

THE HEALTH BENEFITS OF

Citrus fruits



Citrus: the edible fruits of plants belonging to *Citrus* and related genera of the family *Rutaceae* (orange family) including oranges, lemons, grapefruit, limes, mandarins (also referred to as tangerines) and tangelos.

I N T R O D U C T I O N

The nutritional depth of citrus fruit is tremendous.

It is well known citrus fruits contain a range of key nutrients including high levels of vitamin C and significant amounts of dietary fibre, beta-carotene and folic acid. They have a low ratio of sodium to potassium and are low in fat and dietary energy, making them nutrient dense, energy-dilute foods with a low glycaemic index. Citrus fruits are also extremely rich in antioxidants.

In recent years increasing attention has been given to the sum of biologically active elements found in citrus fruits – particularly their plant-based non-nutrients called phytochemicals – because of the role they might play in preventing a range of chronic disease conditions including cancer and heart disease.

The information contained in this booklet is based on a new report by the Consumer Science Program of CSIRO Health Sciences & Nutrition. Titled *The Health Benefits of Citrus Fruits*, it is the most comprehensive review to date of the dietary benefits of citrus fruits and a growing body of international research into their significance in preventing and protecting against chronic diseases.

The full report *The Health Benefits of Citrus Fruits* (2003) by Dr Katrina Baghurst, Consumer Science Program, CSIRO Health Sciences & Nutrition can be reviewed and downloaded from the Australian Citrus Growers website: www.austcitrus.org.au.



P H Y T O C H E M I C A L S



Plant-based non-nutrients called phytochemicals are emerging as an important dietary factor.

Citrus fruits contain hundreds of phytochemicals and there is increasing interest in the possibility that these substances contribute to optimal health and may protect against some of the common chronic diseases such as cancer and cardiovascular disease, degenerative eye and cognitive conditions, and general damage caused by ageing.

The phytochemical classes found in citrus have already been identified by the United States National Cancer Institute as warranting further research with regard to protection against cancer and cardiovascular disease.

Phytochemical classes found in citrus:

- Flavonoids
- Glucarates
- Carotenoids
- Coumarins
- Mono-terpenes
- Tri-terpenes
- Phenolic acids


Individual phytochemical components found in citrus:

- Hesperidin
- Naringin
- Tangeritin
- Limonene
- Nomilin
- Perillyl alcohol
- Mycrecetin
- Quercetin
- Sinsensetin
- Tangeretin
- Nobiletin

An orange has over 170 different phytochemicals and more than 60 flavonoids, many of which have been shown to have anti-inflammatory, anti-tumour and blood clot inhibiting properties, as well as strong antioxidant effects.

An increasing number of studies have also shown a greater absorption of the nutrients in citrus when taken with all the other biologically active phytonutrients they contain.

Polyphenols (also known as polyphenolics and plant phenols) are high in citrus with oranges totalling 84mg Gallic Acid equivalents/100mg. They have been shown to have a range of health related effects including antioxidant, anti-viral, anti-allergenic, anti-inflammatory, anti-proliferative and anti-carcinogenic. Most interest has centred on a possible role in cancer and heart disease, and more recently their role in brain functions such as learning and memory.



An orange has over 170 different phytochemicals and more than 60 flavonoids, many of which have been shown to have anti-inflammatory, anti-tumour and blood clot inhibiting properties, as well as strong antioxidant effects.

Found in citrus peels, **coumarins** are another class of phytochemicals that have been investigated for their health properties. Limited experimental studies suggest that coumarins might protect against human cancer. Auraptene, the most common coumarin in citrus, has been shown to inhibit cancerous growth in animal experiments.

Liminoids, from the class of tri-terpenes, stimulate a detoxifying enzyme system and inhibit tumour formation. Other phytochemicals found in citrus, such as **phytosterols**, have also shown anti-cancer properties in experimental studies.

Flavonoids

The polyphenol sub-group of flavonoids are particularly abundant in citrus plants and most species accumulate substantial quantities of flavonoids during organ development.


Citrus fruits contain four types of flavonoids: **flavanones**, **flavones**, **flavanols** and **anthocyanins** (found only in blood oranges), and more than 60 individual flavonoids have been identified.

Flavanones are the most abundant, but the highly methoxylated flavones have higher biological activity even if in lower concentrations.

The antioxidant properties of these substances give them anti-cancer, anti-viral and anti-inflammatory capabilities. They can also affect capillary fragility and platelet aggregation.

Carotenoids

The most well known carotenoid found in citrus is **beta-carotene**, the precursor of vitamin A (retinol). Some navel oranges and pink grapefruit also contain **lycopene**. Both are powerful antioxidants. Other carotenoids – **lutein** and **zeaxanthin** – are also present in citrus, and **cryptoxanthin** is abundant in oranges and mandarins (tangerines).



DISEASE PREVENTION



CSIRO's report shows a compelling trend of protection against various types of cancers from the dietary intake of citrus fruits. An earlier report by the World Cancer Research Fund also concluded the evidence for a protective effect of citrus consumption on cancer is particularly abundant.

Increasing attention has been given to the role citrus fruits might have in preventing cancer, coronary heart disease, stroke, diabetes, cataracts, arthritis, macular degeneration, Alzheimer's disease and inflammatory bowel disease.

A number of mechanisms of action have been proposed for the protective effects of citrus fruits against degenerative and other disease, not least because they have the highest antioxidant activity of all fruit classes. The overall antioxidant capacity for citrus fruits ranges from 100umol/100g Trolox Equivalents for grapefruit to 700umol/100g for some oranges. While ascorbic acid accounts for a great proportion of the antioxidant activity, other components such as non-nutrient carotenoids, polyphenols like flavonoids, glutathione and various enzyme systems may also contribute.

Other mechanisms of action could include:

- Regulation of gap-junction communication between cells;
- Enhancement of the immune system from pro-vitamin A carotenoids and vitamin E;
- Inhibition of tumour growth by beta-carotene;
- Inhibition of nitrosation by vitamin C and phenolics in the intestine;
- Inhibition of the enzyme topoisomerase II in cancer cells and "normalisation" of tumour cells by flavonoids.

Cancer

Most human epidemiological evidence for the potential effects of citrus consumption on chronic diseases relates to cancer:

CSIRO's *The Health Benefits of Citrus Fruits* is the most comprehensive review of research into this area and shows a compelling trend of protection against various types of cancers from the dietary intake of citrus fruits.

CSIRO reviewed all the case-control and cohort studies into cancer and citrus consumption from around the world, including those for colorectal, stomach, lung, breast, prostate, bladder, oesophagael, oro-pharyngeal, laryngeal, naso-pharyngeal, pancreatic and female reproductive tract cancers.

One large US study showed that one extra serve of fruit and vegetables a day reduced the risk of stroke by 4%, and this increased by 5-6 times for citrus fruits.



The report tables 48 studies that show a statistically significant protective effect against some types of cancer from citrus consumption and a further 21 studies that show a non-significant trend towards protection.

This follows an earlier report by the World Cancer Research Fund¹ which concluded the evidence for a protective effect of citrus consumption on cancer is particularly abundant. In particular it found convincing evidence for citrus consumption as protective for stomach cancer, and a possible protective role in oral and oesophageal cancer.

Overall, the greatest protection from increased citrus consumption appears to be for oesophageal, oro-pharyngeal/laryngeal (mouth, larynx and pharynx) and stomach cancers, where studies showed risk reductions of 40 – 50%.

Cardiovascular Disease & Stroke

A recent study by the World Health Organisation² also found convincing evidence of positive effects from the dietary intake of citrus fruits on cardiovascular disease through:

- The variety of phytonutrients they contain;
- Folate, which probably reduces cardiovascular risk;
- Potassium, which lowers high blood pressure, protecting against stroke and cardiac arrhythmias.

Studies have also identified vitamin C, carotenoids and the flavonoids found in citrus fruits as having protective cardiovascular qualities.

One large US³ study showed that one extra serve of fruit and vegetables a day reduced the risk of stroke by 4%, and this increased by 5-6 times for citrus fruits. This indicates a 19% reduced risk of stroke from one extra serve of citrus fruit a day.

Other Conditions

Evidence of positive effects associated with citrus consumption or components found in citrus can also be found in studies for arthritis, asthma, Alzheimer's disease and cognitive impairment, Parkinson's disease, macular degeneration, diabetes, gallstones, multiple sclerosis, cholera, gingivitis, optimal lung function, cataracts, ulcerative colitis and Crohn's disease.

As low fat, nutrient dense foods with a low glycaemic index, citrus fruits are also protective against overweight and obesity, conditions which increase the risk of heart disease, certain cancers, diabetes, high blood pressure and stroke, and add to symptoms of other conditions like arthritis.

What does this mean for Australians?

The multiple health benefits of citrus consumption are clear. As further research is undertaken and more findings emerge, it seems the most exciting breakthroughs are yet to come.

What we already know suggests increased consumption of citrus fruits could have a positive impact on the number of Australians suffering from cancer and cardiovascular diseases – the major causes of death in this country.

Oesophageal, oro-pharyngeal/laryngeal (mouth, larynx and pharynx) and stomach cancers, for which increased citrus consumption shows risk reductions of up to 50%, were responsible for about 2,500 deaths in Australia in 2001, 7% of all cancer deaths that year.

If the US data on reduced risk of stroke is applicable in Australia an increase in consumption of citrus fruits could potentially save about \$150 million per year from the national health bill.

As low fat, low energy, nutrient dense and low glycaemic index foods, citrus fruits are also of great importance in Australia where obesity (and as a result Type 2 diabetes) is reaching epidemic proportions.

Despite all this and the availability of home grown, low cost, high quality citrus fruit, intakes in Australia, as in most developed western societies, do not reach recommended levels.

Fortunately there is evidence that maximum benefits come from increasing the consumption of low-intake consumers, such as from one to two, or two to three serves per day. This makes it easier for health professionals to recommend and a realistic dietary habit for consumers to adopt.

Some of the simplest ways to incorporate citrus fruit into the daily diet include drinking freshly squeezed citrus juices, adding citrus flesh, rind or juices to marinades, desserts and meals, and eating orange or mandarin slices for between meal snacks.



A U S T R A L I A N S E A S O N S

Oranges (*Citrus sinensis*) – May to October (Navels), October to April (Valencias)

Grapefruit (*Citrus paradisi*) – All year; best November to April

Mandarins (*Citrus reticulata*) – March to November; best May to October

Lemons (*Citrus limon*) – All year

Limes (*Citrus aurantifolia*) – All year; best January to April

Useful Websites

Australian Citrus Growers: www.austcitrus.org.au

Florida Citrus Organisations, US (UltimateCitrus): <http://www.ultimatecitrus.com>

Produce Marketing Association: <http://www.aboutproduce.com>

European Community (Intercitrus): <http://www.orangefruit.net>



The Cancer Council supports the NHMRC Dietary Guidelines for fruits, vegetables and legumes. Vegetables and fruit are recommended both for their probable cancer protective effect and their low fat/high fibre contribution to the diet. The Cancer Council recommends people eat a variety of vegetables and fruit, including oranges.



Heart Foundation

The National Heart Foundation of Australia supports the NHMRC Dietary Guidelines for fruits, vegetables and legumes. Vegetables and fruit are recommended as a healthy choice of snack foods because of their low fat/high fibre contribution to the diet. The National Heart Foundation of Australia recommends that healthy eating be about eating more bread, cereals, rice, pasta, vegetables, fruits and legumes.

References

- 1 World Cancer Research Fund & American Institute for Cancer Research. *Food nutrition and the prevention of cancer: a global perspective*. AICR; Washington, DC, 1997.
- 2 World Health Organisation, *Diet, Nutrition and the Prevention of Chronic Disease*. Report of a joint WHO/FAO Expert Consultation, Geneva, 2003: http://www.who.int/hpr/NPH/docs/who_fao_expert_report.pdf
- 3 Joshipura KJ, Hu FB, Manson JAE, Stampfer MJ et al. *The effect of fruit and vegetable intake on risk of coronary heart disease*. *Annals Int Med*, 2001.

Acknowledgements

Information from *The Health Benefits of Citrus Fruits* (2003) reprinted with permission from the author and the Consumer Science Program, CSIRO Health Sciences & Nutrition. Thanks to Shane Landon, Catherine Saxelby and Karen Kingham for their input. Thanks to Australian citrus growers for their contribution.

Published by Horticulture Australia Limited: www.horticulture.com.au

Delivering R&D outcomes to industry is made possible by the Commonwealth Government's 50 per cent investment in all Horticulture Australia's R&D initiatives.