCPs
- 'HCP Reach' of current strategic plan

Opportunities

- Improve specificity in health knowledge
- Make top of mind for the HCP
- Different berries for different nutrients
- Therapeutic effects of the berry bioactives
- Taste and culinary education
- Strengthening reach via more investment in channel/digital activation

Threats

- Lack a hook/tension
- Not being remembered for anything specific
- Not solving a specific health problem, relevant for GPs
- Limited budget and time (project reduced by 12 mths)

- A targeted clear educational message & target audience needed
- Strengthening reach of comms plan

"The what": Targeted messaging

The opportunity

How do we leverage the berry scope report to create a clear educational message that makes berries top of mind for the HCP?

Objectives

1. Increased awareness, knowledge and confidence in discussing the health and nutrition benefits of fresh berries (blue, black, and raspberries).
2. Increase HCP recommendations for the consumption of fresh berries (blue, black, and raspberries).

Primary messaging

Berry polyphenol : Polyphenols (a prebiotic) for gut and brain health.

- Polyphenols as an established prebiotic and neuro-protective dietary component.
- Emerging polyphenol and berry science on gut and brain health. – key on trend topics for HCPs (& consumers)
- Berries as the highest source of polyphenols.

Secondary messaging

Berry unique: the unique characteristics of each berry type.

Berry foodie: from farm to fork (growing, culinary, fun facts).

The 'WHO': HCP audience segmentation

	ASSESSMENT	TARGET (Y/N)
HCP (social media) influencers	• High trust, credibility, reach and influence. • In increasingly digital space key to building coalition of supporters and amplifying message.	• Yes • Continue to communicate and leverage #berrywelltribe to disseminate & amplify messages.
Dietitians Registered nutritionists	• High credibility/trust, mod-lower reach • Influencers of wider HCP landscape. • Key group to develop as advocates to ensure successful project	• Yes • Primary group to target and develop as advocates.
Naturopaths Nutritionists (non-degree qualified)	• High credibility/trust and primary health providers for subset population. • Targeting will ensure coverage of all primary providers to consumers.	• Yes • Primary group to target and develop as advocates.
GPs	• High trust, credibility and reach. • Very little time for nutrition • High cost to reach. • Current science not strong enough to be solution to their problems. • Unlikely to see significant shift in recommended behaviour	• No • Secondary target for future project activation.
Practice Nurses	• High reach and trusted consumer influencer. • Current targeted messaging not suited to solving their needs (acute care environment)	• No • Secondary target for future project activation.
Personal trainers	• High reach and trusted consumer influencer. • Recommended targeted messaging not suited to solving their needs which centre around weight management/sports performance. • With reduced time/budget not primary target	• No • **Key** target for future project activation.

The 'How': Proposed changes to deliverables

Deliverable	Recommendation	Target	Rationale
Collateral			
2 Minute Animation	**Keep** Bring to life the hook and memorable targeted "(Berry) Polyphenols for gut and brain health"	ALL	Engaging comms medium that can be leveraged in digital activation campaign.
6 x Factsheets	**Change** 1 x HCP facing factsheet (4 page) 1 x client facing factsheet (A4 DSP) Both focused on targeted messaging	ALL	Targeted messaging.
Educational Events			
NRAUS Webinar	**Keep** 1 hour webinar targeting Primarily Naturopaths • TBC: Wolfgang Marx on *Berry/Polyphenol science in gut/brain health* and/or Dr Jason Hawrelak (Naturopath) and Nicole Dynan (Dietitian)	**Primary: Naturopaths, KOL influencers** *Secondary: Dietitians-Nutritionists*	• Key and cost-effective way to target Naturopaths – can advertise events through association. • Jason Hawrelak is highly regarded naturopath in the gut health area, also with credibility with dietitians. • Wolfgang is key researcher in polyphenol & gut/brain health.
Dietitian Connection (1 day) Conference (in person Melbourne)	**Change** Dietitian Australia (3 day) Conference (in person Melbourne) • Breakfast (TBC) – Wolfgang Marx on the Berry/polyphenol Science & Nicole Dynan on unique berry attributes and culinary aspects • Trade display over 3 days of conference	**Primary: Dietitians-Nutritionists**	• Higher reach and ROI (1000 vs 300). • Nicole Dynan well-regarded dietitians who are great communicators in area of gut health and key digital KOL influencers.
GPCE conference	**Change** Redirect into Digital Outreach Campaign to drive reach of messaging, resources & HCP to Berries Hub: • Paid influencer posts (as part of KOL activation0 • Dietitian/Naturopath channel comms • Social media campaign	ALL	• GPs Lower ROI and not recommended. • Need to strengthen the comms plan message reach.

Note: No change to total overall budget

Feedback / Discussion

- **Any concerns/builds?**
- **Any other activations to consider?**
- **Any other HCP speakers worth considering to utilise at educational events?**

Meeting Minutes

- **Positive feedback on deliverables to date:** Liked the infographics and KOL digital outreach seen as positive impact on the end consumer.
- **Overall agreement from PRG on the strategy refinement recommendations:**
  - **Similarly focused target audience and messaging seen as common sense.**
  - **Jemma supported recommendation to Dietitian Australia - will gain better reach than Dietitian Connection conference.**
  - **Discussion on messaging and whether polyphenol is the right target (compared to bioactives/antioxidants) –** Agreed this is the best term.
  - **Discussion on whether focus on polyphenol will only support blueberry and not other berries –** Discussed that while polyphenol leading messaging, it is relevant to berries as a group. Importantly it will be also supported by secondary messages around unique berries and culinary attributes.
  - **Jill highlighted not to forget GPs are consumers and whilst current science not supportive to recommend Berries directly in practice,information will influence their own and families health –** discussed including them as target audience within digital outreach campaign.
- **Other**:
  - Berries Australia website – reminder to ensure collateral shared with them for their website.

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Thank you

MT21000 Health and nutrition information for the Berry industry

PRG Meeting 3

4th September 2023

Agenda

1. Project Overview
2. Review project achievements to date
3. Upcoming deliverables
4. Feedback/Discussion

Project overview

The project: MT21000

Supports the **Strategic Investment Plan** of the Blueberry, and Raspberry and Blackberry Funds to increase domestic consumption of fresh Australian Berries.

End of project outcomes:

1. Health care professionals to have an **increased awareness** and **knowledge** and **confidence** in discussing with clients the health and nutrition benefits of Australian berries.
2. **Increase** health care professional **recommendations for the consumption** of fresh blueberries, raspberries, and blackberries.

"The what": Targeted messaging

The opportunity	**How do we leverage the berry scope report to create a clear educational message that makes berries top of mind for the HCP?**
Objectives	1. Increased awareness, knowledge and confidence in discussing the health and nutrition benefits of fresh berries (blue, black, and raspberries). 2. Increase HCP recommendations for the consumption of fresh berries (blue, black, and raspberries).
Primary messaging	**Berry polyphenol : Polyphenols (a prebiotic) for gut and brain health.** • Polyphenols as an established prebiotic and neuro-protective dietary component. • Emerging polyphenol and berry science on gut and brain health. – key on trend topics for HCPs (& consumers) • Berries as the highest source of polyphenols.
Secondary messaging	**Berry unique:** the unique characteristics of each berry type.
	Berry foodie: from farm to fork (growing, culinary, fun facts).

The 'How': Proposed changes to deliverables

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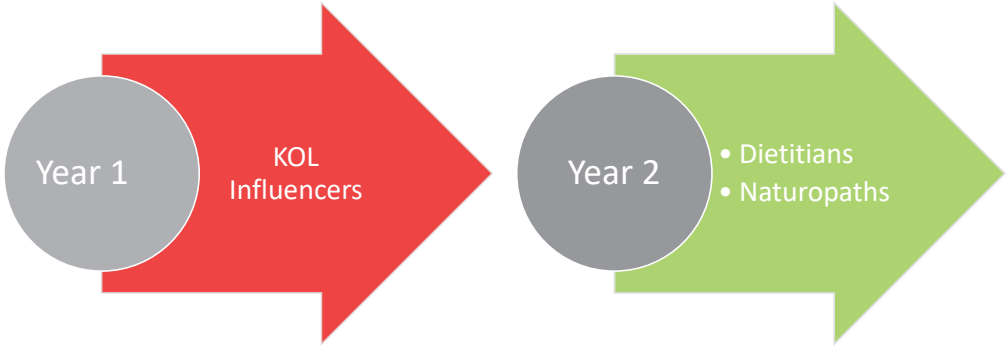
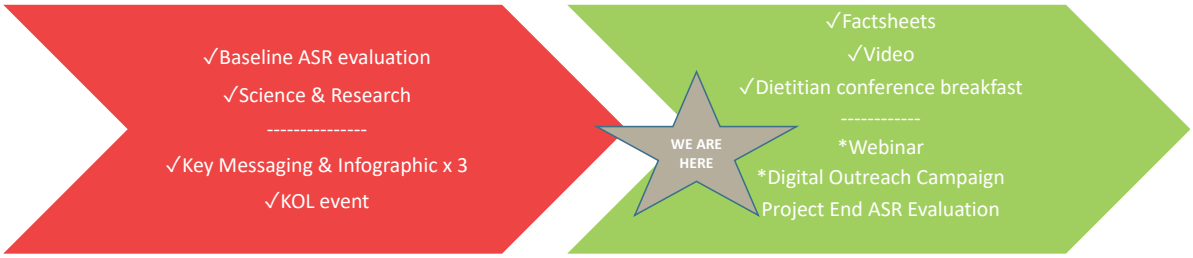
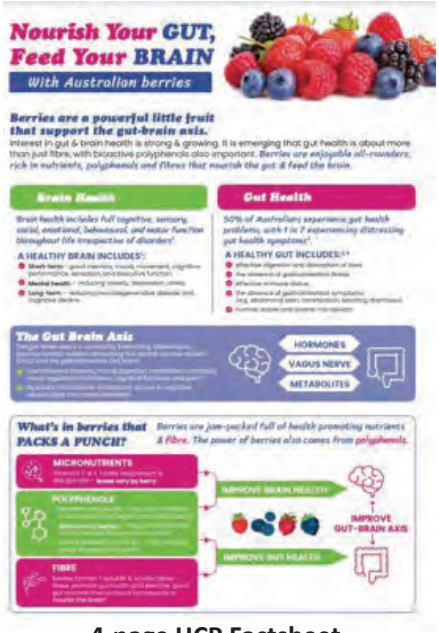
Top-line approach & Target Audiences



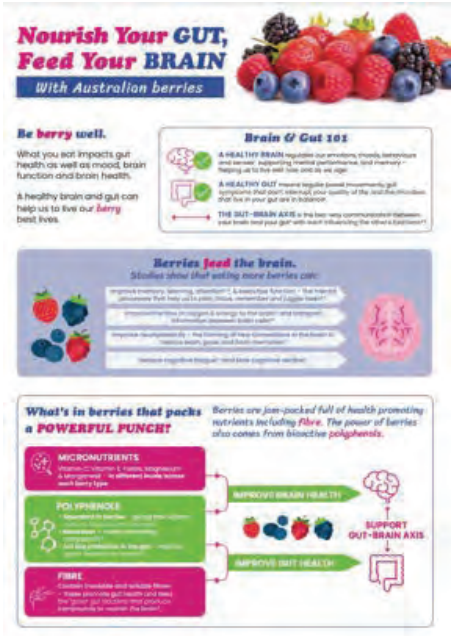


FACTSHEETS

Two Factsheets produced



4-page HCP Factsheet



2-page Consumer-facing Factsheet

DIETITIAN AUSTRALIA CONFERENCE

23-25th July Melbourne

- Over 600 delegates attended conference
- NRAUS Team educated dietitians visiting stand during breaks, on nutrition & health benefits of berries and the berries hub, converting 113 people (KPI>100) to register for the competition.
- From both the NRAUS edm, breakfast and trade display we recruit 166 new subscribers (KPI>50) to the database and 48 unique users checked out #berrieshub during conference.
- Berry sampling was KEY winner, attracting visitors with word-of-mouth buzz circulating to ‘check out the berry stand for the best tasting berries’.

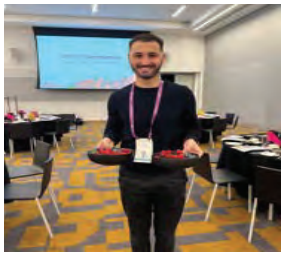
Breakfast Session
Tuesday 25th July

"Berries – a powerful solution to support the gut-brain axis"

Featuring:

Emma Stirling
Nicole Dynan
Dr Emma Beckett




Dietitian's Australia Berry Breakfast Evaluation – Summary results

ATTENDEES

58 Attended
(KPI: >40 attendees)

47 (81%)Completed Survey
(KPI: >30%)

REGISTRATIONS

48 Registered
10 additional attendees accommodated on the day
110 on waiting list

Target KPIs were achieved for: attendance, evaluation completion, and for all outcomes measured in the participant evaluation.

100% found event '**Excellent**' or '**very good**'
(KPI: >80% ✓)

Mean **4.8**/5
1 Poor · 2 OK · 3 Good · 4 Very good · 5 Excellent

100% found event '**extremely informative**' or '**very informative**'
(KPI: >80% ✓)

4.5/5
Unacceptable · Less than acceptable · Acceptable · Very informative · Extremely Informative

100% found event '**extremely engaging**' or '**very engaging**'
(KPI: >80% ✓)

4.6/5
Unacceptable · Less than acceptable · Acceptable · Very Informative · Extremely Engaging

91.5% found information presented '**extremely useful**' or '**very useful**'
(KPI: >80% ✓)

4.4/5
Useless · Somewhat useful · Useful · Very Useful · Extremely Useful

84.5% intend to recommend berries '**always**' or '**often**'
(KPI: >80% ✓)

4.1/5
Never · Rarely · Sometimes · Often · Always

Dietitian's Australia Berry Breakfast Evaluation – Comments

Overall Sentiment:

informative, knowledgeable, engaging and loved the energy of the presenters

"Vibrant and knowledgeable presenters and delicious food"

"Food is the best way to bring people together and engage - just like the kitchen is the heart of the home and best place to have a meaningful conversation"

"Great speaking ability and engaging activities"

"Loved the engagement. Such vitality and passion."

"Could not ask for a more engaging and passionate and knowledgeable team"

"Presenters were very energetic and passionate"

"The content and the energy of the presenters!"

High engagement scores driven by:

Mix of scientific information with practical, as well as the caliber of presenters and interactive nature of the session

"Good mix of science and how to apply in an appetizing way"

"The session highlighted the importance for dietitians to upskill in describing the sensory properties of food in our nutrition comms"

"It was creative, inspiring, and educational"

"Lots of scientific information in an easy to digest format (especially at 8am in the morning!), engaging audience, encouraging creativity… the list goes on!"

"Very interesting to know that berries can decrease the cognitive decline"

"Great presenters; fun vibe; delicious berries and food!"

"The interactive session really brought it all together"

Dietitian's Australia Berry Breakfast Evaluation – Comments

Most valuable out-takes:

Health benefits and different ways to use and recommend

"Practical Application and sound evidence-based messaging"

"Encourage regular berries consumption"

"Thinking of unconventional pairings, the whole eating experience (aroma, mouthfeel etc)"

"Thinking about how berries can be used beyond just eating them"

"Different fibre types in various berries and roles in brain health"

"Many different ways to use berries to recommend to patients and so much fibre!"

"Brain health studies"

"Versatile ways to use berries."

What was done best:

Energy, engagement of the presenters and science/practical format

"Breakfast and the variety/fit/relevance of content"

"Education, food, entertainment"

"Tasting and recipe idea, food provided were delicious"

"Engagement of presenters"

"Speakers and audience involvement"

"Delicious food! And excellent presenters"

"Good mix of talk and activity"

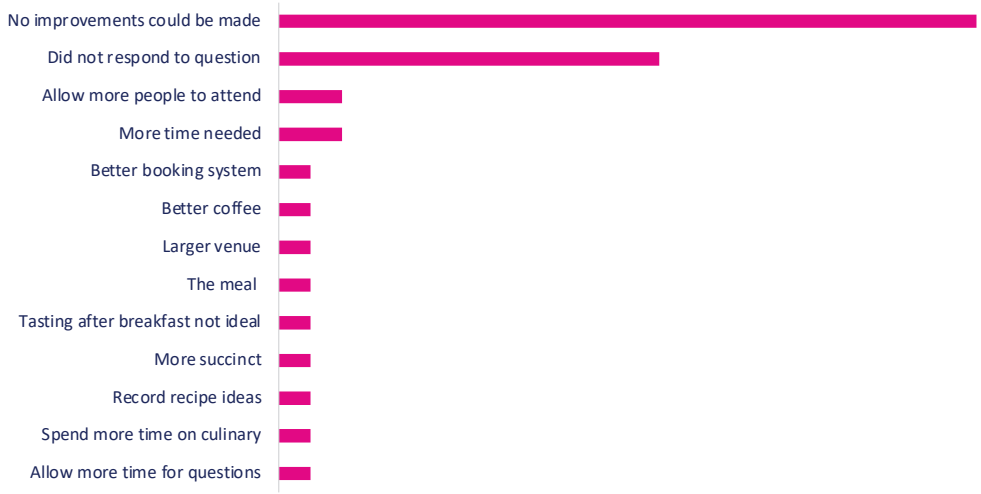
"Different presenters with practical recommendations"

"All of it! Wouldn't change a thing!"

"Everything!"

Dietitian's Australia Berry Breakfast Evaluation – Recommendations

Overall, attendees satisfied with nearly half respondents stating no improvements needed.

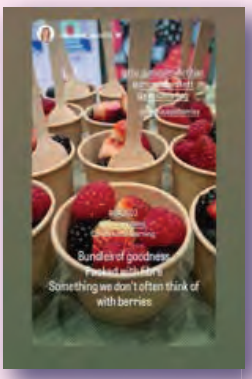


Dietitian's Australia Berry Breakfast Evaluation – Social Media

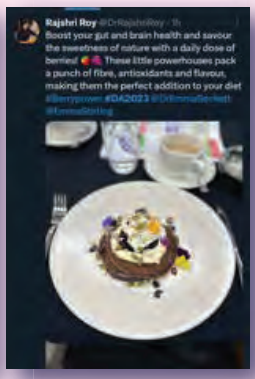
10 unique posters from 58 attendees (17.2%)
(KPI: >25%)

Key Observations

- The most active time for posting conference-related material was after the final session for the day
- Conference-related activity on Twitter was much lower than it had been in previous years, likely reflective of recent changes to the platform.



Instagram Stories



Twitter

Instagram Post

*Selected images representative of typical content across platforms

Dietitian's Australia Berry Breakfast Evaluation – Learnings

Recommendations for future events

- Very few suggestions for improvements.
- Information regarding culinary uses of berries was highly valued by participants and should be included in future events
- Review strategy and approach for engaging healthcare professionals on social media – consider incorporation of incentives or gamification to increase engagement

ANIMATION

https://youtu.be/WAkGNmqgsLU

UPCOMING DELIVERABLES

WEBINAR

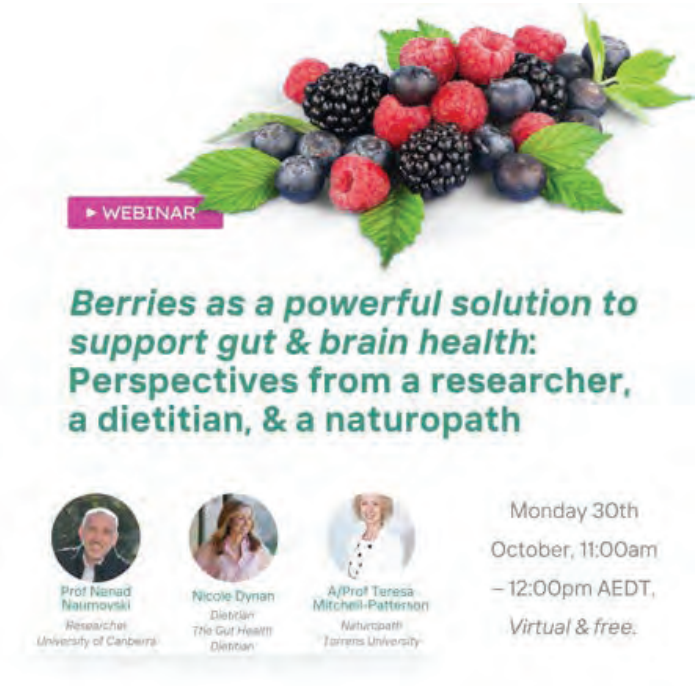
NRAUS Webinar

Target: Naturopaths, Dietitians

Date: 30th October 2023. 11am

Hosted by **Dr Emma Beckett**, this webinar will deliver the latest scientific evidence around polyphenols and the nutrition and health benefits of berries, the highest food sources of polyphenols with **Dr Nenad Naumovski**.

Attendees will gain clinical insights, culinary tips and practical pearls of incorporating berries into everyday diets to support short- and long-term health conditions relating to the gut and brain, from gut health dietitian **Nicole Dynan** and Naturopath and academic **A/Prof Teresa Mitchell-Paterson.**



DIGITAL ACTIVATION CAMPAIGN

Digital Outreach Activation

ACTIVATION CHANNEL	WHAT	HOW	WHEN (TIMING)
BERRIES HCP DATABASE	1. ASR Survey Findings 2. Infographics 3. Factsheets & Social tiles 4. Berries Webinar invite 5. Berries Animation & Post webianr 6. Berries Wrap up	NRAUS Managed Mailchimp	8 June 2022 3 March 2023 15 Aug 2023 16 Sept 2023 7 Nov 2023 Feb 2023
WEBSITE	• All resources • Subscribe email	NRAUS Berry Hub	Ongoing
NRAUS Social Media Posts	• Social Posts on NRAUS owned platform of project assets		
SOCIAL MEDIA Advertising	• Berries Webinar invite • Berries Resources (lead generation): Video reel of resources	NRAUS/Australian Berries Paid ad	30 Sept 2023 (4 wks) Nov 2023
KOL DATABASE	• Social tile pack & recipes • Berries Webinar invite • Berry resources/animation - target via social platform only top 10 with incentive	Direct Email/DM in Social	Dec 2022 Sept 2023 Nov 2023

Activation Channel Plan: HCP Channels

ACTIVATION CHANNEL	WHAT	HOW	WHEN (TIMING)
DIETITIANS	• Berry webinar invite • Berry resources: Hero Client friendly resource	• DC (Dietitians) EDM – eNews post within Sunday update (100 words, image and weblink)	Sept 18 2023 Nov 2023
NATUROPATHS	• Berries webinar invite • Berry Resource/s: Hero Client friendly hero	• Event Listing ANTA website • Event Listing NHAA website • ANTA EDM	Sept/Oct 2023 Nov 2023
NSA	• Webinars (Resources)	• Members only area placement & placement in newsletter	Sept 2023

Minutes

- Positive feedback on outputs from the current reporting period. Jemma who attended DA reported her positive experience of breakfast session and takeout of being inspired with savoury preparation methods. Culinary application important dimension to nutrition education communication.
- Animation well received. Consider cutting down the version for socials but agreed as it was, despite length was engaging in delivery.
- Berries Australia (BA) noted the work has been shared with comms and growers within the journal but opportunity for the project and outputs to be given more visibility internally. BA advised they are planning conference in 2025 and would be keen on having NRAUS present.
- Resources developed here seen to be relevant and useful even in consumer channels if aligned with brand comms. Opportunity to present the project and its outputs to the Berries Australia Marketing team.
- Sonia picked up on consumer factsheet that 'Flavanols' listed twice. NRAUS confirmed post meeting it is correct, but they are different types. A differentiator has been added and updated on factsheet on the hub.
- Discussion regarding future opportunities post project end. Recommendations will be made by NRAUS and communicated in final report.
- Hort Innovation agreed that resources developed from the project can be utilised and disseminated by Driscolls.
- Webinar and project digital outreach plans were presented, and approach was seen as appropriate.

ACTIONS:
Jutta to follow up with Rachel to organise a meeting to present overview of project to marketing and discuss extension opportunity for 2025 Conference.
Rachel to communicate project and outputs to key funding decision makers to support future potential project/extensions.
Jutta to send invite to the webinar to be shared with PRG to pass on to their channels to enhance visibility.

NRAUS

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Thank you

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MT21000: Health and nutrition information for the Berry industry

PRG MEETING 4

March 2024

Agenda

1 Project Overview
2 Project review
3 Impact
4 Key Learnings
5 Recommendations
6 Discussion

Project **OVERVIEW**

THE PROJECT: MT21000

Supports the **Strategic Investment Plan** of the Blueberry, and Raspberry and Blackberry Funds to increase domestic consumption of fresh **Australian Berries**.

End of project outcomes:

1. Health professionals to have an increased awareness and knowledge and confidence in discussing with clients the health and nutrition benefits of Australian berries.

2. Increase in health professional recommendations for the consumption of fresh blueberries, raspberries, and blackberries.

THE PROJECT: MT21000

Intermediate outcomes:

- Secure ≥5,000 views of the video
- Build relationship with ~40 KOLs with min reach 100,000 followers.
- ≥50% HPs aware of resource availability on berry hub.
- ≥50% HPs utilising or intending to utilise resources.
- ≥80% HPs who use resources reporting that they find them useful
- 30% increase database from ASR survey recruitment baseline

“The what”: Targeted messaging

The opportunity

How do we leverage the berry scope report to create a clear educational message that makes berries top of mind for the HCP?

Objectives

1. Increased awareness, knowledge and confidence in discussing the health and nutrition benefits of fresh berries
2. Increase HCP recommendations for the consumption of fresh berries

Primary messaging

Berry polyphenol :

Polyphenols (a prebiotic) for gut and brain health.

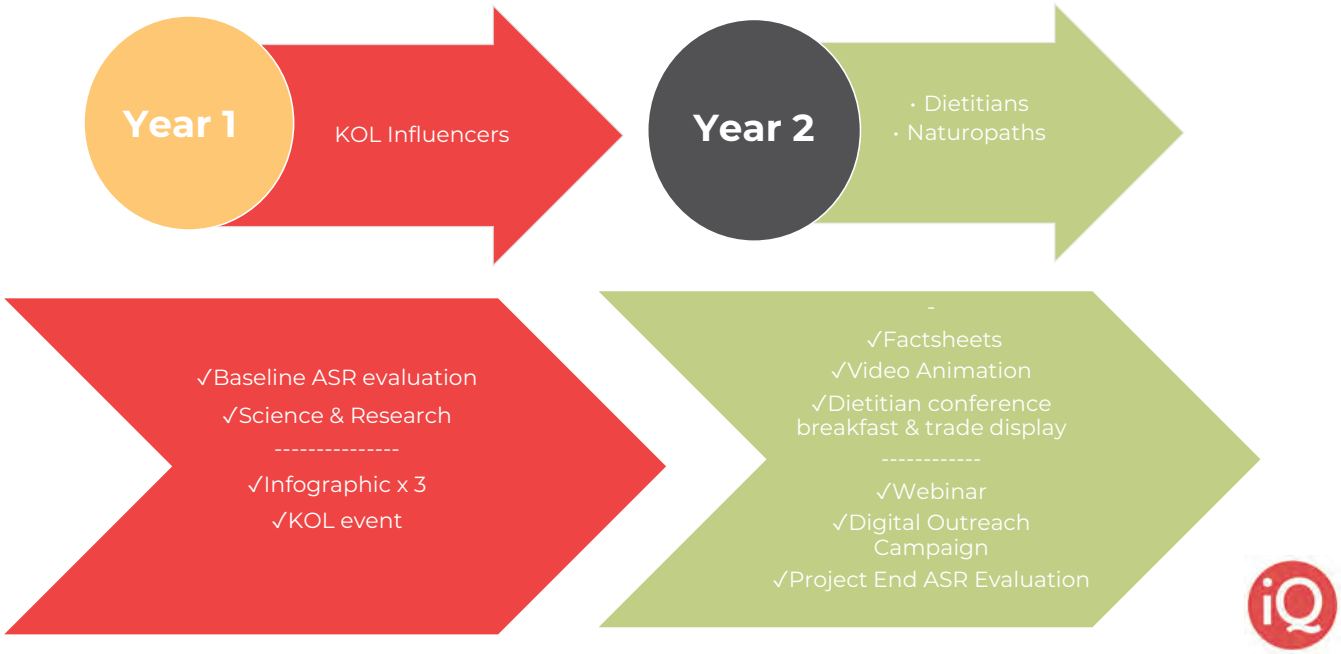
- Polyphenols as an established prebiotic and neuro-protective dietary component.
- Emerging polyphenol and berry science on gut and brain health. – key on trend topic
- Berries as the highest source of polyphenols.

Secondary messaging

Berry unique: the unique characteristics of each berry type.

Berry foodie: from farm to fork (growing, culinary, fun facts).

Project Plan



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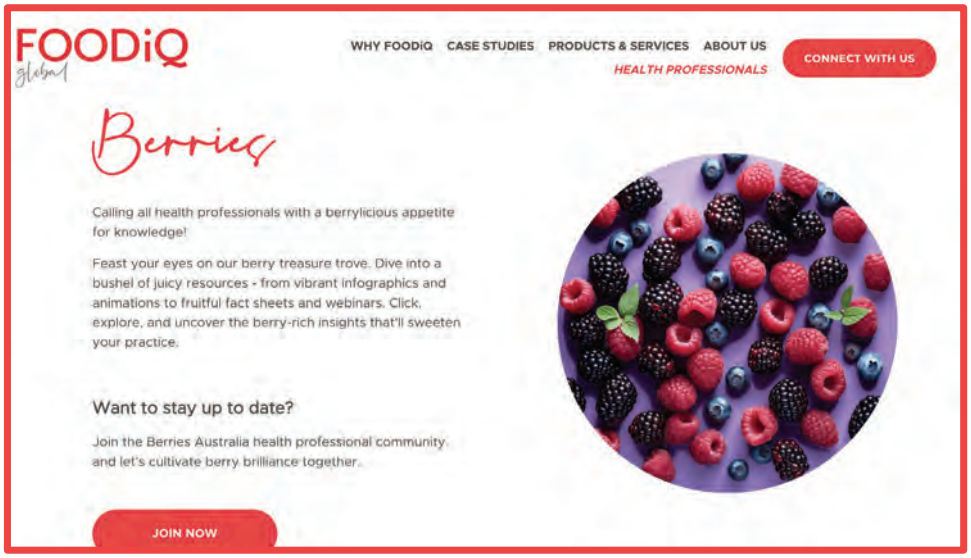
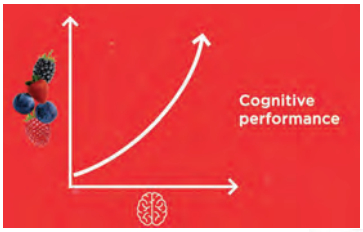
Project **REVIEW**

Berries Hub



Fact Sheets, Infographic & social tiles

Animation



Educational events

KOL Online event

December 2022

DAA Conference Breakfast

July 2023

FOODiQ Webinar

October 2023

Digital activation

Social media

Channel comms

KOL Influencers

Key deliverables: and inter-connections

Educational events:

KOL Event, Conference & Webinars to build advocates & educate on the nutrition & health benefits of berries

KOL#BERRY WELL TRIBE ONLINE EVENT
Dec 2022 Online

DIETITIANS AUSTRALIA CONFERENCE
July 2023 Breakfast & Trade display

FOODiQ WEBINAR
Nov 2023

Drive attendees to hub & database

Web-page:

Berry Hub– Nutrition & Health Section as central information repository

Resources:

- 3 x **Infographics** – Berry nutritious, Berry Polyphenol, Berry Healthy
- 1 x **HCP Factsheets:** Evidence based research summary
- 1 x **Consumer Factsheet:** Nourish the gut, Feed the brain
- **Social media pack**
- **Video animation**
- **Webinar recording**

Build Database of subscribers

Educate, disseminate resources, drive to berries hub

6+ x **EDMs to owned Berries HCP database**

Comms:

Digital Outreach Campaign to drive awareness hub/resources/ events & database acquisition

Channel comms

Social media (Paid & organic)

HCP Influencers

IMPACT

HCP Database

Educational Activities - Summary

	Audience	Event 'Excellent or Very good' Overall	Event 'Extremely or Very' Engaging	Event 'Extremely or Very' Informative	Event 'Extremely or Very' Useful	Intend to recommend berries 'Always or often'
KOL Online Event	19	100%	100%	100%	78%	NA
Dietitians Australia Conference breakfast	58	100%	100%	100%	85%	**85%***
FOODiQ Webinar	763 register; 169 live	97%	90%	93%	92%	**93%***

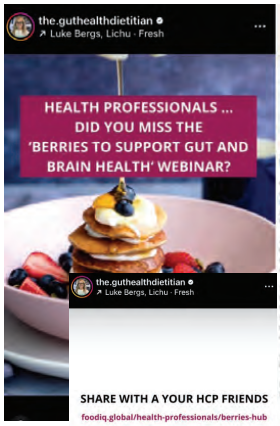
Target > 80%
***Target 75%**

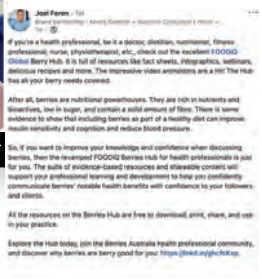
Channel & social media results

	Audience	Open rate %	Reach	Total clicks	CTR %		Cost per contact
Dietitian Connection	11937	49.0%	5823	192	2%	(Average 2%)	$26.04
Australian Natural Therapists	7000	30.8%	2154	351	5%	(Above average)	$3.50
		Impressions	**Reach**	**Total clicks**	**Av CTR%**	**Sign up database**	
Social media (HP)		236,000	86,653	1531	1.7%	87	$1.96
		>1 min view					
Animation		5935	(KPI: 5000)				

KOL activation

	Profession	Followers
Nicole Dynan	Dietitian	21,100
Steph Geddes	Nutritionist	21,500
Simon Austin	Dietitian	6857
Prue Mynard	Dietitian	14,000
Rebecca Gawthorne	Dietitian	257,000
Tara Leong	Nutritionist	35,000
Joel Feren	Dietitian	9930
TOTAL REACH		365 ,387





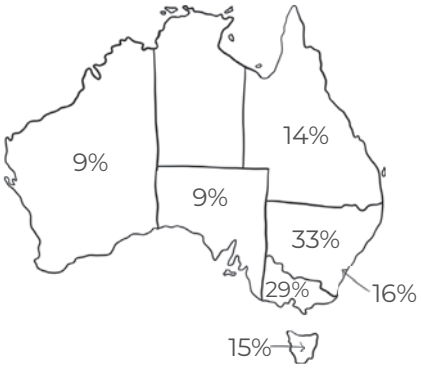
Survey statistics

518 surveys completed → 368 eligible

27%	18%	16%	10%	6%	25%
Dietitian	Nutritionist	Nurse	Naturo-path	Drs	Other

83% HPs; 17% students *slightly more students than baseline

29%	27%	19%	11%	10%
25-34	35-44	45-54	55-64	65+



Resource Access & usefullness

25% of participants had accessed the Berries Hub resources

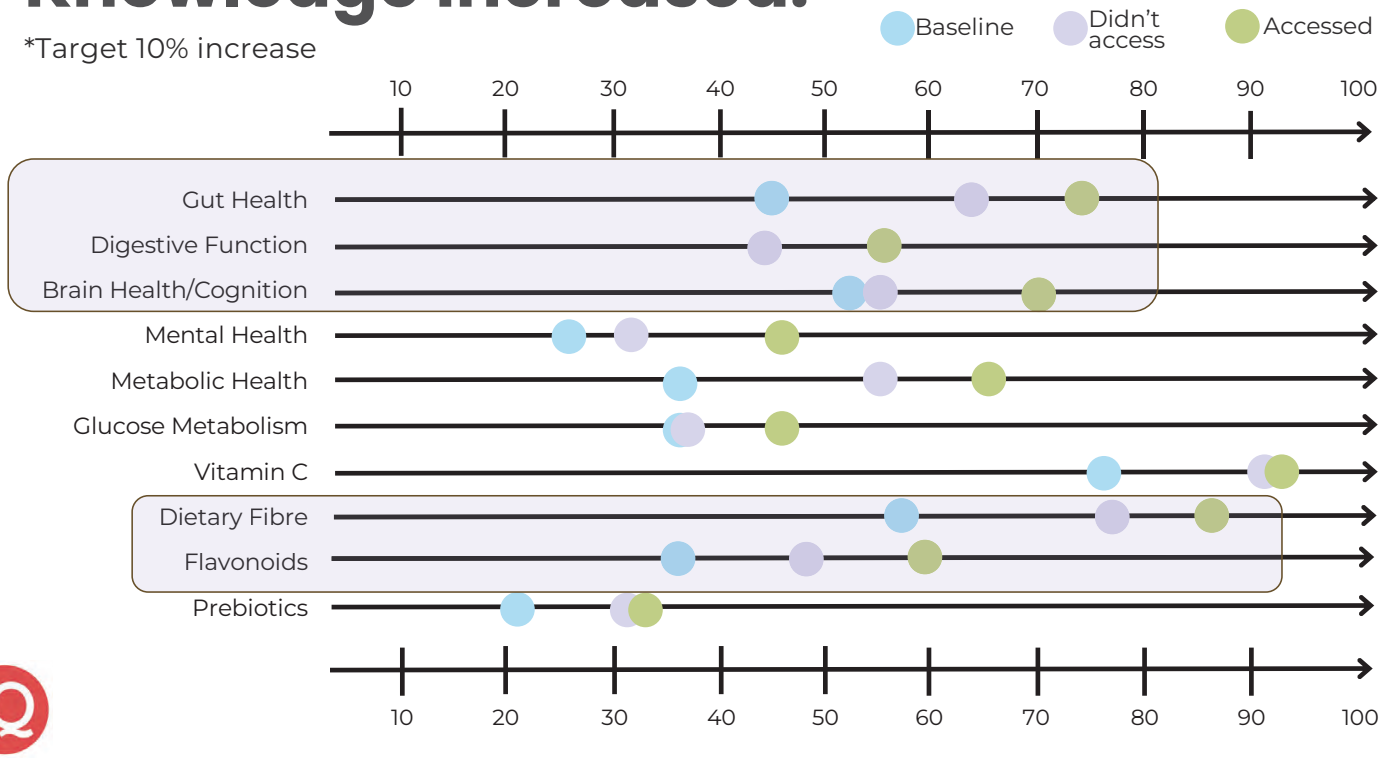
- target 50%
- rebrand
- change in recruitment strategies

100% of participants that accessed the FOODiQ Berries Hub resources found them useful

- target 80%
- 52% very useful
- 38% useful
- 10% somewhat useful

Knowledge increased:

*Target 10% increase



Confidence & familiarity increased

Confidence in discussing the nutritional benefits of berries.

very or quite confident

- Baseline: 50%
- Didn't access: 45%
- Accessed: **60%**

***Target 75%**

Familiarity with the nutritional properties of berries.

familiar or very familiar

- Baseline: 50%
- Didn't access: 40% (5% very familiar)
- Accessed: **69%** (25% very familiar)

***Target 65%**

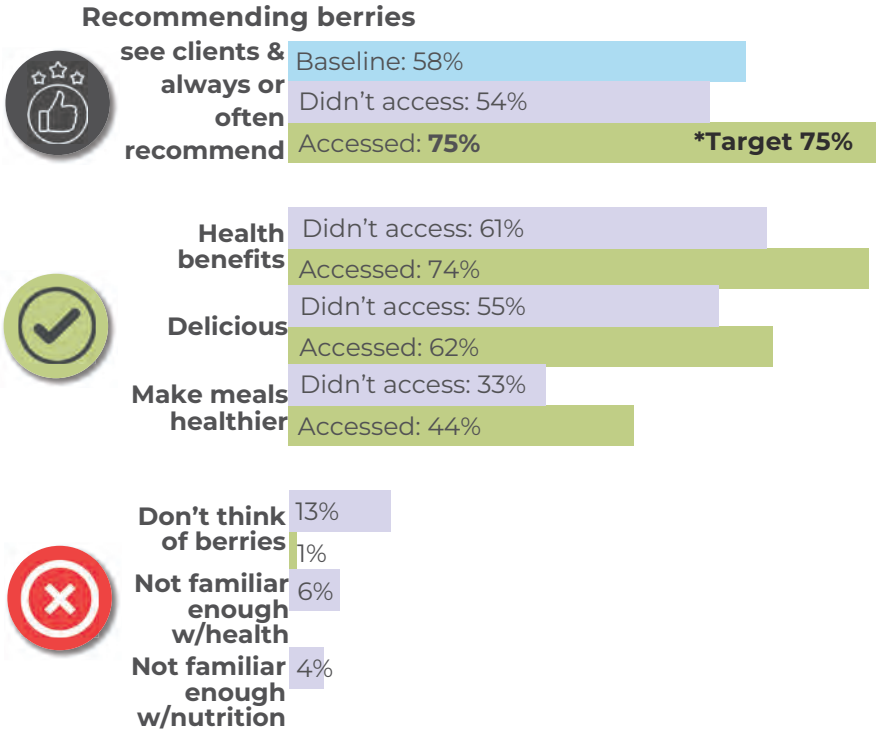
Familiarity with the health properties of berries.

familiar or very familiar

- Baseline: 50%
- Didn't access: 41% (5% very familiar)
- Accessed: **63%** (20% very familiar)

***Target 65%**

Frequency of recommending increased



"The content was applicable to my clinical practice"

"Free resources were relevant and helpful."

"I enjoyed how it summarised all the research and benefits into 1 seminar, so it was all valuable and a great summary of what's out there."

"It is the raw information I need in order to justify the importance of berries to my clients."

"Ways of cooking/eating supported by evidence about why and dose."

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Key **LEARNINGS**

What are project strengths?

Strategy/Messaging

- ✓ Access to resources & education leads to recommendation
- ✓ Single minded messaging hit mark – HCP knowledge on key messages improved the most.
- ✓ Digital activation was effective in extending reach awareness
- ✓ KOL influencers cost effective and credible way to amplify our comms

Science/Research

- ✓ Existing science strong in brain health.
- ✓ Brain health linked to gut health via gut-brain axis, Key trending topic.

Education/Comms

- ✓ Solid engaged database
- ✓ Outputs all met or exceeded KPIs.
- ✓ Overall positive open feedback on educational events; relevant, informative, practical

iQ

What are project weaknesses/limitations?

Strategy/Messaging

- ✓ Only able to target dietitians & naturopaths
- ✓ Fitness professionals were not targeted and are key group which could drive reach more significantly.
- ✓ Only able to address concerns on pesticide usage (a key barrier) top line as not key message
- ✓ Only 25% surveyed had accessed hub.

Science/Research

- ✓ Gaps in knowledge - science limited to mainly blueberries
- ✓ Primary research is focussed on freeze-dried powders, purees and extracts – not whole berries.

Education/Comms

- ✓ Repository of information/resources only on FOODiQ - benefits of credibility but not capitalising long term brand equity

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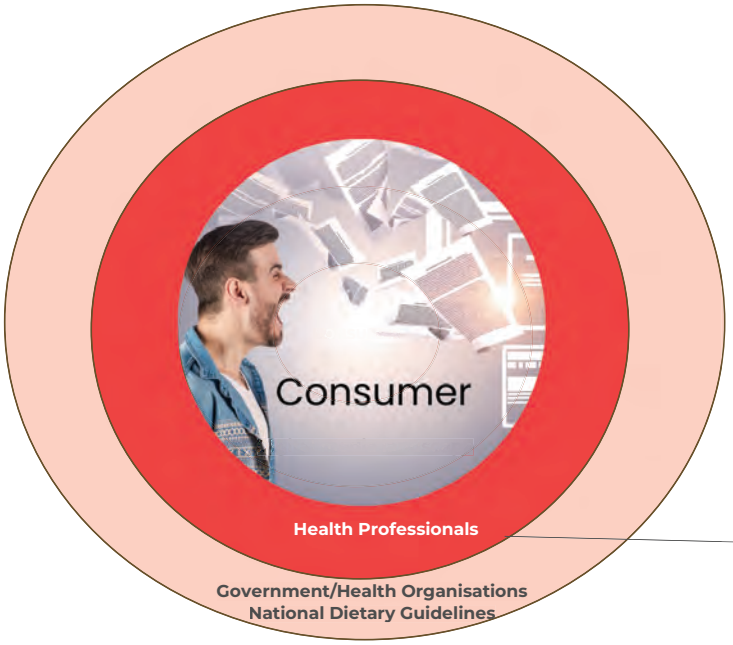
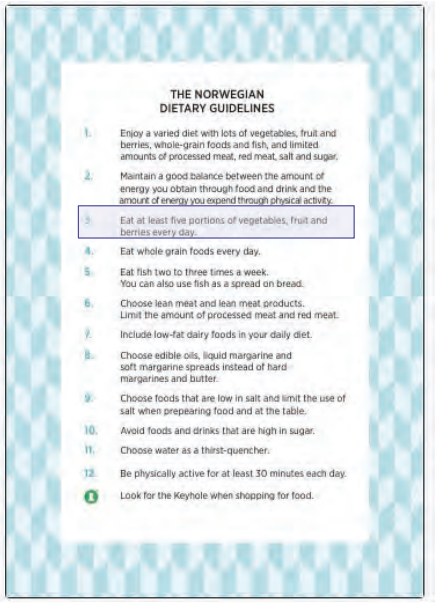
Project **RECOMMENDATIONS**

HP are a credible and trusted beacon to navigate the consumer ecosystem



Future gazing: Berries called out in dietary guidelines



THE NORWEGIAN
DIETARY GUIDELINES

1. Enjoy a varied diet with lots of vegetables, fruit and berries, whole-grain foods and fish, and limited amounts of processed meat, red meat, salt and sugar.
2. Maintain a good balance between the amount of energy you obtain through food and drink and the amount of energy you expend through physical activity.
3. Eat at least five portions of vegetables, fruit and berries every day.
4. Eat whole grain foods every day.
5. Eat fish two to three times a week. You can also use fish as a spread on bread.
6. Choose lean meat and lean meat products. Limit the amount of processed meat and red meat.
7. Include low-fat dairy foods in your daily diet.
8. Choose edible oils, liquid margarine and soft margarine spreads instead of hard margarines and butter.
9. Choose foods that are low in salt and limit the use of salt when prepearing food and at the table.
10. Avoid foods and drinks that are high in sugar.
11. Choose water as a thirst-quencher.
12. Be physically active for at least 30 minutes each day.

Look for the Keyhole when shopping for food.

What are the opportunities?

Short term	**Dedicated berries HP hub** Set up HP Berries hub on Berries Australia website or standalone	**Maintain conversation with HP database to support long term SIP** ✓ Create & implement an ongoing integrated website-digital HP engagement strategy - develop quarterly science summaries & e-news ✓ 'Bring science to kitchen™' - berries roadshow in key states. ✓ Recipe book development & leverage in digital comms
Big Picture	**'Paddock to Plate' campaign** ✓Overcome key barriers to recommendations ✓Targeted research on stakeholders to understand perceptions/needs ✓Connect agricultural practice to food ✓HP tailored 'Paddock to Plate' –research, education & digital campaign to address concerns	**Research iQ – strategic plan to identify innovative opportunities to be leveraged.** For example: • Research focused on raspberries & blackberries • Direct berry microbiome/gut function studies to improve understanding • 'Food as medicine for aged care eg berries to reduce IBS/constipation, improve mood ✓An iQ process could identify, highlight, prioritise
Target audience	**Extension HP Target Audience** Extend target audience to other HP (particularly fitness professionals)	**Wide target audience focus** ✓Education & communications campaigns targeting schools, food service industry ✓Extend HP communications through to consumer comms

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DISCUSSION

Minutes

- Feedback from PRG team was complimentary for the project and work done to date.
- Rachel (Berries Australia) was in agreement with the value of focus on HP audience and extremely keen to maintain the momentum and relationship with HCP ongoing and keen to investigate with HORT how this could be supported with future funding.
- All PRG members saw the 'Paddock to Plate' a valuable opportunity to peruse, not only for Berry Industry but across industries. Sonia (Driscolls) noted the concerns around pesticides is a difficult territory due to the dominant voices on social media/trending documentaries that often detail US practices that are not relevant in Australia. This was perceived to be an important territory for HP to lead the conversation.
- Rachel (Berries Australia) also saw there would be interest in future research, particularly around raspberries and blackberries which are under-researched versus blueberries.
- Rachel (Berries Australia) voiced that it would be valuable and strategically important to have FOODiQ and specifically Emma attend the Growers conference in Feb 2025 to educate and inspire on what the project has achieved and what opportunities there are for the future.

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Thank **YOU!**

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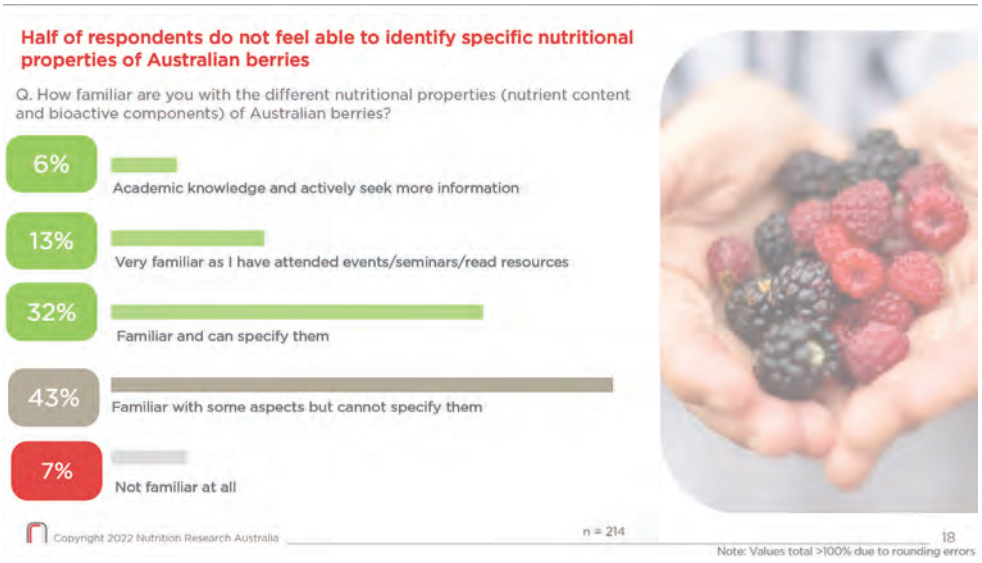
APPENDIX 15:

AUSTRALIAN BERRY JOURNAL

CONTENT SUBMISSION FORM

Journal Edition	**N**	**SPRING 2022**	**SUMMER 2022**	**AUTUMN 2023**	
(Please highlight)	**WINTER 2023**	**SPRING 2023**	**SUMMER 2023**	**AUTUMN 2024**	
	WINTER 2024	**SPRING 2024**	**SUMMER 2024**	**AUTUMN 2025**	
Content Author(s) *(Include author's title/role and organisation name)*	Jutta Wright Project Manager Nutrition Research Australia (NRAUS)				
About the Author *(if applicable)*					
Article/Content Title *(Please keep to less than 10 words)*	Raising awareness of Nutrition and Berry Benefits with Healthcare Professionals.				
Article/Content Subtitle *(If applicable)*					
Hort Innovation Project Number & Name *(If applicable)*	MT21000 Health and nutrition information for the Berry industry				
Acknowledgement text *(If applicable)*					
3-4 Key Messages *(Applicable for complex scientific or technical articles)*					
Journal Section Placement Requested	Industry / General	Rubus	Strawberry	Blueberry	
Logo(s) required with this article/content? *(List filenames & provide images and any brand guidelines)*					

Images/Graphics to accompany this article/content? *(List filenames, provide in high resolution 300dpi & provide any required photo copyright credit per photo)*	**Image 1:** Finding from HCP Market Research  **Image 2:** Sample of the baseline market research recruitment materials that ran in May 2022.	

		
Postal Address: *(Please provide full postal address to receive ONE printed copy of the edition featuring this article)*		
Word Count *(Include subtitles)*	530	

In February 2022, Nutrition Research Australia (NRAUS) kicked off a 2-year strategic levy investment project, Health and Nutrition Information for the Berry Industry (MT21000) which is part of the Blueberry, Raspberry and Blackberry Funds.

Why do we need this project?

Not only are berries a nutritional standout, rich in vitamins, minerals, and dietary fibre; they are also a source of numerous non-nutritive and colourful "bioactives", compounds which give fruit and other plant foods colour, but also give us additional health benefits including reduced risk of chronic diseases. One bioactive getting more attention of late, are polyphenols. Berries are one of the highest dietary sources of polyphenols and have an impressive nutrition story to tell.

Health care professionals are a trusted source of nutrition information, that can increase awareness of both their specific health benefits and culinary uses. However, the specific therapeutic effects, bioactives, and the doses required to achieve these, is not common knowledge among health-care professionals. There is an opportunity to educate health care professionals on the latest berry nutrition science, and their culinary uses to make it relevant and practical, thereby ensuring berries are top of mind and support client recommendation.

What has been accomplished so far?

In May 2022, NRAUS launched their Berries healthcare professional Market Research Survey. The survey sought to obtain baseline data on perceptions and attitudes to be used as a benchmark for project evaluation at project end as part of monitoring & evaluation, plus gain market insights to help tailor key message development and adjust the communication plan. The survey of over 200 respondents, found whilst the majority of HCPs rate themselves as confident discussing the benefits of berries, aside from being able to specify they contain vitamin C and more generally bioactives, more than half were not able to specify any other nutrients or specific bioactive types.

Nearly half (42%) of respondents are not regularly recommending berries to their clients and when they do, a mix of berries or blueberries most common, with very few specifically recommending blackberries or raspberries. Nutritional and health benefits, taste and convenience are key drivers. Not being top of mind (40%) and lack of nutritional and health knowledge for 1 in 4 are the key barriers to recommendation. Cost was reported an issue for only small subset of respondents (15%). Most are not familiar with growing practices of Australian berries with large proportion (25%) not familiar at all and yearn for information on how growing affects nutritional quality and the effects of pesticides.

The NRAUS science team, led by Dr Michelle Blumfield, undertook a comprehensive, referenced 'deep dive' literature review in first half of 2022 to investigate 'What are the health effects of Australian berries (strawberries, blueberries, raspberries and blackberries)?' Its aim was to provide an evidence base to inform key messages in the education campaign. It highlighted berries to provide unique nutrition benefits, that differ between berry type. One of the key findings was at berry consumption was associated with positive health effects linked to vascular health, brain health, exercise recovery, weight and aging, and reduced risk cardiovascular disease and type 2 diabetes. Current focus in now on planning and activating the communication and education campaign.

[Note if we are able to include some more words, please include the following: What is to come?]

What is to come?

Engaging collateral is to be developed include infographics, facts sheet and an animation, all to be freely available via an NRAUS dedicated 'Berries hub'. In December, an exciting and exclusive key opinion leader (KOL) online event is planned. It aims to build a healthcare professional KOL ambassador and influencer network that can communicate and amplify project key messages throughout the project via their health-care professional and consumer community. Other planned educational activities include a webinar, and dietitian and GP conferences.

MT21000 BERRY NEWS Article

Prepared for:

Berries Australia
May 2023

Prepared by:

Nutrition Research Australia Pty Ltd

The Nutrition Research Australia (NRAUS) team are currently halfway through the 2-year strategic levy investment project, Health and Nutrition Information for the Berry Industry (MT21000), part of the Blueberry, Raspberry and Blackberry Funds. In the past 6 months they have been busy with the development of collateral and kicking off the communication and educational phase of the project, which included development of infographics and an exclusive online event for healthcare influencers.

In an increasingly digital world, many nutrition key opinion leaders (KOLs) are increasingly communicating their views via the social media platforms. These healthcare influencers were considered a key strategic communication group to target and educate for this project. Whilst many consumers are followers of these healthcare influencers, using them to gain direct credible nutrition education, they are also followed by fellow healthcare professionals who utilise them to keep up to date with credible information. Educating this group not only helps get the message out, but also provides the important credibility that a healthcare professional provides.

The #Berrywelltribe online KOL event was undertaken in December 2022. The event featured celebrity cook and award-winning author Alice Zaslavsky and global health and wellbeing expert Dr Flav co-presenting from Alice's kitchen in Melbourne, Victoria. While the one-hour event was pre-scripted to deliver specific messages, it was delivered in a free-flowing, interactive and 'unscripted' way with attendees able to openly engage with the presenters via the zoom meeting platform. Attendees were educated on the unique nutritional delivery of each of the four berries (blackberry, blueberry, raspberry, strawberry), their unifying standout content of a particular bioactive, called polyphenols and their health benefits. They also learnt fun facts and practical culinary nutrition tips and tricks to preparing and eating, to provide inspiration for client recommendation. The event was an overwhelming success with 100% of attendees rating the event as excellent or very good.

To support the event, infographics were developed and bundled together with linked social tiles as part of the KOL digital influencer kit for the attendees to share with their followers post the event. Three infographic brochures were developed, reflecting the content shared with attendees at the event including, "Berry nutritious" showcasing the unique nutritional attributes of each berry type (blackberry, blueberry, raspberry and strawberry), preparation tips and growing practices, "Berry polyphenol" educating on emerging research supporting significant health benefits of polyphenols, a key bioactive compound in plant foods, with berries being one of the highest dietary sources and, "Berry healthy" providing a snapshot of berry health effects. These resources will be also shared throughout the rest of project at upcoming educational events.

The team are currently working on developing factsheets that provide more in detail information on the current research along with client friendly versions to support their practice that will be disseminated at the upcoming annual 3-day Dietitians Australia Conference being held in Melbourne in July.

Join the 'Berry Well Tribe'!

5 December 2022

11.30am – 12.30pm

Click here to register

You're invited to an exclusive online event featuring Australia's friendliest voice in food Alice Zaslavsky and expert in global health and wellbeing Dr. Flav.

As part of the 'Berry Well Tribe' you'll receive access to the latest scientific research around the nutrition and health benefits of berries along with recipes, social content and prizes to share with your community.

In this event, join fellow Australian high-profile nutrition and healthcare professionals as Alice Zaslavsky prepares some delicious berry recipes live from her kitchen. It's an event not to be missed!

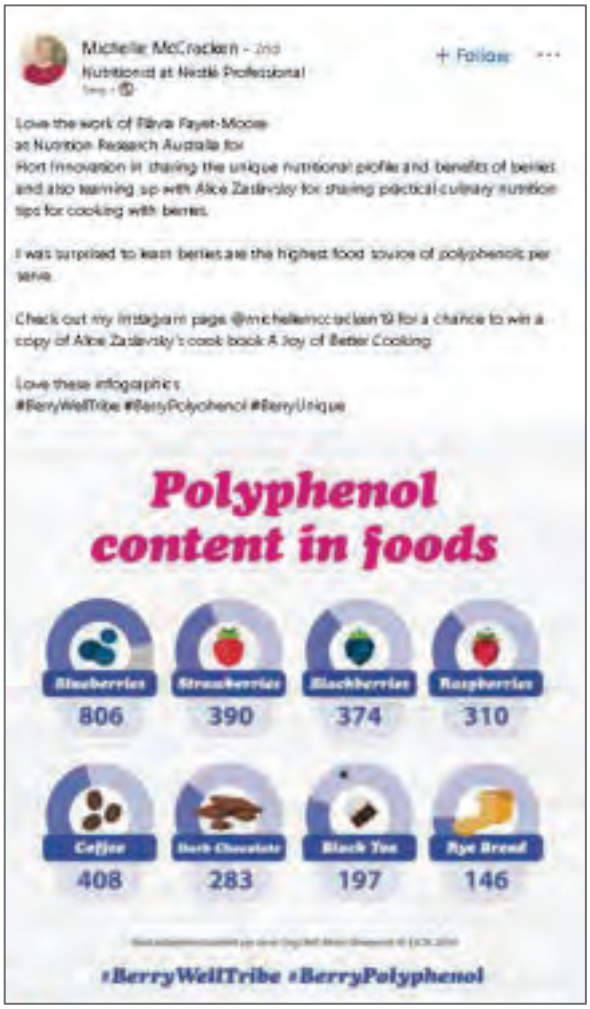
Presented by Alice Zaslavsky and Dr. Flav

Award-winning celebrity cook, author and broadcaster Alice Zaslavsky who will host a live cooking demonstration from her kitchen to provide inspiring and practical tips and insights to bring berries to life.

Plus, changemaker, nutrition scientist and thought leader [redacted] will explore the latest science-based health and nutrition benefits of berries.


Did you know that the 'health effects' of berries start within 30 minutes of eating them? And the positive, prebiotic effects in the gut microbiota occur within weeks?
Blackberry
Raspberry
Blueberry


A/Prof Sara Grafenauer
Fabulous Berry event with Alice Zaslavsky &
So many great insights... No wonder why these beauties are right up front in grocery stores now


Michelle McCracken
Nutritionist at Nestlé Professional
+ Follow
Love the work of Flávia Fayet-Moore at Nutrition Research Australia for their innovation in sharing the unique nutritional profile and benefits of berries and also teaming up with Alice Zaslavsky for sharing practical culinary nutrition tips for cooking with berries.
I was surprised to learn berries are the highest food source of polyphenols per serve.
Check out my Instagram page @michellemccracken19 for a chance to win a copy of Alice Zaslavsky's cook book A Joy of Better Cooking
Love these infographics
#BerryWellTribe #BerryPolyphenol #BerryUnique
Polyphenol content in foods
Blueberries 806
Strawberries 390
Blackberries 374
Raspberries 310
Coffee 408
Dark Chocolate 283
Black Tea 197
Rye Bread 146
#BerryWellTribe #BerryPolyphenol


Berry Healthy
Berry Polyphenol
Berry Nutritious
Which berry?
Farming

MT21000: Berry News

Prepared for:

Berries Australia
March 2024

Prepared by:

FOODiQ Global

Enhancing Health Professional Engagement: Insights from the MT21000 Strategic Levy Investment Project

The FOODiQ Global (formerly Nutrition Research Australia) team have concluded their appointment to the 2-year strategic levy investment project, Health and Nutrition Information for the Berry Industry (MT21000), part of the Blueberry, Raspberry and Blackberry Funds. Successfully meeting project outcomes, some of the key outputs from the project has included the development of seven health professional (HP) resources including evidence summary fact sheet, consumer friendly fact sheet, infographics, social tiles and an educational animation, all housed on the FOODiQ Health Professional Berries Hub. Additionally, the team developed and executed three educational activities including KOL online event, Dietitians' Conference and dedicated FOODiQ HP webinar.

In January 2024, a final digital outreach campaign effectively disseminated the resources and hub to HPs through targeted social media campaigns, email outreach communications to HP organizations, and engagement with key opinion leaders (KOLs). The project successfully met all intermediate and end-of-project outcomes, with educational events receiving high ratings for information, usefulness, and engagement. Over the past year the project has amassed a sizeable HP database of nearly 1200 engaged subscribers.

As a result of these efforts, the project significantly increased HP knowledge of the nutrition and health benefits of berries, leading to a notable rise in their intent to recommend berries to clients. Specifically, at project end, over two-thirds of HCPs report that are aware of nutrition and health benefits of berries which increased by over a third during the project, and three in every four HPs reporting they recommend berries 'always or often' to their clients compared to just over half (58%) at baseline. All HP who accessed the resources reported them to be useful. The resources played a pivotal role in enhancing HP familiarity and confidence, with those accessing the resources demonstrating nearly twice the confidence in discussing berry nutrition and health benefits compared to those who did not.

The impact of the project is evident in the substantial increase in HP recommendation rates for berries to clients, indicating a clear correlation between resource access and recommendation behaviour. However, despite the resources' perceived usefulness, the proportion of participants accessing them was lower than anticipated, highlighting the need for further awareness campaigns to maximize resource utilisation.

FOODiQ global

These findings underscore the importance of driving awareness among HPs as a crucial strategy for promoting berry consumption and driving industry growth. While the project has made significant strides in educating this influential stakeholder group, continued investment is recommended to sustain and expand these efforts.

Post-project recommendations to Hort Innovation include short-, medium-, and long-term strategic investment opportunities. Short to medium-term strategies focus on maintaining engagement with the existing HP database while expanding communication efforts to reach a broader spectrum of HPs, including fitness professionals.

Medium to longer-term strategies involve investing in research to strengthen the evidence base supporting berries, particularly lesser-researched varieties such as raspberries and blackberries. Additionally, a targeted campaign highlighting the journey from 'Paddock to Plate' aims to address concerns surrounding pesticide usage, further promoting berry consumption.

APPENDIX 16:

MT21000: NUTRITIONiQ Update

Prepared for:

Hort Innovation

March 2023

Prepared by:

Nutrition Research Australia Pty Ltd

Summary

The aim of this literature update is to provide updates to the science presented in the Berries and Human Health report, and provide updates to information where required. PubMed was searched for articles published from the last date of the search performed for the Berries and Human Health report, using the same search strategy as previously outlined. Only human research studies have been included in this update.

Eighteen full text articles were retrieved and included in this current update. Intervention trials covered all berries (blueberries, strawberries, raspberries, and blackberries), however, the majority of systematic reviews and review articles focused on blueberries.

The key findings for this literature update are consistent with the findings in the Berries and Human Health report for their effects on vascular function, blood pressure, and metabolic markers. Effects of berry consumption on the microbiome are an emerging and promising area of research.

Background

To create a database of all the research conducted on berries and health, and to stay abreast of the latest clinical developments and advances in this area, our NUTRITIONiQ (NiQ) literature database service is executed every six months throughout the campaign. The NUTRITIONiQ database service conducts regular scientific searches and media monitoring that targets peer-reviewed literature, media reports, and clinical trial registries.

This NiQ research update captures systematic reviews, randomised controlled trials, and observational research conducted and published since April 22nd 2022, to capture literature published since the 'Berries and Human Health' report was completed. This ensures NRAUS stays across the latest in Berries Science and information gathered will be used to create 'Fun Facts', which may be included throughout the campaign to:

- Support key messages for resource and communication development
- Generate ideas for berries-related content
- Provide cutting-edge science for EDM updates
- Be used in communications with berries growers.

Methods

The search strategy that informed the Berries and Human Health report was repeated for this update. PubMed database search was conducted on March 7th, 2023, for any new papers published since April 22nd, 2022. Search terms included (strawberry OR strawberries OR blueberry OR blueberries OR raspberry OR raspberries OR blackberry OR blackberries OR berry OR berries)[title/abstract] AND (systematic review OR review OR scientific integrity review OR randomised controlled trial OR clinical trial OR meta-analysis OR cohort)[publication type].

Results

The search returned 75 articles for screening. From those, 22 relevant full text articles were retrieved, with 17 of those relevant to the current project. Included in these were five articles describing clinical intervention studies (blueberries, n=2; strawberries, n=1; raspberries, n=1; blackberries, n=1), eight systematic reviews (blueberries, n=6; raspberries, n=1; mixed berries, n=1), and five review articles (blueberries, n=1; raspberries, n=1; mixed berries, n=3). Key findings from intervention studies and systematic reviews have been summarized below, and the abstracts for all papers have been provided in **Tables 1** and **2.** The included outcomes related mainly to cardiovascular risk factors or oxidative stress, but also included cognitive function and mental wellbeing, oral health, and microbiome.

Key findings are consistent with those reported in the Berries and Human Health Report, including:

Limited effects on blood pressure

- No acute effects of berries on systolic or diastolic blood pressure in healthy adults [1-3]
- Blueberry supplementation reduced diastolic and systolic blood pressure in a systematic review and meta-analysis of adults with metabolic syndrome [4]
- Individual berries may have differential effects on blood pressure. Blueberries and raspberries appear to be more consistently associated with reductions in blood pressure, whereas evidence for strawberries is highly inconsistent [5]

Beneficial effects in endothelial and vascular function

- Blueberry consumption is associated with improvements in endothelial function in one systematic review [6] and improved vascular function in another [7]

Some beneficial effects in metabolic markers, which greater benefits seen in those with metabolic syndrome or diabetes

- Meta-analysis of 22 studies showed blueberry and cranberry consumption were associated with reduced fasting glucose and HbA1c in adults with diabetes, with no change in adults without diabetes [8]

- Blueberry supplementation in adults with metabolic syndrome was associated with improved blood lipid profile (TG, LDL-C, TC, HDL-C) and insulin levels with no changes to body weight, glucose, or HbA1C [4]
- No effect of blueberries or freeze-dried blueberry powder on metabolic markers (TG, TC, LDL-C, HDL-C) in healthy adults [9]
- Daily blueberry juice over 20 days was associated with reductions in total and LDL cholesterol compared with placebo [3]

Effects on microbiome

- Chewing gum 4x daily with xylitol and freeze-dried blackberry powder resulted in differential changes to the oral microbiome compared to the xylitol control group [10]
- Four weeks of red raspberry consumption increased *Eubacterium eligens* and decreased *Ruminococcus gnavis* from baseline, however there was no control group for comparison [11].

One new area of emerging research was identified:

Chemopreventative properties of berries

- Bioactives from strawberries and black raspberries are being explored for potential chemopreventative properties in oesophageal cancers
    - A small, single-arm, uncontrolled intervention pilot study found 60g dietary strawberries daily for 6 months may suppress the progression of pre-cancerous lesions in the oesophagus, while 30g had not. Mechanistic studies show strawberries inhibit cell proliferation and pro-inflammatory cytokines in oesophageal cells. There is insufficient evidence to make clinical recommendations. [12]

Table 1: Summary of new published studies on Melons from July 2022 to January 2023 based on search criteria.

AUTHOR/YEAR ORIGINAL RESEARCH	TITLE	ABSTRACT	REF
Blueberries			
Sinclair J et al, 2022	Effects of Montmorency Tart Cherry and Blueberry Juice on Cardiometabolic and Other Health-Related Outcomes: A Three-Arm Placebo Randomized Controlled Trial	The current study aimed to investigate the influence of tart cherry and blueberry juices on cardiometabolic and other health indices following a 20-day supplementation period. Forty-five adults were randomly assigned to receive tart cherry, blueberry, or a placebo, of which they drank 60 mL per day for 20 days. The primary outcome, which was systolic blood pressure, and secondary measures, including anthropometric, energy expenditure, substrate oxidation, hematological, diastolic blood pressure/resting heart rate, psychological wellbeing, and sleep efficacy, were measured before and after the intervention. There were no statistically significant differences (p > 0.05) for systolic blood pressure; however, total and LDL cholesterol were significantly improved with blueberry intake (pre: total cholesterol = 4.36 mmol/L and LDL cholesterol = 2.71 mmol/L; post: total cholesterol = 3.79 mmol/L and LDL cholesterol = 2.23 mmol/L) compared to placebo (pre: total cholesterol = 4.01 mmol/L and LDL cholesterol = 2.45 mmol/L; post: total cholesterol = 4.34 mmol/L and LDL cholesterol = 2.67 mmol/L). Furthermore, psychological wellbeing indices measured using the Beck Depression Inventory, State Trait Anxiety Inventory, and COOP WONCA improved statistically in the blueberry arm compared to placebo. Given the clear association between lipid concentrations and the risk of cardiovascular disease as well as the importance of psychological wellbeing to health-related quality of life, this investigation indicates that it could be an effective approach to assist in managing cardiometabolic disease.	[3]
Wang Y et al, 2022	Effects of Blueberry Consumption on Cardiovascular Health in Healthy Adults: A Cross-Over Randomised Controlled Trial	Blueberries are rich in polyphenols, and their effect on cardiovascular health, including risk factors for endothelial dysfunction and hypertension, has been investigated in interventional studies. However, the difference between blueberry treatments in varied forms for their cardiovascular-protective effect remains poorly understood. The current study assessed the effects of whole blueberry and freeze-dried blueberry powder compared to a control on cardiovascular health in young adults. A cross-over randomised controlled trial (RCT) was implemented with 1 week of treatment for three treatment groups, each followed by 1 week of wash out period. Systolic (SBP) and diastolic blood pressure (DBP), pulse wave velocity (PWV), plasma cholesterol (low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and total cholesterol) and triglyceride levels (TAG), and glucose and nitrite (NO_2^-) concentrations were compared following fresh blueberry, freeze-dried blueberry powder, and control treatments. Thirty-seven participants with a mean age of 25.86 ± 6.81 completed the study. No significant difference was observed among fresh blueberry, blueberry powder, and the control arm. Plasma NO_2^- levels were improved by 68.66% and 4.34% separately following whole blueberry and blueberry powder supplementations compared to the baseline, whereas the control supplementation reported a decrease (-9.10%), although it was not statistically	[9]

		significant. There were no other effects shown for SBP, DBP, total cholesterol, HDL-C, LDL-C, TAG, or glucose. No difference was shown between whole blueberry and freeze-dried blueberry powder consumption for improving cardiovascular health.	
Strawberries			
Basu A et al, 2023	Dietary Strawberries Improve Serum Metabolites of Cardiometabolic Risks in Adults with Features of the Metabolic Syndrome in a Randomized Controlled Crossover Trial	Dietary strawberries have been shown to improve cardiometabolic risks in multiple clinical trials. However, no studies have reported effects on serum metabolomic profiles that may identify the target pathways affected by strawberries as underlying mechanisms. We conducted a 14-week randomized, controlled crossover study in which participants with features of metabolic syndrome were assigned to one of the three arms for four weeks separated by a one-week washout period: control powder, 1 serving (low dose: 13 g strawberry powder/day), or 2.5 servings (high dose: 32 g strawberry powder/day). Blood samples, anthropometric measures, blood pressure, and dietary and physical activity data were collected at baseline and at the end of each four-week phase of intervention. Serum samples were analysed for primary metabolites and complex lipids using different mass spectrometry methods. Mixed-model ANOVA was used to examine differences in the targeted metabolites between treatment phases, and LASSO logistic regression was used to examine differences in the untargeted metabolites at end of the strawberry intervention vs. the baseline. The findings revealed significant differences in the serum branched-chain amino acids valine and leucine following strawberry intervention (high dose) compared with the low-dose and control phases. Untargeted metabolomic profiles revealed several metabolites, including serum phosphate, benzoic acid, and hydroxyphenyl propionic acid, that represented improved energy-metabolism pathways, compliance measures, and microbial metabolism of strawberry polyphenols, respectively. Thus, dietary supplementation of strawberries significantly improves the serum metabolic profiles of cardiometabolic risks in adults.	[1]
Raspberries			
Zhang et al, 2022	Red Raspberry and Fructo-Oligosaccharide Supplementation, Metabolic Biomarkers, and the Gut Microbiota in Adults with Prediabetes: A Randomized Crossover Clinical Trial	BACKGROUND: Evidence suggests that the gut microbiota and cardiometabolic status are associated, suggesting dietary interventions that alter the microbiota may affect metabolic health. OBJECTIVES: We investigated whether supplementation with (poly)phenol-dense red raspberries (RRB), alone or with a fructo-oligosaccharide (FOS) prebiotic, would improve biomarkers of cardiometabolic risk in individuals with prediabetes (PreDM) and insulin resistance (IR) and whether the effects are related to modulation of the gut microbiota. METHODS: Adults with PreDM-IR (n = 26; mean ± SEM age, 35 ± 2 years; fasting glucose, 5.7 ± 0.1 mmol/L; HOMA-IR, 3.3 ± 0.3) or who were metabolically healthy (reference group; n = 10; age, 31 ± 3 years; fasting glucose, 5.1 ± 0.2 mmol/L; HOMA-IR, 1.1 ± 0.1) participated in a randomized crossover trial with two 4-week supplementation periods, in which they consumed either RRB (125 g fresh equivalents) daily or RRB + 8g FOS daily, separated by a 4-week washout. The primary outcome variable was the change in the gut microbiota composition, assessed by shotgun sequencing before (baseline) and at the end of each supplementation period. Secondary outcomes were changes in glucoregulation, lipid metabolism, anti-inflammatory status, and	[11]

		anthropometry. The trial is registered at ClinicalTrials.gov, NCT03049631. RESULTS: In PreDM-IR, RRB supplementation reduced hepatic-IR (-30.1% ± 14.6%; P = 0.04) and reduced plasma total and LDL cholesterol [-4.9% ± 1.8% (P = 0.04) and -7.2% ± 2.3% (P = 0.003), respectively] from baseline. Adding FOS (RRB + FOS) improved β-cell function [insulin secretion rate, +70.2% ± 32.8% (P = 0.02); Disposition Index, +94.4% ± 50.2% (P = 0.04)], but had no significant effect on plasma cholesterol compared to baseline. RRB increased Eubacterium eligens (2-fold) and decreased Ruminococcus gnavus (-60% ± 34%), whereas RRB + FOS increased Bifidobacterium spp. (4-fold) and decreased Blautia wexlerae (-23% ± 12%) from baseline (all P values ≤ 0.05). R. gnavus was positively correlated with hepatic-IR, and E. eligens and Bifidobacterium catenulatum were negatively correlated with cholesterol concentrations (P ≤ 0.05). CONCLUSIONS: Increased Bifidobacterium spp., concurrently with reduced R. gnavus, was associated with metabolic improvements in adults with PreDM-IR, warranting further research on the mechanisms involved in (poly)phenol/FOS-microbial interactions with host metabolism.	
Blackberries			
Miller CS et al, 2022	Effect of chewing gum containing Xylitol and blackberry powder on oral bacteria: A randomized controlled crossover trial	OBJECTIVE: The aim was to determine the effect of chewing gum containing xylitol and freeze-dried blackberry powder on oral bacteria. DESIGN: This was a randomized, controlled, cross-over study (RCT #: NCT05133557). Fifty participants chewed gum over an 8 h period, four times for 20 min at 2-hour intervals, containing 700 mg xylitol (CG) with or without 50 mg blackberry powder (BG), while wearing a stent containing a sterile enamel chip. After a 1 week washout, participants chewed gum from the other group following the same protocol. The primary outcome was the amount of nine oral bacteria in saliva as determined by quantitative PCR. The secondary outcome was bacteria formed on enamel chips. RESULTS: Chewing BG for four twenty-minute intervals reduced mean total bacteria load and the relative abundance of six of the nine bacteria studied in saliva ($p < 0.05$). In comparison, only four bacteria were reduced in abundance in the CG group. After gum chewing and regardless of group, S. sanguinis and A. naeslundii were the predominant bacteria adherent to enamel, with S. mutans representing < 1 % of the total bacteria on enamel. CONCLUSION: Bacterial loads in saliva were rapidly, differentially, and significantly reduced after one day of chewing BG.	[10]

Table 2: Summary of Systematic Reviews and Review articles on Berries from April 2022 to March 2023

AUTHOR/YEAR	TITLE	ABSTRACT	REF
SYSTEMATIC REVIEWS			
Blueberries			
Azari H et al, 2023	Beneficial effects of blueberry supplementation on the components of metabolic syndrome: a systematic review and meta-analysis	Metabolic syndrome (MetS) is a combination of interconnected disorders that puts a heavy burden on society. This study investigated the impact of blueberry (BB) supplementation on components of MetS. A systematic search for studies in Embase, Science Direct, Cochrane and PubMed was done. Interventions for at least 2 weeks and studies which investigated the effects of BB on components of MetS in human subjects were included. 25 studies were eligible for inclusion in the review. 21 studies were included in the meta-analysis and the remaining 4 studies in the systematic review. The time range of the assessed studies was from 2007 to 2021. The results of the meta-analysis demonstrated that BB had no significant effect on waist circumference, body mass index (BMI), glycated hemoglobin (HbA1C), glucose level and homeostatic model assessment for insulin resistance (HOMA-IR); however, studies showed a significant improvement in systolic and diastolic blood pressure, triglycerides, total cholesterol, low-density lipoproteins (LDL), high-density lipoproteins (HDL) and insulin levels. In conclusion, the data in this meta-analysis show that BB supplementation is a beneficial option for the management of MetS in humans.	[4]
De Oliveira et al, 2022	Blueberry Consumption and Changes in Obesity and Diabetes Mellitus Outcomes: A Systematic Review	Low-grade inflammation and oxidative stress are key mechanisms involved in obesity and related disorders. Polyphenols from blueberry (BB) and bilberries (BiB) might protect against oxidative damage and inflammation. To summarize the effects of BiB or BB consumption in parameters related to obesity and its comorbidities, a search of the literature was performed in PubMed, Embase, and Cochrane Library repositories to identify all studies that evaluated associations of whole BB or BiB with obesity and associated disorders. Thirty-one studies were eligible for inclusion in this review: eight clinical trials and 23 animal studies. In humans, BB consumption only consistently decreased oxidative stress and improved endothelial function. In rodents, BB or BiB consumption caused positive effects on glucose tolerance, nuclear factor-kappa B (Nf-κb) activity, oxidative stress, and triglyceride (TG) content in the liver and hepatic steatosis. The high content of anthocyanins present in BB and BiB seems to attenuate oxidative stress. The decrease in oxidative stress may have a positive impact on glucose tolerance and endothelial function. Moreover, in rodents, these berries seem to protect against hepatic steatosis, through the decreased accumulation of hepatic TGs. BB and BiB might also attenuate inflammation by decreasing Nf-κb activity and immune cell recruitment into the adipose tissue.	[6]
Delpino FM et al, 2022	Effects of blueberry and cranberry on type 2 diabetes parameters in individuals with or without diabetes: A	AIMS: Blueberry and cranberry are rich in polyphenols that are associated with diabetes reduction. This study aimed: 1) to systematically review the literature on the effects of blueberry and cranberry consumption and type 2 diabetes parameters in individuals with or without type 2 diabetes and 2) to quantify these effects by carrying out a meta-analysis. DATA SYNTHESIS: A systematic review and meta-analysis were performed using articles present in seven databases (PubMed, LILACS, Scielo,	[8]

	systematic review and meta-analysis of randomized clinical trials	Scopus, Web of Science, Cochrane, and Embase), including publications until May 2021. We included randomized clinical trials that compared blueberry or cranberry effects on type 2 diabetes parameters, such as fasting blood glucose, insulin resistance, and glycated hemoglobin. Quality of the studies was performed using the Cochrane scale, while the Egger test assessed the publication bias and meta-regression the estimated effect sizes with potential moderator variables. From the 2034 studies identified, 39 were read in full and 22 were included in meta-analysis. In individuals with diabetes, the consumption of blueberry or cranberry significantly reduced fasting blood glucose [MD: -17.72 mg/dl; 95% CI: -29.62, -5.82; p = 0.03; I2 = 57%] and glycated hemoglobin [MD: -0.32%; 95% CI: -0.57, -0.07; p = 0.15; I2 = 39%], whereas for insulin resistance the effects were null. Results were not significant for the general population, except in the sensitivity analysis for fasting blood glucose. CONCLUSIONS: The consumption of blueberry and cranberry significantly reduced fasting blood glucose and glycated hemoglobin levels in individuals with diabetes, with high credibility of the evidence.	
Gonçalves AC, 2022	Cherries and Blueberries-Based Beverages: Functional Foods with Antidiabetic and Immune Booster Properties	(Review Article) Nowadays, it is largely accepted that the daily intake of fruits, vegetables, herbal products and derivatives is an added value in promoting human health, given their capacity to counteract oxidative stress markers and suppress uncontrolled pro-inflammatory responses. Given that, natural-based products seem to be a promising strategy to attenuate, or even mitigate, the development of chronic diseases, such as diabetes, and to boost the immune system. Among fruits, cherries and blueberries are nutrient-dense fruits that have been a target of many studies and interest given their richness in phenolic compounds and notable biological potential. In fact, research has already demonstrated that these fruits can be considered functional foods, and hence, their use in functional beverages, whose popularity is increasing worldwide, is not surprising and seem to be a promising and useful strategy. Therefore, the present review reinforces the idea that cherries and blueberries can be incorporated into new pharmaceutical products, smart foods, functional beverages, and nutraceuticals and be effective in preventing and/or treating diseases mediated by inflammatory mediators, reactive species, and free radicals.	[13]
Martini D et al, 2023	Blueberries and their bioactives in the modulation of oxidative stress, inflammation and cardio/vascular function markers: a systematic review of human intervention studies	Blueberries represent a rich source of (poly)phenols and other bioactive compounds. Numerous in vitro and animal model studies documented the potential health-promoting properties of blueberries and blueberry-bioactives, while little is still known about their effects in humans. The objective of the present systematic review is to provide main evidence and the potential mechanisms of action of blueberry and its (poly)phenols in the regulation of markers related to oxidative stress, inflammation, vascular and cardiometabolic function in health and disease states. A total of 45 human intervention studies were included in this review. Overall, the evidence suggests that blueberries may play a role in the improvement of markers of vascular function. Their effects were observed following both post-prandial and long-term consumption, particularly in subjects with risk factors and/or disease conditions. Conversely, the conflicting results on inflammation, oxidative stress and cardiometabolic	[7]

		risk markers were most likely due to differences among studies in terms of study design, subject characteristics, duration of intervention, dosage, and type of biomarkers analyzed. For these reasons, high-quality, well-designed, human intervention studies are warranted to strengthen the current findings on vascular function and provide more evidence about the impact of blueberries on the different markers considered. In addition, studies focusing on the relationship between the structure and the function of (poly)phenols will be fundamental for a better comprehension of the mechanisms behind the health effects observed.	
Soveid N et al, 2022	The Potential Effect of Blueberry on Cognitive Health and Mood State Based on Human Intervention Studies: Systematic review & Mini Meta-analysis	BACKGROUND: Blueberries are known for their high content of several bioactive compounds, specifically anthocyanin, which have been shown to be the most beneficial of the flavonoid family in terms of neuro-protection. Several human interventional studies have been conducted to assess the effects of blueberry intake on cognitive performance, however, the results of clinical trials are inconclusive. Therefore, this systematic review and meta-analysis evaluated the effect of blueberry supplementation on some aspects of cognitive performance and mood parameters using data from clinical trials based on existing evidence. METHODS: Relevant studies, published up until April 2021, were searched through PubMed/Medline, Scopus, Embase and Google Scholar. The random effect size was used to estimate the pooled effect size. Heterogeneity between studies was evaluated by the Cochrane Q test and I-squared (I2). To detect the potential source of heterogeneity, subgroup analysis was conducted. RESULTS: Fourteen randomized trials were included in the quantitative analysis, and six were pooled for statistical analysis. Blueberry intervention resulted in no significant change in mood state score (WMD = 0.03; 95% CI:-0.80 to 0.87, P = 0.16). Moreover, no significant effect of blueberry intake was shown in attention task reaction time (WMD = -1.50 ms; 95% CI:-24.75 to -21.75, P = 0.9), percentages of attention task accuracy (WMD = 0.85; 95% CI:-2.57 to 0.86, P = 0.3), one-back test accuracy (WMD = 0.03; 95% CI:-0.04 to 0.09, P = 0.4). Significant effect was indicated (WMD = 0.08; 95% CI: 0.02 to 0.13, P = 0.005) in two-back test accuracy. CONCLUSION: We found a significant effect of blueberry consumption on two-back test accuracy as a cognitive outcome. More high quality clinical trials according to the challenges mentioned seem to indicate the use of blueberry as a supplement for cognitive and mood health efficiently.	[14]
Raspberries			
Lopez-Corona AV et al, 2022	Antioxidant, Anti-Inflammatory and Cytotoxic Activity of Phenolic Compound Family Extracted from Raspberries (Rubus idaeus): A General Review	**(Review Article)** Raspberries (Rubus idaeus) possess a wide phenolic family profile; this serves the role of self-protection for the plant. Interest in these compounds have significantly increased, since they have been classified as nutraceuticals due to the positive health effects provided to consumers. Extensive chemical, in vitro and in vivo studies have been performed to prove and validate these benefits and their possible applications as an aid when treating several chronic degenerative diseases, characterized by oxidative stress and an inflammatory response. While many diseases could be co-adjuvanted by the intake of these phenolic compounds, this review will mainly discuss their effects on	[15]

		cancer. Anthocyanins and ellagitannins are known to provide a major antioxidant capacity in raspberries. The aim of this review is to summarize the current knowledge concerning the phenolic compound family of raspberries, and topics discussed include their characterization, biosynthesis, bioavailability, cytotoxicity, antioxidant and anti-inflammatory activities.	
Nikparast A et al, 2023	The Effects of Blackcurrant and Raspberry Consumption on Blood Pressure: A Systematic Review and Meta-Analysis of Randomized Controlled Trials	A systematic review and meta-analysis were designed to summarize studies conducted on the effects of raspberry and blackcurrant consumption on blood pressure (BP). Eligible studies were detected by searching numerous five online databases including PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar, until December 17, 2022. We pooled the mean difference and its 95% confidence interval (CI) by applying a random-effects model. Overall, the impact of raspberry and blackcurrant on BP was reported in ten randomized controlled trials (RCTs) (420 subjects). Pooled analysis of six clinical trials revealed that raspberry consumption has no significant reduction in systolic blood pressure (SBP) (weighted mean differences [WMDs], -1.42; 95% CI, -3.27 to 0.87; p = 0.224) and diastolic blood pressure (DBP) (WMD, -0.53; 95% CI, -1.77 to 0.71; p = 0.401), in comparison with placebo. Moreover, pooled analysis of four clinical trials indicated that blackcurrant consumption did not reduce SBP (WMD, -1.46; 95% CI, -6.62 to 3.7; p = 0.579), and DBP (WMD, -2.09; 95% CI, -4.38 to 0.20; p = 0.07). Raspberry and blackcurrant consumption elicited no significant reductions in BP. More accurate RCTs are required to clarify the impact of raspberry and blackcurrant intake on BP.	[2]
Mixed Berries			
Komarnytsky S et al, 2023	Berries in Microbiome-Mediated Gastrointestinal, Metabolic, and Immune Health	**(Review Article)** PURPOSE OF REVIEW: Current research has shown that berry-derived polymeric substrates that resist human digestion (dietary fibers and polyphenols) are extensively metabolized in the gastrointestinal tract dominated by microbiota. This review assesses current epidemiological, experimental, and clinical evidence of how berry (strawberry, blueberry, raspberry, blackberry, cranberry, black currant, and grapes) phytochemicals interact with the microbiome and shape health or metabolic risk factor outcomes. RECENT FINDINGS: There is a growing evidence that the compositional differences among complex carbohydrate fractions and classes of polyphenols define reversible shifts in microbial populations and human metabolome to promote gastrointestinal health. Interventions to prevent gastrointestinal inflammation and improve metabolic outcomes may be achieved with selection of berries that provide distinct polysaccharide substrates for selective multiplication of beneficial microbiota or oligomeric decoys for binding and elimination of the pathogens, as well as phenolic substrates that hold potential to modulate gastrointestinal mucins, reduce luminal oxygen, and release small phenolic metabolites signatures capable of ameliorating inflammatory and metabolic perturbations. These mechanisms may explain many of the differences in microbiota and host gastrointestinal responses associated with increased consumption of berries, and highlight potential	[16]

		opportunities to intentionally shift gut microbiome profiles or to modulate risk factors associated with better nutrition and health outcomes.	
Shi N & Chen T, 2022	Chemopreventive Properties of Black Raspberries and Strawberries in Esophageal Cancer Review	**(Review article)** Esophageal cancer is one of the most fetal malignancies in the world. Esophageal squamous cell carcinoma (SCC) and esophageal adenocarcinoma (AC) are two main types of esophageal cancer and each with distinct epidemiological, etiological and histopathological characteristics. The continued global prevalence of tobacco use and alcohol consumption, coupled with limited intake of fresh fruits and vegetables, ensures that esophageal cancer will remain one of the major health threats. In addition to promoting quitting smoking and alcohol abuse, one of the strategies of cancer prevention is to identify foods, food components, or dietary patterns that can prevent or delay the onset of esophageal cancer. A food-based approach has the advantage of a complex of mixtures of bioactive components simultaneously targeting multiple processes in carcinogenesis. We have employed a preclinical rodent model of esophageal SCC to assess the effects of black raspberries (BRB) and strawberries. Our investigations demonstrate that BRB and strawberries are potent inhibitors of esophageal cancer. To prepare for this review, a literature search was performed to screen BRB and strawberries against esophageal cancer using electronic databases from PubMed, Science Direct and Google Scholar. Search was conducted covering the period from January 2000 to June 2022. Our present review has provided a systematic review about chemopreventive effects of BRB and strawberries in esophageal cancer by collecting and compiling diverse research findings from the above sources. In this review, we discussed the anti-tumor potentials of BRB and strawberries in esophageal SCC and esophageal AC separately. For each cancer type, we discuss animal models and research findings from both animal bioassays and human clinical studies. We also discuss the potential mechanisms of action of berries and their key bioactive components.	[12]
Sweeney M et al, 2022	The Effects of Berry Polyphenols on the Gut Microbiota and Blood Pressure: A Systematic Review of Randomized Clinical Trials in Humans	Berry consumption has beneficial effects on blood pressure. Intestinal microbiota transform berry phytochemicals into more bioactive forms. Thus, we performed a systematic review of randomized clinical trials to determine whether berry polyphenols in foods, extracts or supplements have effects on both the profile of gut microbiota and systolic and diastolic blood pressure in humans. PubMed, Cochrane Library, Scopus, and CAB Abstracts (EBSCOhost) were searched for randomized clinical trials in humans published from 1 January 2011 to 29 October 2021. Search results were imported into Covidence for screening and data extraction by two blinded reviewers, who also performed bias assessment independently. The literature search identified 216 publications; after duplicates were removed, 168 publications were screened with 12 full-text publications assessed for eligibility. Ultimately three randomized clinical trials in humans met the eligibility criteria. One randomized clinical trial showed a low risk of bias while the other two randomized clinical trials included low, high or unclear risk of bias. Together the randomized clinical trials showed that berry consumption (Aronia berry, strawberries, raspberries, cloudberries and bilberries) for 8-12 weeks had no significant effect	[17]

		on both blood pressure and the gut microbiota. More randomized clinical trials are needed to determine the effects of berry consumption on the profile of gut microbiota and blood pressure in humans.	
Vendrame S et al, 2022	The Role of Berry Consumption on Blood Pressure Regulation and Hypertension: An Overview of the Clinical Evidence	**(Review Article)** The existence of a relationship between the consumption of dietary berries and blood pressure reduction in humans has been repeatedly hypothesized and documented by an increasing body of epidemiological and clinical evidence that has accumulated in recent years. However, results are mixed and complicated by a number of potentially confounding factors. The objective of this article is to review and summarize the available clinical evidence examining the effects of berry consumption on blood pressure regulation as well as the prevention or treatment of hypertension in humans, providing an overview of the potential contribution of distinctive berry polyphenols (anthocyanins, condensed tannins and ellagic acid), and results of dietary interventions with blueberries, bilberries, cranberries, raspberries, strawberries, chokeberries, cherries, blackcurrants and açai berries. We conclude that, while there is insufficient evidence supporting the existence of a direct blood pressure lowering effect, there is stronger evidence for specific types of berries acting indirectly to normalize blood pressure in subjects that are already hypertensive.	[5]

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MT21000: NUTRITIONiQ Update

Prepared for:

Hort Innovation

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Prepared by:

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Summary

The aim of this literature update is to provide updates to the science presented in the Berries and Human Health report, and provide updates to information where required. PubMed was searched for articles published from the last date of the search performed for the Berries and Human Health report, using the same search strategy as previously outlined. Only human research studies have been included in this update.

Eighteen full text articles were retrieved and included in this current update. Intervention trials covered all berries (blueberries, strawberries, raspberries, and blackberries), however, most were systematic reviews and review articles focused on blueberries.

The key findings for this literature update are consistent with the findings in the Berries and Human Health report for their effects on gastrointestinal health, cognitive and cardiovascular health, metabolic markers, and some protective effects on bone calcium and oral cancer. Effects of berry consumption on the microbiome are an emerging and promising area of research.

Background

To create a database of all the research conducted on berries and health, and to stay abreast of the latest clinical developments and advances in this area, our NUTRITIONiQ (NiQ) literature database service is executed every six months throughout the campaign. The NUTRITIONiQ database service conducts regular scientific searches and media monitoring that targets peer-reviewed literature, media reports, and clinical trial registries.

This NiQ research update captures systematic reviews, randomised controlled trials, and observational research conducted and published since March 7th, 2023, to capture literature published since the 'Berries and Human Health' and subsequent NIQ update reports were completed. This ensures NRAUS stays across the latest in Berries Science and information gathered will be used to create 'Fun Facts', which may be included throughout the campaign to:

- Support key messages for resource and communication development
- Generate ideas for berries-related content
- Provide cutting-edge science for EDM updates
- Be used in communications with berries growers.

Methods

The search strategy that informed the Berries and Human Health report was repeated for this update. PubMed database search was conducted on September 1st, 2023, for any new papers published since March 7th, 2022. Search terms included (strawberry OR strawberries OR blueberry OR blueberries OR raspberry OR raspberries OR blackberry OR blackberries OR berry OR berries)[title/abstract] AND (systematic review OR review OR scientific integrity review OR randomised controlled trial OR clinical trial OR meta-analysis OR cohort)[publication type].

Results

The search returned 103 articles for screening. From those, 18 of these are relevant to the current project. Included in these were eight clinical intervention studies (blueberries, n=6; strawberries, n=1; raspberries, n=1); Six review articles (blueberries, n=2; strawberries, n=1; Raspberry, n=1; blackberries, n=1; mixed berries, n=1); Four systematic reviews (blueberries, n=1; mixed berries, n=3). Key findings from intervention studies and systematic reviews have been summarized below, and the abstracts for all papers have been provided in **Tables 1** and **2.**

Similar to the previous NUTRITIONiQ update, intervention studies primarily feature blueberries. Evidence supporting blueberries and health remains strong, with intervention studies showing beneficial effects across a variety of health outcomes. The primary areas of evidence with the most robust supporting evidence remains cognitive and cardiovascular health. However, a new systematic review of pre-clinical studies provides evidence of biologically plausible pathways to explain the emerging relationships between blueberries and/or compounds in blueberries and gut health, which provides more supportive evidence for a causal relationship.

Key findings

There is a strengthening of the evidence that blueberries improve markers of gastrointestinal health and reduce inflammation, including a systematic review demonstrating biological pathways of action

- An intervention using freeze-dried blueberries, equivalent to 180g fresh blueberries per day for six weeks, found relief of abdominal symptoms (composite measure including gas, pain, and bloating) and improved general markers of well-being, quality of life, and life functioning compared with an energy-matched placebo (sugar) in 43 patients with functional gastrointestinal disorder (FGID). This suggests that blueberries included daily as a regular component of the diet may be a useful dietary strategy for preventing gastrointestinal discomfort in adults with FGID [1].
- A systematic review of pre-clinical studies demonstrated that blueberry likely improves gut health through a variety of mechanisms including: enhancing intestinal morphology; reducing gut permeability; suppressing oxidative stress; ameliorating gut inflammation; and modulating the composition and function of gut microbes. These findings provides

mechanistic support for existing observational and intervention research in humans, and strengthens the likelihood that blueberries have a causal relationship with improved gut health outcomes [2].

- Consumption of 1 cup/day of blueberries for 18 days was linked to a reduction in pro-inflammatory diHOMES and sustained elevations in omega-3-derived anti-inflammatory oxylipins in response to a 90-min bout of unaccustomed exercise. These results suggest that blueberries may have anti-inflammatory properties that could benefit exercise recovery in this population [3].

Further evidence that blueberry compounds benefits both cardiovascular and cognitive health

- Significant increases in flow-mediated dilation (FMD) and reductions in 24-hour ambulatory systolic blood pressure were observed in response to the consumption of wild blueberry polyphenols. This suggests that wild blueberries may have beneficial effects on cardiovascular health [4].
- Wild blueberry (WBB) powder, improves vascular and cognitive function and decreases 24 h ambulatory systolic BP in healthy older individuals. This suggests that WBB (poly)phenols may reduce future CVD risk in an older population and may improve episodic memory processes and executive functioning in older adults at risk for cognitive decline [4].
- Wild blueberries have been found to improve cognitive abilities and restore the speed of cognitive processing. This suggests that WBB may be a useful dietary intervention for improving cognitive function [5].

Nutrients and compounds in berries may help reduce oxidative stress and improve blood lipid profile

- Strawberries are a source of vitamin C and folate, and may enhance the antioxidant potential of LDL in healthy young women. These findings suggest that strawberries may have a protective effect against oxidative stress in this population [6].
- Unripe black raspberry extract has been found to significantly lower LDL-C and TC levels. This suggests that unripe black raspberry extract may have a therapeutic potential for improving lipid profiles [7].

Preliminary evidence that blueberries may have a protective effect on bone calcium levels in post-menopausal women

- In postmenopausal women, interventions using freeze-dried blueberries showed a beneficial effect on net bone calcium balance at lower doses (equivalent to 1 cup (150 g)/day fresh blueberries), with no effect at higher doses (equivalent to 3 cups (300 g)/day). This suggests that regular consumption of blueberries of up to one cup per day may have a protective effect on bone health in this high-risk population group. [8]

Preliminary evidence suggests protective effects against oral cancer

- Compounds found in cranberries and blueberries have been shown to exhibit protective effects against oral cancer. This suggests that these fruits may have a chemo preventative effect against this type of cancer [9].

Table 1: Summary of new published studies on Berries from March 2023 to September 2023 based on search criteria.

AUTHOR/YEAR	TITLE	ABSTRACT	REF
ORIGINAL RESEARCH			
Blueberries			
Hodges et al, 2023	Moderate consumption of freeze-dried blueberry powder increased net bone calcium retention compared with no treatment in healthy postmenopausal women: a randomized crossover trial	Background: Preclinical studies suggest that blueberry consumption is associated with improved bone health. Objectives: We conducted a blueberry dose-response study in ovariectomized (OVX)-rats that informed a study in postmenopausal women using the urinary appearance of calcium (Ca) tracers from prelabelled bone to reflect changes in bone balance. We hypothesized that blueberry consumption would reduce bone loss in a dose-dependent manner compared with no treatment. Methods: OVX rats were fed 4 doses of blueberry powder (2.5%, 5%, 10%, and 15%) in randomized order to determine bone 45Ca retention. Fourteen healthy, non-osteoporotic women ≥4 y past menopause were dosed with 50 nCi of 41Ca, a long-lived radioisotope, and equilibrated for 5 mo to allow 41Ca deposition in bone. Following a 6-wk baseline period, participants were assigned to a random sequence of 3 6-wk interventions, a low (17.5 g/d), medium (35 g/d), or high (70 g/d) dose of freeze-dried blueberry powder equivalent to 0.75, 1.5, or 3 cups of fresh blueberries incorporated into food and beverage products. Urinary 41Ca:Ca ratio was measured by accelerator mass spectrometry. Serum bone resorption biomarkers and urinary polyphenols were measured at the end of each control and intervention period. Data were analysed using a linear mixed model and repeated measures analysis of variance. Results: In both OVX rats and postmenopausal women, blueberry interventions benefited net bone calcium balance at lower but not at higher doses. In women, net bone calcium retention increased by 6% with the low (95% CI: 2.50, 8.60; $P < 0.01$) and 4% with the medium (95% CI: 0.96, 7.90; $P < 0.05$) dose compared with no treatment. Urinary excretion of hippuric acid increased dose-dependently with blueberry consumption. No significant relationships were found between bone resorption biomarkers, 25-hydroxyvitamin D, and interventions. Conclusions: Moderate consumption (<1 cup/d) of blueberries may be an effective strategy to attenuate bone loss in healthy postmenopausal women. This trial was registered at clinicaltrials.gov as NCT02630797.	[8]
Wilder-Smith et al, 2023	Blueberries Improve Abdominal Symptoms, Well-Being and	Blueberries beneficially modulate physiologic mechanisms relevant to the pathogenesis of functional gastrointestinal disorders (FGID). Forty-three patients with FGID received freeze-dried blueberries (equivalent to 180 g fresh blueberries) or sugar and energy-matched placebo in a double-blind,	[1]

	Functioning in Patients with Functional Gastrointestinal Disorders	randomized, cross-over study. After 6 weeks of treatment, the differences in Gastrointestinal Clinical Rating Scale (GSRS) scores and abdominal symptom relief were compared as primary outcome measures. The quality of life and life functioning ratings (OQ45.2 questionnaire), Bristol stool scales, and fructose breath test results constituted secondary outcome measures. Blueberry treatment resulted in more patients with relevant abdominal symptom relief compared to placebo (53% vs. 30%, p = 0.03). Total and pain GSRS scores improved insignificantly (mean treatment differences [95% CI]: -3.4 [-7.4 to 0.6] (p = 0.09) and -1.0 [-2.2 to 0.1] (p = 0.08), respectively). OQ45.2 scores improved during blueberry treatment compared to placebo (treatment difference -3.2 [95% CI: -5.6 to -0], p = 0.01). Treatment effect differences for the further measures did not reach statistical significance. Blueberries relieved abdominal symptoms and improved general markers of well-being, quality of life, and life functioning more than placebo in patients with FGID. Consequently, the polyphenol and fiber components of blueberries exert broad beneficial effects separate from the sugars present in both treatments.	
Nieman et al, 2023	Blueberry intake elevates post-exercise anti-inflammatory oxylipins: a randomized trial	This study determined if 18 days of supplementation with blueberries (BL) compared to placebo (PL) could mitigate muscle soreness and damage and improve inflammation resolution in untrained adults (n = 49, ages 18-50 years) after engaging in a 90-min bout of "weekend warrior" eccentric exercise. The BL freeze dried supplement provided 1 cup of fresh blueberries per day equivalent with 805 mg/day total phenolics and 280 mg/day anthocyanins. Urine levels of eight BL gut-derived phenolics increased after 14- and 18-days supplementation with 83% higher concentrations in BL vs. PL (p < 0.001). The 90-min exercise bout caused significant muscle soreness and damage during 4d of recovery and a decrease in exercise performance with no significant differences between PL and BL. Plasma oxylipins were identified (n = 76) and grouped by fatty acid substrates and enzyme systems. Linoleic acid (LA) oxylipins generated from cytochrome P450 (CYP) (9,10-, 12,13-dihydroxy-9Z-octadecenoic acids) (diHOMEs) were lower in BL vs. PL (treatment effect, p = 0.051). A compositive variable of 9 plasma hydroxydocosahexaenoic acids (HDoHEs) generated from docosahexaenoic acid (DHA, 22:6) and lipoxygenase (LOX) was significantly higher in BL vs. PL (treatment effect, p = 0.008). The composite variable of plasma 14-HDoHE, 17-HDoHE, and the eicosapentaenoic acid (EPA)-derived oxylipin 18-hydroxyeicosapentaenoic acid (18-HEPE) (specialized pro-resolving lipid mediators, SPM, intermediates) was significantly higher in BL vs PL (treatment effect, p = 0.014). Pearson correlations showed positive relationships between post-exercise DHA-LOX HDoHEs and SPM intermediates with urine blueberry gut-derived phenolics (r = 0.324, p = 0.023, and r = 0.349, p = 0.015, respectively). These data indicate that 18d intake of 1 cup/day blueberries compared to PL was linked to a reduction in pro-inflammatory diHOMES and sustained elevations in DHA- and EPA-derived anti-inflammatory oxylipins in response to a 90-min bout of unaccustomed exercise by untrained adults.	[3]

Wood et al, 2023	Wild blueberry (poly)phenols can improve vascular function and cognitive performance in healthy older individuals: a double-blind randomized controlled trial	Background: Evidence suggests that the intake of blueberry (poly)phenols is associated with improvements in vascular function and cognitive performance. Whether these cognitive effects are linked to increases in cerebral and vascular blood flow or changes in the gut microbiota is currently unknown. Methods: A double-blind, parallel randomized controlled trial was conducted in 61 healthy older individuals aged 65-80 y. Participants received either 26 g of freeze-dried wild blueberry (WBB) powder (302 mg anthocyanins) or a matched placebo (0 mg anthocyanins). Endothelial function measured by flow-mediated dilation (FMD), cognitive function, arterial stiffness, blood pressure (BP), cerebral blood flow (CBF), gut microbiome, and blood parameters were measured at baseline and 12 wks following daily consumption. Plasma and urinary (poly)phenol metabolites were analyzed using microelution solid-phase extraction coupled with liquid chromatography-mass spectrometry. Results: A significant increase in FMD and reduction in 24 h ambulatory systolic BP were found in the WBB group compared with the placebo group (0.86%; 95% CI: 0.56, 1.17, P < 0.001; -3.59 mmHg; 95% CI: -6.95, -0.23, P = 0.037; respectively). Enhanced immediate recall on the auditory verbal learning task, alongside better accuracy on a task-switch task was also found following WBB treatment compared with placebo (P < 0.05). Total 24 h urinary (poly)phenol excretion increased significantly in the WBB group compared with placebo. No changes in the CBF or gut microbiota composition were found. Conclusions: Daily intake of WBB powder, equivalent to 178 g fresh weight, improves vascular and cognitive function and decreases 24 h ambulatory systolic BP in healthy older individuals. This suggests that WBB (poly)phenols may reduce future CVD risk in an older population and may improve episodic memory processes and executive functioning in older adults at risk for cognitive decline. Clinical Trial Registration number in clinicaltrials.gov: NCT04084457.	[4]
Cheatham et al, 2023	Six-month intervention with wild blueberries improved speed of processing in mild cognitive decline: a double-blind, placebo-controlled, randomized clinical trial	Background: As the sector of the population over 65y increases, cognitive decline and dementia become a public health issue. Interventions to improve brain health and thus, quality of life for older adults are needed. Objective: It was hypothesized that those consuming a flavonoid-rich, lyophilized wild blueberry powder would evidence improvements in cognitive performance as measured behaviorally and electrophysiologically compared to those consuming a placebo powder across a 6-month intervention period.	[5]

		Design: In a double-blind, randomized placebo-controlled trial, participants experiencing cognitive issues as determined by scores on the Montreal Cognitive Assessment (MoCA) were randomized to consume either wild blueberry (n = 44) or placebo (n = 42) powder daily for 6 months. Participants who were not experiencing any cognitive issues were included as a reference group (n = 45). Participants were tested at baseline and outcome on the Cambridge Neurological Test Automated Battery (CANTAB) and in an electrophysiological paradigm known as event-related potentials (ERP). Results: Tests of specific cognitive abilities using the CANTAB showed speed of processing not only improved in the blueberry intervention group relative to the placebo group across the 6-month intervention, but blueberries also restored speed of processing to the level of the reference group. The ERP results also showed that, relative to those consuming placebo, speed of processing improved for those in the blueberry group; this improvement was most prominent in those 75-80y. Conclusions: Consumption of wild blueberries for six months improves cognitive aging sequelae by improving the speed of information processing in older adults. Trial registration: ClinicalTrials.gov identifier: NCT01515098.	
Woolf et al, 2023	Daily blueberry consumption for 12 weeks improves endothelial function in postmenopausal women with above-normal blood pressure through reductions in oxidative stress: a randomized controlled trial	Estrogen-deficient postmenopausal women have oxidative stress-mediated suppression of endothelial function that is exacerbated by high blood pressure. Previous research suggests blueberries may improve endothelial function through reductions in oxidative stress, while also exerting other cardiovascular benefits. The objective of this study was to examine the efficacy of blueberries to improve endothelial function and blood pressure in postmenopausal women with above-normal blood pressure, and to identify potential mechanisms for improvements in endothelial function. A randomized, double-blind, placebo-controlled, parallel-arm clinical trial was performed, where postmenopausal women aged 45-65 years with elevated blood pressure or stage 1-hypertension (total n = 43, endothelial function n = 32) consumed 22 g day-1 of freeze-dried highbush blueberry powder or placebo powder for 12 weeks. Endothelial function was assessed at baseline and 12 weeks through ultrasound measurement of brachial artery flow-mediated dilation (FMD) normalized to shear rate area under the curve (FMD/SRAUC) before and after intravenous infusion of a supraphysiologic dose of ascorbic acid to evaluate whether FMD improvements were mediated by reduced oxidative stress. Hemodynamics, arterial stiffness, cardiometabolic blood biomarkers, and plasma (poly)phenol metabolites were assessed at baseline and 4, 8, and 12 weeks, and venous endothelial cell protein expression was assessed at baseline and 12 weeks. Absolute FMD/SRAUC was 96% higher following blueberry consumption compared to baseline ($p < 0.05$) but unchanged in the placebo group ($p > 0.05$), and changes from baseline to 12 weeks were greater in the blueberry group than placebo ($+1.09 \times 10\text{-}4 \pm 4.12 \times 10\text{-}5$vs. $+3.82 \times 10\text{-}6 \pm 1.59 \times 10\text{-}5$, $p < 0.03$, respectively). The FMD/SRAUC response to ascorbic acid infusion was lower ($p < 0.05$) at 12 weeks compared to baseline in the blueberry group	[10]

		with no change in the placebo group (p > 0.05). The sum of plasma (poly)phenol metabolites increased at 4, 8, and 12 weeks in the blueberry group compared to baseline, and were higher than the placebo group (all p < 0.05). Increases in several plasma flavonoid and microbial metabolites were also noted. No major differences were found for blood pressure, arterial stiffness, blood biomarkers, or endothelial cell protein expression following blueberry consumption. These findings suggest daily consumption of freeze-dried blueberry powder for 12 weeks improves endothelial function through reduced oxidative stress in postmenopausal women with above-normal blood pressure. The clinical trial registry number is NCT03370991 (https://clinicaltrials.gov).	
Strawberries			
Kishimoto et al, 2023	Effects of acute strawberry consumption on serum levels of vitamin C and folic acid, the antioxidant potential of LDL and blood glucose response: a randomised cross-over controlled trial	Strawberry contains many bioactive compounds such as vitamin C and polyphenols as well as folate, a vitamin that is especially important for women of childbearing age. We investigated the effects of the acute consumption of strawberry on the serum levels of vitamin C and folate, and on the antioxidant potential of low-density lipoprotein (LDL). In a randomised, placebo-controlled, double-blind, crossover study, twenty-three healthy female volunteers (age 22·5 ± 1·4 years) ingested 500 g of a strawberry purée beverage or a sugar content-matched placebo beverage. Blood samples were collected at fasting and at 0·5, 1, 2 and 4 h post-ingestion. The serum concentrations of vitamin C and folate were significantly elevated from 0·5 to 4 h after the strawberry beverage ingestion (P < 0·001); the levels peaked at 2 h, with peak levels of 15·0 ± 2·5 μg/ml for vitamin C and 14·4 ± 7·0 ng/ml for folate. Notably, at 1 h after the strawberry beverage ingestion, the LDL oxidation lag time was significantly prolonged (P < 0·05), suggesting that the antioxidant potential of LDL was increased. After the ingestion of either beverage, the serum levels of glucose and insulin reached a peak at 0·5 h and then quickly returned to baseline levels. These results suggest that strawberries are a useful source of vitamin C and folate and may help enhance the antioxidant potential of LDL in healthy young women.	[6]
Raspberries			
Jung et al, 2023	Effects of Unripe Black Raspberry Extract Supplementation on Male Climacteric Syndrome and Voiding Dysfunction: A Pilot, Randomized, Double-Blind, Placebo-Controlled Trial	Male climacteric syndrome (MCS) is a medical condition that can affect middle-aged men whose testosterone levels begin to decline considerably. These symptoms may include fatigue, decreased libido, mood swings, and disturbed sleep. MCS can be managed with lifestyle modifications and testosterone replacement. However, testosterone therapy may cause number of side effects, including an increased risk of cardiovascular issues. This study aims to evaluate the efficacy and safety of unripe black raspberry extract (BRE) against MCS and voiding dysfunction in men with andropause symptoms. A total of 30 subjects were enrolled and randomly assigned to the BRE group (n = 15) or the placebo group (n = 15). Participants were supplemented with 4800 mg BRE or placebo twice daily for 12 weeks. The impact of BRE was assessed using the Aging Male's Symptoms (AMS scale), International Prostate Symptom Score (IPSS) and the IPSS quality of life index (IPSS-QoL). Additionally, male sex hormones, lipid profiles, and anthropometric indices were assessed 6 and 12 weeks after treatment. The AMS scores did not differ significantly between the two groups. In the BRE group, the	[7]

		total IPSS and IPSS-QoL scores decreased significantly after 12 weeks compared to baseline ($p < 0.05$), but there was no significant difference compared to the placebo group. However, a significant difference was observed in the IPSS voiding symptoms sub-score compared to the placebo group. Furthermore, LDL-C and TC levels were also significantly lower in the BRE group than in the placebo group ($p < 0.05$). Collectively, the study provides strong evidence supporting the safety of BRE as a functional food and its supplementation potentially enhances lipid metabolism and alleviates MCS and dysuria symptoms, limiting the development of BPH.

Table 2: Summary of Systematic Reviews and Review articles on Berries from March 2023 to September 2023

AUTHOR/YEAR	TITLE	ABSTRACT	REF
SYSTEMATIC REVIEWS			
Blueberries			
Ivarsson Jr et al, 2023	Blueberry Supplementation and Skin Health	Environmental stressors such as air pollutants, ozone, and UV radiation are among the most noxious outdoor stressors affecting human skin and leading to premature skin aging. To prevent the extrinsic aging, the skin is equipped with an effective defensive system. However, cutaneous defense mechanisms can be overwhelmed through chronic exposure to environmental pollutants. Recent studies have suggested that the topical usage of natural compounds, such as blueberries, could be a good strategy to prevent skin damage from the environment. Indeed, blueberries contain bioactive compounds found to induce an active skin response against the environmental noxious effects. In this review, results from recent studies on this topic are discussed in order to build the argument for blueberries to possibly be an effective agent for skin health. In addition, we hope to highlight the need for further research to elucidate the mechanisms behind the use of both topical application and dietary supplementation with blueberries to bolster cutaneous systems and defensive mechanisms.	[11]
Esquivel-Chirino et al, 2023	The Protective Role of Cranberries and Blueberries in Oral Cancer	Background: Oral cancer has a high prevalence worldwide, and this disease is caused by genetic, immunological, and environmental factors. The main risk factors associated with oral cancer are smoking and alcohol. Results: There are various strategies to reduce risk factors, including prevention programs as well as the consumption of an adequate diet that includes phytochemical compounds derived from	[9]

		cranberries (Vaccinium macrocarpon A.) and blueberries (Vaccinium corymbosum L.); these compounds exhibit antitumor properties. Results: The main outcome of this review is as follows: the properties of phytochemicals derived from cranberries were evaluated for protection against risk factors associated with oral cancer. Conclusions: The secondary metabolites of cranberries promote biological effects that provide protection against smoking and alcoholism. An alternative for the prevention of oral cancer can be the consumption of these cranberries and blueberries.	
Lucia et al, 2023	Scientific Evidence for the Beneficial Effects of Dietary Blueberries on Gut Health: A Systematic Review	Emerging evidence indicates the association between an unhealthy gut and chronic diseases. A healthy gut comprises an intact gut epithelium and balanced gut microbes. Diet is one of the critical factors that modulate gut health by positively or negatively affecting the intestinal barrier and gut microbes. Blueberries are an excellent source of health-promoting bioactive components, and this systematic review is conducted to evaluate the effect of dietary blueberries on gut health. A literature search is conducted on PubMed/MEDLINE, Scopus, Web of Science, and Embase databases to review relevant studies published between 2011 and 2022 according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The Systematic Review Center for Laboratory Animal Experimentation Risk of Bias (SYRCLE-RoB) tool is used for methodological quality assessments. Sixteen studies included from four countries are reviewed and the results are synthesized narratively. This data analysis indicates that blueberry supplementation improves gut health by improving intestinal morphology, reducing gut permeability, suppressing oxidative stress, ameliorating gut inflammation, and modulating the composition and function of gut microbes. However, there are significant knowledge gaps in this field. These findings indicate that further studies are needed to establish the beneficial effects of blueberries on gut health.	[2]
Strawberries			
Newerli-Guz et al, 2023	Bioactive Ingredients with Health-Promoting Properties of Strawberry Fruit (Fragaria x ananassa Duchesne)	Strawberries (Fragaria x ananassa Duchesne) belong to the berry group and are characterized primarily by delightful sensory properties. Due to their chemical composition, these fruits are a rich source of bioactive compounds that can modify the metabolic and physiological functions of the body. The aim of this work is to present the current state of research on bioactive ingredients found in these fruits in the context of their health-promoting properties. The paper presents compiled and reviewed data on the content of polyphenolic compounds, organic acids, and vitamins, especially vitamin C, in strawberries. The content of these compounds is influenced by many different factors that are discussed in the paper. It also draws attention to the presence of oxalates and allergenic compounds, which are classified as anti-nutritional compounds of strawberries.	[12]
Raspberries			
Hu, et al, 2023	Raspberry polyphenols alleviate	Neurodegenerative diseases are neurological disorders that become more prevalent with age, usually caused by damage or loss of neurons or their myelin sheaths, such as Alzheimer's disease and	[13]

	neurodegenerative diseases: through gut microbiota and ROS signals	epilepsy. Reactive oxygen species (ROS) are important triggers for neurodegenerative disease development, and mitigation of oxidative stress caused by ROS imbalance in the human body is important for the treatment of these diseases. As a widespread delicious fruit, the raspberry is widely used in the field of food and medicine because of its abundant polyphenols and other bioactive substances. Polyphenols from a wide variety of raspberry sources could alleviate neurodegenerative diseases. This review aims to summarize the current roles of these polyphenols in maintaining neurological stability by regulating the composition and metabolism of the intestinal flora and the gut-brain axis signal transmission. Especially, we discuss the therapeutic effects on neurodegenerative diseases of raspberry polyphenols through intestinal microorganisms and ROS signals, by means of summary and analysis. Finally, methods of improving the digestibility and utilization of raspberry polyphenols are proposed, which will provide a potential way for raspberry polyphenols to guarantee the health of the human nervous system.	
Blackberries			
Martins et al, 2023	Blackberries and Mulberries: Berries with Significant Health-Promoting Properties	Blackberries and mulberries are small and perishable fruits that provide significant health benefits when consumed. In reality, both are rich in phytochemicals, such as phenolics and volatile compounds, and micronutrients, such as vitamins. All the compounds are well-known thanks to their medicinal and pharmacological properties, namely antioxidant, anti-inflammatory, anti-cancer, antiviral, and cardiovascular properties. Nevertheless, variables such as genotype, production conditions, fruit ripening stage, harvesting time, post-harvest storage, and climate conditions influence their nutritional composition and economic value. Given these facts, the current review focuses on the nutritional and chemical composition, as well as the health benefits, of two blackberry species (Rubus fruticosus L., and Rubus ulmifolius Schott) and one mulberry species (Morus nigra L.).	[14]
Mixed Berries			
Venturi et al, 2023	Berry Dietary Interventions in Metabolic Syndrome: New Insights	Metabolic Syndrome (MetS) is characterized by a group of dysmetabolic conditions, including abdominal obesity, dyslipidemia, glucose intolerance and/or insulin resistance, and hypertension. Generally, MetS is accompanied by an exacerbation of oxidative stress, inflammation, and vascular dysfunction. Increasing evidence suggests that berries and berry bioactives could play a potential role in the prevention and mitigation of the risk factors associated with MetS. The present systematic review summarizes the more recently available evidence deriving from human intervention studies investigating the effect of berries in subjects with at least three out of five MetS parameters. The PubMed, Scopus, and Embase databases were systematically searched from January 2010 until December 2022. A total of 17 human intervention trials met the inclusion criteria. Most of them were focused on blueberry (n = 6), cranberry (n = 3), and chokeberry (n = 3), while very few or none were available for the other berries. If considering MetS features, the main positive effects were related to lipid profile (low and high-density lipoproteins, cholesterol, and triglycerides) following blueberries	[15]

		and chokeberries, while conflicting results were documented for anthropometric parameters, blood pressure, and fasting blood glucose levels. Other markers analyzed within the studies included vascular function, oxidative stress, and inflammation. Here, the main positive effects were related to inflammation with a reduction in interleukin 6 and tumor necrosis factor-alpha following the intake of different berries. In conclusion, although limited, the evidence seems to support a potential role for berries in the modulation of lipid profile and inflammation in subjects with MetS. Furthermore, high-quality intervention trials are mandatory to demonstrate the role of berries in reducing risk factors for MetS and related conditions. In the future, such a demonstration could bring the adoption of berries as a potential dietary strategy to prevent/counteract MetS and related risk factors.	
Stote et ak, 2023	The Effect of Berry Consumption on Oxidative Stress Biomarkers: A Systematic Review of Randomized Controlled Trials in Humans	Bioactive compounds in berries may scavenge reactive oxygen and nitrogen species by donating electrons to free radicals, thereby protecting DNA, proteins, and lipids from oxidative damage. Evidence shows that berry consumption has beneficial health effects, though it remains unclear whether berries exert a significant impact on oxidative stress in humans. Thus, we performed a systematic review of randomized controlled trials (RCT) to examine the effects of non-acute (more than a single dose and ≥7 days) berry consumption on biomarkers of oxidative stress. Searches were conducted in PubMed, Cochrane Library, and Scopus; results were imported into Covidence for screening and data extraction. The literature search identified 622 studies that were screened, and 131 full-text studies assessed for eligibility. Ultimately, 28 RCTs met the eligibility criteria. Common biomarkers of oxidative stress (antioxidants, DNA damage, isoprostanes, malondialdehyde, and oxidized LDL) were systematically reviewed, and results were reported narratively. Of the approximate 56 oxidative stress biomarkers evaluated in the 28 RCTs, 32% of the biomarkers were reported to have statistically significant beneficial results and 68% of the biomarkers were reported as having no statistically significant differences. More well-designed and longer-term berry RCTs are needed to evaluate biomarkers of oxidative stress.	[16]
Helm et al, 2023	Effect of Dietary Berry Supplementation on Antioxidant Biomarkers in Adults with Cardiometabolic Risks: A Systematic Review of Clinical Trials	Cardiometabolic conditions are closely associated with inflammation and oxidative stress. Dietary berries may serve as a beneficial nutrition intervention to address the features of cardiometabolic dysfunction and associated oxidative stress. The high antioxidant status of dietary berries may increase antioxidant capacity and reduce biomarkers of oxidative stress. This systematic review was conducted to investigate these effects of dietary berries. The search was conducted using PubMed, Cochrane Library, Web of Science, and citation searching. Through this search we identified 6309 articles and 54 were included in the review. Each study's risk of bias was assessed using the 2019 Cochrane Methods' Risk of Bias 2 tool. Antioxidant and oxidative stress outcomes were evaluated, and the magnitude of effect was calculated using Cohen's d. A range of effectiveness was reported in the included studies and the quality of the studies differed between the parallel and crossover trials. Considering the inconsistency in reported effectiveness, future investigations are warranted to	[17]

		determine the acute and sustained reductions of oxidative stress biomarkers from dietary berry intake (PROSPERO registration# CRD42022374654).	
Mostafa et al, 2023	Biomarkers of Berry Intake: Systematic Review Update	Berries are rich in (poly)phenols, and these compounds may be beneficial to human health. Estimating berry consumption through self-reported questionnaires has been challenging due to compliance issues and a lack of precision. Estimation via food-derived biomarkers in biofluids was proposed as a complementary alternative. We aimed to review and update the existing evidence on biomarkers of intake for six different types of berries. A systematic literature search was performed to update a previous systematic review on PubMed, Web of Science, and Scopus from January 2020 until December 2022. Out of 42 papers, only 18 studies were eligible. A multimetabolite panel is suggested for blueberry and cranberry intake. Proposed biomarkers for blueberries include hippuric acid and malvidin glycosides. For cranberries, suggested biomarkers are glycosides of peonidin and cyanidin together with sulfate and glucuronide conjugates of phenyl-γ-valerolactone derivatives. No new metabolite candidates have been found for raspberries, strawberries, blackcurrants, and blackberries. Further studies are encouraged to validate these multimetabolite panels for improving the estimation of berry consumption.	[18]

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MT21000: NutritioniQ Update

Prepared for:

Hort Innovation
March 2024

Prepared by:

FOODiQ Global

Summary

The aim of this literature update is to provide updates to the science presented in the Berries and Human Health report, and provide updates to information where required. PubMed was searched for articles published from the last date of the search performed for the Berries and Human Health report, using the same search strategy as previously outlined. Only human research studies have been included in this update.

Three full text articles were retrieved and included in this current update. Intervention trials covered only blueberries. The articles report beneficial effects of blueberries on vascular function and cognition.

The key findings for this literature update are consistent with the findings in the Berries and Human Health report for their effects on gastrointestinal health, cognitive and cardiovascular health, metabolic markers, and some protective effects on bone calcium and oral cancer. Effects of berry consumption on the microbiome are an emerging and promising area of research.

Background

To create a database of all the research conducted on berries and health, and to stay abreast of the latest clinical developments and advances in this area, our NUTRITIONiQ (NiQ) literature database service is executed every six months throughout the campaign. The NUTRITIONiQ database service conducts regular scientific searches and media monitoring that targets peer-reviewed literature, media reports, and clinical trial registries.

This NiQ research update captures systematic reviews, randomised controlled trials, and observational research conducted and published since September 1st, 2023, to capture literature published since the 'Berries and Human Health' and subsequent NIQ update reports were completed. This ensures FOODiQ stays across the latest in Berries Science and information gathered will be used to create 'Fun Facts', which may be included throughout the campaign to support key messages for resource and communication development.

Methods

The search strategy that informed the Berries and Human Health report was repeated for this update. PubMed database search was conducted on March 6th, 2024, for any new papers published since September 1st, 2023. Search terms included (strawberry OR strawberries OR blueberry OR blueberries OR raspberry OR raspberries OR blackberry OR blackberries OR berry OR berries)[title/abstract] AND (systematic review OR review OR scientific integrity review OR randomised controlled trial OR clinical trial OR meta-analysis OR cohort)[publication type].

Results

The search returned 88 articles for screening. From those, three of these are relevant to the current project. Included in these was one clinical intervention studies (blueberries, n=1). One review article (blueberries, n=1); One systematic review (blueberries, n=1). Key findings from intervention studies and systematic reviews have been summarized below, and the abstracts for all papers have been provided in **Tables 1** and **2.**

Intervention study only feature blueberries. Evidence supporting blueberries and health remains strong, with intervention studies showing beneficial effects across a variety of health outcomes. The primary areas of evidence with the most robust supporting evidence remains cognitive and health. However, a new systematic review of pre-clinical studies provides evidence of biologically plausible pathways to explain the emerging relationships between blueberries and/or compounds in blueberries and gut health, which provides more supportive evidence for a causal relationship.

Key Findings

Evidence that blueberries improve cognitive function and protection effects on vascular function.

- Cognitive ability tests using the CANTAB demonstrated that blueberry intervention improved speed of processing compared to the placebo group over a 6-month period, even restoring it to the level of the reference

group. The ERP results further confirmed this improvement, particularly in individuals aged 75-80 years. [3]
- Blueberry consumption improves vascular function through improving nitric oxide bioavailability, oxidative stress, and inflammation. [1]

Limited evidence showing blueberry can improve blood pressure in adults with cardiometabolic disease.

- There can be a significant reduction in blood pressure after blueberry and cranberry supplementation, however, this finding was inconsistent across studies.
- Pooled findings report a non-significant decrease in both diastolic and systolic blood pressure in patients with cardiometabolic disease.

Overall, these papers provide further evidence of beneficial effects of blueberries on vascular function, perhaps with greater benefits observed in the microvascular system. This is highly consistent with previous research findings and is likely related to the positive effects of blueberries in relation to cognition.

Taken together, although blueberries alone may be insufficient to significantly lower blood pressure in adults with cardiometabolic disease, there is an opportunity to promote blueberries as a dietary strategy in this population group to reduce the risk of future cognitive decline or impairment.

As with previous NiQ updates, most of the available research has been conducted using blueberries, there is a need for research in other berry types to determine whether findings are translatable to other berry types.

Table 1: Summary of new published studies on Berries from September 2023 to March 2024 based on search criteria.

AUTHOR/YEAR	TITLE	ABSTRACT	REF
ORIGINAL RESEARCH			
Blueberries			
Cheatham et al, 2023	Six-month intervention with wild blueberries improved speed of processing in mild cognitive decline: a double-blind, placebo-controlled, randomized clinical trial	Background: As the sector of the population over 65y increases, cognitive decline and dementia become a public health issue. Interventions to improve brain health and thus, quality of life for older adults are needed. Objective: It was hypothesized that those consuming a flavonoid-rich, lyophilized wild blueberry powder would evidence improvements in cognitive performance as measured behaviorally and electrophysiologically compared to those consuming a placebo powder across a 6-month intervention period. Design: In a double-blind, randomized placebo-controlled trial, participants experiencing cognitive issues as determined by scores on the Montreal Cognitive Assessment (MoCA) were randomized to consume either wild blueberry (n = 44) or placebo (n = 42) powder daily for 6 months. Participants who were not experiencing any cognitive issues were included as a reference group (n = 45). Participants were tested at baseline and outcome on the Cambridge Neurological Test Automated Battery (CANTAB) and in an electrophysiological paradigm known as event-related potentials (ERP). Results: Tests of specific cognitive abilities using the CANTAB showed speed of processing not only improved in the blueberry intervention group relative to the placebo group across the 6-month intervention, but blueberries also restored speed of processing to the level of the reference group. The ERP results also showed that, relative to those consuming placebo, speed of processing improved for those in the blueberry group; this improvement was most prominent in those 75-80y. Conclusions: Consumption of wild blueberries for six months improves cognitive aging sequelae by improving the speed of information processing in older adults.	[3]

Table 2: Summary of Systematic Reviews and Review articles on Berries from September 2023 to March 2024

AUTHOR/YEAR	TITLE	ABSTRACT	REF
ORIGINAL RESEARCH			
Blueberries			
Woolf et al, 2023	Protective effects of blueberries on vascular function: A narrative review of preclinical and clinical evidence	Blueberries are rich in nutrients and (poly)phenols, popular with consumers, and a major agricultural crop with year-round availability supporting their use in food-based strategies to promote human health. Accumulating evidence indicates blueberry consumption has protective effects on cardiovascular health including vascular dysfunction (i.e., endothelial dysfunction and arterial stiffening). This narrative review synthesizes evidence on blueberries and vascular function and provides insight into underlying mechanisms with a focus on oxidative stress, inflammation, and gut microbiota. Evidence from animal studies supports beneficial impacts on vascular function. Human studies indicate acute and chronic blueberry consumption can improve endothelial function in healthy and at-risk populations and may modulate arterial stiffness, but that evidence is less certain. Results from cell, animal, and human studies suggest blueberry consumption improves vascular function through improving nitric oxide bioavailability, oxidative stress, and inflammation. Limited data in animals suggest the gut microbiome mediates beneficial effects of blueberries on vascular function; however, there is a paucity of studies evaluating the gut microbiome in humans. Translational evidence indicates anthocyanin metabolites mediate effects of blueberries on endothelial function, though this does not exclude potential synergistic and/or additive effects of other blueberry components. Further research is needed to establish the clinical efficacy of blueberries to	[1]

		improve vascular function in diverse human populations in a manner that provides mechanistic information. Translation of clinical research to the community/public should consider feasibility, social determinants of health, culture, community needs, assets, and desires, barriers, and drivers to consumption, among other factors to establish real-world impacts of blueberry consumption.	
Delpino et al, 2023	The effects of blueberry and cranberry supplementation on blood pressure in patients with cardiovascular diseases: A systematic review and meta-analysis of randomized clinical trials	Blueberries and cranberries are berry fruits with the highest number of randomized clinical trials (RCTs) focusing on blood pressure (BP). This systematic review and meta-analysis of RCTs analyzed the effects of blueberry and cranberry supplementation alone and in concert with systolic BP (SBP) and diastolic BP (DBP) in patients with cardiometabolic diseases. The searches were performed until August 2023 in the following databases: PubMed, Scopus, Web of Science, Cochrane, and Embase. Studies that examined the effects of blueberry or cranberry intake/supplementation were included. The risk of bias was evaluated using the Rob 2 scale. A meta-analysis was performed to estimate the effects of blueberry and cranberry supplementation on BP levels in patients with cardiometabolic diseases. A total of 17 articles were included, from which two found significant results from blueberry and/or cranberry supplementation in reducing BP. Pooled results revealed statistically non-significant reductions of -0.81 mm Hg for SBP (95% confidence interval [CI]: -2.26, 0.63; I2 = 0%) and -0.15 mm Hg for DBP (95% CI: -1.36, 1.05; I2 = 27%). Blueberry and/or cranberry supplementation had neutral effects on SBP and DBP in patients with cardiometabolic diseases, regardless of duration or age. Further high-quality studies are needed to firmly establish clinical efficacy.	[2]

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