Tea and Antioxidant properties

Introduction

Increasing evidence is highlighting the role antioxidants may have in protecting against certain conditions such as heart disease, stroke and cancers. It has been proposed that the mechanisms leading to these diseases may be promoted by free radicals and that antioxidants may oppose the action of these molecules. In addition to the well known antioxidants such as Vitamins C and E, there is growing research demonstrating the potentially beneficial effects of plant-derived antioxidants, polyphenols, found in fruits, vegetables, nuts, cereals and drinks such as tea and red wine.

Free radicals explained

Free radicals are unstable molecules that include the hydrogen atom, nitric oxide (NO) and molecular oxygen (O_2). These naturally occur in the body as a result of chemical reactions during normal cellular processes. They can also be formed in response to excess pollution, too much UV sunlight and exposure to cigarette smoke. In an attempt to stabilise, they attack other molecules in the body potentially leading to cell damage and triggering the formation of another free radical resulting in a chain reaction. Some scientists believe that this type of free radical action has been implicated in certain chronic and ageing diseases such as cancer, heart disease, stroke, rheumatoid arthritis, cataracts and Alzheimer's disease.

Protective mechanisms of antioxidants

Antioxidants are compounds that help to inhibit the many oxidation reactions caused by free radicals thereby preventing or delaying damage to the cells and tissues. Their mechanisms of action include:-

- Scavenging reactive oxygen and nitrogen free radical species
- Decreasing the localised oxygen concentration thereby reducing molecular oxygen's oxidation potential
- Metabolising lipid peroxides to non-radical products
- Chelating metal ions to prevent the generation of free radicals

In this way antioxidants limit the free radical damage from:-

- Oxidising Low Density Lipoprotein (LDL) cholesterol, which may increase the risk of athersclerosis
- Promoting platelet adhesion, which can lead to thrombosis thereby increasing the risk of heart disease or stroke
- Damaging the cell's DNA, which may lead to cancer
- Blocking the normal endothelial cell function and vasodilatation in response to nitric oxide, a potential mechanism for heart disease and cancer
- Triggering inflammation
- Impairing immune function

Some antioxidants are synthesised within the cells themselves (endogenous) and others need to be provided in the diet. Table 1 gives examples of antioxidants with established or proposed activity in the body.

Table 1

Endogenous Antioxidants	Antioxidants provided in the diet
Polyamines Melatonin Oestrogen Superoxide dismutase Glutathione peroxidase Catalase Lipoic Acid Caeruloplasmin Albumin Lactoferrin Transferrin	Vitamin E Vitamin C Carotenoids Polyphenols Copper

Sources of dietary antioxidants

Traditionally dietary antioxidants were thought of as Vitamin E and C and the carotenoid - carotene. In recent years there has been particular interest in the antioxidant activity and health benefits of other phytochemicals. Table 2 lists two examples of phytochemicals and their food sources.

Table 2

Phytochemical	Categories	Sub-category	Food Sources
Carotenoids	Carotene	-carotene	Carrots, pumpkins, avocados
		b- carotene	Carrots, red peppers, apricots, spinach
	Lycopene		Tomatoes, pink grapefruit, watermelons
	Lutein		Spinach, kale, brussel sprouts
Polyphenols	Flavonoids	Anthocyanins	Berries, red wine, black grapes
		Flavones	Celery, parsley, olives
		Flavonols; Quercetin, Rutin	Tea, apples, onions, wine, garlic
		Flavonols; Catechins	Tea, wine, pears, apples, chocolate
		Flavanones	Citrus fruit
		Isoflavones	Legumes
	Phenolic Acids	Hydroxybenzoic Acid; Gallic Acid, Ellagic Acid, Salicylic Acid	Berries, Tea, Grapes, Walnuts
	Other Phenolic compounds	Capsaicin	Chillies, Peppers
		Tannins	Tea, red wine, grapes

Tea has one of the highest total flavonoid contents of all plants at 15% of the leaf by dry weight[1] and is also the major source of flavonoids in the UK diet, providing approximately 80% of dietary flavonoids for the population as a whole.[1]

Tea Flavonoids

The types and amounts of flavonoids present in tea will differ dependent on the variety of leaf, growing environment, processing, manufacturing, particle size of ground tea leaves and infusion preparation. [2-4] Typically 93% of total tea phenolic compounds are flavonoids [1]. Green teas contain more of the simple flavonoids called catechins, while the oxidisation that the leaves undergo to make black tea converts these simple flavonoids to the more complex varieties called theaflavins and thearubigins. For more information about green and black teas please refer to the fact sheet 'Black and Green Tea: How do they differ?'

Tea flavonoids are water-soluble and one study[1] has shown that a cup of UK tea that has been allowed to brew for 40-60 seconds will typically deliver approximately 140mg of flavonoids whilst a second carried out by the UK Tea Trade Technical Committee[2] using typical UK consumer brewing conditions and encompassing the range of blends and bag weights commonly on sale in the UK gives a figure of 125mg/235ml serving. The longer the tea is left to brew, the higher the concentration of flavonoids.[4]

Tea flavonoids demonstrate antioxidant activity [5-8] and while not a replacement for fruit and vegetables, the antioxidant activity of tea has been compared to that of fruit and vegetables in a number of studies. One study concluded that at the typical UK daily consumption of 3 cups a day,[9] tea has approximately the same antioxidant power as eating six apples.[10] Another study found that one or two cups of tea has the same 'radical scavenging capacity' as five portions of fruit and vegetables or 400mg vitamin C equivalents.[11]

Health benefits of tea flavonoids

For many years it has been known that the plant polyphenols are antioxidant in vitro, in fact many common flavonoids are several times more potent than Vitamin C or E[12,13]. This growing interest in the antioxidant activity of phenolic compounds has led to increased research into their potential health benefits e.g.

-Heart Disease and Stroke

- -Several reports indicate that tea flavonoids inhibit the oxidation of LDL cholesterol in vitro[12,14-17]
- -A reduction in blood lipids has been demonstrated in animal studies [18-20]
- -Certain tea flavonoids exhibit anti-inflammatory actions in animals.[21,22]
- -Athersclerosis is a disease with a strong inflammatory component
- -Improvements in blood vessel function, specifically the vascular endothelium, has been seen in patients with established CHD[23]
- -Several in vitro studies[24-27] and one human trial[28] have found that platelet aggregation can be inhibited by various flavonoids

The antioxidant activity of tea flavonoids may account for the results of a number of epidemiological studies suggesting that they may have a protective role in conditions such as cardiovascular disease.[29-36]

-Cancer
    -In vitro studies have demonstrated that the initiation stage of cancer can be prevented by the action of tea flavonoids[37-45]
    -Tea polyphenols have been shown to inhibit DNA synthesis of leukaemia cells and lung carcinoma cells[46,47]
    -Animal studies have shown that tea and its flavonoids protects against many types of cancer e.g. skin tumors in mice[48-50], lung cancer in mice[51-53] and digestive cancer in mice and rats[54]
-Antibacterial effects
    -Tea extracts exhibit inhibitory effects against Salmonella typhi, Campilobacter jejuni, Campilobacter coli, Helicobacter pylori, Shigella, Clostridium, Pseudomonas, Candida and others[55-58]

-Dental Caries
    -Green tea and various catechins have exhibited inhibitory effects on the growth of cariogenic bacteria by preventing the adherence and growth of bacteria at the tooth surface[59,60]

Absorption of tea flavonoids

Until recently the majority of the research demonstrating the antioxidant activity of tea flavonoids was either using animal models or laboratory cellular studies. Emerging evidence is concluding that the body does in fact absorb some of these antioxidants,[61-67] e.g. when green tea extract is consumed by healthy human volunteers, various catechins are found in the plasma in a dose-dependent concentration varying between 0.2-2.0% of the ingested amount, with a maximum concentration being achieved 1.4 to 2.4 hours after consumption[65-67]. Some studies have shown that plasma antioxidant activity peaks 30-60 minutes after tea consumption and returns close to baseline by 90 minutes[62,68,69]. Further research is currently being undertaken on the metabolism, distribution and excretion of tea flavonoids and its metabolites.
The addition of milk to tea, as enjoyed by the majority of the UK population, does not appear to affect the bioavailabilty of the tea flavonoids.[61,62,70]

In summary…

It is well known that fruit and vegetables are good sources of antioxidants, however, what is less well known is the amount of antioxidants present in tea. The major group of antioxidants in tea are flavonoids that appear to be digested, absorbed and metabolised by the body. There is a wealth of evidence demonstrating that tea and flavonoids exhibit beneficial effects in animal and in vitro studies and provide a promising area of research for future human studies.
So as well as eating more fruit and vegetables, antioxidant intake can be topped up by drinking more tea, helping to promote overall health and well-being.

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