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Understanding the composition and potential health claims for Central Otago fruit waste

Lister CE

December 2022

Confidential report for:

Central Otago District Council, Summerfruit New Zealand, LILO Desserts, The Bio-resource Processing Alliance BPA2210

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Executive summary

Understanding the composition and potential health claims for Central Otago fruit waste

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December 2022

This report contributes to the wider project being managed by the Central Otago District Council (CODC) “Understanding fruit loss in Central Otago”. Within this wider project, the workstream led by Plant & Food Research (PFR) focused on evaluating potential commercial products and was funded through the Bioresource Processing Alliance (BPA), project 2210. This report covers a desktop survey, to draw information from databases, the scientific literature and food regulations to gather information on the five fruits included in this study (apples, apricots, cherries, nectarines and peaches). The information gathered included:

- Typical composition of the selected fruits (nutrients and phytochemicals), including distribution
- Potential health benefits.

There are several key nutrients in the fruits included in this study:

- Apples: dietary fibre, vitamin C and, in some varieties, vitamin E
- Apricots: dietary fibre, vitamin A, vitamin C, potassium
- Cherries: dietary fibre, vitamin C, potassium
- Nectarines: dietary fibre, vitamin C, vitamin E, potassium and, in some varieties, niacin and vitamin A
- Peaches: dietary fibre, vitamin C, vitamin E, potassium, and in some varieties niacin and vitamin A.

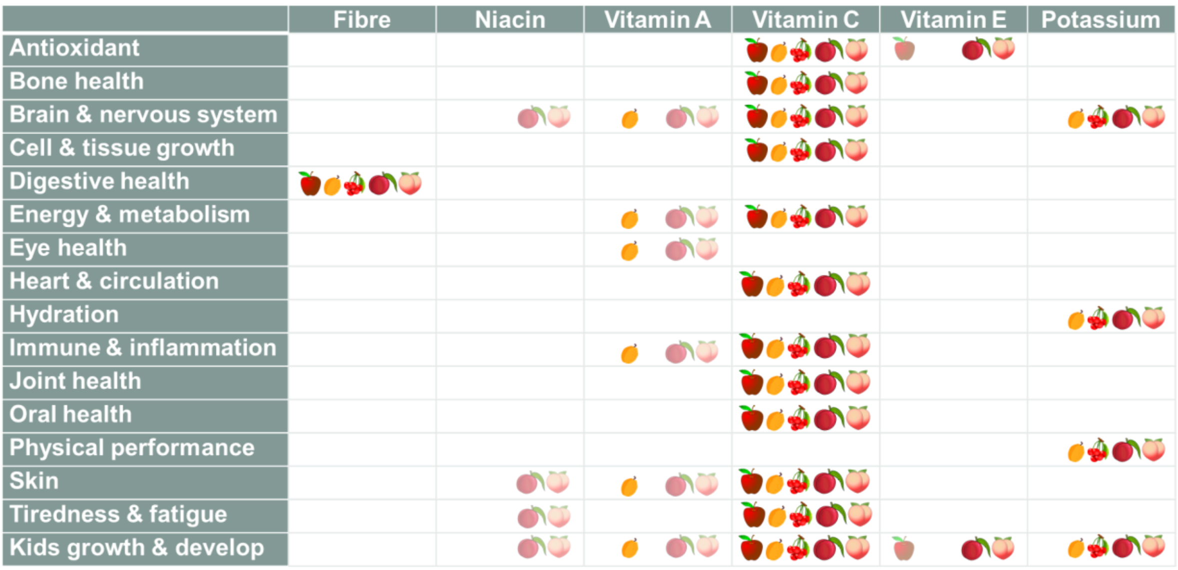
The main class of phytochemicals in all the fruits are the phenolics and the specific composition varies with the fruit type. Carotenoids are also notable in apricots and in yellow-fleshed nectarines and peaches. These phytochemicals may confer a range of health benefits, but health claims cannot currently be made for them.

It is important to note that there are a range of factors influencing the nutrient/phytochemical content of crops:

- Genetics
- Distribution of the nutrients within the fruit (e.g. phytochemicals are highest in the skin)
- Growing conditions (e.g. climate)

- Cultural practices
- Maturity at harvest
- Method of harvesting
- Postharvest storage and treatments
- Consumer use (e.g. cooking)
- Processing (e.g. peeling, heating, concentrating).

Based on Food Standards Australia New Zealand (FSANZ) regulations, there are several pre-approved health claims that could be made on the fruit/fruit products if they meet certain criteria. The Figure below indicates the possible claim areas for each of the fruits based on claimable nutrients. Note that the shaded images indicate where the claims may depend on the variety. Care must be taken with the wording around claims; they must be linked to the nutrient (rather than the fruit as a whole); and they cannot refer to enhancement of function. For example, an immunity claim can say ‘supports a healthy immune system’ but cannot say ‘boosts immunity’. Outside these health areas or in relation to the phytochemicals present in the fruit, claims would need to be self-substantiated and this would require clinical trials so would incur considerable investment. There is plenty of scope to make claims on products using the pre-approved claims.



In developing any products with nutrient content or health claims it is important to consider a number of other factors:

- Consumer purchase decisions
- How claims stack up against those of other products
- Potential to leverage claims through combinations with other ingredients, e.g. synergy of ingredients that may be able to make stronger immunity claims or digestive health.

In conclusion, there are various potential opportunities to make nutrition and health claims for any of the five fruit included in this study. There are some common key nutrients (dietary fibre and vitamin C) but there is variation in other nutrients and hence the potential range of claims that could be made.

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1 Background

This report contributes to the wider project being managed by the Central Otago District Council (CODC) “Understanding fruit loss in Central Otago”. More details on that project can be found here: https://www.codc.govt.nz/services/economic-development/fruit-loss.

CODC kick-started initial discussions on fruit waste in Central Otago through commissioning the report “Understanding Fruit loss in Central Otago,” that quantified on-farm fruit losses in the district. This brought together stakeholders (growers, processors, industry, researchers and food innovators) to identify steps towards reducing fruit loss via commercial activity. A steering group representing key stakeholders has led three key pieces of work:

1. Understanding processing capability and capacity in the region;
2. Evaluating potential commercial products made from fruit by-products; and
3. Validating global demand for fruit value streams.

The project led by Plant & Food Research (PFR) focused on the second workstream, evaluating potential commercial products and was funded through the Bioresource Processing Alliance (BPA), project 2210. This report covers a desktop survey, to draw information from databases, scientific literature and the food regulations. The aim of this part of the project was to gather information on:

- Typical composition of the selected fruits (nutrients and phytochemicals), including distribution and
- Potential health benefits.

Five fruits were included in this study as outlined in Table 1.

Table 1. Details of the fruits included in this study.

Common name	Other common names	Scientific name	Other/previous scientific names
Apple		*Malus domestica*	*Malus pumila; Malus communis; Malus frutescens; Malus paradisiaca; Malus sylvestris; Pyrus malus; Pyrus malus var. paradisiaca; Pyrus dioica*
Apricot		*Prunus armeniaca*	
Cherry	Sweet cherry	*Prunus avium*	
Nectarine		*Prunus persica* var. *nucipersica*	
Peach		*Prunus persica*	*Amygdalus persica*

This report sits alongside the other PFR part of this project: ‘New consumer products made from apples, cherries, apricots, peaches and nectarines’.

2 Fruit composition and nutrient content claims

2.1 Background

2.1.1 Nutrients and phytochemicals

The plant components have been differentiated into nutrients and phytochemicals. These two classes of components differ in a number of ways and these are summarised in Table 2. These differences have resulted in different approaches to collating the data.

Table 2. Summary of key differences between nutrients and phytochemicals.

	Nutrients	Phytochemicals
Human requirement	Essential for the maintenance of life and for growth but may also have additional health benefits	May be beneficial to human health and disease prevention but not regarded as essential for life; huge variation in likely amounts required to deliver benefits
Recognition	Long established	More recent emergence in scientific literature but slowly gaining recognition
Reference intakes	Exist (although amounts needed for some health benefits may differ from recommended daily intakes)	Not yet established
Distribution	More widespread, although some restricted to certain food groups	Some classes can be very restricted to certain families only
Analysis methods	Well established; largely available through commercial laboratories and accredited	More complex and varied; usually not available through commercial laboratories and if are, not accredited methods.

Nutrients are defined as substances that provide nourishment essential for the maintenance of life and for growth. As such, there are distinct requirements for their intake. Phytochemicals can be defined, in the strictest sense, as chemicals produced by plants as secondary metabolites. They are key components contributing to sensory attributes like aroma, taste, and colour. In addition, there is more and more evidence that many phytochemicals improve human health (Liu 2013; Monjotin et al. 2022). While there is ample evidence to support the health benefits of diets rich in fruits, vegetables, legumes, whole grains, and nuts, evidence that these effects are due to specific phytochemicals is limited. Phytochemical concentrations tend to vary a great deal, more even within a plant species than nutrients do, based on plant form and colour. It is likely that the benefits of specific fruit come from the combinations of nutrients and phytochemicals they contain.

New Zealand food composition data were collated from the New Zealand Food Composition Database (NZFCD; New Zealand Food Composition Database 2022). Additional data were gathered from the FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022) and the Australian Food Composition Database (Food Standards Australia New Zealand 2022). The information was mined to provide additional information on the range of typical concentrations reported for the various fruits (e.g. noting where there may be variance based of subtypes, such as colour variants).

The approach taken for the phytochemicals was slightly different in that there is no data in the NZFCD beyond a few carotenoids. Some information is available in the USDA database (the main carotenoids), but further information was sought from sources such as Phenol Explorer (http://phenol-explorer.eu/) and the scientific literature.

2.1.2 Making nutrient content claims

Food Standards Australia New Zealand (FSANZ) regulations dictate what nutrient content claims can be made on foods in New Zealand and Australia. Nutrient content claims are voluntary statements that refer to a relationship between a food and a component. A nutrient content claim states how much of a nutrient or substance is in a food. Examples might be, 'a good source of vitamin C' or 'gluten-free'. There are three particularly important schedules under the Australia New Zealand Food Standards Code:

- Schedule 1 — RDIs and ESADDIs (Food Standards Australia New Zealand 2018)
- Schedule 4 — Nutrition, health and related claims (Food Standards Australia New Zealand 2017a)
- Schedule 12 — Nutrition information panels (Food Standards Australia New Zealand 2017b).

To determine the significance of nutrients it is important that nutrients are expressed on a percent daily intake (DI), recommended dietary intake (RDI) or Estimated Safe and Adequate Daily Dietary Intakes (ESADDI) per serve basis. The FSANZ labelling DI/RDI/ESADDI values are outlined in Tables 3–5. Vitamins and minerals, with the exception of potassium, can be claimed as a source at 10% RDI/ESADDI and a good source at 25% RDI/ESADDI per serve (as specified by Food Standards Australia New Zealand 2018).

Table 3. Daily intakes for core nutrients for food labelling purposes as specified in Food Standards Australia New Zealand (FSANZ) Standard 1.2.8 (Food Standards Australia New Zealand 2021a).

Food component	Units	Reference value
Energy	kJ	8700
Protein	g	50
Fat	g	70
Saturated fatty acids	g	24
Carbohydrate	g	310
Sodium	mg	2300
Sugars	g	90
Dietary fibre	g	30

Table 4. Vitamin and mineral daily requirements as specified in Schedule 1 of the Food Standards Code (Food Standards Australia New Zealand 2018) and source/good source thresholds as specified in Schedule 4 (Food Standards Australia New Zealand 2017).

Nutrient	Units	Adult requirement	RDI or ESADDI	Source	Good source
Vitamins					
Biotin (B5)	μg	30	ESADDI	≥3	≥7.5
Folate (B9)	μg	200	RDI	≥20	≥50
Niacin (B3)	mg	10	RDI	≥1	≥2.5
Pantothenic acid	mg	5	ESADDI	≥0.5	≥1.25
Riboflavin (B2)	mg	1.7	RDI	≥0.17	≥0.43
Thiamin (B1)	mg	1.1	RDI	≥0.11	≥0.28
Vitamin A	μg	750	RDI	≥75	≥188
Vitamin B6	mg	1.6	RDI	≥0.16	≥0.4
Vitamin B12	μg	2	RDI	≥0.2	≥0.5
Vitamin C	mg	40	RDI	≥4	≥10
Vitamin D	μg	10	RDI	≥1	≥2.5
Vitamin E	mg	10	RDI	≥1	≥2.5
Vitamin K	μg	80	ESADDI	≥8	≥20
Minerals					
Calcium	mg	800	RDI	≥80	≥200
Chromium	μg	200	ESADDI	≥20	≥50
Copper	mg	3	ESADDI	≥0.3	≥0.75
Iodine	μg	150	RDI	≥15	≥37.5
Iron	mg	12	RDI	≥1.2	≥3
Magnesium	mg	320	RDI	≥32	≥80
Manganese	mg	5	ESADDI	≥0.5	≥1.25
Molybdenum	μg	250	ESADDI	≥25	≥62.5
Phosphorus	mg	1000	RDI	≥100	≥250
Selenium	μg	70	RDI	≥7	≥17.5
Zinc	mg	12	RDI	≥1.2	≥3

Abbreviations: ESADDI = Estimated Safe and Adequate Daily Dietary Intake; RDI = recommended dietary intake.

Table 5. Claimable concentrations for other nutrients as specified in Schedule 4 of the Food Standards Code (Food Standards Australia New Zealand 2017).

Nutrient	Claimable amount	Source	Good source
Cholesterol (low)	<20 mg/100 g		
Energy (for contributing energy for normal metabolism)	≥420 kJ/serve		
Fat (low)	≤3 g/100 g		
Monounsaturated fatty acids (MUFA)		≥40% MUFA and <28% saturated and trans fatty acids	
Omega-3 fatty acids[a]		≥200 mg ALA acid/serve or >30 mg total EPA and DHA/serve	>60 mg total EPA and DHA/serve (the food may contain less than 200 mg ALA/serve)
Omega-6 fatty acids		≥40% omega-6 and <28% saturated and trans fatty acids	
Omega-9 fatty acids		≥40% omega-9 and <28% saturated and trans fatty acids	
Polyunsaturated fatty acids (PUFA)		≥40% PUFA and <28% saturated and trans fatty acids	
Protein	≥5 g per serve	5 g/serve	10 g/serve
Potassium[b]	≥200 mg per serve		
Saturated and trans fatty acids (low)	<1.5 g/100 g		
Sodium/salt (low)	≤120 mg per 100 g		

[a] Must also have as a proportion of the total fatty acid content, <28% saturated fatty acids and trans fatty acids; or <5 g saturated fatty acids and trans fatty acids/100 g.
[b] There is just a single threshold for potassium so can just say contains/source and not good source.
Abbreviations: ALA = alpha-linolenic acid; DHA = docosahexaenoic acid; EPA = eicosapentaenoic acid.

It is important to note that in other countries the regulations may differ. There can be differences in DI/RDI/ESADDI values, the thresholds at which claims can be made and serving sizes (FSANZ does not prescribe serving sizes; beyond that they must be reasonable but some countries such as the USA prescribe set weights).

2.2 Nutrient composition

2.2.1 Apples

The key nutrients of dietary significance in commercial apple varieties are dietary fibre and vitamin C. In some varieties vitamin E is also claimable. For more detailed information on the nutrient composition of apples (New Zealand grown combined varieties) see Appendix 1. It is important to note that in some cases there is considerable variation in the nutrients across the selected databases and the different varieties within each database (Table 6).

Table 6. Variation in the key nutrients in apples across different varieties. Data from New Zealand (New Zealand Food Composition Database 2022), Australia (Food Standards Australia New Zealand 2022) and USA (U.S. Department of Agriculture, Agricultural Research Service 2022).

		New Zealand			Australia			USA		
	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max
Dietary fibre	g/100 g	2.5	1.9	2.7	2.5	2.1	3.2	2.4	1.4	3.5
Vitamin C	mg/100 g	7	3	18	5	2	9	5	4	6
Vitamin E	mg/100 g	0.36	0.16	1.07	0.35	0.00	1.30	0.18	0.08	0.38

2.2.2 Apricots

The key nutrients of dietary significance in commercial apricot varieties are dietary fibre, vitamin A (from provitamin A carotenoids), vitamin C and potassium. In some varieties vitamin E is also claimable. For more detailed information on the nutrient composition of apricots see Appendix 2. As with apples it is important to note that there is some significant variation in the nutrients across the different databases (Table 7). Vitamin A varies multiple fold and will relate to fruit colour (the orange carotenoids are what contributes to vitamin A activity).

Table 7. Variation in the key nutrients in apricots across different varieties. Data from New Zealand (New Zealand Food Composition Database 2022), Australia (Food Standards Australia New Zealand 2022) and USA (U.S. Department of Agriculture, Agricultural Research Service 2022).

		New Zealand			Australia			USA		
	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max
Dietary fibre	g/100 g	2.0	1.9	2.2	1.5	-	-	2.0	1.5	2.5
Vitamin A[a]	µg/100 g	536	286	863	385	-	-	96	52	158
Vitamin C	mg/100 g	7	4	11	3	-	-	10	-	-
Vitamin E	mg/100 g	1.18	0.81	1.50	0.80	-	-	0.89	-	-
Potassium	mg/100 g	241	210	270	290	-	-	259	214	322

[a] The vitamin A is derived from carotenoids with provitamin A activity.

2.2.3 Cherries

The key nutrients of dietary significance in commercial sweet cherry varieties are dietary fibre, vitamin C and potassium. For more detailed information on the nutrient composition of New Zealand cherries see Appendix 3. As with the other fruit it is important to note that there is some variation in the nutrients across the different databases and even within databases due to the different varieties analysed (Table 8).

Table 8. Variation in the key nutrients in cherries across different varieties. Data from New Zealand (New Zealand Food Composition Database 2022), Australia (Food Standards Australia New Zealand 2022) and USA (U.S. Department of Agriculture, Agricultural Research Service 2022).

		New Zealand			Australia			USA		
	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max
Dietary fibre	g/100 g	1.6	1.2	2.3	1.5	-	-	2.1	1.7	2.4
Vitamin C	mg/100 g	4	15	27	19	-	-	7	5	10
Potassium	mg/100 g	230	180	264	230	-	-	222	129	267

2.2.4 Nectarines

The key nutrients of dietary significance in commercial nectarine varieties are dietary fibre, vitamin C, vitamin E and potassium. In some varieties niacin and/or vitamin A (provitamin A carotenoids in yellow-fleshed fruit) are also claimable. For more detailed information on the nutrient composition of New Zealand nectarines, see Appendix 4. As with apples it is important to note that there is some significant variation in the nutrients across the different databases (Table 9). As with apricots there are significant differences in vitamin A presumably due to variation in fruit colour (can be while to yellow).

Table 9. Variation in the key nutrients in nectarines across different varieties. Data from New Zealand (New Zealand Food Composition Database 2022), Australia (Food Standards Australia New Zealand 2022) and USA (U.S. Department of Agriculture, Agricultural Research Service 2022).

		New Zealand			Australia			USA		
	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max
Dietary fibre	g/100 g	1.6	-	-	1.6	-	-	1.7	1.1	2.2
Niacin	mg/100 g	0.52	-	-	0	-	-	1.12	0.81	1.39
Vitamin A[a]	µg/100 g	60	-	-	8	-	-	332	-	-
Vitamin C	mg/100 g	4	-	-	1	-	-	5.4	-	-
Vitamin E	mg/100 g	1.86	-	-	0.8	-	-	0.77	0.43	1.02
Potassium	mg/100 g	210	-	-	240	-	-	201	149	228

[a] The vitamin A is derived from carotenoids with provitamin A activity.

2.2.5 Peaches

The key nutrients of dietary significance in commercial peach varieties are dietary fibre, vitamin C, vitamin E and potassium. In some varieties niacin and/or vitamin A (provitamin A carotenoids in yellow fleshed fruit) are also claimable. For more detailed information on the nutrient composition of New Zealand peaches, see Appendix 5. As with apples it is important to note that there is some significant variation in the nutrients across the different databases (Table 10).

Table 10. Variation in the key nutrients in nectarines across different varieties. Data from New Zealand (New Zealand Food Composition Database 2022), Australia (Food Standards Australia New Zealand 2022) and USA (U.S. Department of Agriculture, Agricultural Research Service 2022).

		New Zealand			Australia			USA		
	Units	Average	Min	Max	Average	Min	Max	Average	Min	Max
Dietary fibre	g/100 g	1.8	1.7	1.9	1.6	-	-	1.5	1.1	1.8
Niacin	mg/100 g	0.80	0.70	1.10	0	-	-	0.81	0.68	1.0
Vitamin A	µg/100 g	69	19	103	81	-	-	16	7	29
Vitamin C	mg/100 g	9	6	13	2	-	-	7	-	-
Vitamin E	mg/100 g	1.18	0.79	1.50	0.7	-	-	0.73	0.32	1.01
Potassium	mg/100 g	213	190	230	210	-	-	190	138	238

[a] The vitamin A is derived from carotenoids with provitamin A activity.

2.3 Fruit phytochemical composition

There is a diversity of different phytochemicals with the main classes being carotenoids, phenolics (including flavonoids), indoles, glucosinolates, organosulfur compounds, phytosterols, triterpenoids and saponins (Fraga et al. 2019; Liu 2013; Monjotin et al. 2022). These classes differ significantly in their chemical structures (Figure 1) and properties. Carotenoids and selected phenolics are classes commonly present in significant amounts in fruits and in particular the fruits in this study.

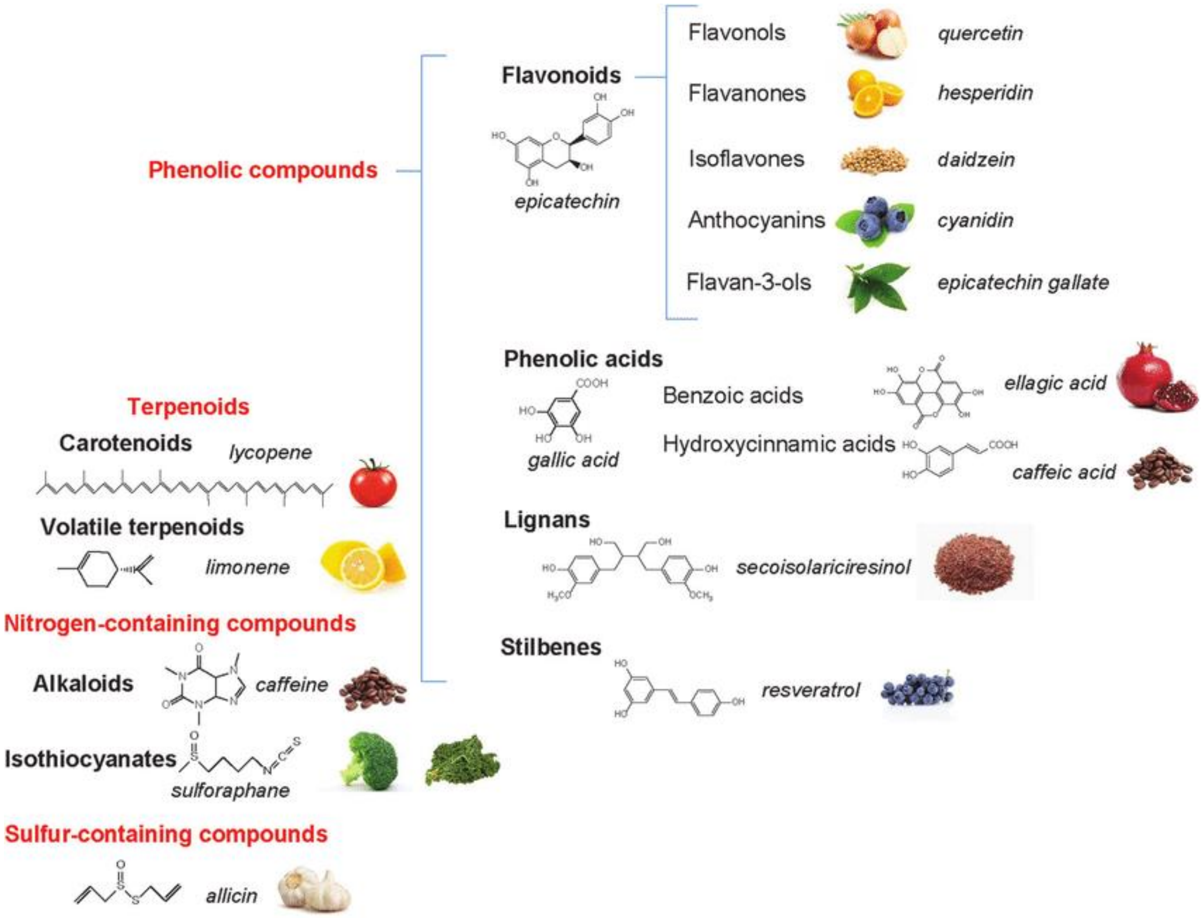


Figure 1. Structure of some of the common phytochemicals. Reproduced from Fraga et al. 2019 under Creative Commons Attribution-NonCommercial 3.0 Unported Licence (The effects of polyphenols and other bioactives on human health - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Structure-of-common-phytochemicals_fig1_331040814 [accessed 9 December 2022]).

Pome fruit (e.g. apple) and drupes (which include apricots, cherries, nectarines and peaches) have some commonalities in their phenolic profiles containing phenolic acids such as chlorogenic acids, anthocyanins, flavonols, catechins and proanthocyanidins. The specific compounds in the specific fruits do vary as do their proportions and concentrations. Total phenolics concentrations in the fruit included in this study are provided in Table 11. Some other fruit do have much higher concentrations, especially berry fruit (elderberry, black raspberry blueberry, blackcurrant) where concentrations can reach 500–2000 mg per 100 g fresh weight (http://phenol-explorer.eu/; Neveu et al. 2010).

Table 11. Total phenolic content of the fruits in this study. Data as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Apples	201	66	430	105	171
Apricots	133	133	133	0	1
Cherries	175	75	339	77	23
Nectarines	55	29	80	12	25
Peaches	279	23	300	196	13

2.3.1 Apples

There is a large diversity of phytochemicals present in apples including a range of different phenolic compounds, triterpenoids, and organic acids (Nezbedova et al. 2021). Data on the specific carotenoid and phenolic content of apples are provided in Appendix 6, although unlike some of the other fruit in this study carotenoids are low. There are several key classes of phenolic classes present in apples:

- Phenolic acids, e.g. chlorogenic acid (caffeoylquinic acid)
- Monomeric flavan-3-ols, e.g. catechin and epicatechin
- Proanthocyanidins, e.g. procyanidin B2
- Flavonols, e.g. quercetin glycosides, particularly the 3-galactoside
- Dihydrochalcones, e.g. phloridzin and phloretin 2'-O-xylosyl-glucoside
- Anthocyanins, e.g. cyanidin 3-galactoside.

Most studies have shown that there is a similar pattern of phenolic classes for most apple cultivars, although there are some differences in absolute quantities and proportions. Cider apples differ from dessert apples by their relatively high content of procyanidins responsible for their astringency and bitterness (Guyot et al. 2003).

The distribution of the flavonoids within the apple varies with many of the phytonutrients present at higher concentrations in the skin compared to the flesh (Nezbedova et al. 2021). In general, the apple peel contains about 2–4 times higher concentration of phenolic compounds, and higher concentration of total procyanidins and total flavonoids, compared to flesh (Lata 2007). The distribution between the skin and the flesh also varies according to the class of phenolic. Flavonols and anthocyanins are mainly present in the skin (Price et al. 1999). The other classes are present in both the flesh and skin of the fruit but chlorogenic acid is higher in the flesh (Awad et al. 2000). Phloridzin is particularly abundant in the seeds (Ehrenkranz et al. 2005).

Processing can have various impacts on the phenolic content and composition. Apple polyphenols are not all recovered in juice with most of the polyphenols are retained in the pomace (Price et al. 1999). Clarification treatments used in juice manufacture significantly differ in their effects on the phenolic composition of final apple juice, and the extent of polyphenol loss (Gliszczynska-Swiglo & Tyrakowska 2003). Because phenolics are much higher in the peel, if the peel is not used in products, the concentrations of phenolics will be lower but if there is a waste stream of apple peels it will be high in phenolics.

Triterpenoids are another group of phytochemicals present in apple peels. The main triterpenoid is ursolic acid but others present included oleanolic and betulinic acids (Nezbedova et al. 2021). Ursolic acid has been shown to be present in apple pomace, the main by-product obtained during the production of apple juice (Cargnin & Gnoatto 2017).

2.3.2 Apricots

Apricots are high in carotenoids and contain a range of phenolics. Data on the specific carotenoid and phenolic content of apricots are provided in Appendix 7. The predominant carotenoid is beta-carotene (which has provitamin A activity) but other carotenoids have also been reported including alpha and gamma-carotene, lycopene, beta-cryptoxanthin, phytoene, phytofluene and lutein (Kafkaletou et al. 2019). The carotenoid and phenolic concentrations vary significantly between varieties (Alajil et al. 2021). Apricots contain several key classes of phenolics:

- Phenolic acids, e.g. chlorogenic acid (caffeoylquinic acid)
- Monomeric flavan-3-ols, e.g. catechin and epicatechin
- Proanthocyanidins, e.g. procyanidin B1, B3, B7
- Flavonols, e.g. quercetin 3-rutinoside (rutin), kaempferol 3-rutinoside.

The main phenolic acid in apricots is chlorogenic acid but gallic, ferulic, caffeic, 4-aminobenzoic, procatechin, salicylic, and p-coumaric acids have also been reported (Sochor et al. 2010). Some other flavonoids including protocatechuic acid, naringenin 7-O-glucoside (prunin) and quercetin 3-O-glucoside have been identified but not quantified (Radi et al. 2004).

It has been noted that processed and unprocessed apricots share similar qualitative profiles of phenolics but lower quantities are found in processed products (http://phenol-explorer.eu/; Neveu et al. 2010).

In addition to carotenoids and phenolics, mono- and polysaccharides as well as organic acids are also present (Tomás-Barberán et al. 2013). In a recent study the key organic acids were citric and malic with concentrations varying from 1.0 to 2.9 g per 100 g fresh weight (Kafkaletou et al. 2019). Apricot kernels also contain a wide range of bioactives including fatty acids and phytosterols (Tomás-Barberán et al. 2013), although caution must be taken due to the presence of amygdalin.

2.3.3 Cherries

Data on the specific carotenoid and phenolic content of cherries are provided in Appendix 8, but, like apples, the carotenoids are low. There are several key classes of phenolic classes present in cherries:

- Anthocyanins, e.g. cyanidin-3-0-rutinoside
- Monomeric flavan-3-ols, e.g. epicatechin
- Proanthocyanidins, e.g. B2, B7, C1
- Phenolic acids, e.g. chlorogenic.

The anthocyanin content of cherries can vary significantly and is related to fruit colour – the deeper red/purple the colour, the higher the anthocyanins. During cherry maturation, total hydroxycinnamic acid content decrease while total anthocyanin content increase (Mozetic et al. 2004). During storage anthocyanins are degraded but can be stabilised by freezing (Esti et al. 2002).

There has been some talk of the presence of melatonin in sweet cherry. Sour/tart cherries, in particular the Montmorency variety, have been reported to contain high concentrations of tryptophan, serotonin and melatonin and thus have been linked to improving sleep quality (Howatson et al. 2012; Pereira et al. 2020). Montmorency tart cherries contains contain about 1.3 µg or melatonin per 100 g, although the Balaton only had 0.2 µg/100 g (Burkhardt et al. 2001). Other studies have not detected melatonin in mature sweet cherries or reported very low concentrations (e.g. the highest variety reported by only had 22 ng per 100 g fresh weight; González-Gómez et al. 2009). It may be because melatonin although present in immature fruit decreases steadily with maturation (Xia et al. 2020).

2.3.4 Nectarines

Details of the carotenoid and phenolic composition of nectarines are provided in Appendix 9. The carotenoids present in nectarines include beta-carotene, beta-cryptoxanthin and lutein. Naturally white-fleshed nectarines have much lower carotenoids than yellow-fleshed nectarines (Gil et al. 2002). With regards the phenolics these include:

- Anthocyanins, e.g. malvidin 3,5-diglucoside (very low concentrations)
- Monomeric flavan-3-ols, e.g. catechin
- Proanthocyanidins, e.g. B1
- Flavonols, e.g. quercetin 3-glucoside
- Phenolic acids, e.g. chlorogenic acid.

Nectarines and peaches have a similar profile of phenolic compounds (Tomás-Barberán et al. 2001). The small amounts of anthocyanins are present in the skin and sometimes around the stone.

Major organic acids in nectarines were reported to be malic, succinic, citric and acetic acid (Jayarajan et al. 2019). Total organic acids 3.3 to 4.6 g per 100 g fresh weight (Jayarajan et al. 2019).

2.3.5 Peaches

Details of the carotenoid and phenolic composition of peaches are provided in Appendix 10. The carotenoids present in nectarines include beta-carotene, beta-cryptoxanthin and lutein/zeaxanthin and violaxathin has also been reported (Dabbou et al. 2016). As noted above, peaches possess similar qualitative and quantitative phenolic profiles to nectarines (Tomás-Barberán et al. 2001). The phenolics in peaches include:

- Anthocyanins, e.g. cyanidin 3-glucoside (very low concentrations)
- Monomeric flavan-3-ols, e.g. catechin
- Proanthocyanidins, e.g. B1
- Flavonols, e.g. quercetin 3-glucoside and 3-rutinoside
- Phenolic acids, e.g. chlorogenic acid.

2.4 Understanding the nutrients and phytochemicals

Appendix 11 provides some more background information on the nutrients and phytochemicals of significance in the fruit crops included in this report. This appendix includes a description of key compounds/classes of compound (dietary fibre, niacin, vitamin A, vitamin C, vitamin E, potassium, carotenoids, beta-carotene, beta-cryptoxanthin, triterpenoids, flavonols, anthocyanins, flavan-3-ols, proanthocyanidins and phenolic acids) and provides more details on:

- Dietary sources
- Dietary requirement per day
- Solubility (water/fat)
- Stability
- Bioavailability
- Safety
- Supplements (including vs food sources)
- Overarching health benefits.

It is important to note that there are a range of factors influencing the nutrient/phytochemical content of crops: genetics, growing conditions (e.g. climate), cultural practices, maturity at harvest, method of harvesting, postharvest storage and treatments and consumer use (e.g. cooking). Some of the factors that may have an impact include:

- Temperature and light intensity, greatly affect the nutritional quality of fruits
- Soil type, the rootstock used for fruit tree cultivation, mulching, irrigation, and fertilisation influence the water and nutrient supply to the plant, which can in turn affect the nutritional quality of the harvested plant part
- The method of harvesting (hand versus mechanical) can significantly affect the composition and postharvest quality of fruits
- Rainfall affects water supply to the plant, which may influence the composition of the harvested plant part and its susceptibility to mechanical damage and decay during subsequent harvesting and handling operations
- The effects of mineral and elemental uptake from fertilisers by plants are significant and variable
- Cultural practices such as pruning and thinning determine the crop load and fruit size, which can in turn influence the nutritional composition of fruits
- Distribution of the nutrient within the fruit. In many cases the skin is higher in some nutrients and phytochemicals and thus peeling can reduce their concentrations. Data from the NZFCD (New Zealand Food Composition Database 2022) shows peeling an apple reduces the dietary fibre (2.0 down to 1.4 g per 100 g) and vitamin C (5 down to 3 mg per 100 g).

2.5 Potential toxins

It is important to note that the seeds/kernels of all the fruit in this study may contain amygdalin. Amygdalin is classified as a cyanogenic glycoside and when digested it gets broken down, producing hydrogen cyanide. This is unlikely to present any issues as amounts are low but caution should be taken if any products are to be developed where the seeds/stones/kernels may be crushed.

3 Health claims

As with nutrient content claims, FSANZ regulations dictate what health claims can be made on foods in New Zealand and Australia (Figure 2). Of particular importance is Schedule 4 — Nutrition, health and related claims (Food Standards Australia New Zealand 2017a). Health claims are voluntary statements that refer to a relationship between a food and a health benefit. In New Zealand/Australia, health claims are classified into general level health claims and high-level health claims (in overseas markets these may vary slightly but in general similar principles apply). The Ministry for Primary Industries (MPI) provides the following definitions:

- A general level health claim links a food product to a health effect that relates to general health and wellbeing. An example might be ‘Calcium is good for strong bones’
- A high-level health claim identifies products that can protect against a serious disease or a risk factor for a serious disease. An example might be ‘Diets high in calcium and vitamin D may reduce the risk of osteoporosis’. Note therapeutic claims referring to treatment of a disease cannot be made.

Foods must meet certain nutrition requirements to carry a health claim. There is a step-up approach and there are two ways to make a general level health claim: either make a claim based on a pre-approved food-health relationship or self-substantiate a claim by providing scientific evidence (Figure 3). For high-level health claims only, pre-approved claims can be used.

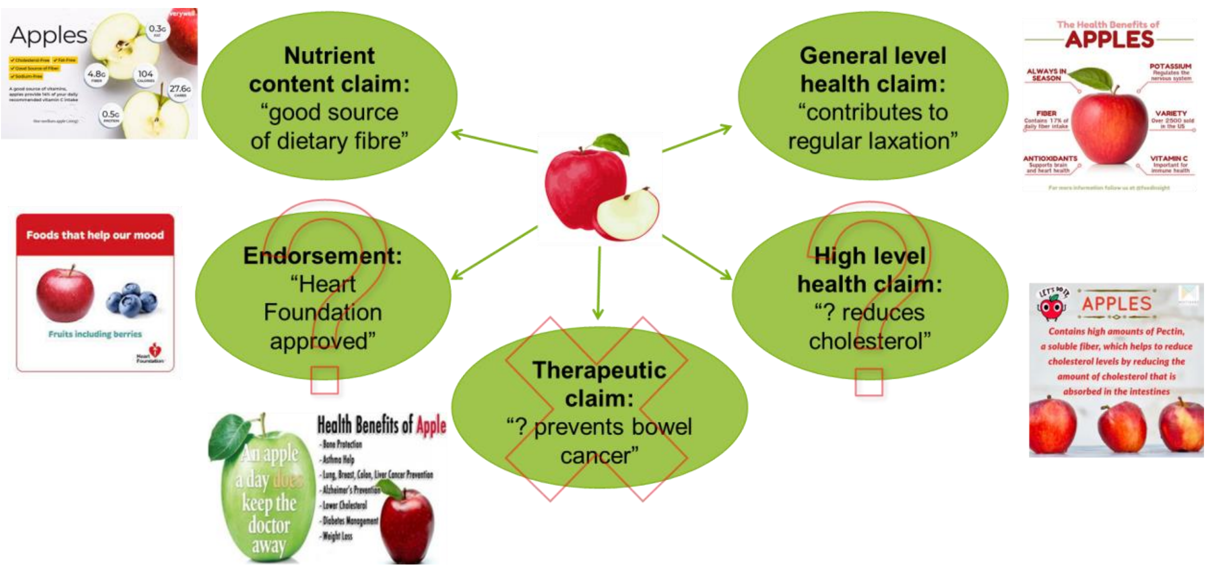


Figure 2. Outline of the types of claims that are permitted or not under Food Standards Australia New Zealand (FSANZ) regulations (https://www.foodstandards.gov.au/consumer/labelling/nutrition/Pages/default.aspx).

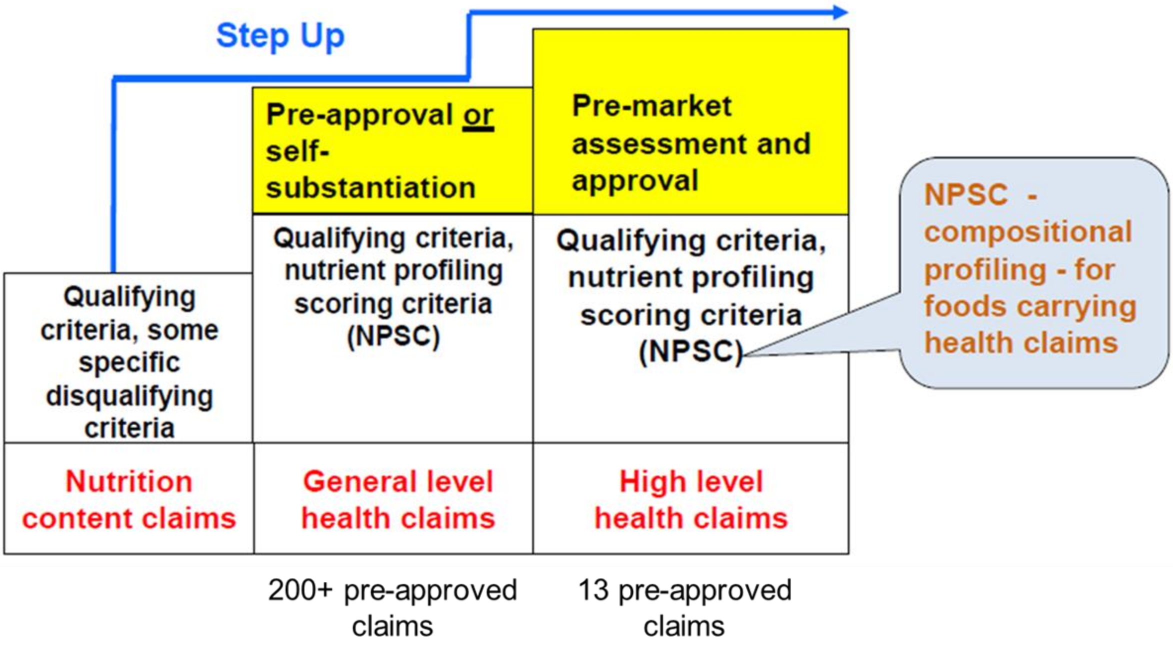


Figure 3. The step-up approach to making claims under Food Standards Australia New Zealand (FSANZ) regulations.

To use pre-approved health claims, foods must also meet the Nutrient Profiling Scoring Criterion (NPSC). The NPSC is a nutrient profiling system used to determine whether a food is suitable to make a health claim, based on its nutrient profile. Further details on the NPSC can be found in 'Short guide for industry to the Nutrient Profiling Scoring Criterion' (Food Standards Australia New Zealand 2016). The NPSC considers the energy, saturated fat, sodium and sugars content of the food, along with certain ingredients such as fruit and vegetables and, in some instances, dietary fibre and protein. Points are allocated based on 100 g or 100 mL of the food (based on the units used in the nutrition information panel, NIP). The profiling score can be calculated using FSANZ's Nutrient Profiling Scoring Calculator (Food Standards Australia New Zealand 2021b). For whole fresh fruit there are no issues meeting the NPSC but if processed products are to be developed, this will be something important to consider.

In other countries there can be differences in the types of health claims and the process for using/applying to add them. MPI has produced a document that outlines some of the regulations in different countries (https://www.mpi.govt.nz/dmsdocument/9307-2015-16-global-regulatory-environment-of-health-claims-on-foods).

3.1 Potential pre-approved health claims for the fruit

FSANZ provides a list of pre-approved health claims (Food Standards Australia New Zealand 2018a). The nutrients identified as of relevance for the fruits in this study are:

- Dietary fibre
- Niacin
- Vitamin A

- Vitamin C
- Vitamin E
- Potassium.

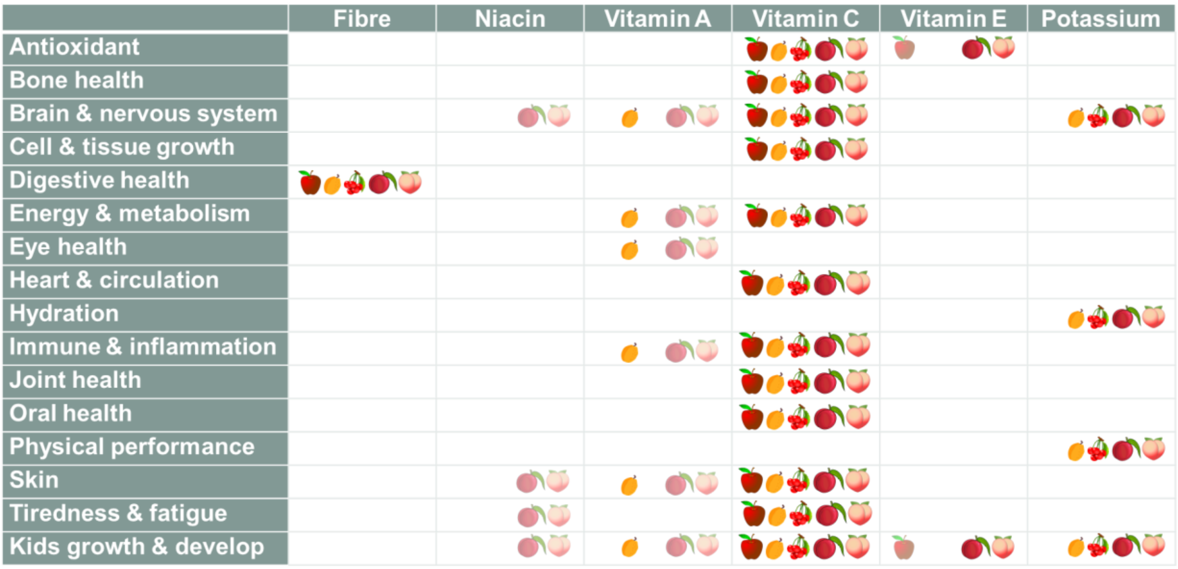
For purposes of this project these have been mapped to general wellness areas (Table 12). If a nutrient reaches the claimable concentration (e.g. 10% RDI for vitamins and minerals or 200 mg for potassium, and 2 g of dietary fibre), these health claims can be applied. Each fruit will have a range of health claims as outlined in Table 13. Ideally the best options are those were there is more than one nutrient providing the same health effect. Care must be taken with the wording around claims – they must be linked to the nutrient (rather than the fruit as a whole) and they cannot refer to enhancement of function. For example, an immunity claim can say 'supports a healthy immune system' but cannot say 'boosts immunity'.

Table 12. Potential Food Standards Australia New Zealand (FSANZ) pre-approved health claims and mapping to more general wellness areas for the key nutrients in the selected fruits in this study.

Nutrient	Health claim	Wellness area
Dietary fibre	Contributes to regular laxation	Digestive health
Niacin	Necessary for normal neurological function	Brain and nervous system
	Necessary for normal energy release from food	Energy & metabolism
	Necessary for normal structure and function of skin and mucous membranes	Skin
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal psychological function	Brain and nervous system
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Vitamin A	Necessary for normal vision	Eye health
	Necessary for normal skin and mucous membrane structure and function	Skin
	Necessary for normal cell differentiation	Cell & tissue growth
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal iron metabolism	Energy & metabolism
	Contributes to normal immune system function	Immune function & inflammation
Vitamin C	Contributes to iron absorption from food	Energy & metabolism
	Necessary for normal connective tissue structure and function	Joint health; Cell & tissue growth; Bone health
	Necessary for normal blood vessel structure and function	Heart & circulation
	Contributes to cell protection from free radical damage	Prevention oxidative damage (antioxidant)
	Necessary for normal neurological function	Brain and nervous system
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal collagen formation for the normal structure of cartilage	Joint health
	Contributes to normal collagen formation for the normal structure of bones	Bone health
	Contributes to normal collagen formation for the normal function of teeth	Oral health

Nutrient	Health claim	Wellness area
	Contributes to normal collagen formation for the normal function of gums	Oral health
	Contributes to normal collagen formation for the normal function of skin	Skin
	Contributes to normal energy metabolism	Energy & metabolism
	Contributes to normal psychological function	Brain and nervous system
	Contributes to the normal immune system function	Immune function & inflammation
	Contributes to the reduction of tiredness and fatigue	Tiredness & fatigue
Vitamin E	Contributes to cell protection from free radical damage	Prevention oxidative damage (antioxidant)
	Contributes to normal growth and development in children	Growth & development in children
Potassium	Necessary for normal water and electrolyte balance	Hydration
	Contributes to normal growth and development in children	Growth & development in children
	Contributes to normal functioning of the nervous system	Brain and nervous system
	Contributes to normal muscle function	Physical performance

Table 13. The potential health claim areas that could be used for the fruit included in this study. The lighter fruit indicate where the nutrients may only be claimable for certain varieties.



3.2 Additional health benefits

In addition to claims linked to specific nutrients in the fruit there have been scientific studies exploring the health benefits of the fruits themselves and the phytochemicals present. It is important to note that any of these claims specifically related to the fruit (as opposed to related to the nutrients present as discussed above) would need to be self-substantiated and this would require clinical trials so would incur considerable investment.

3.2.1 Apples

Of the fruit included in this study apples have had the most investigation with regards human health including many human clinical trials. There have been several recent reviews covering the health benefits of apples (da Silva et al. 2021; Gayer et al. 2019; Kim et al. 2022; Oyenihi et al. 2022; Yuste et al. 2022). In addition, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) reviewed the literature and concluded the largest body of evidence for apples from human intervention studies was a reduction in cardiovascular disease risk (James-Martin et al. 2016). From all the studies the potential areas where apples may have health benefits include:

- Heart health
- Weight management
- Digestive health
- Bone health
- Brain and nervous system
- Immune function and inflammation
- Joint health
- Prevention oxidative damage (antioxidant)
- Allergies
- Blood sugar management (diabetes)
- Lung health
- Metabolic syndrome
- Reducing cancer risk.

Some of these health areas do align with the pre-approved claims that can be made for the key nutrients in apples.

3.2.2 Apricots

For apricots there have been no specific human clinical intervention trials. However, there have been in vitro and animal studies that have been covered in several reviews (Al-Soufi et al. 2022; Fratianni et al. 2018; Sartaj et al. 2015; Tomás-Barberán et al. 2013). The health benefits reported for apricots in the scientific literature include:

- Heart health
- Brain health (Alzheimer’s disease)
- Antioxidant
- Anti-inflammatory
- Antidiabetic
- Hepatoprotective
- Oral health

- Antimicrobial
- Antiviral
- Anticancer.

Some of these health areas do align with the pre-approved claims that can be made for the key nutrients in apricots.

3.2.3 Cherries

There have been some human studies with cherries, although there have been more with tart cherries than sweet cherries. There have also been numerous in vitro and animal studies. The health benefits of cherries have been reviewed by several research groups (Blando & Oomah 2019; Goncalves et al. 2019; Hussain et al. 2021; Kelley et al. 2018; McCune et al. 2011; Nunes et al 2021; Tomás-Barberán et al. 2013). The potential health benefits reported in the literature include:

- Cardiovascular benefits
- Antidiabetic
- Reduction in impacts of inflammatory diseases (arthritis, gout)
- Brain health/neuroprotective (Alzheimer's disease)
- Antioxidant
- Antiaging
- Anticancer.

Some of these health areas do align with the pre-approved claims that can be made for the key nutrients in cherries.

3.2.4 Nectarines

For nectarines there have been no specific human clinical trials. However, there have been in vitro and animal studies that have been summarised by Byrne et al. (2009) and Tomás-Barberán et al. (2013). The health benefits reported for nectarines in the scientific literature are quite limited but include:

- Antioxidant
- Anti-inflammatory
- Antiaging/longevity
- Anticancer.

It may be that there are other health benefits but there has been less study than other more common fruit. However, they do have a lower phenolic content and hence there may be less beneficial effects on health.

3.2.5 Peaches

As with nectarines, there have been no specific human clinical trials with peaches but in vitro and animal studies have been summarised by Bento et al. (2020) and Tomás-Barberán et al. (2013). The health benefits reported for peaches in the scientific literature include:

- Antioxidant
- Antimicrobial
- Anti-inflammatory
- Antiparasitic
- Antidiabetic
- Reducing neurodegeneration
- Heart health
- Anticancer.

Some of these health areas do align with the pre-approved claims that can be made for the key nutrients in peaches. Because they have been less studied than some other fruit there may be other health benefits as well.

3.3 Considerations for health benefit marketing

In developing any products with nutrient content or health claims it is important to consider a number of other factors. For example:

- How do health claims stack up against other products? For example, berries (e.g. blackcurrants) are higher in anthocyanins than cherries
- The trade off with other consumer purchase considerations:
    - price
    - flavour
    - appearance, e.g. colour
    - convenience
    - environmental footprint.
- Health claims are likely to be more successful when consumers understand/believe them and can “feel the benefit”
- Health halos – some fruit carry a perceived health halo that may not be linked to nutrient content claims and these can be leveraged off.

There is also the potential to leverage claims through combinations with other ingredients, e.g. synergy of ingredients that may be able to make stronger immunity claims or digestive health.

4 Impacts of processing on claims

A key consideration when developing products is the impact of processing on claims. Some considerations have already been discussed including the differences in distribution of the nutrients and phytochemicals within the fruit. Different nutrients and phytochemicals also differ in their sensitivity to heat and light and some of these are mentioned in the summaries included in Appendix 11.

Figure 4 provides some examples of what can happen during processing:

- Juicing: This will remove dietary fibre (which is left behind in the pomace) and vitamin C will be degraded but can be added back
- Pureeing: This process will retain dietary fibre but like juicing vitamin C is usually degraded but again can be added back
- Formulation:
    - Addition of sugar or fat to products although it may not impact on the claimable nutrients, it could limit whether the pre-approved claims can be made as these could adversely affect the Nutrient Profiling Scoring Criteria (see section 3). Careful formulation can still enable claims though. For example, sweetening with addition of apple puree to score plus points may enable claims still to be made.
    - Addition of other ingredients that have desirable nutritional profiles and contain key nutrients may strengthen a health claim, e.g. blending of apples, blackcurrants and oats will achieve higher dietary fibre and vitamin C contents.

Further information on product development and the processes involved is provided in the report by Massarotto et al. (2022).

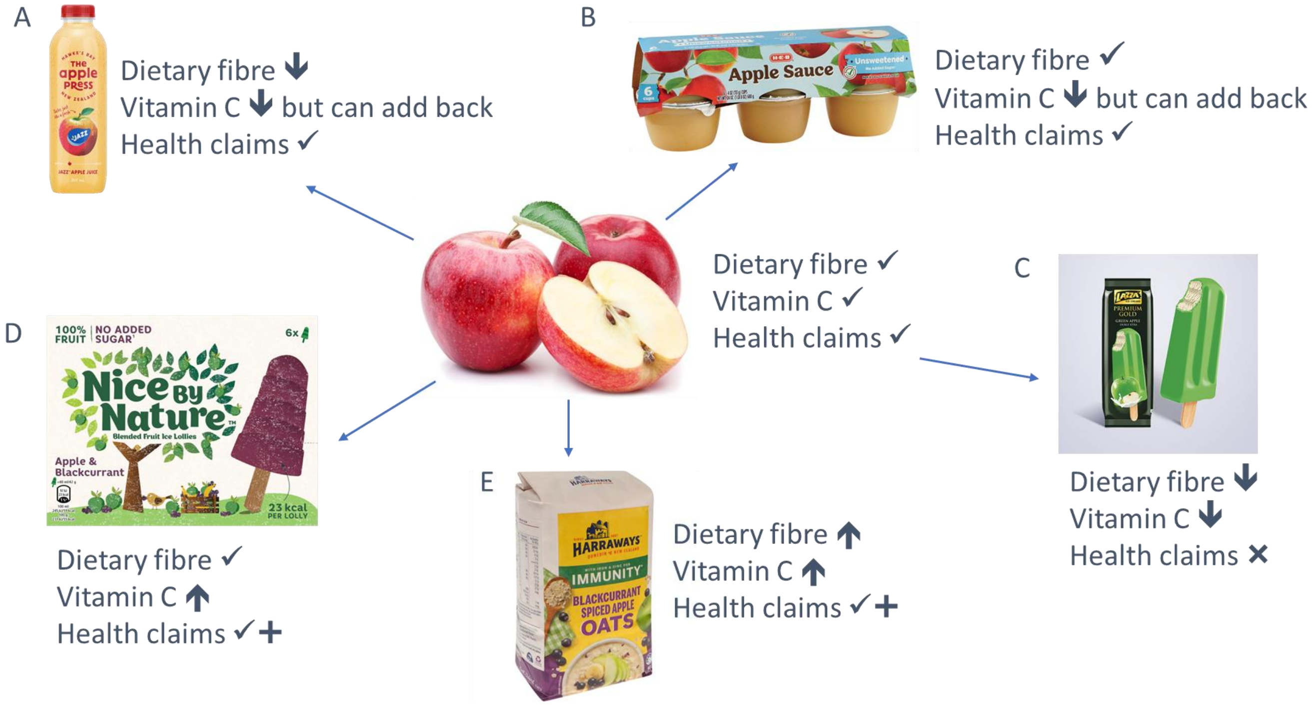


Figure 4. Examples of the effects processing can have on nutrition and health claims.

Note: the claims suggested are not necessarily being made for these products, but are just examples of what could be possible with the right raw materials and processes. The example products and typical processing are as follows:

A = Fruit juice: Selection and preparation of raw material, juice extraction, filtration (optional), pasteurisation, filling and bottling.
B = Fruit puree: Selection and preparation of raw material, peeling and removal of pits, pureeing/blending (possible addition of other fruit purees/pieces), pasteurisation and packing.
C = Fruit juice-coated ice cream: juice processing as above and formulation of finished product, which would involve forming, coating, freezing and packing.
D = Fruit ice block: Fruit puree/juice blend, so processes as above for products A and B then forming, freezing and packing steps. Note if made with juice alone, then it would not contain the dietary fibre.
E = Oat-based breakfast cereal with fruit additions: The addition of fruit in a product like this would need to be in a dried format so would involve selection and preparation of raw material, cutting/slicing and drying (or may need more complex processing if other than a simple dried addition). Dried product would then be added to formulated product and packed.

5 Conclusions

Table 14 summarises the key nutrients and phytochemicals that are present in these fruits, as well as the health benefits reported in the literature. Although these health benefits have been reported, these are not necessarily claimable based on food regulations. It is also important to note that there are a range of factors influencing the nutrient/phytochemical contents of crops: genetics, growing conditions (e.g. climate), cultural practices, maturity at harvest, method of harvesting, postharvest storage and treatments, and consumer use (e.g. cooking). The distribution of the nutrients can also vary within the fruit, and the phytochemicals are highest in the skin. Thus, sometimes products like pomace waste from juicing have concentrated amounts of phytochemicals.

Table 14. The key nutrients and phytochemicals in the fruit included in this study, along with the potential health benefits reported in the literature for the fruits themselves or fruit extracts. The nutrients/phytochemicals in brackets may be present in significant amounts only in some varieties.

Fruit	Key nutrients	Key phytochemicals	Potential health benefits
Apples	dietary fibre, vitamin C, (vitamin E)	Phenolics: phenolics acids, flavan-3-ol monomers and proanthocyanidins, flavonols, dihydrochalcones, (anthocyanins) Triterpenoids: ursolic acid	Heart health, weight management, digestive health, bone health, brain and nervous system, immune function & inflammation, joint health, prevention oxidative damage (antioxidant), allergies, blood sugar management (diabetes), lung health, metabolic syndrome, anticancer
Apricots	dietary fibre, vitamin A, vitamin C, potassium, (vitamin E)	Carotenoids: beta-carotene, beta-cryptoxanthin Phenolics: flavan-3-ol monomers and proanthocyanidins, phenolic acids	Heart health, antioxidant, anti-inflammatory, antidiabetic, hepatoprotective, antimicrobial, antiviral, anticancer
Cherries	dietary fibre, vitamin C, potassium	Phenolics: anthocyanins, flavan-3-ol monomers and proanthocyanidins, phenolic acids	Cardiovascular benefits, antidiabetic, reduction in impacts of inflammatory diseases (arthritis, gout), brain health (Alzheimer's disease), antioxidant, antiaging, anticancer
Nectarines	dietary fibre, vitamin C, vitamin E, potassium, (niacin, vitamin A)	Carotenoids: beta-carotene Phenolics: flavan-3-ols, proanthocyanidins, phenolic acids, (anthocyanins)	Antioxidant, anti-inflammatory, anti-aging, anticancer
Peaches	dietary fibre, vitamin C, vitamin E, potassium, (niacin, vitamin A)	Carotenoids: beta-carotene Phenolics: flavan-3-ol monomers and proanthocyanidins, phenolic acids, (anthocyanins)	Antioxidant, antimicrobial, anti-inflammatory, antiparasitic, antidiabetic, reducing neurodegeneration, heart health, anticancer

Based on Food Standards Australia New Zealand (FSANZ) regulations there are several pre-approved health claims that could be made on the fruit/fruit products if they meet certain criteria, e.g. are a source of a particular nutrient and meet the Nutrient Profiling Scoring Criteria (NPSC).

In developing any products with nutrient content or health claims it is important to consider several other factors. This includes consumer purchase decisions and how claims stack up against other products. There is also the potential to leverage claims through combinations with other ingredients, e.g. synergy of ingredients that may be able to make stronger immunity claims or digestive health.

In conclusion, there are various potential opportunities to make nutrition and health claims on any of the five types of fruit included in this study. There are some common key nutrients (dietary fibre and vitamin C) but there is variation in other nutrients and hence the potential range of claims that could be made.

6 Acknowledgements

Thank you to Limei Feng (PFR) for assisting with collating information on the nutrient and phytochemical composition of the fruit and Alison Wallace for the health benefits. Also, thanks to Carl Massarotto (PFR) for coordination and providing feedback.

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Notes for using Appendices:

The data provided in these appendices provides more detail than is included in the body of the report. This may be useful if data are needed for product labels and development, including formulation.

Appendices 1–5 provide data on the selected phytochemical composition of the five fruits.

- Data are presented on a per 100 g basis as well as per standard serve (weight varies slightly for the different fruit and is an indication of possible serving size only) and the percentage recommended dietary intake (DI) per serve
- DI values are calculated as per FSANZ labelling regulations
- Rows highlighted in green indicate where nutrients are of dietary significance. The lighter green indicates where the concentrations may be borderline for claims and/or variable between cultivars.

Appendices 6–10 provide data on the selected phytochemical composition of the five fruits.

- Data are presented in two tables — one for carotenoids and one for the key classes
- Because phytochemicals have no DIs, it is not possible to indicate which compounds are present at concentrations of dietary significance
- Because the phytochemicals vary significantly between varieties and with growing conditions, the range of values commonly reported is given. Note that these values are indicative only and there may be varieties with values outside these ranges, given the ranges do not necessarily include New Zealand data.

Appendix 1. Typical nutritional composition of apples

Data from the NZFCD (New Zealand Food Composition Database 2022) for entry L1153 'Apple, flesh & skin, raw, combined varieties'. Serving size = 1 apple (130 g).

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Carbohydrates					
	Carbohydrate by difference, FSANZ	g	14.4		11.1
	Total carbohydrate by difference	g	17.2		13.2
	Total carbohydrates by summation	g	16.5		12.7
Available					
	Available carbohydrates by weight	g	13.9		10.7
	Available carbohydrate by difference	g	14.4		11.1
	Available carbohydrates in monosaccharide equivalent	g	14.2		10.9
	Available carbohydrate, FSANZ	g	13.9	4	10.7
Sugars					
	Sugars, total	g	13.5	15	10.4
	Sugar, added	g	0		0
	Sugar, free	g	0		0
	Sugars, total (monosaccharide equivalents)	g	13.7		10.5
	Disaccharides, total	g	3.8		2.9
	Disaccharides, total (monosaccharide equivalents)	g	4		3
	Monosaccharides, total	g	9.8		7.5
Individual Sugars					
	Fructose	g	7.9		6.1
	Glucose	g	1.8		1.4
	Lactose	g	0		0
	Lactose (monosaccharide equivalents)	g	0		0
	Maltose	g	0		0
	Maltose (monosaccharide equivalents)	g	0		0
	Sucrose	g	3.8		2.9
	Sucrose (monosaccharide equivalents)	g	4		3
Starch					
	Starch, total	g	0.4		0.3
	Starch, total (monosaccharide equivalents)	g	0.4		0.3
Unavailable					
	Fibre, water-insoluble	g	1.9		1.5
	Fibre, water-soluble	g	0.8		0.6
	Fibre, total dietary	g	2.6	9	2
Carotenoids					
	Alpha-carotene	µg	0		0
	Beta-carotene	µg	27		21
Energy					

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
	Energy, total metabolisable (kcal)	kcal	60		46
	Energy, total metabolisable (kcal, including dietary fibre)	kcal	65		50
	Energy, total metabolisable (kJ)	kJ	255		196
	Energy, total metabolisable (kJ, including dietary fibre)	kJ	277		213
	Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal	66		51
	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	kJ	277	3	213
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal	69		53
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ	287		221
Fats and Fatty Acids					
	Fat, total	g	0.4	1	0.3
	Cholesterol	mg	0		0
	Fatty acids, total	g	0.07		0.05
	Fatty acids, total long chain polyunsaturated omega-3	g	0		0
	Fatty acids, total monounsaturated	g	0.01		0.01
	Fatty acids, total monounsaturated trans	g	0		0
	Fatty acids, total polyunsaturated	g	0.04		0.03
	Fatty acids, total polyunsaturated omega-3	g	0.01		0.01
	Fatty acids, total polyunsaturated omega-6	g	0.03		0.02
	Fatty acids, total saturated	g	0.03	0	0.02
	Fatty acid 13:0	g	0.001		0.001
	Fatty acid 16:0	g	0.01		0.008
	Fatty acid 18:0	g	0.003		0.002
	Fatty acid 18:1	g	0.008		0.006
	Fatty acid 18:1 omega-9	g	0.007		0.005
	Fatty acid 18:2	g	0.03		0.023
	Fatty acid 18:2 omega-6	g	0.03		0.023
	Fatty acid 18:3	g	0.007		0.005
	Fatty acid 18:3 omega-3	g	0.007		0.005
	Fatty acid 20:0	g	0.003		0.002
	Fatty acid 20:4	g	0.001		0.001
	Fatty acid 20:4 omega-6	g	0.001		0.001
	Fatty acid 22:0	g	0.001		0.001
	Fatty acid 24:1	g	0		0
Minerals					
	Calcium	mg	6	1	5
	Copper	mg	0.05	2	0.04
	Iodide	µg	0.65	0	0.5
	Iron	mg	0.14	1	0.11
	Magnesium	mg	6	2	5

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
	Manganese	µg	46	1	35
	Phosphorus	mg	12	1	9
	Potassium	mg	130		100
	Selenium	µg	0	0	0
	Sodium	mg	0	0	0
	Zinc	mg	0.04	0	0.03
Protein					
	Protein, total; calculated from total nitrogen	g	0.3	1	0.2
Vitamins Water Soluble					
	Dietary folate equivalents	µg	0	0	0
	Folate, total	µg	0		0
	Folate food, naturally occurring food folates	µg	0		0
	Folic acid, synthetic folic acid	µg	0		0
	Niacin equivalents, total	mg	0.05	1	0.04
	Niacin equivalents from tryptophan	mg	0.05		0.04
	Niacin, preformed	mg	0		0
	Riboflavin	mg	0.09	5	0.07
	Thiamin	mg	0	0	0
	Vitamin B12	µg	0	0	0
	Vitamin B6	mg	0.05	3	0.04
	Vitamin C	mg	6.3	16	4.8
Vitamins Fat Soluble					
	Vitamin A, retinol equivalents	µg	4		3
	Vitamin A, retinol activity equivalents	µg	3	0	2
	Retinol	µg	0		0
	Beta-carotene equivalents	µg	27		21
	Vitamin D; calculated by summation	µg	0	0	0
	Cholecalciferol (Vitamin D3)	µg	0		0
	Ergocalciferol (Vitamin D2)	µg	0		0
	Vitamin E, alpha-tocopherol equivalents	mg	0.96	10	0.74
	Alpha-tocopherol	mg	0.91		0.7
	Beta-tocopherol	mg	0.12		0.09
	Delta-tocopherol	mg	0		0
	Gamma-tocopherol	mg	0.03		0.02
Other					
	Ash	g	0.1		0.1
	Alcohol	g	0		0
	Caffeine	mg	0		0
	Dry matter	g	17.9		13.8
	Proximates, total	g	129		99.5
	Water	g	112		86.2

Abbreviations: DI = daily intake; FSANZ = Food Standards Australia New Zealand.

Appendix 2. Typical nutritional composition of apricots

Data from the NZFCD (New Zealand Food Composition Database 2022) for entry L1168 ‘Apricot, flesh & skin, raw, fresh’. Serving size = 2 apricots (144 g).

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Carbohydrates					
	Carbohydrate by difference, FSANZ	g	13.5		9.4
	Total carbohydrate by difference	g	16.3		11.3
	Total carbohydrates by summation	g	11.8		8.2
Available					
	Available carbohydrates by weight	g	9.1		6.3
	Available carbohydrate by difference	g	13.5		9.4
	Available carbohydrates in monosaccharide equivalent	g	9.3		6.5
	Available carbohydrate, FSANZ	g	9.1	3	6.3
Sugars					
	Sugars, total	g	9.1	10	6.3
	Sugar, added	g	0		0
	Sugar, free	g	0		0
	Sugars, total (monosaccharide equivalents)	g	9.3		6.5
	Disaccharides, total	g	4.8		3.3
	Disaccharides, total (monosaccharide equivalents)	g	5		3.5
	Monosaccharides, total	g	4.3		3
Individual Sugars					
	Fructose	g	1.7		1.2
	Glucose	g	2.6		1.8
	Lactose	g	0		0
	Lactose (monosaccharide equivalents)	g	0		0
	Maltose	g	0		0
	Maltose (monosaccharide equivalents)	g	0		0
	Sucrose	g	4.8		3.3
	Sucrose (monosaccharide equivalents)	g	5		3.5
Starch					
	Starch, total	g	0		0
	Starch, total (monosaccharide equivalents)	g	0		0
Unavailable					
	Fibre, water-insoluble	g	1.4		1
	Fibre, water-soluble	g	1.3		0.9
	Fibre, total dietary	g	2.7	9	1.9
Carotenoids					
	Alpha-carotene	µg	0		0
	Beta-carotene	µg	1570		1090

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Energy					
	Energy, total metabolisable (kcal)	kcal	45		31
	Energy, total metabolisable (kcal, including dietary fibre)	kcal	49		34
	Energy, total metabolisable (kJ)	kJ	187		130
	Energy, total metabolisable (kJ, including dietary fibre)	kJ	209		145
	Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal	50		35
	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	kJ	209	2	145
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal	68		47
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ	285		198
Fats and Fatty Acids					
	Fat, total	g	0.3	0	0.2
	Cholesterol	mg	0		0
	Fatty acids, total	g	0		0
	Fatty acids, total saturated	g	0	0	0
Minerals					
	Calcium	mg	24	3	17
	Copper	mg	0.12	4	0.08
	Iodide	µg	0	0	0
	Iron	mg	0.33	3	0.23
	Magnesium	mg	17	5	12
	Manganese	µg	137	3	95
	Phosphorus	mg	37	4	26
	Potassium	mg	389		270
	Selenium	µg	0	0	0
	Sodium	mg	0	0	0
	Zinc	mg	0.29	2	0.2
Protein					
	Protein, total; calculated from total nitrogen	g	1.3	3	0.9
Vitamins Water Soluble					
	Dietary folate equivalents	µg	0	0	0
	Folate, total	µg	0		0
	Folate food, naturally occurring food folates	µg	0		0
	Folic acid, synthetic folic acid	µg	0		0
	Niacin equivalents, total	mg	0.82	8	0.57
	Niacin equivalents from tryptophan	mg	0.24		0.17
	Niacin, preformed	mg	0.58		0.4
	Riboflavin	mg	0.1	6	0.07
	Thiamin	mg	0.01	1	0.01
	Vitamin B12	µg	0	0	0

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
	Vitamin B6	mg	0.07	4	0.05
	Vitamin C	mg	5.1	13	3.5
Vitamins Fat Soluble					
	Vitamin A, retinol equivalents	µg	262		182
	Vitamin A, retinol activity equivalents	µg	131	17	91
	Retinol	µg	0		0
	Beta-carotene equivalents	µg	1570		1090
	Vitamin D; calculated by summation	µg	0	0	0
	Cholecalciferol (Vitamin D3)	µg	0		0
	Ergocalciferol (Vitamin D2)	µg	0		0
	Vitamin E, alpha-tocopherol equivalents	mg	0.39	4	0.27
	Alpha-tocopherol	mg	0.39		0.27
	Beta-tocopherol	mg	0.01		0.01
	Delta-tocopherol	mg	0		0
	Gamma-tocopherol	mg	0.01		0.01
Other					
	Ash	g	1		0.7
	Alcohol	g	0		0
	Caffeine	mg	0		0
	Dry matter	g	18.9		13.1
	Proximates, total	g	140		96.9
	Water	g	125		86.9

Abbreviations: DI = daily intake; FSANZ = Food Standards Australia New Zealand.

Appendix 3. Typical nutritional composition of cherries

Data from the NZFCD (New Zealand Food Composition Database 2022) for entry L45 ‘Cherry, flesh & skin, raw’. Serving size 1 cup = (150 g).

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Carbohydrates					
	Carbohydrate by difference, FSANZ	g	26.1		17.4
	Total carbohydrate by difference	g	27.9		18.6
	Total carbohydrates by summation	g	22.9		15.3
Available					
	Available carbohydrates by weight	g	21		14
	Available carbohydrate by difference	g	26.1		17.4
	Available carbohydrates in monosaccharide equivalent	g	21		14
	Available carbohydrate, FSANZ	g	21	7	14
Sugars					
	Sugars, total	g	20.9	23	13.9
	Sugar, added	g	0		0
	Sugar, free	g	0		0
	Sugars, total (monosaccharide equivalents)	g	20.9		13.9
	Disaccharides, total	g	0.3		0.2
	Disaccharides, total (monosaccharide equivalents)	g	0.3		0.2
	Monosaccharides, total	g	20.6		13.7
	Polysaccharides, non-starch	g	1.2		0.8
	Polysaccharides, non-starch, water-insoluble	g	0.6		0.4
	Polysaccharides, non-starch, water-soluble	g	0.8		0.5
Individual Sugars					
	Fructose	g	9.8		6.5
	Glucose	g	10.8		7.2
	Lactose	g	0		0
	Lactose (monosaccharide equivalents)	g	0		0
	Maltose	g	0		0
	Maltose (monosaccharide equivalents)	g	0		0
	Sucrose	g	0.3		0.2
	Sucrose (monosaccharide equivalents)	g	0.3		0.2
Starch					
	Starch, total	g	0.1		0.1
	Starch, total (monosaccharide equivalents)	g	0.1		0.1
Unavailable					
	Fibre, total dietary	g	1.9	6	1.3
Carotenoids					
	Alpha-carotene	µg	0		0

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
	Beta-carotene	µg	39		26
Energy					
	Energy, total metabolisable (kcal)	kcal	93		62
	Energy, total metabolisable (kcal, including dietary fibre)	kcal	96		64
	Energy, total metabolisable (kJ)	kJ	394		263
	Energy, total metabolisable (kJ, including dietary fibre)	kJ	410		273
	Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal	98		65
	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	kJ	410	5	273
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal	118		79
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ	496		331
Fats and Fatty Acids					
	Fat, total	g	0.4	1	0.2
	Cholesterol	mg	0		0
	Fatty acids, total	g	0.3		0.2
	Fatty acids, total monounsaturated	g	0.11		0.07
	Fatty acids, total polyunsaturated	g	0.12		0.08
	Fatty acids, total saturated	g	0.09	0	0.06
Minerals					
	Calcium	mg	24	3	16
	Chloride	mg	6		4
	Copper	mg	0.15	5	0.1
	Iodide	µg	0.2	0	0.13
	Iron	mg	1.09	9	0.73
	Magnesium	mg	18	6	12
	Manganese	µg	135	3	90
	Phosphorus	mg	32	3	21
	Potassium	mg	316		211
	Selenium	µg	1	1	0.7
	Sodium	mg	4	0	3
	Sulphur	mg	12		8
	Zinc	mg	0.12	1	0.08
Protein					
	Protein, total; calculated from total nitrogen	g	1.4	3	0.9
Vitamins Water Soluble					
	Biotin	µg	0.6	2	0.4
	Dietary folate equivalents	µg	9	4	6
	Folate, total	µg	9		6
	Folate food, naturally occurring food folates	µg	9		6
	Folic acid, synthetic folic acid	µg	0		0

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
	Niacin equivalents, total	mg	0.9	9	0.6
	Niacin equivalents from tryptophan	mg	0.3		0.2
	Niacin, preformed	mg	0.6		0.4
	Pantothenic acid	mg	0.3	6	0.2
	Riboflavin	mg	0	0	0
	Thiamin	mg	0.04	3	0.03
	Vitamin B12	µg	0	0	0
	Vitamin B6	mg	0.07	5	0.05
	Vitamin C	mg	30	75	20
Vitamins Fat Soluble					
	Vitamin A, retinol equivalents	µg	6		4
	Vitamin A, retinol activity equivalents	µg	3	0	2
	Retinol	µg	0		0
	Beta-carotene equivalents	µg	39		26
	Vitamin D; calculated by summation	µg	0	0	0
	Cholecalciferol (Vitamin D3)	µg	0		0
	Ergocalciferol (Vitamin D2)	µg	0		0
	Vitamin E, alpha-tocopherol equivalents	mg	0.63	6	0.42
	Alpha-tocopherol	mg	0.63		0.42
	Delta-tocopherol	mg	0		0
	Gamma-tocopherol	mg	0		0
Other					
	Ash	g	0.8		0.6
	Alcohol	g	0		0
	Caffeine	mg	0		0
	Dry matter	g	30.6		20.4
	Proximates, total	g	145		96.6
	Water	g	119		79.6

Abbreviations: DI = daily intake; FSANZ = Food Standards Australia New Zealand.

Appendix 4. Typical nutritional composition of nectarines

Data from the NZFCD (New Zealand Food Composition Database 2022) for entry L1166 'Nectarine, yellow, flesh & skin, fresh, raw'. Serving size = 1 nectarine (120 g).

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Carbohydrates					
	Carbohydrate by difference, FSANZ	g	13.8		11.5
	Total carbohydrate by difference	g	16.1		13.4
	Total carbohydrates by summation	g	13.1		10.9
Available					
	Available carbohydrates by weight	g	10.8		9
	Available carbohydrate by difference	g	13.8		11.5
	Available carbohydrates in monosaccharide equivalent	g	11.2		9.3
	Available carbohydrate, FSANZ	g	10.8	3	9
Sugars					
	Sugars, total	g	10.8	12	9
	Sugar, added	g	0		0
	Sugar, free	g	0		0
	Sugars, total (monosaccharide equivalents)	g	11.2		9.3
	Disaccharides, total	g	7.7		6.4
	Disaccharides, total (monosaccharide equivalents)	g	8.1		6.7
	Monosaccharides, total	g	3.1		2.6
Individual Sugars					
	Fructose	g	1.7		1.4
	Glucose	g	1.4		1.2
	Lactose	g	0		0
	Lactose (monosaccharide equivalents)	g	0		0
	Maltose	g	0		0
	Maltose (monosaccharide equivalents)	g	0		0
	Sucrose	g	7.7		6.4
	Sucrose (monosaccharide equivalents)	g	8.1		6.7
Starch					
	Starch, total	g	0		0
	Starch, total (monosaccharide equivalents)	g	0		0
Unavailable					
	Fibre, water-insoluble	g	1.2		1
	Fibre, water-soluble	g	1.1		0.9
	Fibre, total dietary	g	2.3	8	1.9
Carotenoids					
	Alpha-carotene	µg	0		0
	Beta-carotene	µg	25		21

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Energy					
	Energy, total metabolisable (kcal)	kcal	49		41
	Energy, total metabolisable (kcal, including dietary fibre)	kcal	54		45
	Energy, total metabolisable (kJ)	kJ	211		176
	Energy, total metabolisable (kJ, including dietary fibre)	kJ	229		191
	Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal	55		46
	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	kJ	229	3	191
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal	67		56
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ	280		233
Fats and Fatty Acids					
	Fat, total	g	0.2	0	0.2
	Fatty acids, total saturated	g	0	0	0
Minerals					
	Calcium	mg	7	1	6
	Copper	mg	0.09	3	0.08
	Iodide	µg	0	0	0
	Iron	mg	0.17	1	0.14
	Magnesium	mg	11	3	9
	Manganese	µg	82	2	68
	Phosphorus	mg	28	3	23
	Potassium	mg	252		210
	Selenium	µg	0	0	0
	Sodium	mg	0	0	0
	Zinc	mg	0.12	1	0.1
Protein					
	Protein, total; calculated from total nitrogen	g	1.1	2	0.9
Vitamins Water Soluble					
	Dietary folate equivalents	µg	0	0	0
	Folate, total	µg	0		0
	Folate food, naturally occurring food folates	µg	0		0
	Folic acid, synthetic folic acid	µg	0		0
	Niacin equivalents, total	mg	1.02	10	0.85
	Niacin equivalents from tryptophan	mg	0.2		0.17
	Niacin, preformed	mg	0.82		0.68
	Riboflavin	mg	0.08	5	0.07
	Thiamin	mg	0.01	1	0.01
	Vitamin B12	µg	0	0	0
	Vitamin B6	mg	0.02	1	0.02
	Vitamin C	mg	8.1	20	6.7

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Vitamins Fat Soluble					
	Vitamin A, retinol equivalents	µg	5		4
	Vitamin A, retinol activity equivalents	µg	2	0	2
	Retinol	µg	0		0
	Beta-carotene equivalents	µg	25		21
	Vitamin D; calculated by summation	µg	0	0	0
	Cholecalciferol (Vitamin D3)	µg	0		0
	Ergocalciferol (Vitamin D2)	µg	0		0
	Vitamin E, alpha-tocopherol equivalents	mg	1.02	10	0.85
	Alpha-tocopherol	mg	1.02		0.85
	Beta-tocopherol	mg	0.01		0.01
	Delta-tocopherol	mg	0		0
	Gamma-tocopherol	mg	0.01		0.01
Other					
	Ash	g	0.6		0.5
	Alcohol	g	0		0
	Caffeine	mg	0		0
	Dry matter	g	18		15
	Proximates, total	g	117		97.5
	Water	g	102		85

Abbreviations: DI = daily intake; FSANZ = Food Standards Australia New Zealand.

Appendix 5. Typical nutritional composition of peaches

Data from the NZFCD (New Zealand Food Composition Database 2022) for entry L1167 ‘Peach, yellow, flesh and skin, fresh, raw’. Serving size = 1 peach (160 g).

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Carbohydrates					
	Carbohydrate by difference, FSANZ	g	15.9		9.9
	Total carbohydrate by difference	g	18.7		11.7
	Total carbohydrates by summation	g	14.7		9.2
Available					
	Available carbohydrates by weight	g	11.8		7.4
	Available carbohydrate by difference	g	15.9		9.9
	Available carbohydrates in monosaccharide equivalent	g	12.3		7.7
	Available carbohydrate, FSANZ	g	11.8	4	7.4
Sugars					
	Sugars, total	g	11.8	13	7.4
	Sugar, added	g	0		0
	Sugar, free	g	0		0
	Sugars, total (monosaccharide equivalents)	g	12.3		7.7
	Disaccharides, total	g	8.8		5.5
	Disaccharides, total (monosaccharide equivalents)	g	9.2		5.8
	Monosaccharides, total	g	3		1.9
Individual Sugars					
	Fructose	g	1.8		1.1
	Glucose	g	1.3		0.8
	Lactose	g	0		0
	Lactose (monosaccharide equivalents)	g	0		0
	Maltose	g	0		0
	Maltose (monosaccharide equivalents)	g	0		0
	Sucrose	g	8.8		5.5
	Sucrose (monosaccharide equivalents)	g	9.2		5.8
Starch					
	Starch, total	g	0		0
	Starch, total (monosaccharide equivalents)	g	0		0
Unavailable					
	Fibre, water-insoluble	g	1.6		1
	Fibre, water-soluble	g	1.3		0.8
	Fibre, total dietary	g	2.9	10	1.8
Carotenoids					
	Alpha-carotene	µg	0		0
	Beta-carotene	µg	178		111

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Energy					
	Energy, total metabolisable (kcal)	kcal	56		35
	Energy, total metabolisable (kcal, including dietary fibre)	kcal	61		38
	Energy, total metabolisable (kJ)	kJ	235		147
	Energy, total metabolisable (kJ, including dietary fibre)	kJ	258		161
	Energy, total metabolisable, available carbohydrate, FSANZ (kcal)	kcal	62		39
	Energy, total metabolisable, available carbohydrate, FSANZ (kJ)	kJ	258	3	161
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kcal)	kcal	78		49
	Energy, total metabolisable, carbohydrate by difference, FSANZ (kJ)	kJ	326		204
Fats and Fatty Acids					
	Fat, total	g	0.3	0	0.2
	Fatty acids, total saturated	g	0	0	0
Minerals					
	Calcium	mg	8	1	5
	Copper	mg	0.11	4	0.07
	Iodide	µg	0	0	0
	Iron	mg	0.32	3	0.2
	Magnesium	mg	14	4	9
	Manganese	µg	139	3	87
	Phosphorus	mg	34	3	21
	Potassium	mg	317		198
	Selenium	µg	0	0	0
	Sodium	mg	0	0	0
	Zinc	mg	0.18	1	0.11
Protein					
	Protein, total; calculated from total nitrogen	g	1.3	3	0.8
Vitamins Water Soluble					
	Dietary folate equivalents	µg	0	0	0
	Folate, total	µg	0		0
	Folate food, naturally occurring food folates	µg	0		0
	Folic acid, synthetic folic acid	µg	0		0
	Niacin equivalents, total	mg	1.76	18	1.1
	Niacin equivalents from tryptophan	mg	0.24		0.15
	Niacin, preformed	mg	1.47		0.92
	Riboflavin	mg	0.11	7	0.07
	Thiamin	mg	0.02	1	0.01
	Vitamin B12	µg	0	0	0
	Vitamin B6	mg	0.02	1	0.01
	Vitamin C	mg	10.1	25	6.3

Category	Nutrient	Unit	Quantity per Serve	%DI per Serve	Quantity per 100 g
Vitamins Fat Soluble					
	Vitamin A, retinol equivalents	µg	30		19
	Vitamin A, retinol activity equivalents	µg	14	2	9
	Retinol	µg	0		0
	Beta-carotene equivalents	µg	178		111
	Vitamin D; calculated by summation	µg	0	0	0
	Cholecalciferol (Vitamin D3)	µg	0		0
	Ergocalciferol (Vitamin D2)	µg	0		0
	Vitamin E, alpha-tocopherol equivalents	mg	1.26	13	0.79
	Alpha-tocopherol	mg	1.26		0.79
	Beta-tocopherol	mg	0.02		0.01
	Delta-tocopherol	mg	0		0
	Gamma-tocopherol	mg	0.02		0.01
Other					
	Ash	g	0.6		0.4
	Alcohol	g	0		0
	Caffeine	mg	0		0
	Dry matter	g	21		13.1
	Proximates, total	g	156		97.5
	Water	g	139		86.9

Abbreviations: DI = daily intake; FSANZ = Food Standards Australia New Zealand.

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Appendix 6. Details of the selected phytochemical composition of apples

Carotenoid composition for ‘Apples, raw, with skin’ (FDC ID: 171688) as provided in FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022). Values given in µg per 100 g fresh weight.

Carotenoid	Average	Minimum	Maximum	Number of samples
Beta -carotene	27	11	81	14
Alpha-carotene	0	0	0	14
Beta-cryptoxanthin	11	0	16	14
Lutein + zeaxanthin	29	11	73	14

Phenolic composition of 'Apple [Dessert], whole, raw' as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

Class of compound	Specific compound	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Flavonoids						
Anthocyanins	Cyanidin 3-O-arabinoside	0.06	0.00	0.17	0.07	41
	Cyanidin 3-O-galactoside	0.81	0.00	3.11	0.88	50
	Cyanidin 3-O-xyloside	0.06	0.00	0.21	0.09	41
Dihydrochalcones	3-Hydroxyphloretin 2'-O-glucoside	0.11	0.00	0.29	0.12	41
	Phloretin 2'-O-xylosyl-glucoside	2.58	0.88	7.99	2.09	47
	Phloridzin	2.69	0.64	9.11	1.92	56
Flavanols	(+)-Catechin	1.22	0.00	3.40	0.83	83
	(-)-Epicatechin	8.37	1.80	19.16	3.67	89
	Procyanidin dimer B2	14.56	0.90	38.46	9.19	57
Flavonols	Quercetin	0.13	0.00	0.22	0.06	46
	Quercetin 3-O-arabinoside	1.40	0.72	4.44	1.12	51
	Quercetin 3-O-galactoside	2.36	0.96	4.80	1.20	51
	Quercetin 3-O-glucoside	0.64	0.20	2.40	0.77	51
	Quercetin 3-O-rhamnoside	1.33	0.52	5.30	1.57	51
	Quercetin 3-O-rutinoside	0.22	0.10	0.32	0.06	45
	Quercetin 3-O-xyloside	0.78	0.50	2.28	0.58	51
Phenolic acids						
Hydroxybenzoic acids	Gentisic acid	0.22	0.13	0.29	0.08	3
	Syringic acid	0.90	0.00	2.63	1.21	8
Hydroxycinnamic acids	4-Caffeoylquinic acid	0.54	0.00	0.76	0.44	7
	4-p-Coumaroylquinic acid	2.25	0.32	6.77	1.92	43
	5-Caffeoylquinic acid	13.37	1.60	43.00	11.26	76
	5-p-Coumaroylquinic acid	1.05	1.00	1.10	0.07	2
	Caffeic acid	0.33	0.00	0.93	0.45	10
	Ferulic acid	0.07	0.00	0.21	0.10	5
	p-Coumaric acid	0.27	0.00	0.70	0.21	51

Appendix 7. Details of the selected phytochemical composition of apricots

Carotenoid composition for ‘Apricots, raw’ (FDC ID: 171697) as provided in FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022). Values given in µg per 100 g fresh weight.

Carotenoid	Average	Minimum	Maximum	Number of samples
Beta -carotene	1090	615	1770	8
Alpha-carotene	19	0	37	8
Beta-cryptoxanthin	104	22	231	8
Lutein + zeaxanthin	89	46	132	2

Phenolic composition of 'Apricot, raw' as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

Class of compound	Specific compound	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Flavonoids						
Flavanols	(+)-Catechin	2.96	0.31	4.95	3.28	7
	(-)-Epicatechin	3.47	0.02	6.06	4.27	7
	Procyanidin dimer B1	0.09	0.09	0.09	0	3
	Procyanidin dimer B3	0.05	0.05	0.05	0	3
	Procyanidin dimer B7	0.01	0.01	0.01	0	3
	Procyanidin trimer EEC	0.01	0.01	0.01	0	3
Flavonols	Kaempferol 3-O-rutinoside	0.12	0.01	0.56	0.15	11
	Quercetin 3-O-rutinoside	0.83	0.24	2.27	0.61	11
Phenolic acids						
Hydroxycinnamic acids	3-Caffeoylquinic acid	5.38	2.6	7.8	1.88	5
	3-Feruloylquinic acid	0.6	0.4	1.2	0.34	5
	3-p-Coumaroylquinic acid	0.38	0.2	0.7	0.2	5
	5-Caffeoylquinic acid	3.58	0.3	10.3	2.7	16
	5-Feruloylquinic acid	0.04	0	0.2	0.09	5
	5-p-Coumaroylquinic acid	0.06	0	0.3	0.13	5

Appendix 8. Details of the selected phytochemical composition of cherries

Carotenoid composition for ‘Cherries, sweet, raw’ (FDC ID: 171719) as provided in FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022). Values given in µg per 100 g fresh weight.

Carotenoid	Average	Minimum	Maximum	Number of samples
Beta -carotene	38	25	60	6
Alpha-carotene	0	0	0	2
Beta-cryptoxanthin	0	0	0	2
Lutein + zeaxanthin	85	84	85	2

Phenolic composition of ‘Sweet cherry, raw’ as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

Class of compound	Specific compound	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Flavonoids						
Anthocyanins	Cyanidin 3-O-glucoside	18.73	0	48	16.32	16
	Cyanidin 3-O-rutinoside	143.27	1.57	393	97.62	16
	Pelargonidin 3-O-rutinoside	1.24	0	3.91	1.3	16
	Peonidin 3-O-glucoside	0.76	0	3	0.84	16
	Peonidin 3-O-rutinoside	7.42	0	27.5	7.54	16
Flavanols	(+)-Catechin	1.5	0.61	2.17	1.1	7
	(-)-Epicatechin	7.78	5.45	9.53	2.88	7
	(-)-Epicatechin 3-O-gallate	0.09	0	0.2	0.14	7
	(-)-Epigallocatechin	0.05	0	0.11	0.08	7
	Procyanidin dimer B1	0.23	0.23	0.23	0	3
	Procyanidin dimer B2	2.1	2.1	2.1	0	3
	Procyanidin dimer B3	0.08	0.08	0.08	0	3
	Procyanidin dimer B4	0.18	0.18	0.18	0	3
	Procyanidin dimer B5	0.2	0.2	0.2	0	3
	Procyanidin dimer B7	1.01	1.01	1.01	0	3
	Procyanidin trimer C1	1.85	1.85	1.85	0	3
Phenolic acids						
Hydroxycinnamic acids	3-Caffeoylquinic acid	44.71	8.2	128.16	33.7	30
	3-Feruloylquinic acid	0.43	0	0.8	0.4	3
	3-p-Coumaroylquinic acid	38.43	7.18	131.45	41.3	30
	4-Caffeoylquinic acid	0.77	0	1.8	0.93	3
	4-p-Coumaroylquinic acid	1.27	1.1	1.5	0.21	3
	5-Caffeoylquinic acid	2.2	1.8	2.5	0.36	3

Appendix 9. Details of the selected phytochemical composition of nectarines

Carotenoid composition for ‘Nectarines, raw’ (FDC ID: 169914) as provided in FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022). Values given in µg per 100 g fresh weight.

Carotenoid	Average	Minimum	Maximum	Number of samples
Beta -carotene	150	100	331	10
Alpha-carotene	0	0	0	9
Beta-cryptoxanthin	98	59	159	9
Lutein + zeaxanthin	130	63	245	8

Phenolic composition of ‘Nectarine, whole’ as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

Class of compound	Specific compound	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Flavonoids						
Anthocyanins	Malvidin 3,5-O-diglucoside	0.3	0	1.78	0.64	8
Flavanols	(+)-Catechin	4.72	1.09	11.29	3.67	12
	Procyanidin dimer B1	9.95	2.8	17.17	5.26	8
Flavonols	Quercetin 3-O-glucoside	0.11	0	0.47	0.2	8
	Quercetin 3-O-rutinoside	0.1	0	0.56	0.21	8
Phenolic acids						
Hydroxycinnamic acids	3-Caffeoylquinic acid	3.96	1.83	6.16	1.5	8
	5-Caffeoylquinic acid	6.08	3.49	8.61	1.58	8

Appendix 10. Details of the selected phytochemical composition of peaches

Carotenoid composition for ‘Peaches, yellow, raw’ (FDC ID: 169928) as provided in FoodData Central (U.S. Department of Agriculture, Agricultural Research Service 2022). Values given in µg per 100 g fresh weight.

Carotenoid	Average	Minimum	Maximum	Number of samples
Beta -carotene	162	77	289	32
Alpha-carotene	0	0	3	32
Beta-cryptoxanthin	67	3	178	32
Lutein + zeaxanthin	91	10	167	8

Phenolic composition of 'Peach, whole' as provided in Phenol-Explorer (http://phenol-explorer.eu/; Neveu et al. 2010). Data all in mg per 100 g fresh weight.

Class of compound	Specific compound	Mean content	Minimum	Maximum	Standard deviation	Number of samples
Flavonoids						
Flavanols	(+)-Catechin	2.33	2.33	2.33	0	4
Phenolic acids						
Hydroxycinnamic acids	3-Caffeoylquinic acid	8.75	3.3	14.2	7.71	2
	3-Feruloylquinic acid	0.2	0.2	0.2	0	2
	3-p-Coumaroylquinic acid	0.35	0.3	0.4	0.07	2
	5-Caffeoylquinic acid	15.5	4.3	26.8	15.91	2

Appendix 11. Background information on the nutrients and phytochemicals of relevance

Abbreviations: DI = daily intake; DV = daily values; FSANZ = Food Standards Australia New Zealand; IU = international units; RAE = retinol activity equivalents; RDI = recommended dietary intake; UL = upper intake level.

Dietary fibre

Alternative names	Fibre, soluble fibre, insoluble fibre
Description	Fibre is only found in plant products. It is a diverse group of compounds, including lignin and complex carbohydrates, which cannot be easily digested by the enzymes in the small intestine. Fibre can be further categorised into soluble fibre and insoluble fibre.
Dietary Sources	Good sources of dietary fibre include legumes, nuts, whole grains, bran products, fruit, and non-starchy vegetables. Legumes, whole grains, and nuts are generally more concentrated sources of fibre than fruit and vegetables. All plant-based foods contain mixtures of soluble and insoluble fibre. Oat products and legumes are rich sources of soluble and viscous fibre. Wheat bran and whole grains are rich sources of insoluble and non-viscous fibre.
Dietary requirement per day	30 g DI
Solubility (water/fat)	Both water soluble & insoluble.
Stability	Fibre is relatively unchanged by cooking.
Bioavailability	Not absorbed but does not need to be to have an effect.
Safety	Some people experience abdominal cramping, bloating, or gas when they abruptly increase their dietary fibre intakes. Some fibres have been found to cause gastrointestinal distress in some individuals, including abdominal cramping, bloating, gas, and diarrhoea: guar gum, inulin and oligofructose, fructooligosaccharides, polydextrose, resistant starch, and psyllium.
Supplements (including vs food sources)	Isolated fibres and fibre supplements are available such as psyllium (e.g., Metamucil).
Overarching comments on health benefits	Soluble fibre acts like a sponge, absorbing fluid and making the bowel contents softer and able to move more easily. It also helps lower blood cholesterol and improve blood glucose control. Insoluble fibre acts as a ‘bulking agent’ which, with soluble fibre, helps to keep us regular. FSANZ has one pre-approved health claim for dietary fibre related to regular laxation.

Niacin

Alternative names	Nicotinic acid, vitamin B3
Description	Niacin is a water-soluble B vitamin.
Dietary Sources	Good sources of niacin include yeast, meat, poultry, red fish (e.g., tuna, salmon), cereals (especially fortified cereals), legumes, and seeds. Milk, green leafy vegetables, coffee, and tea also provide some niacin. lean meats, liver, poultry, milk, canned salmon.
Dietary requirement per day	10 mg RDI
Solubility (water/fat)	water
Stability	Only slightly susceptible to damage by air, light, and heat, with up to a 5-10% loss during processing and cooking.
Bioavailability	In plants, especially mature cereal grains like corn and wheat, niacin may be bound to sugar molecules in the form of glycosides, which significantly decrease niacin bioavailability.
Safety	Niacin from foods is not known to cause adverse effects. Most adverse effects have been reported with pharmacologic preparations of niacin.
Supplements (including vs food sources)	Niacin supplements are available as nicotinamide or nicotinic acid. Nicotinamide is the form of niacin typically used in nutritional supplements and in food fortification.
Overarching comments on health benefits	Niacin helps maintain healthy skin and nerves. It also assists in your digestion and the conversion of food into energy. FSANZ has several pre-approved health claims for niacin.

Vitamin A

Alternative names	Retinol, retinoids, retinoic acid, provitamin A
Description	Vitamin A is the term used to describe many related compounds. Retinol and retinal are often referred to as preformed vitamin A. Beta-carotene and some other carotenoids that can be converted into retinol are termed provitamin A carotenoids. There are hundreds of different carotenoids present in plants, but only a small percentage of them are provitamin A carotenoids. Beta-carotene is the most predominant provitamin A carotenoid, other forms include alpha-carotene and beta-cryptoxanthin.
Dietary Sources	Free retinol is not generally found in food. Retinyl esters (including retinyl palmitate) are the storage form of retinol in animals and thus the main precursors of retinol in food from animals. Plants contain carotenoids, some of which are precursors for vitamin A (e.g. α-carotene, β-carotene, and β-cryptoxanthin). Yellow- and orange-coloured vegetables contain significant quantities of carotenoids. Green vegetables also contain carotenoids, though yellow-to-red pigments are masked by the green pigment of chlorophyll.
Dietary requirement per day	750 µg RDI
Solubility (water/fat)	fat
Stability	Carotenoids generally have good stability during food processing. In fact, chopping and cooking may allow vitamin A carotenoids to be more easily absorbed. Because they are fat-soluble, cooking with a small amount of healthy oil (e.g., olive oil) may also be beneficial.
Bioavailability	Retinol is the bioavailable form, found only in animal foods. Some carotenoids have pro-vitamin A activity - the body must convert into the active form. The carotenoids are not as bioavailable as retinol. This is accounted for by expressing as retinol activity equivalent (RAE). Each µg RAE corresponds to 1 µg retinol, 2 µg of β-carotene in oil, 12 µg of "dietary" beta-carotene, or 24 µg of either α-carotene, γ-carotene, or β-cryptoxanthin.
Safety	Overconsumption of preformed vitamin A can be highly toxic and is especially contraindicated prior to and during pregnancy as it can result in severe birth defects. The tolerable (UL for vitamin A in adults is set at 3,000 µg RAE/day. The UL does not apply to vitamin A derived from carotenoids.
Supplements (including vs food sources)	The principal forms of preformed vitamin A in supplements are retinyl palmitate and retinyl acetate. β-Carotene is also a common source of vitamin A in supplements, and many supplements provide a combination of retinol and β-carotene. If a percentage of the total vitamin A content of a supplement comes from β-carotene. Some multivitamin supplements available in the US provide up to 5,000 IU of preformed vitamin A, corresponding to 1,500 µg RAE, which is substantially more than the current RDA for vitamin A. This is because the Daily Values (DV) used by the US Food and Drug Administration (FDA) for supplement labelling are based on the RDA established in 1968 rather than the most recent RDA, and multivitamin supplements typically provide 100% of the DV for most nutrients. Because retinol intakes of 5,000 IU/day (1,500 µg RAE) may be associated with an increased risk of osteoporosis in older adults (see Safety), some companies have reduced the retinol content in their multivitamin supplements to 2,500 IU (750 µg RAE).
Overarching comments on health benefits	Vitamin A is necessary for normal vision, and it also helps form and maintain healthy soft tissue, mucus membranes, and skin. Vitamin A supports a healthy immune system. FSANZ has several pre-approved health claims for vitamin A.

Vitamin C

Alternative names	Ascorbic acid; ascorbate
Description	Vitamin C is a water-soluble vitamin. Unlike most mammals and other animals, humans do not have the ability to make vitamin C and it must be obtained through diet.
Dietary Sources	Restricted to plant-based foods. Different fruit and vegetables vary in their vitamin C content. Top fruit sources include blackcurrants, kiwifruit, citrus fruits, guavas, papayas, strawberries, melons as well as many fruit juices. Many vegetables contain vitamin C but key sources are green leafy vegetables and many of the cruciferous vegetables (broccoli, cauliflower, cabbage, etc. Also, vegetable fruits such as capsicum and some pumpkins/squash.
Dietary requirement per day	40 mg RDI
Solubility (water/fat)	water
Stability	Vitamin C is one of the more unstable vitamins, with losses occurring during cooking, preservation, drying and storage of foods. Up to 65% of the vitamin C in vegetables can be lost during cooking. The best way to maximise vitamin C intake is to consume vitamin C-rich foods in their fresh, raw form and, if cooking, minimise the amount of water used.
Bioavailability	One hundred percent absorption efficiency is observed when ingesting vitamin C at doses up to 200 mg at a time. Once plasma ascorbic acid levels reach saturation, additional vitamin C is largely excreted in the urine.
Safety	There is no scientific evidence that large amounts of vitamin C (up to 10 grams/day in adults) exert any adverse or toxic effects. An upper level of 2 grams/day is recommended to prevent some adults from experiencing diarrhoea and gastrointestinal disturbances.
Supplements (including vs food sources)	Vitamin C supplements are available in many forms, but there is little scientific evidence that any one form is better absorbed or more effective than another. Natural and synthetic L-ascorbic acid are chemically identical and there are no known differences in their biological activities or bioavailability.
Overarching comments on health benefits	Vitamin C is an antioxidant and is important for functioning of the immune system. It promotes healthy bones, skin, teeth and gums through involvement in collagen formation. Vitamin C also helps the body absorb iron. FSANZ has several pre-approved health claims for vitamin C.

Vitamin E

Alternative names	Tocopherols and tocotrienols
Description	Vitamin E is a fat-soluble vitamin. The term vitamin E describes a family of eight antioxidants: four tocopherols (alpha-, beta-, gamma-, and delta-) and four tocotrienols (alpha-, beta-, gamma-, and delta-).
Dietary Sources	Plant seeds, especially sunflower seeds, almonds, and hazelnuts are rich sources of α-tocopherol such that many vegetable oils (e.g. olive oil and canola oil) also contain α-tocopherol. Other sources include tomato, avocado, spinach, asparagus, Swiss chard, and broccoli.
Dietary requirement per day	10 mg RDI
Solubility (water/fat)	Fat
Stability	Although vitamin E is sensitive to light, heat and oxygen, there appears to be minimal loss with cooking. Because it is fat soluble there is little leaching into cooking water.
Bioavailability	Alpha-tocopherol is the form of vitamin E that is preferentially absorbed and accumulated in the body. RRR-α-tocopherol is the most bioavailable form of α-tocopherol in the body. Synthetic α-tocopherol, which is often found in fortified food and nutritional supplements and usually labelled all-rac-α-tocopherol or dl-α-tocopherol, include all eight possible stereoisomers of α-tocopherol (see Function). Because half of the isomers present as a mixture in synthetic α-tocopherol are not usable by the body, synthetic α-tocopherol is less bioavailable than natural α-tocopherol
Safety	Few side effects have been noted in adults taking supplements of less than 2,000 mg of α-tocopherol daily (either natural or synthetic vitamin E). High doses of supplemental α-tocopherol may interfere with the vitamin K-dependent blood clotting cascade and increase the risk of bleeding in individuals taking anticoagulant drugs. A tolerable UL for α-tocopherol in adults is set at 1,000 mg/day and applies to all possible stereoisomers of α-tocopherol.
Supplements (including vs food sources)	RRR-α-tocopherol is the only stereoisomeric form of α-tocopherol found in unfortified foods. The same is not always true for nutritional supplements. Vitamin E supplements generally contain 100 IU to 1,000 IU of α-tocopherol. Supplements made from entirely natural sources contain only RRR-α-tocopherol.
Overarching comments on health benefits	Vitamin E is an antioxidant that protects cells against damage and is important for growth in children. FSANZ has two pre-approved health claims for vitamin E.

Potassium

Alternative names	K
Description	Potassium is an essential dietary mineral and has an important role as an electrolyte.
Dietary Sources	The richest sources of potassium are fruit and vegetables.
Dietary requirement per day	Note there is no RDI used by FSANZ for labelling purposes but claims can be made at 200 mg per serve.
Solubility (water/fat)	Form will determine solubility
Stability	Potassium is not destroyed by heat but some leaches into cooking water (loses about 10%).
Bioavailability	Little is known about the bioavailability of potassium, especially from dietary sources.
Safety	Several disorders characterised by serum phosphorus levels above normal (hyperphosphatemia) have been described, including those resulting from increased intestinal absorption of phosphate salts taken by mouth or by colonic absorption of the phosphate salts in enemas.
Supplements (including vs food sources)	Multivitamin-mineral supplements in the US do not contain more than 99 mg of potassium per serving. Higher doses of supplemental potassium are generally prescribed to prevent and treat potassium depletion and hypokalaemia. The use of more potent potassium supplements in potassium deficiency requires close monitoring of serum potassium concentrations. Potassium supplements are available as several different salts, including potassium chloride, citrate, gluconate, bicarbonate, aspartate and orotate. Because of the potential for serious side effects, the decision to use a potent potassium supplement should be made in collaboration with one's health care provider (see Safety).
Overarching comments on health benefits	Potassium has an important role as an electrolyte. An electrolyte is a substance that conducts electricity in the body, and these electrical impulses enable your cells to send messages back and forth between themselves. Your body maintains a balance between sodium and potassium (less sodium, more potassium). This balance plays a vital role in regulating the fluid levels in your body. Potassium is also important for nerve and muscle function. FSANZ has several pre-approved health claims for potassium.

Carotenoids

Alternative names	Tetraterpenoids
Description	Carotenoids are a large family of phytochemicals which provide the yellow, orange and some red colours of plants. They are fat-soluble compounds. Carotenoids belong to a larger class of phytochemicals known as terpenoids. Carotenoids can be broadly classified into two groups, carotenes (alpha-carotene, beta-carotene, and lycopene) and xanthophylls (beta-cryptoxanthin, lutein, and zeaxanthin). Consuming high amounts of carotenoids can cause our skin to turn yellow-orange in colour, but this condition is harmless.
Dietary Sources	Orange, yellow and some red fruits and vegetables. Also present in green leaves.
Dietary requirement per day	None established (with exception of the specific carotenes that have provitamin vitamin A activity).
Solubility (water/fat)	Fat
Stability	The carotenoids are sensitive to light, heat and oxygen, although when in foods they appear to be more stable. There are large variations in the stability of carotenoids during postharvest storage and cooking. In some cases, carotenoids increase after harvest and are very stable, especially vegetable fruits (e.g. capsicum, tomatoes). Leafy green vegetables are more susceptible to loss of carotenoids.
Bioavailability	Variable depending on specific compounds. Chopping, pureeing, and cooking carotenoid-containing vegetables in oil generally increases the bioavailability (the body's ability to absorb and process them) of the carotenoids they contain. The carotenoids from fruit are generally more bioavailable than those from vegetables.
Safety	Regarded as safe when consumed in foods but have been questions over some supplements.
Supplements (including vs food sources)	Readily available.
Overarching comments on health benefits	Carotenoids may protect the body by decreasing risk of heart disease, stroke, eye diseases (cataracts, macular degeneration), and certain types of cancer. They may also help to support the immune system, slow the aging process, reduce complications associated with diabetes, and improve lung function. At present no health claims are permitted for carotenoids (apart from selected ones which have vitamin A activity) and further human trials are required to substantiate their benefits.

Beta-carotene

Alternative names	
Description	Beta-carotene is a member of the carotenoid family and belongs to the subgroup of carotenes. It is the most commonly occurring carotenoid. It is bright orange in colour and is responsible for the colour of carrots and many other fruit and vegetables. It can be converted to vitamin A in your body (pro-vitamin A) - has a retinol activity equivalent [RAE, the measure of vitamin A activity] of 12:1 ratio or 12 µg β-carotene to 1 µg retinol. β-carotene displays in vitro antioxidant activity as a singlet oxygen quencher but evidence of in vivo antioxidant activity in humans is still controversial.
Dietary Sources	Major sources of β-carotene are carrots, sweet potatoes, spinach, broccoli, kale, pumpkin, mango, apricot and many yellow-orange fruits and green leafy vegetables.
Dietary requirement per day	Because no other specific nutrient functions have been identified at this time, no requirements have been established for any of the carotenoids (with exception of that required to deliver vitamin A equivalents).
Solubility (water/fat)	Fat
Stability	Carotenoids are unstable when exposed to oxygen heat, light and acid but are generally more stable when in a food matrix.
Bioavailability	Food processing and cooking that cause the mechanical breakdown of the food matrix help release Β-carotene from food and improve absorption. Absorption from food requires 3-5 gm of fat in a meal. Humans absorb intact carotenoids directly and circulate or accumulate them in their plasma, liver, and peripheral tissues. For β-carotene dietary supplements, bioavailability is much higher than from food as 2 µg (in oil) can be converted by the body to 1 µg retinol, giving it a RAE ratio of 2:1.
Safety	Regarded as safe when consumed in foods. Large amounts can turn the skin orange.
Supplements (including vs food sources)	Supplemental β-carotene has been examined in three large randomised, placebo-controlled trials with some participants including smokers. The doses of β-carotene ranged from 20 mg/day to 50 mg/every other day and in some studies were combined with either α-tocopherol or retinol. Unexpectedly, the risk of lung cancer was increased in smokers receiving β-carotene supplementation except for the population group consisting of male physicians. The reasons for increased risk are unclear.
Overarching comments on health benefits	Beta-carotene has provitamin A activity (this means that your body can convert it to vitamin A). In addition to the health benefits associated with vitamin A, research indicates beta-carotene may have other benefits including reducing the risk of heart disease and cancer, maintaining skin health and appearance, and helping maintain bone health. To date studies have found that beta-carotene supplements do not have the same health benefits as foods, and some have shown detrimental effects. At present no health claims are permitted for beta-carotene, other than those because of its vitamin A activity. Further human trials are required to substantiate its benefits.

Beta-cryptoxanthin

Alternative names	
Description	β-cryptoxanthin is a richly coloured member of the carotenoid family and belongs to the subgroup of xanthophylls. It has provitamin A carotenoid with a retinol activity equivalent [RAE, the measure of vitamin A activity] of 12:1 ratio, or 12 μg β-cryptoxanthin 1 μg retinol (under FSANZ regulations but elsewhere can be 24:1).
Dietary Sources	Pumpkin, papayas, sweet red peppers, orange juice, tangerines, carrots
Dietary requirement per day	None established (with exception of that required to deliver vitamin A equivalents).
Solubility (water/fat)	Fat
Stability	Carotenoids are unstable when exposed to oxygen heat, light and acid.
Bioavailability	Like β-carotene, β-cryptoxanthin is less easily absorbed than preformed vitamin A and must be converted to retinol and other retinoids by the body. The efficiency of conversion is highly variable depending on the vitamin A status, food matrix, food preparation and individual absorptive capacities.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Less commonly included in supplements that the other main carotenoids
Overarching comments on health benefits	In addition to the health benefits associated with vitamin A, research indicates beta-cryptoxanthin may have other health benefits. Beta-cryptoxanthin may play an important role in heart health and may help maintain bone health. At present no health claims are permitted for beta-cryptoxanthin, other than those because of its vitamin A activity. Further human trials are required to substantiate its benefits.

Triterpenoids (e.g. ursolic acid)

Alternative names	Triterpenes
Description	Triterpenoids are a subgroup of terpenes. One interesting group within the triterpenoids are the cucurbitacins which are an important group of functional components found in Cucurbitaceae. This group also includes compounds such as ursolic and oleanolic acids.
Dietary Sources	basil, bitter melon, cucumbers, garlic, pumpkins, squash, F50 apples, bilberries, cranberries, elder flower, olive oil
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Many are water soluble but some are fat soluble.
Stability	Most of the triterpenes are solid and show good stability.
Bioavailability	Differs by compound and many not very bioavailable.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Some such as ursolic acid available in supplements but not as common as other phytochemicals.
Overarching comments on health benefits	Several health benefits have been studied for various triterpenoids. Many have antibacterial, anticancer, anti-inflammatory and antioxidant activities. At present no health claims are permitted for triterpenoids and further human trials are required to substantiate their benefits.

Flavonoids

Alternative names	Bioflavonoids, polyphenolics
Description	Flavonoids (also sometimes called bioflavonoids) are phenolics that have a common chemical structure and function as protective phytochemicals in fruits and vegetables. They are classified into 12 major subclasses based on chemical structures, six of which, namely anthocyanidins, flavan-3-ols, flavonols, flavones, flavanones, and isoflavones, are of dietary significance. Glycosylated flavonols (bound to at least one sugar molecule) are the most widely distributed flavonoids in the diet and the aglycones usually only occur because of processing.
Dietary Sources	Present in plant foods only including fruits, vegetables, herbs, spices, essential oils and beverages.
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted, and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Variable depending on specific class.
Stability	Flavonoids are relatively stable in intact foods but can be affected by some processing and domestic preparation. The main losses occur due to leaching from foods during cooking. Processing may also cause some changes in the form of the flavonoid, e.g., removing the sugar from the aglycone.
Bioavailability	In general, the bioavailability of flavonoids is low due to limited absorption, extensive metabolism and rapid excretion. The diversity and activity of colonic bacteria determine which metabolites can be produced from ingested flavonoids and can therefore affect the metabolic fate and bioavailability of dietary flavonoids.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Widely available.
Overarching comments on health benefits	Over the past decade, scientists have become increasingly interested in the potential for various dietary flavonoids to explain some of the health benefits associated with fruit- and vegetable-rich diets. Health benefits include reducing cancer, diabetes and heart disease risk, helping maintain healthy bones, brain and vision. They have various modes of action that may be responsible for these benefits such as antioxidant activity, regulation of inflammation, neuroprotective effects, enhancement of immune responses and regulating energy metabolism and gut health. At present no health claims are permitted for flavonoids and further human trials are required to substantiate their benefits.

Anthocyanins (e.g. cyanidin, petunidin, delphinidin, malvidin, pelargonidin, peonidin and their glycosides)

Alternative names	Anthocyanidins
Description	Anthocyanins are water-soluble pigments responsible for most of the red, blue and purple colours of plants. They are phenolic compounds (a subgroup of the flavonoids) which have a very specific structure made up of three phenolic rings. These pigments are commonly named after flowers and include: cyanidin, delphinidin, malvidin, pelargonidin, peonidin and petunidin. In the plant the anthocyanins are virtually always present in the form of glycosides (one or more sugars attached). There are over 500 different anthocyanins found in plants and each plant has its own profile of anthocyanins (usually between one and twenty). Anthocyanins are one of the most prominent flavonoid classes in the diet.
Dietary Sources	Red/blue/purple coloured fruits and vegetables, e.g. apples, blackberries, blackcurrants, blueberries, eggplant, elderberries, radish, raspberries, red cabbage, red wine, strawberries.
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Water soluble, primarily at low pH.
Stability	There are many factors that can affect the stability and colour of anthocyanins. Factors include pH, temperature, light, oxygen, metal ions and the presence of other food components (e.g. sugars, proteins). Because the anthocyanins are water soluble, they are prone to loss by leaching (e.g. into the cooking water on boiling). In some cases, although the red colour the anthocyanins disappears during processing, they are still present but have been converted to their non-coloured form. A few drops of acid (e.g. lemon juice or vinegar) and the colour returns.
Bioavailability	Anthocyanins are poorly absorbed.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Widely available and usually extracted from various fruits, e.g. blackcurrants.
Overarching comments on health benefits	Research indicates anthocyanins may have a wide variety of health benefits including protecting against the signs of aging. Research studies have demonstrated anthocyanins may have benefits for reducing the risk of cancer and diabetes, they may be neuroprotective to help prevent neurological diseases and improve aspects of vision. They have many different activities including antioxidant, anti-inflammatory, antibacterial and antiviral activities. At present no health claims are permitted for anthocyanins and further human trials are required to substantiate their benefits.

Flavan-3-ols (e.g. catechin, epigallocatechin, epicatechin, epicatechin 3-gallate, epigallocatechin 3-gallate, gallocatechin)

Alternative names	catechins, flavanols
Description	Flavan-3-ols are possibly the most complex subclass of flavonoids. Flavan-3-ols are a subgroup of the flavonoids. They include compounds such as catechin, gallocatechin, epicatechin and epigallocatechin. The monomeric flavan-3-ols units can join to form dimers and then larger molecules called the proanthocyanidins. Flavan-3-ols are present in some fruits and vegetables but the highest amounts are found in tea, cocoa and chocolate.
Dietary Sources	Teas (particularly white, green, and oolong), cocoa-based products, grapes, beans, berries, apples
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Some solubility in water but increases with temperature and addition of alcohol.
Stability	Reasonably stable but can form complexes with other compounds over time.
Bioavailability	In general, flavan-3-ol monomers are transformed by intestinal microbiota to metabolites which are easily absorbed into the circulatory system and excreted in both free forms and phase II metabolites in urine. Monomers are readily absorbed in the small intestine, unlike the proanthocyanidins.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Readily available from a range of different sources.
Overarching comments on health benefits	The health benefits of flavan-3-ols are like flavonoids in general. Flavan-3-ols have been reported to exhibit several health beneficial effects by acting as antioxidant, anticarcinogen, cardiopreventive, antimicrobial, anti-viral, and neuroprotective agents. At present no health claims are permitted for flavan-3-ols and further human trials are required to substantiate their benefits.

Flavonols (e.g. isorhamnetin, kaempferol, myricetin, quercetin and their glycosides)

Alternative names	
Description	Flavonols are a class of flavonoids and their diversity stems from the different positions of the phenolic -OH groups. They are distinct from flavanols such as catechin, another class of flavonoids. Flavonols are present in a wide variety of fruits and vegetables. Common flavonols are quercetin, kaempferol and myricetin. They are not to be confused with flavanols (flavan-3-ols).
Dietary Sources	Onions, scallions, kale, broccoli, apples, berries, teas
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Low solubility in water but increases with temperature and addition of alcohol.
Stability	Relatively stable.
Bioavailability	In general, the bioavailability is low due to limited absorption, extensive metabolism and rapid excretion. The diversity and activity of colonic bacteria determine which metabolites can be produced from ingested flavonoids and can therefore affect the metabolic fate and bioavailability of dietary flavonoids.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Readily available from a range of different sources.
Overarching comments on health benefits	The health benefits of flavonols are like flavonoids. They exhibit anticancer activity, have positive effects on major diseases such as cardiovascular disease, type-2 diabetes, Alzheimer's disease and osteoporosis. Various modes of action support the reduction of disease risk including inhibition of platelet aggregation, antioxidant and anti-inflammatory activities. At present no health claims are permitted for flavonols and further human trials are required to substantiate their benefits.

Proanthocyanidins (dimers, trimers, 4-6 mers, 7-10 mers, polymers)

Alternative names	Procyanidins, condensed tannins, oligomeric procyanidins (OPCs), proanthocyanins, procyanidolic oligomers (PCOs)
Description	Proanthocyanidins are a class of polyphenols found in a variety of plants. Proanthocyanidins are a class of polyphenols which are made up of flavan-3-ol units (e.g. catechin and epicatechin and their gallic acid esters). They may be dimers (two units), trimers (three units), or polymers (many units linked together). More complex polyphenols, having the same polymeric building block, form the group of tannins. Procyanidins are the most common class of proanthocyanidins and are made up of catechin and/or epicatechin. Propelargonidins and prodelphinidins are less common.
Dietary Sources	Apples, berries, cocoa-based products, red grapes, red wine.
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Some soluble water but others insoluble.
Stability	Generally stable by can transform to form more complex structures under some conditions.
Bioavailability	The polymeric nature of proanthocyanidins likely prevents their intestinal absorption. Procyanidins are transformed by intestinal microbiota to metabolites which are easily absorbed into the circulatory system and excreted in both free forms and phase II metabolites in urine.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Readily available from a range of different sources.
Overarching comments on health benefits	Proanthocyanidins share common properties with other phenolics. In particular, they may have benefits for atherosclerosis, gastric ulcer, large bowel cancer, urinary tract infections, cataracts and diabetes. At present no health claims are permitted for allicin and further human trials are required to substantiate its benefits.

Phenolic acids (chlorogenic, caffeic, p-coumaric, vanillic, ferulic, sinapic and protocatechuic acids)

Alternative names	
Description	Phenolic acids are a subgroup of the phenolics. The phenolic acids are often further divided into hydroxycinnamic (hydroxy derivatives of cinnamic acid) and hydroxybenzoic structures. The phenolic acids are relatively stable in food during storage. The main losses occur when vegetables are cut and enzymic browning occurs or on cooking. Like other phenolics they are water-soluble and so are lost into cooking water.
Dietary Sources	Alfalfa sprouts, artichokes, chicory, eggplant, lettuce, potatoes, pumpkins, spinach, squash; apples, blueberries, cherries, citrus fruits, coffee, kiwifruit, mangoes, oats, pears, plums, tea, wheat.
Dietary requirement per day	Unlike nutrients (vitamins and minerals), no recommended dietary intake levels have been established for phytochemicals. Health claims are not permitted and further human trials are required to substantiate the benefits suggested below.
Solubility (water/fat)	Water.
Stability	The phenolic acids are relatively stable in food during storage. The main losses occur when vegetables are cut and enzymic browning occurs or on cooking. Like other phenolics, they are water-soluble and so are lost into cooking water.
Bioavailability	Better bioavailability than other phenolics.
Safety	Regarded as safe when consumed in foods.
Supplements (including vs food sources)	Included in some supplements but not generally a focus like some of the other phenolics.
Overarching comments on health benefits	Despite a diversity of chemical structures, the phenolic acids have similar biological activities. They have antioxidant, antimutagenic, antiviral, antibacterial (bactericidal, bacteriostatic), antifungal, antiprotozoal, nematicidal, estrogenic, platelet aggregation inhibiting, hypoglycaemic activities. They may have benefits for heart health and immunity. A diet rich in hydroxycinnamic acids is thought to be associated with beneficial health effects such as a reduced risk of cardiovascular disease. The hydroxycinnamic acids have also shown some potential for the treatment of Alzheimer's disease and have benefits for bone health. Several studies have shown them to have strong antioxidant activity, and some animal studies have suggested they may have anticancer and antidiabetic activity and they are also antimicrobial in vitro. At present no health claims are permitted for phenolic acids and further human trials are required to substantiate its benefits.

7 References

Alajil O, Sagar VR, Kaur C, Rudra SG, Sharma RR, Kaushik R, Verma MK, Tomar M, Kumar M, Mekhemar M 2021. Nutritional and phytochemical traits of apricots (*Prunus armeniaca* L.) for application in nutraceutical and health industry. Foods 10(6): 1344. doi: 10.3390/foods10061344. PMID: 34200904; PMCID: PMC8230439.

Al-Soufi MH, Alshwyeh HA, Alqahtani H, Al-Zuwaid SK, Al-Ahmed FO, Al-Abdulaziz FT, Raed D, Hellal K, Mohd Nani NH, Zubaidi SN, Asni NSM, Hamezah HS, Kamal N, Al-Muzafar H, Mediani A 2022. A review with updated perspectives on nutritional and therapeutic benefits of apricot and the industrial application of its underutilized parts. Molecules 27: 5016. https://doi.org/10.3390/molecules27155016

Awad MA, de Jager A, van Westing LM 2000. Flavonoid and chlorogenic acid levels in apple fruit: characterisation of variation, Scientia Horticulturae 83: 15-54.

Bento C, Goncalves AC, Silva B, Silva LR 2020. Peach (*Prunus persica*): phytochemicals and health benefits. Food Rev Int 10.1080/87559129.2020.1837861: 32.

Blando F, Oomah BD 2019. Sweet and sour cherries: Origin, distribution, nutritional composition and health benefits. Trends Food Sci Technol 86: 517-529.

Burkhardt S, Tan DX, Manchester LC, Hardeland R, Reiter RJ 2001. Detection and quantification of the antioxidant melatonin in Montmorency and Balaton tart cherries (*Prunus cerasus*). J Agric Food Chem 49(10): 4898-4902. doi: 10.1021/jf010321+. PMID: 11600041.

Byrne DH, Noratto G, Cisneros-Zevallos L, Porter W, Vizzotto M 2009. Health benefits of peach, nectarine and plums. In: Patil B, ed. International Symposium on Human Health Effects of Fruits and Vegetables: Favhealth 2007. Leuven 1: Int Soc Horticultural Science. p. 267-273.

Cargnin ST, Gnoatto SB 2017. Ursolic acid from apple pomace and traditional plants: A valuable triterpenoid with functional properties. Food Chemistry 220: 477-489.

Dabbou S, Lussiana C, Maatallah S, Gasco L, Hajlaoui H, Flamini G 2016. Changes in biochemical compounds in flesh and peel from Prunus persica fruits grown in Tunisia during two maturation stages. Plant Physiol Biochem 100: 1-11.

da Silva LC, Viganó J, de Souza Mesquita LM, Dias ALB, de Souza MC, Sanches VL, Chaves JO, Pizani RS, Contieri LS, Rostagno MA 2021. Recent advances and trends in extraction techniques to recover polyphenols compounds from apple by-products. Food Chem X 12: 100133. doi: 10.1016/j.fochx.2021.100133. PMID: 34632369; PMCID: PMC8493574.

Ehrenkranz JRL, Lewis NG, Kahn CR, Roth J 2005. Phlorizin: a review. Diabetes Metab Res Rev 21: 31–38.

Esti M, Cinquanta L, Sinesio F, Moneta E, di Matteo M 2002. Physicochemical and sensory fruit characteristics of two sweet cherry cultivars after cool storage. Food Chem 76: 399-405.

Food Standards Australia New Zealand 2016. Short guide for industry to the Nutrient Profiling Scoring Criterion. https://www.foodstandards.gov.au/industry/labelling/Pages/Short-guide-for-industry-NPSC.aspx [accessed 28 September 2022].

Food Standards Australia New Zealand 2017a. Australia New Zealand Food Standards Code – Schedule 4 — Nutrition, health and related claims. https://www.legislation.gov.au/Details/F2017C00711 [accessed 28 September 2022].

Food Standards Australia New Zealand 2017b. Australia New Zealand Food Standards Code – Schedule 12 — Nutrition information panels. Available at: https://www.legislation.gov.au/Details/F2017C00342 [accessed 28 September 2022].

Food Standards Australia New Zealand 2018. Australia New Zealand Food Standards Code – Schedule 1 — RDIs and ESADDIs. Available at: https://www.legislation.gov.au/Series/F2015L00491 [accessed 28 September 2022].

Food Standards Australia New Zealand 2021a. Australia New Zealand Food Standards Code – Standard 1.2.8 – Nutrition information requirements. Available at: https://www.legislation.gov.au/Details/F2021C00668 [accessed 28 September 2022].

Food Standards Australia New Zealand 2021b. Nutrient Profiling Scoring Calculator. http://archive.foodstandards.gov.au/consumerinformation/nutritionhealthandrelatedclaims/nutrientprofilingcalculator/index_code.cfm [accessed 28 September 2022].

Food Standards Australia New Zealand 2022. Australian Food Composition Database – Release 2. Canberra: FSANZ. Available at www.foodstandards.gov.au.

Fraga CG, Croft KD, Kennedy DO, Tomás-Barberán FA 2019. The effects of polyphenols and other bioactives on human health. Food Funct 10(2):514-528. doi: 10.1039/c8fo01997e. PMID: 30746536.

Fratianni F, Ombra MN, d'Acierno A, Cipriano L, Nazzaro F 2018. Apricots: biochemistry and functional properties. Curr Opin Food Sci 19: 23-29.

Gayer BA, Avendano EE, Edelson E, Nirmala N, Johnson EJ, Raman G 2019. Effects of intake of apples, pears, or their products on cardiometabolic risk factors and clinical outcomes: a systematic review and meta-analysis. Curr Dev Nutr 3(10): 14.

Gil MI, Tomás-Barberán FA, Hess-Pierce B, Kader AA 2002. Antioxidant capacities, phenolic compounds, carotenoids, and vitamin C contents of nectarine, peach, and plum cultivars from California. J Agric Food Chem 50(17): 4976-4982. doi: 10.1021/jf020136b. PMID: 12166993.

Gliszczynska-Swiglo A, Tyrakowska B 2003. Quality of commercial apple juices evaluated on the basis of the polyphenol content and the TEAC antioxidant activity J Food Sci 68: 1844-1849.

Goncalves AC, Bento C, Silva B, Simoes M, Silva LR 2019. Nutrients, bioactive compounds and bioactivity: the health benefits of sweet cherries (*Prunus avium* L.). Curr Nutr Food Sci 15(3): 208-227.

González-Gómez D, Lozano M, Fernández-León MF, Ayuso MC, Bernalte MJ, Rodríguez AB 2009. Detection and quantification of melatonin and serotonin in eight sweet cherry cultivars (*Prunus avium* L.). Eur Food Res Technol 229(2): 223-229.

Guyot S, Marnet N, Sanoner P, Drilleau JF 2003. Variability of the polyphenolic composition of cider apple (*Malus domestica*) fruits and juices. Agric Food Chem 51: 6240-6247.

Howatson G, Bell PG, Tallent J, Middleton B, Mchugh MP, Ellis J 2012. Effect of tart cherry juice (Prunus cerasus) on melatonin levels and enhanced sleep quality. Eur J Nutr 51(8): 909–916.

Hussain S, Javed M, Abid MA, Khan MA, Syed SK, Faizan M, Feroz F 2021. *Prunus avium* L.; phytochemistry, nutritional and pharmacological review. Advan Life Sci 8(4): 307-314.

James-Martin G, Williams G, Stonehouse W 2016. Translating the scientific evidence for apples and pears into health messages. CSIRO report for Horticulture Innovation Australia Ltd (Hort Innovation) https://www.aussieapples.com.au/wp-content/uploads/2017/07/CSIRO-Health-Report-2016.pdf.

Jayarajan S, Sharma RR, Sethi S, Saha S, Sharma VK, Singh S 2019. Chemical and nutritional evaluation of major genotypes of nectarine (*Prunus persica* var *nectarina*) grown in North-Western Himalayas. J Food Sci Technol 56(9): 4266-4273. doi: 10.1007/s13197-019-03896-2. Epub 2019 Jul 1. PMID: 31477997; PMCID: PMC6706499.

Kafkaletou M, Kalantzis I, Karantzi A, Christopoulos MV, Tsantili E 2019. Phytochemical characterization in traditional and modern apricot (*Prunus armeniaca* L.) cultivars – Nutritional value and its relation to origin. Scientia Horticulturae 253: 195-202.

Kelley DS, Adkins Y, Laugero KD 2018. A review of the health benefits of cherries. Nutrients 10(3): 22.

Kim SJ, Anh NH, Jung CW, Long NP, Park S, Cho YH, Yoon YC, Lee EG, Kim M, Son EY et al. 2022. Metabolic and cardiovascular benefits of apple and apple-derived products: a systematic review and meta-analysis of randomized controlled trials. Front Nutr 9: 15.

Łata B 2007. Relationship between apple peel and the whole fruit antioxidant content: year and cultivar variation. J Agric Food Chem 55(3): 663-671.

Liu RH 2013. Health-promoting components of fruits and vegetables in the diet. Adv Nutr 4(3):384S-92S. doi: 10.3945/an.112.003517. PMID: 23674808; PMCID: PMC3650511.

Massarotto C, Huffman L, George S 2022. New consumer products made from apples, cherries, apricots, peaches and nectarines. A Plant & Food Research report prepared for: Central Otago District Council, Summerfruit New Zealand, LILO Desserts, The Bio-resource Processing Alliance. PFR SPTS No. 23287.

McCune LM, Kubota C, Stendell-Hollis NR, Thomson CA 2011. Cherries and health: a review. Crit Rev Food Sci Nutr 51(1): 1-12.

Monjotin N, Amiot M-J, Fleurentin J, Jean-Michel M, Raynal S 2022. Clinical evidence of the benefits of phytonutrients in human healthcare. Nutrients, MDPI, 14 (9): 1-54. ff10.3390/nu14091712ff. ffhal-03681092.

Mozetic B, Trebse P, Simcic M, Hribar J 2004. Changes of anthocyanins and hydroxycinnamic acids affecting the skin colour during maturation of sweet cherries (*Prunus avium* L.). LWT - Food Sci Technol. 37: 123-128.

Neveu V, Perez-Jiménez J, Vos F, Crespy V, du Chaffaut L, Mennen L, Knox C, Eisner R, Cruz J, Wishart D, Scalbert A 2010. Phenol-Explorer: an online comprehensive database on polyphenol contents in foods. Database, doi: 10.1093/database/bap024. http://phenol-explorer.eu/.

New Zealand Food Composition Database 2022. New Zealand Food Composition Database Online Search. The New Zealand Institute for Plant & Food Research Limited and Ministry of Health. https://www.foodcomposition.co.nz/search [accessed 2 October 2022].

Nezbedova L, McGhie T, Christensen M, Heyes J, Nasef NA, Mehta S 2021. Onco-preventive and chemo-protective effects of apple bioactive compounds. Nutrients 13(11) 4025. https://doi.org/10.3390/nu13114025.

Nunes AR, Goncalves AC, Falcao A, Alves G, Silva LR 2021. *Prunus avium* L. (sweet cherry) by-products: a source of phenolic compounds with antioxidant and anti-hyperglycemic properties-a review. Appl Sci-Basel 11(18): 23.

Oyenihi AB, Belay ZA, Mditshwa A, Caleb OJ 2022. "An apple a day keeps the doctor away": The potentials of apple bioactive constituents for chronic disease prevention. J Food Sci 87(6): 2291-2309.

Pereira N, Naufel MF, Ribeiro EB, Tufik S, Hachul H 2020. Influence of dietary sources of melatonin on sleep quality: a review. J Food Sci 85(1): 5-13.

Price KR, Prosser T, Richetin AMF, Rhodes MJC 1999. A comparison of the flavonol content and composition in dessert, cooking and cider-making apples; distribution within the fruit and effect of juicing. Food Chem 66: 489-494.

Radi M, Mahrouz M, Jaouad A, Amiot MJ 2004. Characterization and identification of some phenolic compounds in apricot fruit (*Prunus armeniaca* L.). Sciences des Aliments 24: 173-183.

Sartaj A, Tariq M, Abbasi KS, Talat M, Azhar H 2015. Apricot: nutritional potentials and health benefits - a review. Ann Food Sci Tech 16(1): 175-189.

Sochor J, Zitka O, Skutkova H, Pavlik D, Babula P, Krska B, Horna A, Adam V, Provaznik I, Kizek R 2010. Content of phenolic compounds and antioxidant capacity in fruits of apricot genotypes. Molecules 15(9): 6285-6305. https://doi.org/10.3390/molecules15096285.

Tomás-Barberán FA, Gil MI, Cremin P, Waterhouse AL, Hess-Pierce B, Kader AA 2001. HPLC-DAD-ESIMS analysis of phenolic compounds in nectarines, peaches, and plums, J Agric Food Chem 49: 4748-4760.

Tomás-Barberán FA, Ruiz D, Valero D, Rivera D, Obón C, Sánchez-Roca C, Gil MI 2013. Health Benefits from Pomegranates and Stone Fruit, Including Plums, Peaches, Apricots and Cherries. In: Bioactives in Fruit. Skinner M & Hunter D Eds. Wiley Blackwell. pp. 125-167.

U.S. Department of Agriculture, Agricultural Research Service 2022. FoodData Central. fdc.nal.usda.gov.

Xia H, Shen Y, Shen T, Wang X, Zhang X, Hu P, Liang D, Lin L, Deng H, Wang J, Deng Q, Lv X 2020. Melatonin accumulation in sweet cherry and its influence on fruit quality and antioxidant properties. Molecules 25(3): 753. doi: 10.3390/molecules25030753. PMID: 32050515; PMCID: PMC7037775.

Yuste S, Ludwig IA, Romero MP, Motilva MJ, Rubio L 2022. New red-fleshed apple cultivars: a comprehensive review of processing effects, (poly)phenol bioavailability and biological effects. Food Funct 13(9): 4861-4874.

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