the apple report

A Nutrition and Health Review

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APPLES HAVE…

The highest antioxidant content of Australia's most popular fruits
More antioxidant power than a 1500mg megadose of Vitamin C
Ten times the antioxidant power of goji berry juice
Almost 4 times the antioxidant content of brewed tea
Been identified in human studies to reduce cancer risk
Provided asthma protection and improved lung function
Been linked to a reduction in cardiovascular disease risk
Reduced asthma in children when the mother ate apples during pregnancy
The capacity to aid weight loss while improving overall health profile
A dozen compounds in peel that inhibit or kill cancer cells

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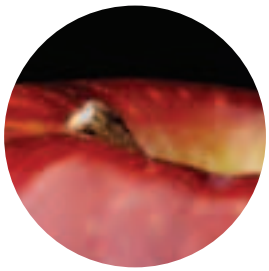
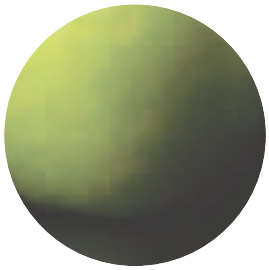
All references contained within the report





AUSTRALIA'S HEALTH CRISIS – A SNAPSHOT

Australia is facing a health challenge on a scale not seen before. Lifestyle related health conditions are responsible for up to one third of all health problems in this country[1]. Poor nutrition along with physical inactivity are risk factors for chronic diseases including heart, stroke and blood vessel disease, diabetes, cancer and kidney disease.

Thousands of Australians die prematurely each year, while thousands more live with significant disability, losing years of healthy, active life. Chronic disease is not just an inevitable consequence of ageing, but can be caused by poor nutrition. Many people could live longer and without illness if they improved their diet and increased their activity[1].

The Human Cost

- Seven of the 10 most common causes of death in Australia in 2002 were due to chronic disease[2].
- Ischaemic heart disease, stroke, lung cancer, colorectal cancer, breast cancer and diabetes mellitus are among the 15 leading causes of ill-health, disability and injury in Australia[3].
- Low levels of fruit and vegetable consumption, physical inactivity and the impact of overweight and obesity have a major impact on the total burden of chronic disease facing Australians[4].

The Financial Cost

- Total public money spent on health care in 2001/2002 was $45.5 billion, with cardiovascular disease and cancer combined costing one fifth of the total (more than $9 billion in one year)[5].
- The indirect costs are difficult to calculate, but include costs related to an inability to work and participate in the community, as well as other costs associated with support services and the contributions of a range of carers (often family members).

PREVENTION MAKES SENSE

Consider the following:

- Increasing fruit consumption by one serve a day per person would result in direct health care savings of $8.6 million a year for breast and lung cancer alone. An additional serve of vegetables would deliver a saving of $24.4 million per year for these cancers[6]. Similarly, one more serve of fruit and/or vegetables would save $156.8million each year from the costs of cardiovascular disease*.
- Increased fruit and vegetable consumption of one serve per day, per person would boost the horticulture industry by $430 million per year[1].

The scientific evidence indicates that a diet high in fruits and vegetables can decrease the risk of chronic diseases, such as cardiovascular disease and cancer, and antioxidant compounds including phenolics, flavonoids and carotenoids from fruits and vegetables may play a key role in reducing chronic disease risk[7].

As such, greater emphasis must be placed on the benefits of public health interventions that enable Australians to increase their fruit and vegetable intake. Dietary changes that are easy to adopt are more likely to be sustained long term and thereby increase the likelihood of meaningful health improvements. The report that follows reveals that part of the dietary solution for better health lies with the humble apple.

An apple a day really does make sense.

APPLES – SIMPLE BUT EFFECTIVE

Apples are widely consumed across the population and generally recognised as being healthy.

However, what is less well known is that apples are a potent source of powerful antioxidants plus other protective plant compounds with epidemiological studies linking their consumption with a reduced risk of some cancers, cardiovascular disease, asthma, and diabetes[7].

In recent studies, apples have been found to have very strong antioxidant activity, inhibit cancer cell proliferation, decrease lipid oxidation, and lower cholesterol. Apples contain a variety of phytochemical compounds, including quercetin, catechin, phloridzin and chlorogenic acid, all of which are strong antioxidants[7].

ANTIOXIDANTS EXPLAINED

Although there is still much to learn about the exact way in which apples exert their beneficial effects, the evidence for a powerful antioxidant role is compelling. Antioxidants help neutralize free radicals – highly reactive, unstable compounds that are produced naturally within the body as well as being derived from external sources such as cigarette smoking, environmental pollutants and ultraviolet light[8].

If free radicals are not inactivated, their chemical reactivity can damage all types of cellular macromolecules including proteins, carbohydrates, lipids and DNA. Indeed, it has been estimated that there are 10,000 oxidative hits to DNA per cell per day in humans[9].

The human body has it's own natural and complementary defenses against free radical damage including an enzyme system that involves glutathione peroxidases, superoxide dismutases

*Australian Fruit and Vegetable Coalition, Better Health Its Simple

DID YOU KNOW?

Red Delicious apple has almost 4 times the antioxidant content of brewed tea*

**Source: US Department of Agriculture, ORAC of Selected Foods, November 2007*

and catalase. A vital second line of defense involves dietary antioxidants[9].

However, due to a combination of a highly oxidative environment and poor diet the body's antioxidant defenses can be overwhelmed and oxidative stress results.

Oxidative stress has been linked to the development of a variety of degenerative diseases including cancer[10], heart disease[11], neuronal degeneration such as Alzheimers[12], and Parkinson's disease[13] as well as the process of ageing[9].

The DNA damage caused by oxidative stress when left un-repaired can lead to base mutation, single and double strand breaks, DNA cross-linking, and chromosomal breakage and re-arrangements. This type of damage, widely considered as cancer inducing, may be prevented or limited by dietary antioxidants in fruits and vegetables[14].

APPLES – EVERY MOUTHFUL COUNTS

In addition to being antioxidant rich, apples are rich in nutrients as well making them a valuable choice each day for enhancing the quality of the diet. Apples contain:

- **Dietary Fibre:** linked to reduced risk for a variety of diseases plus optimum digestive health
- **Long lasting energy:** with a low GI of 38 apples provide a sustained source of energy
- **Potassium:** linked to lower blood pressure plus calcium, iron and zinc
- **Vitamin C:** for healthy skin and bones
- **B vitamins:** for good health
- **Fluid:** for hydration
- No fat, cholesterol or salt

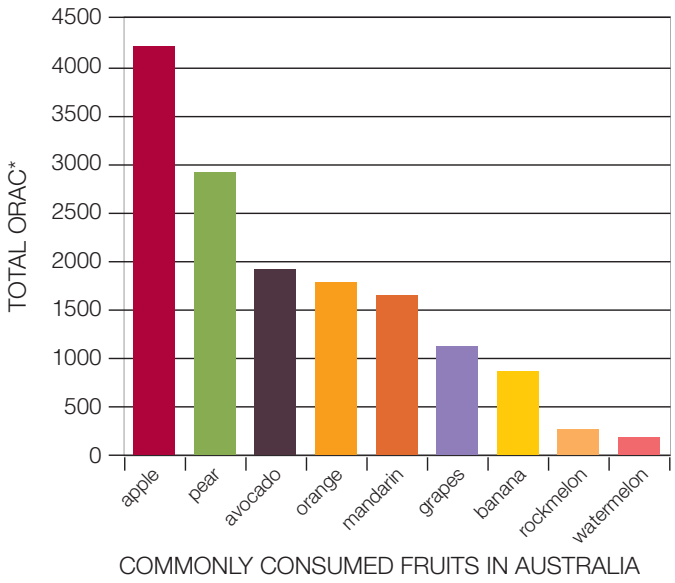
APPLES – AN ANTIOXIDANT POWERHOUSE

Figure 1 shows the total antioxidant capacity for some of Australia's most commonly consumed fruits as measured using ORAC – oxygen radical absorbance capacity*. The ORAC assay is preferred to other techniques because of its biological relevance to the in vivo antioxidant efficacy[15] and is the technique adopted by the US Department of Agriculture[16].

It is evident that apples represent a potent source of antioxidants in a convenient, value for money and well-accepted form with almost 5 times the antioxidant capacity of bananas and more than twice that of an orange. As with any plant crop cultivar variance is to be expected however the storage of apples does not impact the phytochemicals[7].

Figure 1.

Total Antioxidant Capacity



* Total ORAC Values = sum of hydrophilic-ORAC (H-ORAC) and lipophilic-ORAC (LORAC) reported in µmol of Trolox Equivalents per 100 grams.

Source: US Department of Agriculture, Oxygen Radical Absorbance Capacity of Selected Foods, November 2007

#1 AMAZING APPLE FACT

Vitamin C supplements are regularly used for their antioxidant benefit, after all Vitamin C is widely recognized as one of natures most powerful anti oxidants[17].

Just 100g of apple has the equivalent antioxidant power of a 1740mg megadose of Vitamin C[18].

In combination with the fibre, potassium, minerals, long lasting energy and great taste, apples are the ideal choice for giving the body an antioxidant boost.

ANTIOXIDANT CLAIMS – BEWARE THE HYPE!

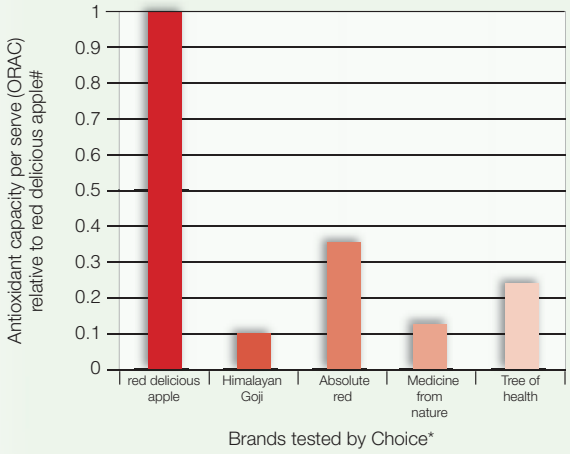
The emergence of so-called superfruit juices has been accompanied with extreme claims about their antioxidant content as well as their supposed health benefits. The claims have become so extreme that Choice* magazine conducted their own analysis to compare the antioxidant content of a serve of these juices to a red delicious apple. The results simply reinforce that eating apples is a much better and affordable way to optimize antioxidant intake.

THE TEST

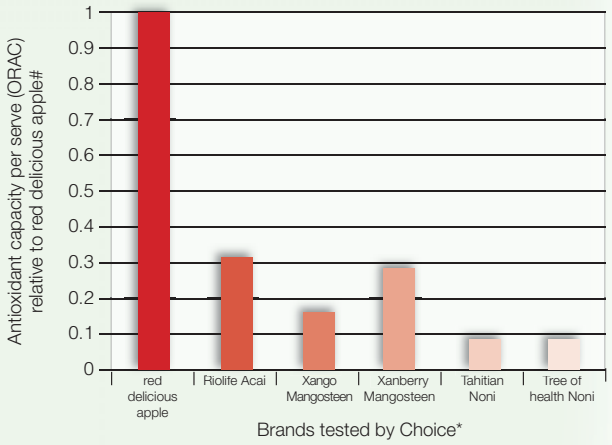
Choice tested the antioxidant activity of a range of these “super” juices using the ORAC assay (Oxygen Radical Absorbance Capacity) at a laboratory and compared the antioxidant capacity of a "serve" of the juice (30ml) to a red delicious apple.

THE RESULTS

Antioxidant capacity of Goji juice relative to a Red Delicous Apple



Antioxidant capacity of Acai, Mangosteen and Noni juice relative to a Red Delicous Apple



**Source: Choice On-line August 2007 Superfruit Juices*
#Total antioxidant capacity of red delicious apple 5,900. Source: Wu et al, 2004 Journal of Agricultural and Food Chemistry 52, 4026-4037

WHAT ARE PHYTOCHEMICALS?

Phytochemicals are substances in plant foods that have health benefits in addition to vitamins, minerals and other nutrients. Thousands of phytochemicals have been isolated and characterized from plants, including fruits and vegetables.

The major categories of dietary phytochemicals include:

- Phenolics
- Carotenoids
- Alkaloids
- Nitrogen-containing compounds
- Organosulphur compounds

In turn, the Phenolics give rise to a significant number of sub-categories of phytochemical groups including:

- Flavonoids
- Phenolic Acids
- Stilbene’s
- Coumarins
- Tannins.

APPLES - THE EVERYDAY ANTIOXIDANT OPTION

Apples are the perfect everyday choice for boosting antioxidant intake.

While the antioxidant content of other fruits like blueberries are widely appreciated and they are certainly encouraged as part of a varied diet, they do not offer an everyday solution for boosting antioxidant status.

Cost, convenience and availability can limit blueberry intake to a small handful, perhaps 75 grams, and while this helps provide more antioxidants, it is still less than an apple.

#2 AMAZING APPLE FACT

It is difficult to identify particular foods as having sufficient evidence to support cancer risk reduction. However…

Apples are one of the very few individual foods specifically identified in human population studies as having the capacity to reduce cancer risk.[7,24]

APPLE PHYTOCHEMICALS

Apples are particularly rich in Flavonoids, this includes, sub-classes such as the Flavonols, Flavones, Flavanols.

Some of the most well researched antioxidant compounds in apples include:

- Quercetin-3-galactoside
- Quercetin-3-glucoside
- Quercetin-3-rhamnoside
- Catechin
- Epicatechin,
- Procyanidin
- Cyanidin-3-galactoside
- Coumaric acid
- Chlorogenic acid
- Gallic acid
- Phloridzin

The compounds most commonly found in apple peels consist of the procyanidins, catechin, epicatechin, chlorogenic acid, phloridzin, and the quercetin conjugates. Apple flesh contains catechin, procyanidin, epicatechin, and phloridzin, but these compounds are found in lower concentrations than in the peels[7].

THE HEALTH BENEFITS OF APPLES

CANCER

Apples are one of the very few individual foods specifically identified in population studies as having the capacity to reduce cancer risk and more specifically lung cancer[7].

An analysis of the Nurses' Health Study and the Health Professionals' Follow-up Study involving 77,000 women and 47,000 men revealed that women who consumed at least one serving per day of apple had a reduced risk of lung cancer[19].

Apples were also identified as reducing lung cancer risk in a case control study in Hawaii where it was found their intake was associated with a reduced risk of lung cancer in both males and females[20]. In fact, apples (along with onions and white grapefruit) reduced lung cancer risk by 40-50% in both men and women while no associations were seen for red wine, green or black tea[7]. Apples are high in flavonoids, especially quercetin and quercetin conjugates[21].

In a Finnish study involving 10,000 men and women and a 24-year follow-up, a strong inverse association was seen between flavonoid intake and lung cancer development[22]. Apples were the only specific foods that were inversely related to lung cancer risk. Since apples were the main source of flavonoids in the Finnish population, it was concluded that the flavonoids from apples were most likely responsible for the decreased risk in lung cancer[7].

Interestingly, the relationship of dietary catechins (found in tea as well as apples) and epithelial cancer was examined in 728 men (aged 65–84) as part of the Zutphen Elderly Study[23]. While tea contributed 87% of the total catechin intake and apples provided just 8%, only apple consumption was associated with decreased epithelial lung cancer incidence and not tea[23]. It has been suggested that the higher bioavailability of apple catechins compared to those in tea may explain this finding[7].

A more recent study[24] to specifically investigate apple intake and cancer risk was conducted in Europe where the researchers analyzed data from thousands of individuals who participated in multi-center case controlled studies over 11 years (1991-2002).

Dietary patterns (including consumption of apples) of cancer patients were compared with patients who did not have any type of cancer. Individuals, who consumed an apple a day or more, had a reduced incidence of different cancers: oral, esophageal, larynx, breast, ovary, prostate and colorectal.

After allowing for consumption of other fruits and vegetables, “the association with apples did not change, and became even stronger for some cancer sites” revealed the authors[24].

Again, the issue of bioavailability of the phytochemicals was identified as potentially important with the investigators noting that apples have the highest level of free phenolic compounds.

The researchers concluded,

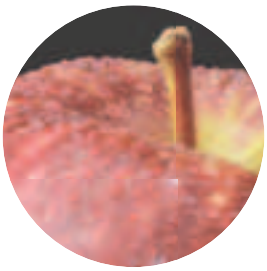
“This investigation found a consistent inverse association between apples and risk of various cancers.”[24]

DID YOU KNOW?

Apple’s antioxidant power is not simply due to its content of Vitamin C?

In fact, the vitamin C content of apples contributes just 0.4% to their total antioxidant activity[7].

Nearly all of the antioxidant potency comes from the variety of other phytochemical compounds found in every juicy apple.



CARDIOVASCULAR DISEASE

A reduced risk of cardiovascular disease has been associated with apple consumption. The Women's Health Study surveyed nearly 40,000 women with more than 6 years follow-up, and found that women ingesting apples had a 13–22% decrease in cardiovascular disease risk[25]. Apple intake was associated with reductions in both the risk of cardiovascular disease and cardiovascular events[7].

A study examining flavonoid intake and coronary mortality found that apple intake (along with onion) was inversely associated with coronary mortality, especially in women[26]. Data collected from this same cohort study also showed an effect for quercetin and apple intake on cerebrovascular disease. Those who had the highest consumption of apples had a lower risk of thrombotic stroke compared to those who consumed the lowest amounts of apples[27].

Apples were also inversely associated with death from coronary heart disease in postmenopausal women in a study of nearly 35,000 women in Iowa[28]. The intakes of catechin and epicatechin, both constituents of apples, were strongly inversely associated with coronary heart disease death.

Flavonoids and risk of coronary heart disease were examined as part of the Zutphen Elderly Study[29]. Flavonoid intake was strongly correlated with a decreased mortality from heart disease in elderly men and also negatively correlated with myocardial infarction. Apple intake contributed to approximately 10% of the total ingested flavonoids and was also associated with a reduced risk of death from coronary heart disease in men, however the relationship was not statistically significant[29].

#3 AMAZING APPLE FACT

Cardiovascular disease (CVD) is the leading cause of death in Australia, accounting for 36 per cent of all deaths in Australia in 2004. It kills one Australian every ten minutes*.

Simply eating apples has been linked to a reduction in CVD risk of up to 22%[25]

Increasing apple intake may help ease the burden of this national health problem

** National Heart Foundation - Statistics*

A new study of more than 34,000 women[30] showed flavonoid-rich apples to be one of three foods (along with red wine and pears) that decrease the risk of mortality for both coronary heart disease (CHD) and cardiovascular disease (CVD) among post-menopausal women. The findings were published in the March 2007 American Journal of Clinical Nutrition.

Using a government database that assesses the flavonoid-compound content of foods, the researchers hypothesized that flavonoid intake (in general and from specific foods), might be inversely associated with mortality from CVD and CHD among the women in the study group. Subjects selected for this research analysis were postmenopausal and part of the ongoing Iowa Women's Health Study, each of which has been monitored for dietary intake and various health outcomes for nearly 20 years.

As a result of the extensive analysis that considered what the women ate, the types of cardiovascular-related diseases they experienced, and the overall flavonoid content of an extensive list of foods, the researchers concluded that apple consumption was linked with the lowest risk for mortality related to both CHD and CVD (not just one or the other) [30].

ASTHMA AND LUNG HEALTH

In Australia, asthma is now recognized as a national health priority and apple consumption has been consistently linked to protection against asthma in a number of studies including an Australian investigation of young adults published in the American Journal of Clinical Nutrition in 2003[31].

Whole apples were found to protect against asthma, current asthma as well as bronchial hyper-reactivity while total fruit and vegetable intake was not associated with asthma risk or severity. Pears were also protective[31].

The link between apple consumption and reduction in asthma found in the Australian research supports a study from Britain that found apples reduced asthma in an adult population[32].

In the UK study, total fruit and vegetable intake was weakly associated with asthma, and apple intake showed a stronger inverse relationship with asthma. This latter effect was most evident in subjects who consumed at least two apples per week. Onion, tea, and red wine consumption were not related to asthma incidence, suggesting an especially beneficial effect of apple flavonoids[7].

Apple intake was associated with a reduced incidence of asthma in a study involving 10, 000

#4 AMAZING APPLE FACT

Around 15% of Australian children and 11% of adults have been diagnosed with asthma. This translates to more than 2 million Australians with the condition.

Apples have been consistently linked to asthma protection and improved lung function[31-35]

Including apples may be valuable and easy step to reducing asthma risk and is a healthy complement for any asthma action plan.

men and women in Finland. Apart from oranges, other fruits and vegetables, such as onions, grapefruit, white cabbage, and juices, were not associated with a decreased risk in asthma[33].

Apple intake has also been associated with better lung function in two European studies where the intake of apples were positively linked with pulmonary function[34,35] with the Dutch study also indicating a negative association between apple intake and chronic obstructive pulmonary disease (COPD)[34]. The Welsh investigation measured forced expiratory volume (FEV) in one second, and was positively correlated with citrus fruit, fruit juice/ squash, and apple consumption. However, the association with citrus fruit and fruit juice/ squash lost significance after adjustment for smoking.

Apple consumption remained positively correlated with lung function after taking into account possible confounders such as smoking, body mass index, social class, and exercise. Participants who consumed five or more apples per week had a significantly greater FEV of 138 mL when compared to those who did not consume apples[35].

APPLES, MATERNAL DIET IN PREGNANCY AND ASTHMA IN CHILDREN

The ability for apples to help prevent asthma has recently been expanded to consider the impact of the maternal diet. New research suggests that mothers who eat apples during pregnancy may protect their children from developing asthma later in life[36].

The study, which tracked the dietary intake of more than 1200 pregnant women, examined the effects of the maternal diet on airway development in their children at the age of 5. The researchers concluded that the children of mothers who ate apples had a significantly reduced risk of asthma and related symptoms such as wheezing.

The researchers stated that there are:

"beneficial associations between maternal apple intake during pregnancy and wheeze and asthma at age five years."[36]

While the association is not yet fully understood, the protective benefits appear to be apple specific, possibly because the apple's flavonoid content has positive effects on airway and immune development[35].

DIABETES AND WEIGHT LOSS

An apple intake of one per day or more resulted in a significant 28% reduction in risk of Type II diabetes compared to those who did not consume apples in a study of more than 38,000 women and published in the journal of the American College of Nutrition[37].The previously discussed Finnish study of 10,000 people, also considered apple intake and Type II diabetes risk and found apple intake was associated with a reduction in risk[33].

Higher quercetin intake, a major component of apple peels, was also associated with a decreased risk in type II diabetes.

Apple and pear intake has also been associated with weight loss in middle aged overweight women in Brazil[38]. Approximately 400 hypercholestemic, but nonsmoking, women were randomized to one of three supplement groups: oat cookies, apples or pears, and each subject consumed one of each supplement three times per day for twelve weeks.

The participants who consumed either of the fruits had a significant weight loss after 12 weeks, whereas those consuming the oat cookies did not have a significant weight loss. Those consuming

#5 AMAZING APPLE FACT

What a mother eats during pregnancy is vital – not only for the growth of the unborn child but their longer-term health.

The children of mothers eating the most apples during pregnancy were less likely to have asthma at the age of 5[36]

Adding apples to the mother's diet is a simple and highly nutritious dietary change that may protect the child against developing asthma.

fruit also had a significantly lower blood glucose level when compared to those consuming the oat cookies[38].

HEALTH BENEFIT SUMMARY

The evidence consistently shows that apple intake may play a significant role in reducing chronic disease risk, with a recent review stating:

"…apples were most consistently associated with reduced risk of cancer, heart disease, asthma, and type II diabetes when compared to other fruits and vegetables and other sources of flavonoids. Apple consumption was also positively associated with increased lung function and increased weight loss."[7]

As a result of the important health benefits linked to apple consumption, considerable research is now actively underway to better understand the bioactive components found in apples and elucidate plausible mechanisms to explain their health benefits.

APPLES – MORE EXCITING DIMENSIONS

ANTIPROLIFERATION EFFECTS

A number of studies have demonstrated the powerful antioxidant capacity of apple extracts[17,18] – a process that involves the extraction and isolation of the phytochemical compounds that are present in both the flesh as well as the skin of apples[18].

However, the compounds found in apples are not limited to antioxidant action and a number of investigations have tested the capacity of apple compounds to exert antiproliferative effects on human cancer cell lines in the laboratory.

Such studies involve the addition of isolated apple extracts to human cancer cell lines and measuring the capacity of that extract to inhibit cancer cell proliferation. The capacity to limit cell growth suggests the compound may also exert a positive impact in vivo – although more research would be required to prove such a role[7].

In 2001, research showed that different varieties of apples had different effects on liver cancer cells with Fuji apple extracts inhibiting cell proliferation by 39% while Red Delicious extracts inhibited cell proliferation by 50% at the same dose[39]. Earlier research also showed the capacity for apples phytochemicals to inhibit proliferation of Caco-2 human colon cancer cells[17].

It has also been demonstrated that apples without skin are less effective in inhibiting Hep G2 liver cancer cells than apples with peel, indicating apple peels possess significant antiproliferative activity[40].

Further investigations have added weight to the potent antiproliferative effect of apple peel extracts[41] while other studies have explored the mechanisms by which the compounds found in apple may be exerting their effects[42].

Indeed, apple peels are rapidly emerging as offering important health advantages:

"The high phenolic content, high antioxidant activity, and high antiproliferative activity of apple peels indicate that they may impart health benefits when consumed and should be regarded as a valuable source of natural antioxidants or bioactive compounds"[41]

The search for a plausible mechanism to explain some of the antiproliferative effects of apple extracts is underway with recent studies identifying nuclear factor κB (NF-κB)[42,43].

Nuclear factor κB (NF-κB) is a transcription factor that plays an important role in inflammation, cell proliferation, apoptosis (programmed cell death), and immunity in eukaryotes. In cancer cells, NF-κB

AN APPLE A DAY – WISE ADVISE

7 good reasons to have an apple each day

- The highest antioxidant content of Australia's most popular fruits
- More fibre than leading breakfast cereals – without the added salt or sugar
- Potential health benefits including a reduced risk of some cancers, CVD, asthma, and diabetes
- Long lasting energy with a low GI of 38
- Valuable fluid
- A good source of potassium with calcium, iron and zinc plus vitamin C
- A tasty and convenient "ready to go" snack

#6 AMAZING APPLE FACT

Adding apples to the diet is a healthy option that increases weight loss

Just 3 apples a day (one before each meal) not only helped women to loose weight but improved their overall health profile[38]

induces resistance to anticancer chemotherapeutic agents by increasing cell proliferation and inhibiting apoptosis. Therefore, inhibition of NF-κB activation in cancer cells is advantageous in cancer therapy by lowering the resistance to chemotherapy.

Apple extracts significantly inhibited the TNF-α-induced NF-κB activation in MCF-7 human breast cancer cells and significantly inhibited proteasomal activity of MCF-7 cells. This result suggests that apple extracts are capable of inhibiting TNF-α-induced NF-κB activation of MCF-7 human breast cancer cells[42].

It has been suggested that because of the ability of apple extracts to inhibit NF-κB signaling, apple consumption may:

- Act as a useful adjunct to chemotherapy
- Assist in the removal of potentially cancerous cells[43].

As such, apples – and the phytochemicals they contain may play both a therapeutic as well as preventative role in cancer[43].

#7 AMAZING APPLE FACT

When it comes to apples – the message is to eat the whole fruit – skin and all !

In 2007, researchers discovered a dozen compounds in apple peel that inhibit or kill cancer cells in the laboratory.[41]

This may help explain the anticancer activities of whole apples and sheds new light on studies linking apples to a reduced risk for some cancers.

INHIBITION OF LIPID OXIDATION

Addition of apple phenolics to human serum decreased diphenylhexatriene-labeled phosphatidylcholine (DPHPC) oxidation in a dose dependent manner[44]. DPHPC is incorporated into low-density lipoprotein (LDL), high-density lipoprotein and very low-density lipoprotein (VLDL) fractions and is an indicator of oxidation.

Apple ingestion led to a decrease in DPHPC oxidation, reflecting the apples antioxidant activity in vivo[44]. The protective effects of apples on LDL oxidation reached its peak at three hours following apple consumption and returned to baseline levels by 24 hours[44].

Diphenylhexatriene labeled propionic acid (DPHPA) binds to serum albumin and is a good measure of oxidation within the aqueous phase of human serum. The same research team also found that consumption of apples led to a decrease in albumin DPHPA oxidation, reaching peak activity at 3 hours[44].

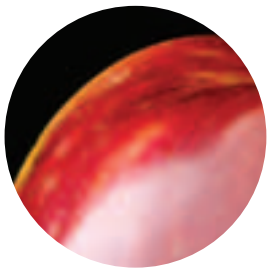
Pearson et al[45] examined the effects of six commercial apple juices and Red Delicious apples (whole apples, peels alone, and flesh alone) on human LDL oxidation in vitro.

The dose of the apple juices and whole apple, apple peel and apple flesh, were standardized for gallic acid equivalents, and each LDL solution was treated with 5 μM gallic acid equivalents for each apple sample.

While LDL oxidation inhibition varied greatly between brands of fruit juice (9 to 34% inhibition), whole apples inhibited LDL oxidation by 34% as did apple peels. The apple flesh alone showed less inhibition (21%)[45].

Proposed mechanisms by which dietary phytochemicals may prevent cancer

Antioxidant activity
  Scavenge free radicals and reduce oxidative stress
Inhibition of cell proliferation
Induction of cell differentiation
Inhibition of oncogene expression
Induction of tumor suppress gene expression
Induction of cell-cycle arrest
Induction of apoptosis
Inhibition of signal transduction pathways
Enzyme induction and enhancing detoxification
  Phase II enzyme
  Glutathione peroxidase
  Catalase
  Superoxide dismutase
Enzyme inhibition
  Phase I enzyme (block activation of carcinogens)
  Cyclooxygenase-2
  Inducible nitric oxide synthase
  Xanthine oxide
Enhancement of immune functions and surveillance
Antiangiogenesis
Inhibition of cell adhesion and invasion
Inhibition of nitrosation and nitration
Prevention of DNA binding
Regulation of steroid hormone metabolism
Regulation of estrogen metabolism
Antibacterial and antiviral effects
Source: Liu RH (2004) Journal of Nutrition



CHOLESTEROL-LOWERING

The protective effect of apples against cardiovascular disease observed in the large scale human studies may be derived, at least in part, from their potential cholesterol-lowering ability. An animal study found that when cholesterol fed rats were supplemented with lyophilized apples, there was a significant drop in plasma cholesterol and liver cholesterols and an increase in high-density lipoproteins (HDL)[46].

Furthermore, they found that cholesterol excretion increased in the feces of rats fed apples, suggesting reduced cholesterol absorption[46].

A similar cholesterol lowering effect was seen in cholesterol fed rats when they were fed apples, pears, and peaches. Apples had a greater cholesterol lowering affect than the other two fruits[47]. The three fruits also increased the plasma antioxidant potential, with apple having the greatest effect. Apples, pears, and peaches all had similar fiber content, but apples contained more phenolic compounds suggesting that perhaps the phenolics in apples contribute to this effect[47].

APPLE STORAGE

After harvest, apples continue to be a living entity and maintain the vital processes of each living cell. In regard to the phytochemical content of apples, they are not greatly affected by storage[7] with some studies[48,49] actually showing an increase in antioxidant activity and /or particular phytochemical level after storage.

THE POWER OF SYNERGY

It is now clear that apples – like so many other plant foods, contain a mixture of "phyto" or "plant" chemicals that operate in an additive and synergistic fashion and in doing so, helps explain the potent antioxidant as well as anti cancer effects observed[14].

A "bioactivity index" has even been suggested to take account of both the antioxidant and antiproliferative effects of various fruits the aim of which is to encourage consumers to "choose fruits on the basis of their beneficial activities". Interestingly, apples were ranked second in this index[18].

Due to the synergistic action of phytochemicals, no single purified supplement or pill can replace the combination of natural compounds found in apples – or other fruit/ vegetable[14].

As expected with any plant crop, there are differences between cultivars as well as some variation in terms of response to available light, stage of fruit development and variety however the storage of apples has little to no effect on the phytochemical content of apples[7].

Apples store very well allowing them to be consumed throughout the year in all parts of Australia thereby enhancing public access to a healthy, nutritious and affordable fresh food.

A HEALTHY LUNCHBOX – APPLE OR MUESLI BAR?

The battle for the school lunchbox has never been more keenly fought with a plethora of new products positioning themselves as the best choice.

It is an important nutrition decision when you consider what it means over the course of a school term and year.

Compare the nutritional difference between a medium apple and one of only three "healthier" muesli bars that met all the nutrition criteria laid down by Choice in their review of lunchbox snacks*

The comparison involves selecting a medium size apple for the lunch box 3 days of the week OR one of the "healthier" muesli bars Choice identified for one 10 week term.

Over the course of one term, compared to an apple, the "healthier" muesli bar provided:

61% more kilojoules
Over 20 times more fat
52% less dietary fibre
Almost 3 times more sodium

Apples contain no saturated fat while the muesli bar contributed 42 grams during one term.

If we look at an entire school year, the differences become even more concerning with the muesli bar adding almost 25,000 extra kilojoules!

Plus – the significant antioxidant content of apples has not been taken into account – the vital bioactive agents considered to hold the key to many of the health benefits for apples.

**Choice on-line Kids Lunch Snacks 2005*

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APRIL 2008