

# **Horticulture Innovation Australia**

## **Final Report**

### **Identifying and understanding the factors influencing bioactive levels in vegetables**

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Research Ltd

Project Number: VG14027

## **VG14027**

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## Summary

This project collated information on the phytonutrients (bioactives) in levied vegetables. It builds on our previous project Veggycation® which largely focussed on the core nutrients (vitamins and minerals) for which claims are currently permitted by Food Standards Australia New Zealand (FSANZ). The initial Veggycation project collated some information on certain classes of phytonutrients but did not provide quantitative data. This current project added this information to the Veggycation framework, including the addition of new phytonutrients and further layers of information on these vegetable components. In particular, detailed data was added on the typical amounts of phytonutrients present, their status with regards to health claims and snippets of the latest research plus new information on postharvest effects.

In order to grow the export market for Australian vegetables, there needs to be a greater understanding of the regulations in relevant overseas territories. In order to achieve this information on the current status of the science and approved legislation relating to the health benefits of phytonutrients in both domestic and relevant Asian export markets was also collated. The current legislation is extremely limiting with claims for phytonutrients other than content claims. Our experience with nutrition and health claim science, and the food standards, leads us to believe that it may take some time before health claims for phytonutrients are proven to clinical standards and accepted by FSANZ and other international regulatory bodies. The industry also faces the challenge that it may take even longer for the health benefits of vegetables to be understood by consumers. However, this project will enable the industry to take steps towards a future where claims can be made. In the longer term this work will better position the vegetable industry for the future to promote fresh vegetables and/or development of vegetable products as health solutions in the domestic and/or export markets due to verifiable levels of bioactive compounds. This will be achieved in part through: 1) improving grower awareness and access to resources which measure product relevant phytonutrients; and 2) enhancing their ability and capacity to consciously influence levels of phytonutrients in a crop via postharvest practices. In the longer term this will translate to increased incidence of vegetable growers positioning vegetables or developing vegetable products as health solutions in the domestic and/or export markets.

This project has developed a useful resource of information on phytonutrients in vegetables and as a result amendments were made and resources added to [www.veggycation.com.au](http://www.veggycation.com.au) as text and downloads.

## **Keywords**

Vegetables; herbs; phytonutrients; bioactives; health; benefits; nutrition; claims; regulations

## Introduction

A previous project (VG12043) undertaken by this team established a web portal to communicate the health benefits of vegetables to stakeholders ([www.veggycation.com.au](http://www.veggycation.com.au)). The aim of this current project was to extend that information to include more detailed information on phytonutrients (bioactives) and the regulations that impact on what can be communicated about them. Note the FSANZ definition of a biologically active substance means a substance, other than a nutrient, with which health effects are associated. We are using the term phytonutrients for those bioactives derived from plants but these compounds are also referred to as phytochemicals. We have deliberately chosen to use the term phytonutrient as it is more consumer friendly and has more positive connotations.

Veggycation is an innovative campaign that aims to simplify the complexity of food standards and enable greater use of relevant nutrition and health labeling for fresh vegetables. At the same time Veggycation helps educate consumers, assisting them to make more informed food choices and increase their vegetable intake. Labelling fresh vegetables with nutrition and health claims has until now been seriously limited by the complexity of the food standards framework. To capitalise on the opportunity offered by the change in food standards in 2013, effective communication of nutrition and health benefit messages about (levied) vegetables to diverse vegetable industry stakeholders was needed. The initial project setting up Veggycation was the first step in doing this.

Initially Veggycation mainly focused on the core nutrients (vitamins and minerals) for which claims are currently permitted by FSANZ, although it did also include some information on phytonutrients. We assessed consumer understanding of health benefits of vegetables and concluded that consumer knowledge was poor and often misguided. Veggycation has been a starting point to help remedy this. Health claims for nutrients are only the first step and are relatively simple in some cases due to a catalog of pre-approved claims and our establishment of criteria for the use of health claim symbols. Phytonutrients differ as there are not pre-approved claims at present. Our experience with nutrition and health claim science, and the food standards, leads us to believe that it may take some time before health claims for phytonutrients are proven to clinical standards and accepted by FSANZ but they are likely to be there in the future. There is also the potential for the industry to develop self-substantiated health claims. The industry also faces the challenge that it may take more time for the health benefits of vegetables to be understood by consumers. However, steps are required to guide the vegetable industry for the longer term benefit and to capture innovation and to educate the consumer so they will uptake new products. Expanding Veggycation to include more information on phytonutrients is one step on the pathway.

Veggycation collated information on certain classes of phytonutrients, such as beta-carotene; however, this was limited due to the scope of that project and time and cost constraints. This new project has built on the Veggycation framework, adding further layers of information to these classes of phytonutrients. In particular, we have added detailed information on the levels of phytonutrients and their status with regards to health claims. Additional phytonutrients not included in the original Veggycation database were also be reported on where there was sufficient data.

Under current health claims regulations in Australia and New Zealand (FSANZ Standard 1.2.7), there are serious limitations to the claims permitted for biologically active substances (as defined in FSANZ Standard 1.2.8) in food products. We believe the FSANZ legislation will evolve over time as increasing scientific evidence is gathered to support health claims for specific compounds. In order to grow the export market for Australian vegetables, there needs to be a greater understanding of the regulations in relevant overseas territories, in particular Asia. Thus information was gathered for these export countries.

# Methodology

The project comprised four main parts:

## 1. Literature and database review

Information on the phytonutrient content of Australian-grown vegetables is limited as the current food composition database for Australia (NUTTAB) does not generally include these components. The exception is a small number of carotenoids but this data is only available for some vegetables and not always in line with other sources of data. Even the scientific literature is limited for the phytonutrient composition and content of Australian grown vegetables. The challenge with the scientific literature is that methods are not standardized and are often taken in isolation so it can be difficult to assess data quality. Only data that was of sufficient quality was accepted for our database purposes.

A number of sources of information were used for this work:

- NUTTAB: This database (<http://www.foodstandards.gov.au/science/monitoringnutrients/nutrientables/nuttab/Pages/default.aspx>) provided limited information on some of the carotenoids.
- United States Department of Agriculture (USDA) Database: The USDA National Nutrient Database for Standard Reference (<http://ndb.nal.usda.gov/>) provided quantitative data for carotenoids and flavonoids.
- ORAC Database: The USDA Database for the Oxygen Radical Absorbance Capacity (ORAC) of Selected Foods, Release 2 ([http://www.orac-info-portal.de/download/ORAC\\_R2.pdf](http://www.orac-info-portal.de/download/ORAC_R2.pdf)) provided quantitative data for total phenolics. Note although this database has officially been withdrawn (due to issues with the ORAC assay) the total phenolic data is still valid and drawn from the published literature.
- Phenol Explorer: The Phenol-Explorer database, release 3.6 (<http://phenol-explorer.eu/>) provided quantitative information on most classes of phenolics. In a small number of cases data was not used because it did not agree with a larger body of information obtained from a variety of scientific literature.
- Scientific literature: Web of Science databases were searched for scientific papers relating to phytonutrients. This included qualitative and quantitative data on phytonutrient composition as well as health benefit and postharvest information for the individual vegetables. Initial searches were restricted to Australian-grown vegetables but there was very limited information and in some cases the study quality was poor or there were insufficient controls to assess the validity of the data. Searches were then extended to include reviews where data for multiple vegetables was included. Where possible searches were restricted to the last 10 years; however, for a few of the more uncommon vegetables the complete

databases were searched. Information was only used where vegetables were clearly identified with the correct scientific name.

- Plant & Food Research data: Our laboratory has collected phytonutrient data for the last 20 years and this information was accessed and used as appropriate where there were no restrictions on the data usage.

Information searched included:

- a) Qualitative and quantitative data on phytonutrients. This data was collated in a spreadsheet and typical average values transferred to the Veggycation database. It had been intended to make comparisons between concentrations in Australian vegetables and overseas data. However, there was such limited Australian data and it was not always of a sufficient quality standard or using comparable methods for this comparison to be possible.
- b) Key factors that may influence levels of phytonutrients, especially postharvest practices (noting that pre-harvest factors such as cultivar, light levels and other growing practices, maturity, etc. were out of scope, but may be identified in VG14025 – it is hoped that data collated in this project may be transferred to Veggycation at some point).
- c) Health benefits, including the latest human clinical trials. If no human clinical trials had been conducted then animal trials were searched for, and failing that in vitro studies.
- d) Suggested intakes of phytonutrients. There is very limited data in this regard at present and the indicative data are inconsistent in some cases. It was decided not to make this information available via Veggycation as it is felt that this may be misleading as there are no official recommendations and data is indicative only at this point.
- e) Other food sources of the phytonutrients.

Data was entered into an Excel spreadsheet and integrated within the searchable [www.veggycation.com.au](http://www.veggycation.com.au) database. Most of the info was made available for Growers/Industry via a separate tab, to avoid confusion in consumer's minds regarding approved and unapproved health information. Some of the more general level of information is available to the general public to start educating them further on phytonutrients.

## **2. Review of regulations**

The current state of play regarding health claims for phytonutrients was reviewed for both domestic and key export markets. This information was collated from websites of the regulatory bodies in each of these countries. Discussion was also had with the Ministry for Primary Industries (MPI), who are the enforcement agency for the FSANZ regulations in New Zealand. The countries included were:

- a. Australia
- b. China
- c. Hong Kong
- d. India

- e. Indonesia
- f. Japan
- g. Malaysia
- h. New Zealand
- i. Philippines
- j. Singapore
- k. Taiwan
- l. Thailand
- m. Vietnam.

### **3. Collation of testing labs**

Within Veggycation we collated the Australian labs which can conduct standard nutrient testing. Within this project we expanded that list to include a wider range of phytonutrient testing. We recognise that many of these tests may not currently be available in commercial labs and research facilities/ universities that may be able to fill these gaps will be identified. Future challenges will be identified (e.g. transference of methodologies, availability of standards) and these will be outlined in the final report. We will also make recommendations for further R&D required to improve and expand phytonutrient testing facilities.

### **4. Communication**

This information was converted into user-friendly information on [www.veggycation.com.au](http://www.veggycation.com.au). Phytonutrient information, in some cases in summary format, was used to update the database behind [www.veggycation.com.au](http://www.veggycation.com.au) so that when information about each levied vegetable is presented, it includes the new phytonutrient data. For some of the information the outcomes are available on [www.veggycation.com.au](http://www.veggycation.com.au) in a searchable format (with appropriate references) in the form of downloadable fact sheets.

SMART metrics: As the potential to utilise these claims may not become available in domestic markets within the lifetime of this project, we will measure success by continuing to collate statistics based on access of info from [www.veggycation.com.au](http://www.veggycation.com.au) and contacts from interested growers with whom we could work on specific aspects of this as required (outside the current project, if required).

## Outputs

The main outputs of this project are communicated via the [www.veggycation.com.au](http://www.veggycation.com.au) website. This has been updated with a wealth of new information on phytonutrients. These changes include additional information available provided in a number of the website sections and individual pages along with three new downloads. Some of the information is restricted to the Growers (& Industry) section.

### Database

In order to update the website a large number of changes and additions have been made to the database that sits behind the website. These changes include:

1) Phytonutrient information: An updated list has been compiled with new compounds and classes of compound. The information gathered for each of these phytonutrients are: alternative names, description, key vegetable sources, other food sources and health benefits. A complete list of all the phytonutrients now included in Veggycation is provided in Appendix 1 along with the status of information able to be included on the website with regards qualitative data, quantitative data and likely intake level required for benefits. There are some gaps in the data where quality information could not be sourced. The additional phytonutrients added as a result of this project are:

- Alkaloids
- Betacyanins
- Betaxanthins
- Brassica sulphur compounds
- Catechin
- Coumestrol
- Cyanidin
- Daidzein
- Delphinidin
- Epicatechin
- Epicatechin 3-gallate
- Epigallocatechin
- Epigallocatechin 3-gallate

- Eriodictyol
- Falcarindiol
- Falcarinol
- Formononetin
- Furanocoumarins
- Gallocatechin
- Genistein
- Glucoraphanin
- Hesperetin
- Hydroxybenzoic acids
- Isorhamnetin
- Malvidin
- Myricetin
- Pelargonidin
- Peonidin
- Petunidin
- Phenolics
- Phytoestrogens
- Polysaccharides
- Sulphur compounds
- Xanthophylls.

- 2) Phytonutrient hierarchy: A new page has been included in the database to show the relationships between the named phytonutrients - classes and subclasses down to individual compounds. This hierarchy table is given in Appendix 2.
- 3) Vegetable information for growers: New information has been included on the latest scientific research on the health benefits of the individual vegetables and postharvest effects on phytonutrients. This information has been made available in only the Growers (& Industry) section of the website at present. A summary of the new information included by vegetable is given in Appendix 3. There are some gaps in the data where there was no relevant information for particular vegetables.
- 4) Asian market claim regulations: A new sheet has been included in the database to summarise

the regulatory information. This includes: regulatory body, website of regulatory body, if it is possible to make a health claim, if there is a list of pre-approved health claims, potential of health claims for phytonutrients, if you can apply to have a new health claim approved for use, requirements for health claims on imported foods, regulatory document and website link for the regulatory documents.

- 5) Adult & kids fun facts plus jokes: The opportunity has been taken to provide new facts to keep the Veggycation website fresh. A focus was made to add some facts that were particularly relevant to phytonutrients. The new information included is provided in Appendix 4.
- 6) Glossary and abbreviations: These sections have been updated to capture new terms and abbreviations used with regards phytonutrients and the health claims regulations.

## Website

There have been a number of visible changes to the Veggycation website. The section For Growers (& Industry) has new information on the Phytonutrients front page including links to two of the downloads.

What is Veggycation? For Veg Lovers For Kids (& Teachers) For Growers (& Industry) Glossary Downloads Cooking Veg

Also in this section:  
Health Benefits  
Vegetable Management  
Nutrients  
Phytonutrients  
HOW TO Guide  
Links  
Case Studies  
Log out

# Phytonutrients

Apart from vitamins and minerals, vegetables are also rich in a wide range of phytonutrients (these are the things that give vegetables their colour and flavour like lycopene, lutein and beta-carotene). Nutrition and health benefit claims cannot be made for phytonutrients. However, this is an area of much research. To find out more about the key vegetable phytonutrients use the search function below.

Please select  VIEW

**NEW!!!!** :- Find a laboratory near you to analyse the phytonutrients in your vegetables. Click [here](#) to download a list.

**NEW!!!!** :- Find out about the regulations in other countries with regard to nutrient and phytonutrient claims by clicking [here](#) and downloading our guide.

The term phytonutrients (pronounced fight-o-nutrients) simply means plant compounds. It is commonly used to refer to the non-nutrients in plant-based foods that provide an array of health benefits, and in particular the plant pigments. Thus, brightly coloured fruits and vegetables are usually rich in phytochemicals, although there are exceptions. There are thousands of different phytochemicals that have been found in plant foods and no doubt more will be discovered. These protective plant compounds are an emerging area of nutrition and health, with new research reported every day. The two most common groups of phytochemicals are:

- Carotenoids (e.g. beta-carotene, lycopene)
- Phenolics/polyphenolics (e.g. anthocyanins, procyanidins, chlorogenic acid)

New downloads

More detailed information on phytonutrients

On the pages for the individual vegetables the key phytonutrients are now quantified if they are present at sufficient concentrations and there is quality data present. If there is data to indicate a compound is present but not the quantity then these compounds are still shown. An example for broccoli is shown below.

Please select  VIEW



### Broccoli

Alternative name: calabrese

Scientific name: *Brassica oleracea* (Italic group)

Serving size: 75 g

Description: Broccoli means 'little sprouts' in Italian and is a member of the brassica family of vegetables. Broccoli has a distinctive 'mustardy' taste. It is the immature flower heads that are normally eaten but the stalks and leaves are also edible. Also look out for Broccolini which has a milder, sweeter flavour and longer, thinner stems. This vegetable is a member of the Brassica, or cabbage, family, also known as a Cruciferous vegetable.

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One serve of this vegetable provides a source of these nutrients.

One serve of this vegetable provides a source (10% of the RDI or 2g for fibre) of these nutrients:  
Fibre (3.6g); Potassium (345mg); Folate (49ug)

One serve of this vegetable provides a good source (25% of the RDI or 4g for fibre) of these nutrients:  
Vitamin C (99mg); Vitamin K (102ug)

*They are expressed as qty/100g in brackets so you can use the data for developing your Nutrient Information Panel.*

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100g of this vegetable contains the following phytonutrients: Beta-carotene (339ug); Lutein & zeaxanthin (1403ug); Phytosterols; Flavonols; Phenolic acids; Lignans (17.5ug); Glucosinolates (258mg); Lipoic acid; Chlorophyll; Glutathione (25mg); Glucaric acid (9.1mg); Carotenes; Carotenoids; Flavonoids; Indoles; Isothiocyanates; Kaempferol; Quercetin (0.1mg); Myricetin (13.7mg); Glucoraphanin (117)

The amounts of key phytonutrients and now reported on the Growers page and not just a presence/absence

Also on the vegetable pages there is the new information on recent research with regards health benefits (human clinical evidence where possible) and postharvest factors that impact on phytonutrients. The image below shows an example for broccoli.

These organisms are closely associated with physical injury, although not as common as bacterial rot, grey mold rot (*Botrytis cinerea*) and black mold (*Alternaria* spp.) can infect broccoli heads, this may occur under rainy, very cool growing conditions.

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**Preparation & Cooking Tips:** Broccoli, Broccolini and Chinese broccoli can be used to replace each other in most dishes, and are much used in Asian cooking. Broccoli is best eaten raw for the greatest nutritional benefit, team it up with a hummous or pesto dip. Consider using the whole head of broccoli - stem and all. The stem has a mild, sweet flavour and is excellent grated into coleslaws, quinoa dishes, risottos and other salads. When cooking, we recommend steaming for a maximum of 3 minutes for flavour, crunch and nutritional and phytonutrient content. Never soak broccoli florets in water before cooking, as this will leach Vitamin C and be detrimental to phytonutrient content. Steaming also increases the availability of carotenoids and vitamin E and increases antioxidant activity. Microwaving and boiling is particularly detrimental to the phytonutrients called glucosinolates, which contribute to the mild peppery flavour, and have been shown in some scientific studies to have positive effects on heart health and anti-cancer activity. Studies of frozen broccoli have shown it to have 20-55% lower Vitamin C content and 31% lower anti-oxidant activity compared with freshly picked broccoli, although eating frozen broccoli is better than not eating broccoli at all!




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**Recent scientific findings (not to be confused with FSANZ-approved health claims)!** Evidence from two independent human studies indicates that consumption of high glucoraphanin broccoli significantly reduces plasma LDL-cholesterol and the reduction was significantly greater than for standard broccoli.

**Reference:** Armah CN, Derdemezis C, Traka MH, Dainty JR, Doleman JF, Saha S, Leung W, Potter JF, Lovegrove JA, Mithen RF 2015. Diet rich in high glucoraphanin broccoli reduces plasma LDL cholesterol: Evidence from randomised controlled trials. *Molecular Nutrition & Food Research* 59(5): 918-926.

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**Postharvest effects on phytonutrients and nutritional quality - Recent scientific findings:** Recent experiments have indicated that LED green light could be a useful technique for extending shelf life, maintaining visual quality and preventing decrease of phytonutrients in broccoli florets. Light treatment extended shelf life and reduced the loss of chlorophyll contents in broccoli stored at 25 degrees C. The content of total phenols and glucosinolates were also markedly increased by LED green light.

**Reference:** Jin P, Yao D, Xu F, Wang HQ, Zheng YH 2015. Effect of light on quality and bioactive compounds in postharvest broccoli florets. *Food Chemistry* 172: 705-709.

Information on the impact of preparation and cooking on phytonutrients is included

Recent research on some of the health benefits is now included

Selected research on postharvest impacts added

## Website Downloads

Three new downloads have been added to the Veggycation website (copies of these are provided in Appendices):

- 1) Find a laboratory near you to analyse the phytonutrients in your vegetables. This document provides the contact details for a number of laboratories that are able to analyse phytonutrients. It will enable growers to have analysis completed to make content claims if they wish.

See Appendix 6.



Laboratories for testing phytonutrients – correct as of 23<sup>rd</sup> November, 2015.

Many commercial (non-academic) laboratories have been contacted in the preparation of this document and have either not responded, or have responded saying they cannot undertake any analysis of the phytochemical list provided. Many universities can undertake analysis of phytonutrients, but may not be available for commercial contract work. We suggest you contact the chemistry or agricultural science departments in the first instance.



CSIRO Food and Nutrition

CSIRO's Food and Nutrition has a range of capabilities that can be used to determine the phytonutrients, flavour (taste and aroma) and potential safety (both microbial and chemical) aspects in most fruits/vegetables. A searchable repository for previous work can be accessed [here](#) (just type in a keyword of interest). CSIRO offers a range of activities, from large interdisciplinary projects to routine services/testing, depending on customer requirements. CSIRO strongly recommends that interested parties discuss their needs using the contact details below; frequently CSIRO has been able to re-direct enquiries to more suitable service providers if this is deemed favourable for the customer.

Contact: Dr Dimitrios Zabaras, Senior Research Scientist

Tel.: +61 2 94908352

Fax: +61 2 94908352

Email: [dimitrios.zabaras@csiro.au](mailto:dimitrios.zabaras@csiro.au)

www: <http://www.csiro.au>

Postal Address: PO Box 52, North Ryde NSW 1670

Physical address: 11 Julius Ave, North Ryde NSW 2113, Australia

The project was funded by Horticulture Innovation Australia using the vegetable levy and matched funds from the Australian Government.  
1  
Information supplied without prejudice. Always contact the relevant company for the most correct information.

- 2) Find out about the regulations in other countries with regard to nutrient and phytonutrient claims. The aim of this document is to help growers understand the regulatory environment in different Asian markets (China, Hong Kong, India, Indonesia, Japan, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam) in comparison to Australia and New Zealand. The information provided includes: regulatory body, website of regulatory body, if it is possible to make a health claim, if there is a list of pre-approved health claims, potential of health claims for phytonutrients, if you can apply to have a new health claim approved for use, requirements for health claims on imported foods, regulatory document and website link for the regulatory documents.

See Appendix 7.



Guide to International Regulations for Making Health Claims  
26<sup>th</sup> November 2015.



- 3) Find out more about Super Vegetables with high phytonutrient claims launched in other countries. This document provides information on a number of different vegetables that have been developed and marketed overseas for their high phytonutrient content.

See Appendix 8.





**Super Broccoli #1**

Beneforte Broccoli was developed by UK scientists and Monsanto using conventional breeding techniques:

- o Launched: UK, October 2011.
- o Developed by: UK scientists at the Institute of Food Research, in collaboration with John Innes Centre, Plant Bioscience Ltd, and Seminis (now Monsanto), using conventional breeding techniques.
  - o Timeframe to develop: Decades.

o UK/EU Claims: Two to three times higher levels of glucoraphanin, which is a glucosinolate. Glucoraphanin is converted into sulforaphane when eaten. Same great flavour. Note there are as yet no FSANZ-approved nutritional or health claims related to this claim.

o Proof: Animal studies have shown sulforaphane can reduce rates of heart disease, act against some forms of cancer and boost the body's levels of antioxidant enzymes. Antioxidant enzymes have been shown to protect DNA from damage and are thought to contribute to healthy ageing. There have been quite a lot of human studies: Armah CN, Dordemelis C, Traka MH, Dainty JR, Doleman JF, Saha S, Leung W, Potter JF, Lovegrove JA, Mithen RF 2015. Diet rich in high glucoraphanin broccoli reduces plasma LDL cholesterol: Evidence from randomized controlled trials. *Molecular Nutrition & Food Research* 59(5): 918-92.

o Success: "The broccoli is selling well at Marks & Spencer" PBL Managing Director, Jan Chojacki. The product is now available in many UK retail outlets.

o Available in Australia? Not yet – launches in USA in 2017.

The project was funded by Horticulture Innovation Australia using the vegetable levy and matched funds from the Australian Government. 1

## Communication

The following communication has been sent out to advise interested parties of the changes made to the Veggycation website.

## New resources for vegetable growers [www.veggycation.com.au](http://www.veggycation.com.au)

Veggycation® continues to add value for the Australian vegetable industry.

Veggycation® is a resource for spreading the word about the nutrition and health benefits of Australian-grown vegetables.

The aim of Veggycation® is to increase the Australian consumer's awareness of why vegetables are so healthy with a view to increasing the consumption of Australian-grown vegetables.

The Veggycation® team\* have collated a huge amount of accredited nutritional information about vegetables and translated pre-approved health claims.



**Recently:** New resources have been added for Veg Lovers and the Australian Vegetable Industry around bioactives, or **phytonutrients**, in vegetables.

These are things like beta-carotene in carrots and spinach, glucosinolates in broccoli and kale, and anthocyanins in red cabbage.

Here are some of the new resources for **Veg Lovers**:

**NEW!!!!** :- [Find out more about Super Vegetables with high phytonutrient claims launched in other countries by clicking here.](#)

[There is also information added to each phytonutrient and to each vegetable about cooking to maintain phytonutrients.](#)

**Growers and other industry members** [can register \(it's FREE!!!\) and login to and download information including:](#)

- **NEW!!!!** :- Find a [laboratory near you to analyse](#) the phytonutrients in your vegetables.
- **NEW!!!!** :- Find out about the [regulations in other countries](#) with regard to nutrient and phytonutrient claims.
- **NEW!!!!** :- Find out more about [Super Vegetables](#) with high phytonutrient claims launched in other countries.

This project was undertaken by Plant & Food Research (NZ) and MacTavish West Pty. Ltd.

## Outcomes

This project collated information on the phytonutrients in levied vegetables. It builds on our previous project Veggycation which largely focussed on the core nutrients (vitamins and minerals) for which claims are currently permitted by Food Standards Australia New Zealand (FSANZ). Veggycation collated information on certain classes of phytonutrients but only provided quantitative data for those components which claims are currently permitted for (e.g. beta-carotene). This current project built on the Veggycation framework, adding new phytonutrients and further layers of information on these vegetable components. In particular, detailed data was added on the typical amounts of phytonutrients present, their status with regards to health claims and snippets of the latest research plus new information on postharvest effects.

In order to grow the export market for Australian vegetables, there needs to be a greater understanding of the regulations in relevant overseas territories. In order to achieve this information on the current status of the science and approved legislation relating to the health benefits of phytonutrients in both domestic and relevant Asian export markets was collated. Under current health claims regulations in Australia and New Zealand (FSANZ Standard 1.2.7), there are serious limitations to the claims permitted for biologically active substances (as defined in FSANZ Standard 1.2.8). We believe the FSANZ legislation will evolve over time as increasing scientific evidence is gathered to support health claims for specific compounds. Thus at this stage, this project represents a data gathering exercise in readiness of change. The nutrition and health claims for food sold in export markets are regulated by different food standards and these regulations also limit the possible claims for phytonutrients. As further research is conducted and shows beneficial effects, in particular in human clinical trials, health claims may be permitted in different markets to varying degrees. Some may require preapproval and/or compilation of evidence dossiers. In some markets, such as China, health claims on fresh products may be unobtainable under current regulations.

We assessed consumer understanding of health benefits of vegetables and concluded that consumer knowledge was poor and often misguided. Our experience with nutrition and health claim science, and the food standards, leads us to believe that it may take some time before health claims for phytonutrients are proven to clinical standards and accepted by FSANZ and other international regulatory bodies. The industry also faces the challenge that it may take even longer for the health benefits of vegetables to be understood by consumers. In the longer term this work will better position the vegetable industry for the future to promote fresh vegetables and/or development of vegetable products as health solutions in the domestic and/or export markets due to verifiable concentrations of compounds. This will be achieved in part through: 1) improving grower awareness and access to resources which measure product relevant phytonutrients; and 2) enhancing their ability and capacity to consciously influence levels of phytonutrients in a crop via pre- and postharvest practices. In the longer term this will translate to increased incidence of vegetable growers positioning vegetables or developing vegetable products as health solutions in the domestic and/or export markets.

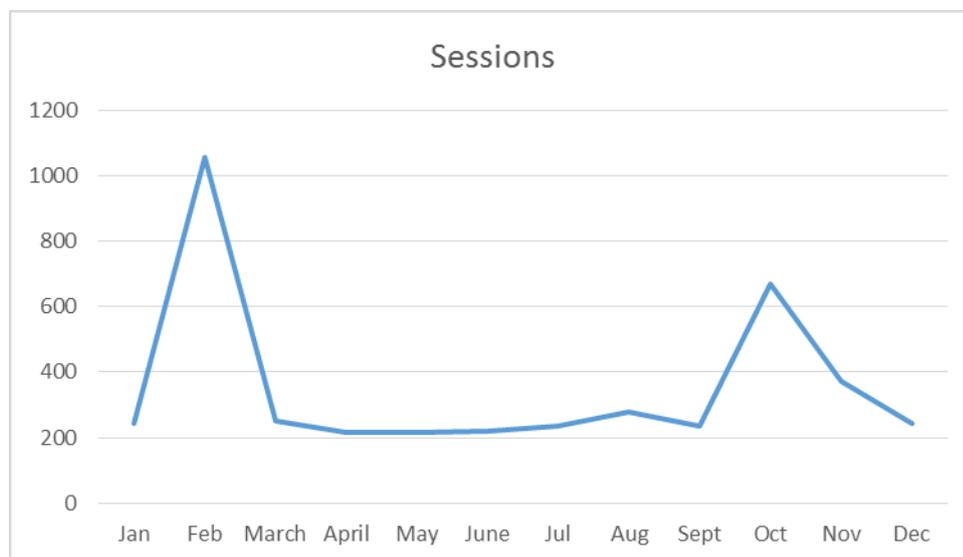
The already rich information source regarding the nutritional quality, health benefits and usability of Australian-grown levied vegetables, available via [www.veggycation.com.au](http://www.veggycation.com.au), has been significantly increased as a result of this project. Three new downloads have been made available to provide more information on topics of relevance around phytonutrients. This will educate both growers and

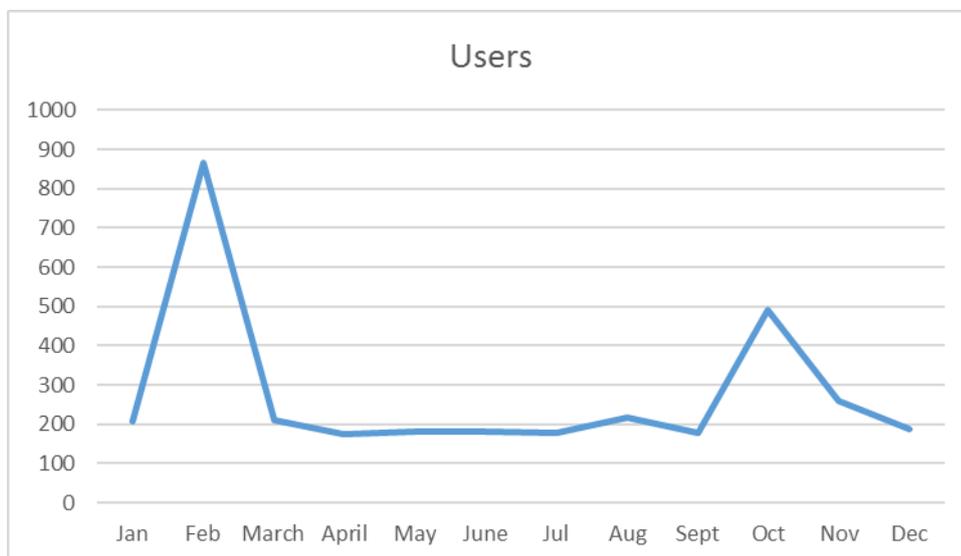
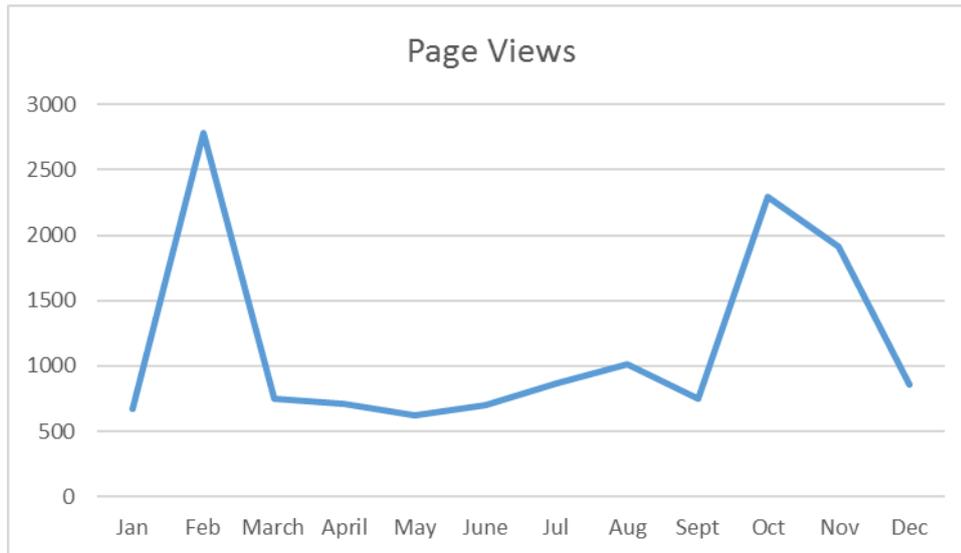
the general public.

This work will better position the vegetable industry for the future to promote fresh vegetables and/or development of vegetable products as health solutions in the domestic and/or export markets due to verifiable levels of compounds. This will be achieved in part through: 1) improving grower awareness and access to resources which measure product relevant phytonutrients; and 2) enhancing their ability and capacity to consciously influence concentrations of phytonutrients in a crop via pre- and postharvest practices. In the longer term this will translate to increased incidence of vegetable growers positioning vegetables or developing vegetable products as health solutions in the domestic and/or export markets.

## Evaluation and Discussion

Www.veggycation.com.au represents a veritable treasure trove of consumer-friendly, vibrant, informative and relevant resources for everyone from kids to vegetable lovers, from teachers to doctors, from dietitians to produce marketers. This project has added more value to this resource, particularly for growers. The proof is in the usage. The following graphs show the data for the whole of 2015. Usage is steady, with greater access following addition of new information such as in October/November; approximately 70% of users each month are new.





The information presented here is only the first step in a process that is likely to take some time. Under current health claims regulations in Australia and New Zealand (FSANZ Standard 1.2.7), there are serious limitations to the claims permitted for phytonutrients beyond content claims. The nutrition and health claims for food sold in export markets are regulated by different food standards and these regulations also limit the possible claims for phytonutrients. As further research is conducted and shows beneficial effects, in particular in human clinical trials, health claims may be permitted in different markets to varying degrees. Some may require preapproval and/or compilation of evidence dossiers. In some markets, such as China, health claims on fresh products may be unobtainable under current regulations and require changes in the regulations and or in country human clinical trials. We believe the international legislation will evolve over time and become more harmonised, as we are already seeing to some extent. As increasing scientific evidence is gathered it will support health claims for specific phytonutrients. Thus at this stage, this project largely presents a data gathering exercise in readiness of change, although it may also allow phytonutrient content claims to be made on some products.

Although health claims cannot be made at present for phytonutrients, content claims can. As highlighted in the super vege download there are a number of vegetables being marketed, mainly overseas, for their higher than standard phytonutrient content. These include high glucosinolate broccoli, high lycopene tomatoes, high flavonoid tomatoes, purple vegetables (anthocyanin content), high carotenoid sweetcorn and super peppers. Unlike some overseas regulations under FSANZ regulations it is not possible to make comparative claims for phytonutrients (i.e. two to three times higher glucoraphanin content) but simply state the phytonutrient content. However, educating the consumer about phytonutrients and greater awareness of the potential benefits, such as communicated via Veggycation, may assist with uptake of new products labelled with a phytonutrient content claim. The advantage of some phytonutrients (such as the anthocyanins and carotenoids that are pigments) is they have a visible point of difference.

One of the challenges with phytonutrients is establishing what intake may be required to have a beneficial effect. The question has been raised whether at least some phytonutrients should be accorded a recommended dietary intake (RDI) or a reference value (RV). This has been discussed for a number of years now and as yet no consensus has been reached. Recommended dietary intake is the amount of essential nutrients considered adequate to meet the known nutritional needs of practically all healthy persons. Reference values incorporate this principle but are expressed as several different values in order to accommodate a variety of purposes. To be regarded as an essential nutrient and to be allocated a RDI, a dietary component must be: (i) a single identified compound or close derivative; (ii) have a key demonstrable biological role and biochemical mechanism on which the RDI or RV is based; and (iii) exhibit a specific deficiency syndrome or impaired physiological function that has been associated with an inadequate intake of the component and that is responsive to dietary supplementation. Because of the complex nature of phytonutrients and the fact they appear in so many different combinations and interact may make defining RDIs very difficult. Different approaches may be needed and it may be more relevant to develop suggested intakes for overall classes of phytonutrients. Further work is required to establish the dietary intakes of phytonutrients/phytonutrient classes required for health benefits.

# Recommendations

## Compilation of Self Substantiation Dossiers

New general health claims are possible under FSANZ standard 1.2.7 and in some overseas regulatory authorities. This usually requires an evidence dossier summarising all the evidence including for the health benefits, amount need to confer a benefit, mode of action and safety. Compiling a self-substantiation dossier is a significant undertaking as there is a lot of information to put together. This is probably beyond the scope of individual growers and may be something the vegetable industry wishes to consider. At present there are a few vegetables that are sitting close to having enough evidence to be able to achieve a claim. Those with greatest likelihood of getting a claim in the near future are high glucosinolate broccoli, high lycopene tomatoes, and high zeaxanthin sweetcorn. As more human clinical trials are published with positive results compilation of dossiers should be considered.

## Expansion of the Veggycation Concept for other HIAL Sectors

Veggycation is a success story but feedback, particularly from dietitians, is that it would be good to have information for other foods that are important. It would be an even more valuable resource if the 'Veggycation' concept was expanded to fruits, nuts, bush tucker – an opportunity to make this a platform cross-sector via HIAL.

## Continued Support of Veggycation

Veggycation is a veritable treasure trove of consumer-friendly, vibrant, informative and relevant resources for everyone from kids to vegetable lovers, from teachers to doctors, from dietitians to produce marketers. We believe the industry should continue to develop targeted resources for teachers, dietitians, wholesalers and retailers to help raise the profile of the health benefits of vegetables, and move from an monologue of "vegetables are good for you" to a dialogue of more specific information which today's consumers can seek out and use that answers their question "So why are vegetables so good for my health?".

To this end, we recommend ongoing management of the Veggycation website and extension activities that will continue to educate and promote the nutrition and health benefit messages of vegetables:

1. Veggycation website management. The website needs to be maintained:

- Keeping the technical aspects of the website fresh and up to date, i.e. the way information is downloaded and held in the user's computer, for more rapid upload when re-accessed – annually.
- Improving and extending links to other valid information sources and HIAL-funded nutrition and health media, reports, projects – on a bi-monthly basis.

- The scientific database needs to be updated to keep abreast of new pre-approved FSANZ claims, new vegetable composition data – annually.
- We recommend extending the database to include a wider range of vegetables that consumers are eating – annually.
- Updating from resources from other, related HIAL & Vegetable industry projects, to provide a greater wealth of information for stakeholders – half-yearly.

## 2. Actively educating consumers

- Veggycation as a branded activity is suitable for promoting increased consumption of vegetables to raise the profile and value of vegetables as part of a healthy diet. This could be extended much further than is currently envisaged via in-store information and on-pack promotions.
- We suggest continued activity and communication with groups such as Nutrition Australia, Dietitians, the Stephanie Alexander Kitchen Garden Foundation, Healthy Children Initiative, etc. to develop more targeted resources for specific demographics, e.g. pre-school children, the elderly.

## 3. Positively leveraging all HIAL-funded nutrition and health work

- Active engagement with related HIAL projects will ensure the wealth of resources that is being developed for and by the vegetable industry in the nutrition and health space are linked and leveraged for maximum effect. It is critical to ensure we are not distributing conflicting messages to the key stakeholders. Agreeing on one portal for their communication to stakeholders could also be useful, and [www.veggycation.com.au](http://www.veggycation.com.au) is the obvious choice.
- An example of such transfer of information is a related project VG14025. Pre-harvest factors such as cultivar, light levels and other growing practices, and maturity were out of scope of this current project, but may have been identified in VG14025 – it is hoped that data collated in this project may be transferred to Veggycation at some point).

## 4. Vegetable recipe development – cooked and fresh

- Following on from the Asian vegetable case study that was completed in our previous project (VG13087), and subject to positive responses, we recommend widening the range of preparation, usage and recipe suggestions available via the website.
- Addition of complete nutritional analysis for these recipes and links with associated health claims would also be valued.

## 5. Improving Australian vegetable composition data

- In compiling the Veggycation database, we observed that there were some vegetables with nutrition composition data that were lacking and/or there were questions over the accuracy of the data in NUTTAB. This was particularly true for certain Asian vegetables; in addition, the NUTTAB data are generic rather than variety specific for vegetables and data for certain key vitamins, such as vitamin K, are not available. This highlights the need for further work to collect relevant nutrient data and ensure all vegetable composition data are sourced from Australian produce. The vegetable industry could take the lead and identify priority vegetable foods for analysis.
- To future proof the application of nutrition and health claims for vegetable foods, the Australian nutrition database should also compile valid phytonutrient information. In undertaking this specific project we found robust phytonutrient data from Australian grown vegetables was almost non-existent. Thus the data presented in Veggycation is mainly from overseas sources. There are certain phytonutrient groups, such as some of the flavonoids and carotenoids along with the glucosinolates in brassicas that should be a priority for collecting baseline data and then identifying varieties with enhanced phytnutrient contents.
- We suggest that provision of guidelines to scientists to ensure that they collect nutrition and phytonutrient data in a credible way that can be used by the industry is also a valid activity.

## **Scientific Refereed Publications**

None to report.

## **Intellectual Property/Commercialisation**

All Intellectual Property rests with HIAL. All the outcomes from this work have already been made available on the [www.veggycation.com.au](http://www.veggycation.com.au) website and are freely available either for consumers to access, or for growers & industry, via the registration-only, Login part of the website.

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# Appendices

Appendix 1: List of all phytonutrients now included in Veggycation

Appendix 2: Phytonutrient hierarchy

Appendix 3: List of vegetables included in Veggycation and the status of phytonutrient and health benefit information

Appendix 4: New fun facts and jokes added to Veggycation

Appendix 5: Additional information on phytonutrients

Appendix 6: Laboratories for testing phytonutrients

Appendix 7: Guide to International Regulations for Making Health Claims

Appendix 8: Super Vegetables with high phytonutrient claims launched in other countries

## Appendix 1: Table of all phytonutrients now included in Veggycation

Phytonutrient	Description	Presence/absence data	Quantitative data
Alkaloids	✓	✓	✓
Allicin	✓	✓	x
Allium sulphur compounds	✓	✓	x
Alpha-carotene	✓	✓	✓
Anthocyanins	✓	✓	by individual compound
Apigenin	✓	✓	✓
Beta-carotene	✓	✓	✓
Beta-cryptoxanthin	✓	✓	✓
Betacyanins	✓	✓	✓
Betalains	✓	✓	by individual compound
Betaxanthins	✓	✓	✓
Brassica sulphur compounds	✓	✓	some individual compounds
Capsaicin	✓	✓	x
Capsaicinoids	✓	✓	x
Capsiate	✓	✓	x
Carotenes	✓	✓	by individual compound
Carotenoids	✓	✓	by individual compound
Catechin	✓	✓	✓
Chlorophyll	✓	✓	✓
Coumarins	✓	✓	✓
Coumestans	✓	✓	by individual compound
Coumestrol	✓	✓	✓
Cyanidin	✓	✓	✓
Daidzein	✓	✓	✓
Delphinidin	✓	✓	✓
Epicatechin	✓	✓	✓
Epicatechin 3-gallate	✓	✓	✓
Epigallocatechin	✓	✓	✓
Epigallocatechin 3-gallate	✓	✓	✓
Eriodictyol	✓	✓	✓
Falcarindiol	✓	✓	✓
Falcarinol	✓	✓	✓
Flavan-3-ols	✓	✓	by individual compound
Flavanones	✓	✓	by individual compound
Flavones	✓	✓	by individual compound
Flavonoids	✓	✓	by individual compound
Flavonols	✓	✓	by individual compound
Formononetin	✓	✓	✓
Fructans	✓	✓	✓
Fructooligosaccharides	✓	✓	as fructans

<b>Phytonutrient</b>	<b>Description</b>	<b>Presence/absence data</b>	<b>Quantitative data</b>
Furanocoumarins	✓	✓	✓
Gallocatechin	✓	✓	✓
Genistein	✓	✓	✓
Glucaric acid	✓	✓	✓
Glucoraphanin	✓	✓	✓
Glucosinolates	✓	✓	✓
Glutathione	✓	✓	✓
Glycoalkaloids	✓	✓	✓
Hesperetin	✓	✓	✓
Hydroxybenzoic acids	✓	✓	✓
Hydroxycinnamic acids	✓	✓	✓
Indoles	✓	✓	x
Inulin	✓	✓	as fructans
Isoflavones	✓	✓	✓
Isorhamnetin	✓	✓	✓
Isothiocyanates	✓	✓	x
Kaempferol	✓	✓	✓
Lignans	✓	✓	✓
Lipoic acid	✓	✓	x
Lutein & zeaxanthin	✓	✓	✓
Luteolin	✓	✓	✓
Lycopene	✓	✓	✓
Malvidin	✓	✓	✓
Monoterpenoids	✓	✓	x
Myricetin	✓	✓	✓
Naringenin	✓	✓	✓
Pelargonidin	✓	✓	✓
Peonidin	✓	✓	✓
Petunidin	✓	✓	✓
Phenolic acids	✓	✓	by individual compound
Phenolics	✓	✓	✓
Phytoestrogens	✓	✓	✓
Phytosterols	✓	✓	✓
Polyacetylenes	✓	✓	✓
Polysaccharides	✓	✓	by subclass
Quercetin	✓	✓	✓
Saponins	✓	✓	x
Sesquiterpenoid lactones	✓	✓	x
Sulfoxides	✓	✓	x
Sulphur compounds	✓	✓	some by individual compound/subclass
Thiosulfinates	✓	✓	x
Triterpenoids	✓	✓	x

<b>Phytonutrient</b>	<b>Description</b>	<b>Presence/absence data</b>	<b>Quantitative data</b>
Xanthophylls	✓	✓	by individual compound
Zeaxanthin	✓	✓	with lutein

## Appendix 2: Phytonutrient hierarchy

The following table was developed to show the relationship between different individual phytonutrients and the classes of compounds they fall under.

<b>Phytonutrient major class</b>	<b>Subclass level 1</b>	<b>Subclass level 2</b>	<b>Subclass level 3 or Individual Compound</b>
Alkaloids	Betalains	Betacyanins	
Alkaloids	Betalains	Betaxanthins	
Alkaloids	Capsaicinoids		Capsaicin
Alkaloids	Glycoalkaloids		
Chlorophyll			
			Glucaric acid
Phenolics	Coumarins	Furanocoumarins	
Phenolics	Coumestans		Coumestrol
Phenolics	Flavonoids	Anthocyanins	Petunidin
Phenolics	Flavonoids	Anthocyanins	Delphinidin
Phenolics	Flavonoids	Anthocyanins	Malvidin
Phenolics	Flavonoids	Anthocyanins	Pelargonidin
Phenolics	Flavonoids	Anthocyanins	Peonidin
Phenolics	Flavonoids	Anthocyanins	Cyanidin
Phenolics	Flavonoids	Flavan-3-ols	Catechin
Phenolics	Flavonoids	Flavan-3-ols	Epicatechin
Phenolics	Flavonoids	Flavan-3-ols	Epicatechin 3-gallate
Phenolics	Flavonoids	Flavan-3-ols	Epigallocatechin
Phenolics	Flavonoids	Flavan-3-ols	Epigallocatechin 3-gallate
Phenolics	Flavonoids	Flavan-3-ols	Gallocatechin
Phenolics	Flavonoids	Flavanones	Eriodictyol
Phenolics	Flavonoids	Flavanones	Hesperetin
Phenolics	Flavonoids	Flavanones	Naringenin
Phenolics	Flavonoids	Flavones	Apigenin
Phenolics	Flavonoids	Flavones	Luteolin
Phenolics	Flavonoids	Flavonols	Isorhamnetin
Phenolics	Flavonoids	Flavonols	Kaempferol
Phenolics	Flavonoids	Flavonols	Myricetin
Phenolics	Flavonoids	Flavonols	Quercetin
Phenolics	Flavonoids	Isoflavones	Daidzein
Phenolics	Flavonoids	Isoflavones	Formononetin
Phenolics	Flavonoids	Isoflavones	Genistein
Phenolics	Flavonoids	Proanthocyanidins	
Phenolics	Lignans		
Phenolics	Phenolic acids	Hydroxycinnamic acids	
Phenolics	Phenolic acids	Hydroxybenzoic acids	
Phenolics	Phytoestrogens		
Polyacetylenes			Falcarinol

Polyacetylenes			Falcarindiol
Polysaccharides	Fructans	Fructooligosaccharides	Inulin
Allium sulphur compounds			Allicin
Allium sulphur compounds		Sulfoxides	
Allium sulphur compounds		Thiosulfinates	
Brassica sulphur compounds	Glucosinolates		Glucoraphanin
Brassica sulphur compounds	Indoles		
Brassica sulphur compounds	Isothiocyanates		
Sulphur compounds			Glutathione
Sulphur compounds			Lipoic acid
Carotenoids	Carotenes		Alpha-carotene
Carotenoids	Carotenes		Beta-carotene
Carotenoids	Carotenes		Lycopene
Carotenoids	Xanthophylls		Beta-cryptoxanthin
Carotenoids	Xanthophylls		Lutein & zeaxanthin
Terpenoids	Monoterpenoids		
Terpenoids	Phytosterols		
Terpenoids	Saponins		
Terpenoids	Sesquiterpenoid lactones		
Terpenoids	Triterpenoids		

**Appendix 3: Table of vegetables included in Veggycation and the status of phytonutrient and health benefit information**

<b>Vegetable</b>	<b>Quantitative data</b>	<b>Recent research on health benefits</b>	<b>Recent research on postharvest factors</b>
Artichokes, Globe	✓	✓	✓
Artichokes, Jerusalem	✓	✓	✓
Asparagus	✓	✓	✓
Basil	✓	✓	✓
Beans, broad	✓	✓	x
Beans, butter	very limited	✓	✓
Beans, green	✓	✓	✓
Beetroot	✓	✓	✓
Bitter melon	✓	✓	✓
Bok Choy	✓	✓	✓
Broccoli	✓	✓	✓
Broccoli, Chinese	very limited	✓	✓
Brussels Sprouts	✓	✓	✓
Cabbage, Chinese	✓	✓	✓
Cabbage, mustard	✓	✓	x
Cabbage red	✓	✓	✓
Cabbage, Savoy	✓	✓	✓
Cabbage, white/green	✓	✓	✓
Capsicum, green	✓	✓	✓
Capsicum, red	✓	✓	✓
Carrots	✓	✓	✓
Carrots, baby	✓	✓	✓
Cassava	✓	✓	✓
Cauliflower	✓	✓	✓
Celeriac	✓	✓	✓
Celery	✓	✓	✓
Chicory	✓	✓	✓
Chillies, green	✓	✓	✓
Chillies, red	✓	✓	✓
Chives	✓	✓	✓
Choy Sum	✓	✓	✓
Choko	✓	✓	✓
Coriander, leaves	✓	✓	✓
Cucumber, apple	very limited	x	x
Cucumber, common	✓	✓	✓
Cucumber, Lebanese	very limited	x	x
Cucumber, telegraph	very limited	x	x
Daikon	✓	✓	x
Eggplant	✓	✓	✓

Endive	✓	✓	✓
Fennel	✓	✓	✓
Garlic	✓	✓	✓
Ginger	✓	✓	x
Kale	✓	✓	✓
Kohlrabi	✓	✓	✓
Leeks	✓	✓	✓
Lettuce	✓	✓	✓
Lettuce, butterhead	✓	✓	x
Lettuce, Cos	✓	✓	✓
Lettuce, iceberg	✓	x	✓
Okra	✓	✓	✓
Onions	✓	✓	✓
Parsley, continental	✓	✓	✓
Parsley, curly	✓	✓	✓
Parsnips	✓	✓	✓
Peas, green	✓	✓	✓
Peas, snow (pod)	✓	✓	✓
Potatoes	✓	✓	✓
Pumpkin	✓	✓	✓
Pumpkin, butternut	very limited	x	x
Pumpkin, golden nugget	very limited	x	x
Pumpkin, Jarrahdale	very limited	x	x
Pumpkin, Queensland blue	very limited	x	x
Radish, red	✓	✓	✓
Radish, white	✓	x	x
Radicchio	✓	✓	✓
Rhubarb	✓	✓	x
Rocket	✓	✓	✓
Shallot	✓	✓	✓
Silverbeet	✓	✓	✓
Spinach	✓	✓	✓
Spinach, water	✓	✓	✓
Spring Onions	✓	✓	x
Sprouts, alfalfa	✓	✓	✓
Sprouts, bean	✓	✓	✓
Squash, button	very limited	x	x
Squash, scallopini	very limited	x	x
Swede	✓	✓	x
Sweetcorn	✓	✓	✓
Sweet potato	✓	✓	x
Taro	✓	✓	✓
Tomatoes, standard red	✓	✓	✓
Tomatoes, cherry	✓	✓	✓

Turnip	very limited	✓	✓
Water chestnut	very limited	✓	✓
Watercress	✓	✓	✓
Zucchini, gold	very limited	x	✓
Zucchini, green	✓	x	✓

## Appendix 4: New fun facts and jokes added to the Vegecation website

The Veggycation website has been updated with the following new fun facts and jokes to keep it fresh.

### Adult fun facts

- Red cabbage juice contains anthocyanins which are natural pH indicators that change colours according to the acidity of the solution.
- There is a phytonutrient for each colour of the rainbow: Red = lycopene, Orange = beta-carotene, Yellow = lutein, Green = chlorophyll, Blue = delphinidin, Indigo = petunidin, Violet = betacyanins
- Onions contain phytonutrients that aid vitamin C in its function?
- The average tomato contains 10,000 phytonutrients.
- Phytonutrients are created by the plant as a defence system for the environmental challenges it faces: insects, animals and UV radiation.
- Capsaicin is used as an analgesic in topical ointments, nasal sprays, and dermal patches to relieve pain.
- It is common for people to experience pleasurable and even euphoriant effects from ingesting capsaicin.
- If you eat a lot of carrots your skin will turn orange.
- The name "betalain" comes from the Latin name of the common beet (*Beta vulgaris*), from which betalains were first extracted.
- While mustard greens (mustard cabbage) sold in the United States are relatively mild in flavor, some varieties, especially those in Asia, can be as hot as a jalapeno pepper depending on their mustard oil (glucosinolate) content.
- Radishes are a member of the cabbage family and contain glucosinolates.
- Most anthocyanins are named after the flowers from which they were first identified.
- The carotenoids lutein and zeaxanthin (carotenoids) accumulate in the macular of the eye.
- Lycopene (a carotenoid) accumulates in prostate tissue.
- If you eat high-carotenoid foods on a regular basis, they will change the colouring of your skin and give you a natural tan-like glow.
- The off-tasting soapiness that carrots sometimes have comes from a high concentration of a volatile compound known as terpenoids. It doesn't necessarily mean they are bad, in fact these compounds are thought to be good for you.

- The word broccoli comes from the Italian plural of broccolo, which means "the flowering crest of a cabbage".
- Tomato flavour is the result of the interplay of acids (primarily citric and malic acids), sugars and 15-20 different volatiles.
- The gooey part of a tomato (aka locular jelly) contains most of the acidity, whereas the walls of a tomato (aka pericarp tissue) give it strength and sweetness, but no acidity. The harder a tomato is, the blander it's likely to taste.
- Brussels sprouts are one of the most hated vegetables around the world. However they are one of the most nutritious and are packed with vitamins and minerals as well as lots of phytonutrients.
- For many vegetables a large percentage of the phytonutrients are present in the skin. That means when you peel them, you're actually peeling away many of the health benefits.
- Technically, tomatoes, green beans, pumpkins, squash and cucumbers are fruit because they have seeds.

### **Kids Fun Facts**

- There is a phytonutrient for each colour of the rainbow: Red = lycopene, Orange = beta-carotene, Yellow = lutein, Green = chlorophyll, Blue = delphinidin, Indigo = petunidin, Violet = betacyanins
- If you eat a lot of carrots your skin will turn orange.
- Radishes are related to cabbages.
- Some of the red, blue and purple pigments in vegetables are actually named after flowers.
- The yellow pigments in some vegetables accumulate in the back of your eye.
- The word 'broccoli' comes from Italian for 'cabbage sprout'.
- The part of broccoli you eat is actually baby flowers that haven't opened yet.
- Vegetable plants develop flowers and form seeds if you let them. We usually eat them before they get the chance to make flowers.
- Most vegetables need warm weather to grow. Some vegetables, like spinach, lettuce, carrots and turnips, can grow in cold weather.
- There are thousands of different tomato varieties and they come in colours other than red.
- The tomato is related to potatoes, peppers and eggplants.
- The sweet potato is a root vegetable and is not closely related to the potato.
- Cutting onions releases a gas which causes a stinging sensation when it comes into contact

with your eyes. Your body produces tears to dilute the irritant and remove it from your eyes.

- Pumpkins are usually orange but can sometimes be yellow, white, green or red.
- The carrot is usually orange in colour although purple, red, white, and yellow varieties also exist.
- The green tops of carrots are edible as a leaf vegetable.
- Corn will always have an even number of rows on each cob.
- With the exception of Antarctica, corn is produced on every continent in the world.
- An ear or cob of corn is actually part of the flower and an individual kernel is a seed.
- Corn is a cereal crop that is part of the grass family.

### **Jokes**

Q: How did the farmer fix his jeans? A: With a vegetable patch.

Q: How do you fix a broken tomato? A: Tomato paste!

Q: What did the little cob of corn call his dad? A: Pop Corn!

Q: What does corn get when you leave it in the barn too long? A: COBwebs

Q: What is small, red and whispers? A: A hoarse radish.

Q: What do you call a retired vegetable? A: A has bean.

Q: What did the lettuce say to the celery? A: Quit stalking me.

Q: Why shouldn't you tell secrets in a corn field? A: There are too many ears.

## **Appendix 5: Additional information on phytonutrients**

This information is provided in the Phytonutrients section of the Veggycation website. This information is viewable to all public. The intention of this information was to improve understanding about the term phytonutrients and in particular with regards antioxidants.

### **Phytonutrients**

The term phytonutrients (pronounced fight-o-nutrients) simply means plant compounds. It is commonly used to refer to the non-nutrients in plant-based foods that provide an array of health benefits, and in particular the plant pigments. Thus, brightly coloured fruits and vegetables are usually rich in phytonutrients, although there are exceptions. There are thousands of different phytonutrients that have been found in plant foods and no doubt more will be discovered. These protective plant compounds are an emerging area of nutrition and health, with new research reported every day. The two most common groups of phytonutrients are:

- Carotenoids (e.g. beta-carotene, lycopene)
- Phenolics/polyphenolics (e.g. anthocyanins, procyanidins, chlorogenic acid)

There are also a vast array of other compounds including glucosinolates, isothiocyanates, indoles, Allium sulphur compounds, chlorophyll, saponins, monoterpenes, glutathione, lipoic acid and ubiquinones.

While phytonutrients are not essential dietary nutrients like vitamins and minerals, they contribute to the beneficial health effects which are linked with eating plant foods. Antioxidant activity has been the primary mechanism of action for phytonutrients that has been investigated in recent years. However, the emerging consensus is that although they are radical scavengers in vitro they do may not function as antioxidants in our body. However, there are many other possible mechanisms of action for phytonutrients to provide health benefits, including appropriate regulation of inflammation, neuroprotective effects, enhancement of immune responses, boosting of phase 2 enzymes, and regulating energy metabolism and gut health.

There are thousands of different phytonutrients that have been found in plant foods and no doubt more will be discovered. These protective plant compounds are an emerging area of nutrition and health, with new research reported every day.

NEW!!!! :- Find out more about Super Vegetables with high phytonutrient claims launched in other countries by clicking [here](#).

### **Eating by colour**

Many of the phytonutrients that may make fruits and vegetables good for us also give them their colour. That's why it's essential to sample the complete colour spectrum every day to get the full preventive benefits of fruits and vegetables. Because colourful fruits and vegetables contain

hundreds if not thousands of different phytonutrients, no one colour group does it all. By eating regularly from each colour group, you're giving yourself the widest health protection possible.

- Blue/purple: Blue/purple fruits and vegetables contain varying amounts of health-promoting phytonutrients such as anthocyanins and other phenolics and many also contain vitamin C.
- Green: "Eat your greens" has been sound advice for generations. Green vegetables contain are particularly rich in phytonutrients including flavonoids and carotenoids but also the green chlorophyll. The brassiaca group also contain sulphur compounds (glucosinolates/ isothiocyanates) and indoles.
- Orange/yellow: The yellow and orange colour of fruits and vegetables is due to carotenoids and many also contain significant amounts of flavonoids.
- Red: Specific phytonutrients in the red group that are being studied for their health-promoting properties include the red pigments lycopene and anthocyanins.
- White/brown: While not a vibrant colour white and brown fruits and vegetables contain varying amounts of phytonutrients. These include sulphur compounds (e.g. allicin), found in the garlic and onion family and some of the brassicas such as cauliflower.

### **Phytonutrients as Antioxidants?**

The word "antioxidant" has often appeared in the popular press in relation to phytonutrients. Food and supplement industries have used marketing claims that relate to the antioxidant status of specific fruits and vegetables, e.g. "best source of antioxidants", "world's strongest antioxidant", "superior antioxidant levels compared with red wine". However, the science behind antioxidant efficacy is complex and may lead to confusion.

So what are antioxidants? Antioxidants are substances which de-activate free radicals and oxidants, rendering them harmless. Although free radicals are important for life when they get out of control (result in oxidative stress) they can cause damage. Free radicals attack our cells and can interfere with important life processes. For example, they can attack DNA which may ultimately lead to cancer and they may do harm to the circulatory system by oxidising fats in the blood so they stick more easily to the artery walls and cause atherosclerosis, leading to heart attacks and strokes. Many other conditions have been linked to free radical damage and oxidative stress including accelerated aging, Alzheimer's disease, cataracts, glaucoma, macular degeneration, Parkinson's disease, rheumatoid arthritis and other inflammatory conditions.

There are many kinds of antioxidants and antioxidant defence mechanisms. The body makes its own antioxidants and has its own defences (e.g. albumin and enzymes such as superoxide dismutase) but we also get many from the food we eat. The major dietary antioxidants include vitamins C and E plus some minerals such as selenium, copper and zinc which boost the bodies own antioxidant defences. In addition there are many scientific papers reporting the antioxidant activity of phytonutrients. However, the majority measure antioxidant activity in vitro (i.e. in a test tube). However, this does not necessarily mean the phytonutrients will act as antioxidants in our body. They have to be absorbed and circulate in the body at a high enough concentration to act as radical scavengers. There is increasing evidence that this may not be the case. The health benefits of the phytonutrients may be due to activities other than antioxidant activity.

## **Appendix 6: Laboratories for testing phytonutrients**

This information is available as a download from the Veggycation website. It is located in the login section for Growers (& Industry). It is intended to help them find a laboratory near them to analyse the phytonutrients in vegetables.



# Veggycation

loving the health benefits

## Laboratories for testing phytonutrients – correct as of 23<sup>rd</sup> November, 2015.

Many commercial (non-academic) laboratories have been contacted in the preparation of this document and have either not responded, or have responded saying they cannot undertake any analysis of the phytochemical list provided. Many universities can undertake analysis of phytonutrients, but may not be available for commercial contract work. We suggest you contact the chemistry or agricultural science departments in the first instance.



### CSIRO Food and Nutrition

CSIRO's Food and Nutrition has a range of capabilities that can be used to determine the phytonutrients, flavour (taste and aroma) and potential safety (both microbial and chemical) aspects in most fruits/vegetables. A searchable repository for previous work can be accessed [here](#) (just type-in a keyword of interest). CSIRO offers a range of activities, from large interdisciplinary projects to routine services/testing, depending on customer requirements. CSIRO strongly recommends that interested parties discuss their needs using the contact details below; frequently CSIRO has been able to re-direct enquiries to more suitable service providers if this is deemed favourable for the customer.

<b>Contact:</b>	Dr Dimitrios Zabarar, Senior Research Scientist
<b>Tel.:</b>	+61 2 94908352
<b>Fax:</b>	+61 2 94908352
<b>Email:</b>	dimitrios.zabarar@csiro.au
<b>www:</b>	<a href="http://www.csiro.au">http://www.csiro.au</a>
<b>Postal Address:</b>	PO Box 52, North Ryde NSW 1670
<b>Physical address:</b>	11 Julius Ave, North Ryde NSW 2113, Australia

The project was funded by Horticulture Innovation Australia using the vegetable levy and matched funds from the Australian Government.

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**National Measurement Institute**



Australian Government  
Department of Industry,  
Innovation and Science

**National  
Measurement  
Institute**

**Analysis Undertaken:**

Inulin (\$295/sample)

Carotenes ( $\alpha$ - and  $\beta$ -: \$115/sample)

Lycopene (\$600 per batch of sample, plus \$150/sample)

Cryptoxanthin (\$600 per batch of sample, plus \$150/sample)

Lutein (\$600 per batch of sample, plus \$150/sample)

Zeaxanthin (\$600 per batch of sample, plus \$150/sample)

These compounds need to be tested on fresh vegetables not frozen. A handling fee applies to each batch of samples submitted.

Catechins: they have experience testing three of the compounds in green tea (Catechin, Epicatechin, Epigallocatechin). For the full suite of six compounds in vegetables they would need to conduct some method validation, including the purchase of standards (some of which would be ordered from overseas). They would essentially need to quote this as a mini project covering the costs for the validation and standards. They also need to know the types of vegetables.

**Contact:** Anne Coyle, Customer Service Officer, Analytical Services Branch

**Tel:** +61 3 9644 4888

**Fax:** +61 3 9644 4999

**Email:** [anne.coyle@measurement.gov.au](mailto:anne.coyle@measurement.gov.au)

**www:** [www.measurement.gov.au](http://www.measurement.gov.au)

**Address:** 1/153 Bertie Street, Port Melbourne VIC 3207

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**Southern Cross University**



**Analysis Undertaken:**

They have methods that cover almost all phytonutrients. Most of the flavonoids, polyphenols, phenolic acids, anthocyanins, carotenoids and iso-flavones are all included in methods they regularly use and can therefore analyse. Some of the specific flavonoids or other constituents they don't have as standards but could probably procure these.

Standard price for quantitative analysis starts at \$175 set-up and \$175 per sample, with prices reducing with scale. Some standards may also require purchase.

**Contact:** Prof. Graham J King, Director

**Tel:** 02 6620 3410

**Email:** [graham.king@scu.edu.au](mailto:graham.king@scu.edu.au)

**Www:** <http://www.scu.edu.au/scps/>

**Postal Address:** Southern Cross Plant Science, Southern Cross University, PO Box 157, LISMORE NSW 2480.

**The New Zealand Institute for Plant & Food Research Limited**

**Analysis Undertaken:** Most phytonutrients. Costs typically start at around \$500 per sample but costs decrease per sample with multiple analyses.

**Contact:** Dr Carolyn Lister, Team Leader - Phytochemistry & Health

**Tel:** +64 3 325 9453

**Fax:** +64 3 325 2074

**Email:** [carolyn.lister@plantandfood.co.nz](mailto:carolyn.lister@plantandfood.co.nz)

**www:** [www.plantandfood.co.nz](http://www.plantandfood.co.nz)

**Postal Address:** Plant & Food Research, Private Bag 4704, Christchurch Mail Centre, Christchurch, 8140, New Zealand.

**Physical Address:** Plant & Food Research, Canterbury Agriculture & Science Centre, Gerald St, Lincoln, 7608, New Zealand.

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**Symbio Laboratories:**



**Analysis undertaken:** beta-carotene only (\$167.28/sample plus invoicing costs).

**Contact:** Sue Avery B.App.Sci. (Food Tech) G.Dip.Bus.Admin

Account Manager - Food Industry

**Email:** [savery@symbiolabs.com.au](mailto:savery@symbiolabs.com.au)

**tel:** 07 3340 5706

**mob:** 0409 276 567

**fax:** 07 3219 0333

**www:** <http://www.symbiolabs.com.au>

**post address:** PO Box 4312 Eight Mile Plains Qld 4113

**address:** 52 Brandl St Eight Mile Plains Qld 4113

End.

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## **Appendix 7: Guide to International Regulations for Making Health Claims**

This information is available as a download from the Veggycation website. It is located in the login section for Growers (& Industry). It is intended to help them understand the regulatory environment for making health claims on products within the Asian market.



Guide to International Regulations for Making Health Claims

26<sup>th</sup> November 2015.

**Horticulture**  
**Innovation**  
Australia

“This project has been funded by Horticulture Innovation Australia Limited using the vegetable levy and funds from the Australian Government.”

#### Disclaimer

Horticulture Innovation Australia Limited (HIA Ltd) makes no representations and expressly disclaims all warranties (to the extent permitted by law) about the accuracy, completeness, or currency of information in ‘Identifying and understanding the factors influencing bioactive levels in vegetables VG14027’.

Reliance on any information provided by HIA Ltd is entirely at your own risk. HIA Ltd is not responsible for, and will not be liable for, any loss, damage, claim, expense, cost (including legal costs) or other liability arising in any way (including from HIA Ltd or any other person’s negligence or otherwise) from your use or non-use of ‘Identifying and understanding the factors influencing bioactive levels in vegetables VG14027’, or from reliance on information contained in the material or that HIA Ltd provides to you by any other means.

## Introduction

Australia and New Zealand work closely together to develop joint food standards. Food Standards Australia New Zealand (FSANZ) has developed a new standard for health claims on food labels and in food advertisements, as part of the Australia New Zealand Food Standards Code (ANZFSA).

Standard 1.2.7 of the Australia New Zealand Food Standards Code – Nutrition, Health and Related Claims, defines the requirements for making a health claim on a food product. It was developed by Food Standards Australia New Zealand (FSANZ) after consultation with food manufacturers, health professionals and government in New Zealand and Australia. Under this standard, a health claim is any representation in food labelling or advertising that links the food to a health effect. For example, “Calcium is good for strong bones” is a health claim.

Standard 1.2.7 was introduced on 18 January 2013. Food businesses have a three-year transition period from that date to make the changes needed for the requirements of this new standard. During this transition period, any health claims on food must comply with either the new Standard 1.2.7 or the Transitional Standard 1.1A. As of 18 January 2016, all health and nutrition claims must comply with Standard 1.2.7. There is a no-stock-in-trade provision, which means all food health claims used in labelling and advertisements must follow the new rules from this date.

Standard 1.2.7 applies to all food sold in Australia and New Zealand (that grown here and imported). If you produce food in Australia but export to other countries you will need to meet any export certification requirements and also comply with the standards of the importing country.

## Australia

### Regulatory Body:

- Food Standards Australia New Zealand (FSANZ) develops the Food Standards Code which is enforced by the Australian states and territories

### Website:

- <http://www.foodstandards.gov.au>
- Enforcement contacts:  
<http://www.foodstandards.govt.nz/about/foodenforcementcontacts/pages/default.aspx>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- ~200 nutrient function claims and 13 reduction of disease risk claims listed in Standard 1.2.7

### Potential health claims for phytonutrients:

- There are no preapproved claims for phytonutrients and thus it would be necessary to accumulate the evidence to make a case for a new health claim.

### Can you apply to have a new health claim approved for use?

- New reduction of disease claims are subject to approval by FSANZ. Details of this process can be found in the FSANZ Act 1991. For new nutrient function claims, there is an option to self-substantiate by conducting a systematic review with a focus on human (intervention) studies. Guidance for self-substantiation can be found on the FSANZ website

### Requirements for health claims on imported foods:

- All foods imported into Australia must comply with labelling and composition standards in the Food Standards Code.

### Regulatory document:

- Standard 1.2.7 Nutrition, Health and Related Claims which should be used in conjunction with other relevant standards of the Food Standards Code.

### Website for regulatory document:

- <https://www.comlaw.gov.au/Details/F2013L00054>

## China

### Regulatory Body:

- China Food and Drug Administration (CFDA)

### Website:

- <http://eng.cfda.gov.cn>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- 65 nutrient function claims are listed in the Standard for Nutrition Labelling of Pre-packaged Foods and 27 health functions have been approved for use for health foods.

### Potential health claims for phytonutrients:

- Some of the health benefits of phytonutrients are on the list of health functions. However, it would be necessary to go through the approval process and have products tested in China to demonstrate efficacy. Claims are not made on fresh products but formulated (functional) foods only.

### Can you apply to have a new health claim approved for use?

- All health (functional) foods (i.e. foods with health claims) must be reviewed and approved by the CFDA. Applications for the registration of a health food are product specific. A full list of the requirements for an application to register a health food is listed in the Provisions for Health Food Registration.

### Requirements for health claims on imported foods:

- For an imported health food the food must have been produced and marketed outside of China for more than one year.

### Regulatory document:

- National Food Safety Standard: Standard for Nutrition Labelling of Pre-packaged Foods. and the Provisions for Health Food Registration (Trial)

### Website for regulatory document:

- [http://china-pharm.com.cn/News\\_View.asp?NewsID=165](http://china-pharm.com.cn/News_View.asp?NewsID=165)

## Hong Kong

### Regulatory Body:

- Centre for Food Safety (CFS)

### Website:

- <http://www.cfs.gov.hk/eindex.html>

### Can you make a health claim?

- Regulated nutrient function claims are permitted. There are no regulations for reduction of disease risk claims but these are not prohibited.

### Is there a list of pre-approved health claims?

- 26 nutrient function claims that are listed as examples.

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Evidence would need to be provided for any claims.

### Can you apply to have a new health claim approved for use?

- Nutrient function claims are allowed as long as they meet certain requirements. New claims do not appear to be subject to approval by the CFS.

### Requirements for health claims on imported foods:

- Centre for Food Safety encourages food importers to avoid using health claims.

### Regulatory document:

- Food and Drugs (Composition and Labelling) (Amendment: Requirements for Nutritional Labelling and Nutrition Claim) Regulation 2008

### Website for regulatory document:

- [http://www.cfs.gov.hk/english/food\\_leg/food\\_leg\\_nl\\_guidance.html](http://www.cfs.gov.hk/english/food_leg/food_leg_nl_guidance.html)

India

Regulatory Body:

- Food Safety and Standards Authority of India (FSSAI)

Website:

- <http://www.fssai.gov.in>

Can you make a health claim?

- Currently health claims are not regulated but there is a draft standard that permits health claims which will come into effect sometime in the future.

Is there a list of pre-approved health claims?

- Draft regulations contain 12 reduction of disease risk claims

Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

Can you apply to have a new health claim approved for use?

- The draft regulations outline the process for getting new nutrient function and reduction of disease risk claims approved by the FSSAI.

Requirements for health claims on imported foods:

- All food products imported into India must comply with the labelling requirements as specified in the regulations.

Regulatory document:

- Draft 'Regulation on Labelling (Claims)' The current 'Food Safety and Standards (Packaging and Labelling)' Regulations do not contain provisions for making nutrition or health claims on foods.

Website for regulatory document:

- <http://www.fssai.gov.in/Portals/0/Pdf/covering%20letter%20for%20draft%20regulation.pdf>

## Indonesia

### Regulatory Body:

- The National Agency of Drug and Food Control

### Website:

- <http://www.pom.go.id/index.php/home/en>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- 11 nutrient function claims & 11 reduction of disease risk claims

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- An application for approval of a new nutrient function or a reduction of disease risk claim must be made to the Head of the National Agency of Drug and Food Control.

### Requirements for health claims on imported foods:

- All food products imported into Indonesia must comply with the labelling requirements.

### Regulatory document:

- 'Control of Claims on Processed Food Labels and Advertising'

### Website for regulatory document:

- <https://extranet.who.int/nutrition/gina/en/node/22946>

## Japan

### Regulatory Body:

- Ministry of Health Labour and Welfare (MHLW) and the Consumer Affairs Agency (CAA)

### Website:

- <http://www.mhlw.go.jp/english/>
- <http://www.caa.go.jp/en/>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- 17 nutrient function claims listed on the MHLW website

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. There are new regulations which may allow fresh foods to make claims without prior government approval as long as there is sufficient scientific evidence.

### Can you apply to have a new health claim approved for use?

- FOSHU claims are product specific. The safety of the food and effectiveness of the functions for health must be assessed, and the claim approved by the MHLW and CAA. More information about FOSHU can be found on the MHLW website. In a recent review of the Food Labelling Act a new system will be established to allow health claims on fresh and processed foods if the food meets certain requirements. Health claims will be allowed without government approval if industry holds a certain amount of scientific evidence on the safety and effectiveness of the food.

### Requirements for health claims on imported foods:

- Given there is a specific regulatory system set up for FOSHU and each product receives a seal of approval for FOSHU, it is unlikely that there will be recognition of health claims made in other countries. Both New Zealand and Japan are actively pursuing ways to better understand the regulatory systems in each other's country including the science that underlies the self- substantiated health claims.

### Regulatory document:

- 'Food Labelling Standard' and 'Foods for Specific Health Use (FOSHU) regulations'

### Website for regulatory document:

- <http://www.mhlw.go.jp/english/topics/foodsafety/fhc/02.html>

## Malaysia

### Regulatory Body:

- Malaysian Ministry of Health (MoH)

### Website:

- <http://moh.gov.my/english.php>

### Can you make a health claim?

- Regulated nutrient function claims are permitted. Reduction of disease risk claims are prohibited.

### Is there a list of pre-approved health claims?

- ~50 nutrient function claims listed in the 'Guide to Nutrition Labelling and Claims'

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- The process for applying to the MoH for approval of a new nutrient function claim is outlined in Appendix 2 of the 'Guide to Nutrition Labelling and Claims'. The application must contain sound scientific evidence for the claim based on data from human intervention trials.

### Requirements for health claims on imported foods:

- All food products imported into Malaysia must comply with the labelling regulations.

### Regulatory document:

- Malaysia's Food Act 1983 and Food Regulations 1985

### Website for regulatory document:

- <http://fsis2.moh.gov.my/fosimv2/hom/frmhomfarsec.aspx?id=21>

## New Zealand

### Regulatory Body:

- Food Standards Australia New Zealand (FSANZ) develops the Food Standards Code which is enforced the Ministry for Primary Industries (MPI)

### Website:

- FSANZ: <http://www.foodstandards.govt.nz>
- MPI: [www.mpi.govt.nz](http://www.mpi.govt.nz)

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- ~200 nutrient function claims and 13 reduction of disease risk claims listed in Standard 1.2.7

### Potential health claims for phytonutrients:

- There are no preapproved claims for phytonutrients and thus it would be necessary to accumulate the evidence to make a case for a new health claim.

### Can you apply to have a new health claim approved for use?

- New reduction of disease claims are subject to approval by FSANZ. Details of this process can be found in the FSANZ Act 1991. For new nutrient function claims, there is an option to self-substantiate by conducting a systematic review with a focus on human (intervention) studies. Guidance for self-substantiation can be found on the FSANZ website

### Requirements for health claims on imported foods:

- All foods imported into Australia and NZ must comply with labelling and composition standards in the Food Standards Code

### Regulatory document:

- Standard 1.2.7 Nutrition, Health and Related Claims which should be used in conjunction with other relevant standards of the Food Standards Code.

### Website for regulatory document:

- <https://www.comlaw.gov.au/Details/F2013L00054>

## Philippines

### Regulatory Body:

- Philippines Food and Drug Administration (FDA) which is part of the Department of Health

### Website:

- <http://www.fda.gov.ph/>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- There is no list of pre-approved health claims.

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- In the Philippines, all food products must be registered with the FDA. Nutrition and health claims will be evaluated by the FDA's Product Services Division based on compliance with the Codex Guidelines.

### Requirements for health claims on imported foods:

- All food products imported into the Philippines must be registered with the FDA.

### Regulatory document:

- The Philippines has adopted Codex Alimentarius 'Guidelines for Use of Nutrition and Health Claims' (CAC/GL 23-1997).

### Website for regulatory document:

- <http://www.codexalimentarius.org/standards/list-of-standards/en/?provide=standards&orderField=fullReference&sort=asc&num1=CAC/GL>

## Singapore

### Regulatory Body:

- Agri-Food and Veterinary Authority (AVA) and Health Promotion Board (HPB) of Singapore

### Website:

- <http://www.ava.gov.sg/>
- <http://www.hpb.gov.sg/>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- 29 nutrient function claims; 7 nutrient function claims (infant formula and food, and food for children); 10 other function claims; 5 reduction of disease risk claims

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- New nutrient-function claims (not reduction of disease risk claims) are subject to approval by the AVA. Details on the application can be found here. To use the reduction of disease risk claims, first the food must have the 'Healthier Choice Symbol' which is subject to approval by the HPB. Food manufacturers then apply to the AVA to use the claim.

### Requirements for health claims on imported foods:

- All imported foods must be registered with the Director-General of the AVA. The Food Regulations require all pre-packed food products for sale in Singapore to be labelled according to the requirements specified.

### Regulatory document:

- 'Food Regulations' Health claims are listed in 'A Guide to Food Labelling and Advertisements'.

### Website for regulatory document:

- <http://www.ava.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/aguidetofoodlabellingandadvertisementsversionjuly2>

## Taiwan

### Regulatory Body:

- Taiwan Food and Drug Administration (FDA), Ministry of Health and Welfare

### Website:

- <http://www.fda.gov.tw/EN/>

### Can you make a health claim?

- Regulated health claims are permitted

### Is there a list of pre-approved health claims?

- ~70 nutrient function claims; 20 broad claims/slogans that are permissible; 13 health effects (some are reduction of disease risk) that have been approved for use on health food products.

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use, although if a claim has been approved in another country it may be able to be used.

### Can you apply to have a new health claim approved for use?

- All health food products must be approved by the FDA; once they have been approved and registered they receive a green TFDA 'Health Food' mark which is valid for five years.

### Requirements for health claims on imported foods:

- Health claims that are not reduction of disease risk claims (nutrient function claims) can be made on foods as long as they are truthful and not misleading. If a nutrient function claim has been approved in another country, it is likely to be allowed. For a new reduction of disease risk claims an application would have to be made to the FDA for scientific evaluation and approval.

### Regulatory document:

- Health Food Control Act of Taiwan (Mandarin); Schedule of Vitamin or Mineral Statements (Mandarin), an (unofficial) English version is available in Appendix 1.

### Website for regulatory document:

- <https://consumer.fda.gov.tw/Law/Detail.aspx?nodeID=518&lawid=277>

## Thailand

### Regulatory Body:

- Thailand Food and Drug Administration (FDA)

### Website:

- <http://www.fda.moph.go.th/eng/index.stm>

### Can you make a health claim?

- Health claims are permitted but there is no regulatory framework

### Is there a list of pre-approved health claims?

- There are no 'pre-approved' nutrient function claims but nutrient function claims must be based on reliable scientific evidence.

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- Domestic producers and importers of food can make an application to the Thai FDA (part of the Ministry of Health) to have a new nutrient function or a new health claim approved. In the Thai Nutrition Labelling document it states that nutrient function claims must be based upon reliable scientific evidence.

### Requirements for health claims on imported foods:

- All imported foods must apply to the Thai FDA for approval of health claims.

### Regulatory document:

- The (Unofficial) Notification of the Ministry of Public Health (No. 182) B.E. 2541 (1998) 'Nutrition Labelling' contains conditions for making nutrient function claims but there is no official regulatory framework for making health claims in Thailand.

### Website for regulatory document:

- [http://www.fda.moph.go.th/eng/eng\\_food/Notification/182-41.pdf](http://www.fda.moph.go.th/eng/eng_food/Notification/182-41.pdf)

## Vietnam

### Regulatory Body:

- Vietnam Ministry of Health

### Website:

- <http://moh.gov.vn/Pages/Index.aspx>

### Can you make a health claim?

- There are regulations for functional foodstuffs and these contain information on making nutrient function claims.

### Is there a list of pre-approved health claims?

- No.

### Potential health claims for phytonutrients:

- It would appear that it may be possible to make health claims for phytonutrients as long as these were validated. Health claims must be based on current relevant scientific substantiation and the level of proof must be sufficient to substantiate the type of claimed effect and the relationship to health as recognized by generally accepted scientific review of the data. These require pre-approval before use.

### Can you apply to have a new health claim approved for use?

- An application for a functional foodstuff should be submitted to the Ministry of Health (Department of Food Safety) and include evidence of the effectiveness on human health. The clinical trials (if conducted outside of Vietnam) must be conducted at accredited medical institutions or be published in scientific journals. The functional foodstuff must also comply with the appropriate Vietnamese Food Safety Provisions.

### Requirements for health claims on imported foods:

- 

### Regulatory document:

- Circular No. 43/2014 'Rules of management for functional foods' which is effective 15 May 2015 (Vietnamese)

### Website for regulatory document:

- <http://luatgiahoang.com/en/home/legal-documents/item/173-th%C3%B4ng-t%C6%B0-43-2014-tt-byt-quy-%C4%91%E1%BB%8Bnh-v%E1%BB%81-qu%E1%BA%A3n-l%C3%BD-th%E1%BB%B1c-ph%E1%BA%A9m-ch%E1%BB%A9c-n%C4%83ng>

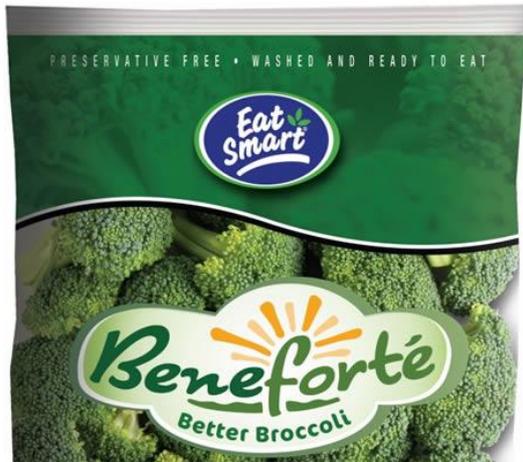
## **Appendix 8: Super Vegetables with high phytonutrient claims launched in other countries**

This information is available as a download from the Veggycation website. It is located in the phytonutrients section and is available to both general public and Growers (& Industry). It is intended to help consumers understand what they may see in advertising. It is also there to help growers understand these products and how FSANZ regulations differ in what is claimable.



# Veggycation

loving the health benefits



## Super Broccoli #1

**Beneforté Broccoli** was developed by UK scientists and Monsanto using conventional breeding techniques.

- **Launched:** UK, October 2011.
- **Developed by:** UK scientists at the Institute of Food Research, in collaboration with John Innes Centre, Plant Bioscience Ltd, and Seminis (now Monsanto), using conventional breeding techniques.
- **Timeframe to develop:** Decades.
- **UK/EU Claims:** Two to three times higher levels of glucoraphanin, which is a glucosinolate. Glucoraphanin is converted into sulforaphane when eaten. Same great flavour. Note there are as yet no FSANZ-approved nutritional or health claims related to this claim.
- **Proof:** Animal studies have shown sulforaphane can reduce rates of heart disease, act against some forms of cancer and boost the body's levels of antioxidant enzymes. Antioxidant enzymes have been shown to protect DNA from damage and are thought to contribute to healthy ageing. There have been quite a lot of human studies: Armah CN, Derdemezis C, Traka MH, Dainty JR, Doleman JF, Saha S, Leung W, Potter JF, Lovegrove JA, Mithen RF 2015. Diet rich in high glucoraphanin broccoli reduces plasma LDL cholesterol: Evidence from randomised controlled trials. *Molecular Nutrition & Food Research* 59(5): 918-92.
- **Success:** "The broccoli is selling well at Marks & Spencer" PBL Managing Director, Jan Chojecki. The product is now available in many UK retail outlets.
- **Available in Australia?** Not yet – launches in USA in 2017.

## Super Broccoli #2



**Booster Broccoli™** The variety was a result of natural breeding, largely by DPIVic and PFZ, with Vilmorin Cie as the genetics (seed) partner.

- **Launched:** 14<sup>th</sup> August, 2009.
- **Developed by:** Booster Broccoli™ was the first vegetable launched by **vitalvegetables®**, a collaboration funded by Horticulture Innovation Australia Ltd (HIA), Plant Food Research New Zealand (PFR), the Victorian Department of Primary Industry (DPIVic), AUSVEG and HortNZ. **vitalvegetables®** (VV) was also supported by Clause Pacific, Rijk Zwaan, Syngenta and marketing partners (Vital Vegetable Marketing Partnership, VVMP Pty Ltd), which included Simplot, Fresh Select, Perfection fresh, Salad fresh, Costa Exchange, Houstons Farm (Tasmania).
- **Claims:** Booster Broccoli™ is packed with over **40% more active antioxidants** than regular broccoli varieties, and has been scientifically proven to produce higher levels of the powerful antioxidant sulforaphane (often abbrev. To SF) than other varieties of broccoli. **‘To boost your body’s natural vitality, include Vital vegetables® as part of your five servings of fruit and vegetables enjoyed each day’.** Note there are as yet no FSANZ-approved nutritional or health claims related to this claim, which was formulated before the implementation of FSANZ Standard 1.2.7.
- **Proof:** Booster Broccoli™ is **scientifically proven** to produce significantly more sulforaphane (or SF) than other leading broccoli varieties. Booster Broccoli has an enhanced level of glucoraphanin when compared to other commonly grown broccoli cultivars.
- **Success:** Initial success was high, and product could not keep pace with demand. This then slowed.
- **Available in Australia?** Not at present, to our knowledge.

**Other Varieties:** There are other broccoli varieties which are ‘super’:

- Purple Sprouting Broccoli: naturally contains anthocyanin pigments. Antioxidant content, total phenolics and flavonoids in raw purple sprouting broccoli was 1.75 times that of normal wholehead broccoli, but the differences were lost upon cooking.

**Cooking recommendations for broccoli:** Steam for 3 mins max.

**Further information:**

- [www.superbroccoli.info](http://www.superbroccoli.info)
- [www.beneforte.com](http://www.beneforte.com)
- [www.horticulture.com.au/.../hortlink/pdfs/Winter\\_2009\\_Hortlink.pdf](http://www.horticulture.com.au/.../hortlink/pdfs/Winter_2009_Hortlink.pdf)

# Super Tomatoes



## High Lycopene Tomatoes

**Varieties:** A number of tomato varieties claim higher lycopene than 'normal':

- Tasti-Lee, aka Health Kick VFFA Hybrid (USA): "50% more lycopene than any other tomato". Great flavour.
- Tesco (UK) launched a variety bred in Holland with 'double the lycopene content of normal tomatoes'.
- BRS Tospodoro is a high-lycopene processing tomato bred in Brazil. It has a self-substantiated average lycopene content

of 10,400 µg/100g in the fully mature fruits.

- Monsanto have a variety higher in lycopene: cv 'Flavance', which has an internal colour that is more red than standard.
- Grow-at-home varieties including: Juliet, Matt's Wild Cherry, Sugar Lump, and Sweetheart, Crimson Queen: all listed as having high lycopene (no specific claims, or proof).
- Genetically modified high-lycopene tomatoes were produced by Purdue University in the early 00's, but no evidence of commercial launch is apparent.

**The following details refer to Tasti-Lee:**

**Launched:** 2010 (USA).

**Developed by:** University researcher, Uni of Florida Gulf Coast Research and Education Centre via conventional breeding techniques; Bejo Seeds. A combination of genetics, and vine-ripened outdoor cultivation.

**Timeframe to develop:** Pat of an ongoing research program over many years.

**Lycopene?:** Lycopene is a carotenoid, also found predominantly in watermelon, some red carrots and papayas; other fruit and vegetables may contain small amounts of lycopene. It provides a red colour, and is registered as a natural food colouring (Aus/NZ: 160d). Lycopene is not linked with Vitamin A production, which arises from alpha- and beta-carotene, although it has been shown to have antioxidant activity. Generally: the redder the tomato, the higher the lycopene content.

**Claims:** "50% more lycopene than any other tomato". Great flavour. Lycopene is a carotenoid identified as having antioxidant with several potential health benefits. There have been numerous studies that have correlated high intake of lycopene with reduced incidents of both cancer and heart disease, stroke and prostate cancer. Note there are as yet no FSANZ-approved nutritional or health claims related to this claim.

**Proof:** There is research that indicates tomatoes and tomato-based products may prevent serum lipid oxidation and reduce the risk of macular degenerative disease. Human studies have examined

the effect of lycopene on cardiovascular disease and prostate cancer, but the studies did not attain sufficient scientific agreement to conclude an effect on any disease.

**Success:** “Once word got out about these great-tasting tomatoes, the demand exceeded our supply”, Shannon Patten, spokeswoman for Publix Super Markets, USA.

**Available in Australia?** Not yet.

**Cooking recommendations:** Always store tomatoes at room temperature for best flavour until cut (then refrigerate). Cooking with oil or butter increases the bioavailability of lycopene, as lycopene is fat-soluble.

**Further information:**

- [www.tasti-lee.com](http://www.tasti-lee.com)

## High-Flavonoid Tomatoes

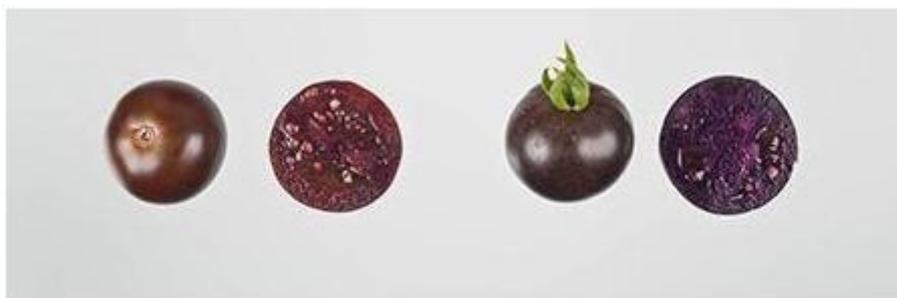


**Varieties:** A number of tomato varieties claim higher flavonoid content than normal, usually due to the presence of blue/purple anthocyanins, and a resultant black/purple colour:

- Indigo Rose – an open-pollinated variety with small (30-60g), purple fruits. Bred using conventional practices by Oregon State University. In development since the 1960's. No specific claims – the colour speaks for itself. The variety has a good balance of sugars and acids and tastes 'just like a tomato'. Indigo Rose fruit must be allowed to ripen fully for complete

development of sugars and acids; light is required for anthocyanin development.

- Some 'black' varieties do not contain flavonoids/anthocyanins, but have the green flesh gene, which prevents chlorophyll breakdown, resulting in a brown compound called pheophytin, and a brownish purple colour to the resultant fruit as it overlays the lycopene which is also present. Grow-at-home varieties including: Black Prince, Purple Cherokee are in this category. We suspect this is also the case for: 'Kumato<sup>®</sup>' – a standard size, hybrid tomato (80-120 grams) with a colour ranging from green to reddish brown or purple, varying in flavour from little flavour to sweeter than typical tomatoes due to a higher fructose content. Very juicy and firm in texture. 'Kumato<sup>®</sup>' was developed by Syngenta using natural breeding techniques. 'MiniKumato<sup>®</sup>' tomatoes are also available.
- Genetically modified, purple tomatoes were recently developed at the John Innes Research Centre (UK). Anthocyanins are present throughout the tomato tissue, not just in the skin. Preliminary findings show the fruit has a longer shelf-life than normal tomatoes. Animal studies are continuing.



- Grow at home varieties such as Purple Smudge, Fahrenheit Blues also accumulate anthocyanins – usually in the skin only.

**Flavonoids?:** Flavonoids in tomatoes include naringenin, but purple tomatoes also contain anthocyanins: these are the same natural chemicals that give red cabbage, blueberries and red apples their natural colour. Anthocyanins have been shown to have a range of health benefits.

**Claims:** With anthocyanins and purple colours, the proof is visibly clear to consumers. Anthocyanins have antioxidant activity in vitro, and there are many studies occurring globally examining various

effects: from improved cognition to heart health. Note there are as yet no FSANZ-approved nutritional or health claims related to these pigments.

**Proof:** Underway.

**Success:** As yet all commercial varieties are produced from conventional breeding. There is no doubt that a purple tomato would have consumer appeal, especially if lycopene content was simultaneous. As yet, content of anthocyanins in purple tomatoes is still lower than fruits such as blueberries, blackberries etc., which are a rich source of anthocyanins.

**Available in Australia?** Not commercially, apart from black/striated varieties such as Kumato® – see above.

**Cooking recommendations:** Best enjoyed raw as part of a salad. Cooking will lead to leaching of the anthocyanins.

# Purple Power

carrots, cabbage, cauliflower, radish, broccoli, Brussel sprouts, kale, onions, potatoes (not beetroot\*)



**Launched:** Increasingly available, to add interest to the vegetable sector and due to increasing awareness of benefits by consumers.

\*Beetroot is purple due to the presence of betalain pigments – which are totally different from anthocyanins.

**Developed by:** Many were around before breeding commenced seriously, some have been developed specifically via conventional breeding techniques.

**Claims:** Varieties that contain anthocyanins (the red/brown/purple colours) in addition to normal pigments may contain higher levels of antioxidant activity and some associated health benefits (e.g. carrot cv 'Cosmic Purple'). Some varieties, for example Purple carrots with a white core (cv 'Purple Haze'), do not contain beta-carotene, unlike orange carrots. The presence of purple pigments does not generally impact on flavour. Note there are as yet no FSANZ-approved nutritional or health claims related to this claim.

**Proof:** Purple pigments can be easily quantified, although none are FSANZ-approved for recommended daily intakes (yet).

**Success:** Purple is here to stay!

**Available in Australia?** Yes – carrots, cabbage, kale.

**Cooking recommendations:** Raw consumption is best, as anthocyanin purple pigments are water-soluble. Chop, grate, blend, juice.

The project was funded by Horticulture Innovation Australia using the vegetable levy and matched funds from the Australian Government.

# SuperCorn



## High Carotenoid Corn

**Varieties:** Research scientists at the Queensland Department of Agriculture, Fisheries and Forestry have developed a number of varieties of sweetcorn with higher levels of zeaxanthin, increasing the level from 0.2-0.3mg/100g fresh weight in 'normal' sweetcorn, to more than 2.0mg/100g fresh weight, via conventional breeding and selection.

In this variety, zeaxanthin is 70% of total carotenoids. When fully mature, dried kernels can have zeaxanthin levels of 8.7mg/100g. High zeaxanthin as a more orange-yellow colour than standard sweetcorn (which accumulates predominantly lutein), thus is visually different.

**Zeaxanthin?:** Zeaxanthin and lutein are isomers of each other, and both are carotenoids. Humans accumulate these carotenoids in the macula, and are thought to protect the photo receptor cells of the eye from damage from blue light, at a dose of circa 2mg/day. Age-related macular degeneration (AMD) is the leading cause of blindness in the developed world; increased consumption of lutein- and zeaxanthin-rich foods is a potential means to prevent, or slow the progress of AMD. Zeaxanthin and lutein are required from the diet, and yellow sweetcorn is a good source of zeaxanthin.

**Claims:** No commercial claims as yet made – but potentially 7-10times higher zeaxanthin levels. Some explanation of the health benefits of this will need to be made. Note there are as yet no FSANZ-approved nutritional or health claims related to this claim.

**Proof:** Scientific analysis and publications.

**Success:** Too early to tell, although when faced with a mixture of yellow (standard) and golden (+zeaxanthin) varieties, cobs were purchased equally. When some communication of the potential benefits of a higher zeaxanthin vegetable was undertaken, consumers purchased more golden corn.

**Available in Australia?** The new sweetcorn hybrids are currently being assessed by industry for potential commercialisation, and it is hoped they will be available in the next few years.

**Cooking recommendations:** As you would normal sweetcorn. Zeaxanthin and lutein are both fat-soluble phytonutrients: so add a dab of butter, a splash of olive oil to your steamed sweetcorn. Making popcorn could have a deleterious effect on the content of phytonutrients, due to the heat used.

## Further info:

- <http://www.qaafi.uq.edu.au/supergold-corn-to-slow-major-eye-disease>
- <http://era.daf.qld.gov.au/4714/>

## SuperPepper



*Note: this pic is not of the ACE pepper, of which copyrighted pics were the only ones available.*

**Varieties:** Marks and Spencer (UK supermarket) launched the 'ACE Pepper' in 2009. A single pepper (or capsicum), contains the RDI for Vitamin C, and half the RDI of Vitamins A (from carotenoids) and E. Normal peppers also contain Vitamins A and C, but the additional Vitamin E makes this one unique, apparently (although check out what Veggycation® says about standard red capsicums, below).

The ACE Pepper is deep red in colour, with a darker hue and longer length than normal peppers. It was developed over three years in the UK; whether by conventional breeding, natural selection or GM, is unclear; other reports state it was discovered in Israel. Apparently it has a lovely, sweet flavour. A small capsicum variety, high in Vitamins A, C and E was also in development as part of **vitalvegetables®**, in Australia/NZ.

**Vitamins?:** Check out Veggycation®.

**Claims:** As above, sometimes simplified to 'all the Vitamins A, C and E one requires in a day'. According M&S, the ACE pepper's vitamin content meets the UK RDA standards for vitamin A (0.7 mg for men, 0.6 mg for women) and vitamin C (40 mg). The company also confirmed that the vitamin content does not dissipate with cooking, so it can be enjoyed in a variety of different raw and cooked dishes.

**Proof:** Analytical data.

**Success:** It may still be available, we have not been able to clarify this.

**Available in Australia?** Not to our knowledge.

**Cooking recommendations:** To obtain the most benefit from this vegetable, high in water-soluble Vitamins (C) and fat-soluble Vitamins (A and E), enjoying it raw would be the best method. A dash of oil or other fat would improve the bioavailability of the fat-soluble vitamins.

End.