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Walnuts: a nutritional gem

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SUMMARY

Walnuts contain between 52 and 70% oil. More than 90% of this oil contains unsaturated fatty acids, and the oleic acid (a monounsaturated fatty acid) content ranges from 12 to 20%. Phytosterols and vitamin E are also dissolved in the oil fraction and these, along with oleic acid, are the most positive nutritional features of walnuts.

Some nutrition experiments have shown the potential cholesterol lowering effect of consuming walnuts but they seldom record the full nutritional profile of the nuts. New Zealand grown cultivars show a wide content range of these important constituents. Nuts may protect against coronary heart disease through a number of mechanisms. Walnuts contain about 10% linolenic acid, which has been associated with reduced risk in several prospective studies[a], possibly due to antithrombotic[a] and antiarrhymic[a] effects of α-linolenic acid. Walnuts are an excellent source of protein, the crude protein content of New Zealand walnuts ranges from 13.6 to 18.1 g crude protein/100 g DM. Walnuts are rich in arginine, a precursor of nitric oxide, a potent vasodilator, which can inhibit platelet adhesion and aggregation. Other suggested benefits of nuts include their high content of magnesium, copper, folic acid, protein, potassium, fibre and vitamin E.

The complete composition of walnuts grown in different parts of the world has not been fully described. New Zealand grown walnuts have distinctive nutritional profiles and some cultivars may prove to have a greater positive metabolic effect than other cultivars. Analysis has shown that Rex, a New Zealand selected walnut, contained the highest level of polyunsaturated fatty acids of any cultivar. Initial analysis showed that feeding the cultivar Rex as a dietary supplement had a positive effect on the blood profile lowering the levels of cholesterol, LDL-cholesterol and triglycerides of most of the volunteers. It is likely that this effect was caused by the addition of polyunsaturated fatty acids, plant sterols and vitamin E from the nuts. The additional dietary fibre found in the nuts should also not be overlooked. Overall these results confirm that walnuts are a healthy addition to the diet.

[a] At the end of this paper you will find an explanation of some of these less common words.

INTRODUCTION

Nuts have been part of the human diet for a long time; remains have been found in archaeological sites dating back to before 10,000 BC. Nuts are a concentrated food and generally store well. Recent research suggests that some early civilisations relied on nuts as a staple food before cereal grains. The world production of nuts is low compared to other food types but the prospect for increasing production is good. Nuts are highly valued for their attractive delicate taste. Their most positive feature is the increasing number of reports indicating that the regular consumption of nuts may have a positive effect on a person's health. For a long time vegetarians have valued nuts as an alternative source of protein, but nuts have more than protein to offer. Hu *et al.,* (1998) suggested that up to eight different constituents might contribute to the positive nutritional benefits of nuts. These constituents occur at high levels in nuts. Linolenic acid, folic acid, arginine, fibre, vitamin E, potassium, copper and magnesium were the original positive constituents listed, plant sterols must now be added to this list.

In a prospective cohort study, regular consumption of nuts has been associated with a reduced risk of both fatal coronary heart disease and non-fatal myocardial infarction (Hu *et al*., 1998). These results are consistent with an earlier epidemiological study (Fraser *et al.,* 1992) which showed that people who consumed nuts five or more times a week had a 50% reduction in risk of coronary heart disease compared to those who never consumed nuts. A similar reduction in relative risk was observed in a cohort of women (Hu *et al*., 1998) in the Nurses' Health Study (Colditz *et al.,* 1997).

Although walnuts (*Juglans regia* L.) are rich in fat, a diet supplemented with walnuts had a beneficial effect on blood lipids, lowering blood cholesterol and reducing the ratio of serum concentrations of low density lipoprotein: high density lipoprotein by 12% (Sabate *et al.*, 1993). The positive results of these experiments have been confirmed in cross-sectional surveys on the effect of walnut consumption on blood cholesterol (Lavedrine *et al.,* 1995). Most experiments have been carried out by feeding walnuts, as they appear to be the most important tree nut at present. One experiment however, has been carried out feeding almonds and the reduction in total and LDL-cholesterol in the blood appeared to be slightly more than when walnuts were fed as a supplement (Abbey *et al.,* 1994).

It is still not clear which constituents of nuts are advantageous when eaten regularly but epidemiological studies suggest that nuts as a group all have a positive effect (Colditz *et al.,* 1997). It is a little unfortunate in this context that, in the Nurses' Health Study peanuts (a legume) were included under the heading "nuts". The prospect for investigating the positive effects of other commonly consumed tree nuts is good. As these nuts have different compositions it may be possible to find a species or cultivar of nut with a very different effect on human metabolism. This would allow the identification of the advantageous constituents.

Walnut kernels generally contain about 60% oil (Prasad, 1994) but this can vary from 52 to 70% depending on the cultivar, location grown and irrigation rate (Greve *et al.,* 1992; Garcia *et al.,* 1994; Beyhan *et al.,* 1995). The major constituents of the oil are triglycerides, free fatty acids, diglycerides, monoglycerides, sterols, sterol esters and phosphatides are all only present in minor quantities (Prasad, 1994). The major fatty acids found in walnut oil are oleic (18:1), linoleic (18:2) and linolenic (18:3) acids. The ratios of these to each other are important to the economic and nutritional value of the nut. A lower linoleic and linolenic acid content may give a longer shelf life, and monounsaturated fatty acids may be more desirable because of

their potential health benefits (Sabaté *et al.,* 1993; Abbey *et al.,* 1994). The high linoleic acid content of walnut oil makes it undesirable for use in cooking as it is more prone to charring but walnuts are a perfect ingredient in a variety of breads, muffins, cakes and biscuits (Anon, 1991).

Fatty acids

Studies in Italy and New Zealand have shown that the total fat and the individual fatty acid contents of different cultivars vary widely (Zwarts *et al.,* 1999; Savage *et al.,* 2000). No differences in the total fat content or the individual fatty acid contents could be observed from year to year (Zwarts *et al.,* 1999). In this study the linolenic acid contents of walnuts grown under the same conditions in New Zealand ranged from 8.0-13.8% while the linolenic contents of walnuts grown in Italy ranged from 12.8-15.3% (Ruggeri *et al.,* 1996; Zwarts *et al.,* 1999). A later study (Savage *et al.,* 2000) on a wider range of walnut cultivars confirmed that the total oil ranged from 64.2 to 68.9% and the linolenic acid content varied between 10.7 and 16.2%. Increased levels of linolenic acid in the diet has been associated with reduced risk of heart attacks in several prospective studies, possibly due to antithrombotic and antiarrhymic effects of α-linolenic acid (Dolecek 1992; Ascherto *et al.,* 1996).

Tocopherols (vitamin E)

A large proportion of the fatty acids in walnuts are unsaturated and the oxidation of unsaturated lipid is linked to the appearance of unpleasant odours and flavours. The oxidation of the polyunsaturated fatty acids occurs slowly even in nuts stored in good conditions (Savage, *et al.,* 2001). So nuts lose their excellent taste and their positive nutrition attributes if they are stored too long. The vitamin E isomers, which are present, provide some protection against oxidation of the unsaturated fatty acids. The measurement of vitamin E isomers is important due to their antioxidative and other positive nutritional effects in human metabolism. So far the measurement of these isomers in walnut oil has not been well documented. Lavedrine *et al.* (1997) has presented some data on the vitamin E content of walnuts grown in France and the USA. They identified α, β and γ tocopherol in fresh and stored nuts and noted the significant losses that occurred after three months storage at 4°C. They identified γ tocopherol as the main tocopherol in walnut oil. The tocopherol content of New Zealand cultivars of walnuts ranges from 290 to 435 μg/g oil (Savage *et al*., 1999). The New Zealand selected cultivar Rex had the lowest total vitamin E content while Dublin's Glory had the highest of all the cultivars (Savage *et al.,* 1999). The proportion of individual vitamin E isomers remained constant in all the nuts.

Sterols

Phytosterols have been regarded as cholesterol-lowering agents since the early 1950's (Ling and Jones, 1995). Plant sterols appear to pass through the intestinal tract almost unabsorbed (Raicht *et al.,* 1980) but plant sterols also appear to interfere with the absorption of cholesterol, which is a very positive thing to do. Animal and human studies have shown that moderate intakes of dietary plant sterols decrease serum total cholesterol and LDL-cholesterol levels (Mattson *et al.,* 1977; 1982; Miettinen, 1990). This effect appears to be due to inhibition of cholesterol absorption (Heinemann *et al.,* 1993, Ling and Jones, 1995). The levels of sterols found in walnuts may be enough to exert a positive effect on human metabolism but this depends on the amount of walnuts eaten on a regular basis. It is interesting to note that the levels found in different cultivars grown under similar conditions vary considerably (Savage and Dutta, 2002). This suggests that it may be possible to select some cultivars with more advantageous nutritional features than others.

Amino acids
Walnuts are an excellent source of protein (protein is made up of individual amino acids some of which are essential in the diet), the protein content of New Zealand walnuts range from 13.6 to 18.1 g crude protein/100 g DM (Savage, 2000). In the same study the amino acid composition of New Zealand grown walnuts were consistent between the 12 different cultivars except for the two American cultivars, Tehama and Vina which showed showed lower amino acid contents. These lower values reflect the lower crude protein contents of these two cultivars. Walnuts contain a relatively low content of lysine and high levels of arginine (Ruggeri *et al.,* 1996). Savage (2001) showed that the ratio for 12 different cultivars grown in New Zealand to be 0.24 which is much lower than other common proteins (Lavedrine *et al.,* (1999). The high levels of arginine in walnuts has already been identified as a positive feature as arginine can be converted into nitric oxide, a potent vasodilator, which can inhibit platelet adhesion and aggregation (Sabaté and Fraser, 1993). A low ratio of lysine/arginine in a protein has been identified as a positive feature in the reduction of the development of atherosclerosis in laboratory animals (Kritchevsky *et al.,* 1982).

Dietary fibre
Dietary fibre has important effects on conditions such as diabetes, hyperlipidemia and obesity and may have preventative implications for conditions such as hypertension, coronary heart disease and some intestinal disorders (Anderson and Bridges, 1988; Kritchevsky, 1988). Although specific associations between dietary fibre and disease may be difficult to prove directly there are benefits in consuming foods rich in fibre. Nuts may protect against coronary heart disease through a number of mechanisms (Sabate *et al.,* 1993; Fraser, 1994). Fibre is mentioned as one of the eight possible positive constituents of nuts (Hu *et al*., 1998). The total dietary fibre content of 12 different cultivars of walnuts harvested in New Zealand ranged from 3.1 to 5.2 g/100g dry matter (Savage, 2000). Lintas and Cappelloni (1992) were able to identify both insoluble and soluble fibre using the Prosky method (Prosky *et al.,* 1988) in a range of nuts grown in Italy. Unfortunately they were unable to identify the different cultivars of the nuts they had analysed. The insoluble fibre content of the nuts they analysed ranged from 15.8 g/100g for macadamia nuts to 3.8 g/100g for pine nuts. In contrast the soluble fibre contents of nuts they analysed appear to be quite low.

Healthy nuts
The positive nutritional advantages of walnuts in lowering blood cholesterol should not be overlooked. These advantages come from the high levels of mono- and polyunsaturated fatty acids fibre and possibly the tocopherol content (Sabaté *et al.,* 1993; Abbey *et al.,* 1994). The experiments of Sabaté *et al.,* (1993) and Abbey *et al*., (1994) are unusual as they used specific foods, walnuts and almonds, to lower total plasma and LDL-cholesterol thus reducing the potential risk of coronary heart disease. The experiments showed an improved lipid profile when walnuts were added to the diet but neither of these experiments recorded the fatty acid profile of the nuts fed to their experimental subjects. This is important, as it has been shown that the fatty acid profile of walnut oil varies between cultivars (Greve *et al.,* 1992; Zwarts *et al.,* 1999; Savage *et al.,* 2000). It is important to identify these differences in locally grown cultivars and to identify which fatty acids give the best nutritional qualities.

Although walnuts are rich in fat, a diet supplemented with walnuts had a beneficial effect on blood lipids, lowering blood cholesterol and lowering the ratio of serum concentrations of low density lipoprotein: high density lipoprotein by 12% (Sabaté *et al.,* 1993). The positive results of these experiments have been confirmed in cross-sectional surveys on the effect of walnut consumption on blood cholesterol (Lavedrine *et al.,* 1999).

Recently, in New Zealand, an experiment where students were fed a supplement of 60 g walnuts per day for two weeks was carried out (Savage *et al.,* 2001). This experiment was unusual in a number of ways. One cultivar (Rex) of known composition was fed as a supplement to the student's diet. No dietary advice was given to change the diet or to reduce other sources of fat intake in the diet. The nuts were fed to both male and female students (total of 30 students) aged 19-25 years and, in contrast, to many other walnut experiments, the subjects were not known to have hypercholesterolemia. After eating the nuts for two weeks both male and female students showed a significant ($p<0.05$) mean fall in blood cholesterol from 4.88 to 4.45 mM/L for males and a mean fall from 5.03 to 4.72 mM/L for female students. This reduction in mean blood cholesterol levels could be observed in a small group of 9 male students two weeks after they had ceased eating the supplements of walnuts (mean cholesterol level 4.49 mM/L). A significant ($p<0.05$) reduction in blood triglycerides could be observed after consuming the walnut supplements; this effect appeared to be greater ($p<0.01$) for the female students. The LDL-cholesterol levels were reduced in both groups; but only the female students showed a significant reduction ($p< 0.05$). It is interesting to note that the magnitude of the change in blood parameters is not great but it has an interesting distribution. Close inspection of the data suggests that two sub-groups of people could be found in the group of students who took part in the experiment; responders and non-responders. The magnitude of the response for the responders group appears to be greater in the group of male students. Fifty % were responders and their mean lowering of blood cholesterol was 18%. Seventy-seven % of the female students appeared to respond to the consumption of walnuts in the diet giving an overall 11% lowering of blood cholesterol.

This experiment shows that eating a small supplement of walnuts in the diet is a reasonable way to modify blood cholesterol levels for a portion of the population. This blood cholesterol lowering effect in the responding group could still be observed two weeks after completing the experiment. These results confirm the epidemiological and population studies which show that people who regularly consume nuts as part of their diet appear to lower their risk of coronary heart disease.

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An index of useful words

Antithrombotic –a compound that reduces the chance of blood clotting, blood tends to clot on the rough walls of atheromatous vessels and thus sometimes block them enough to cause a heart attach or stroke

Atherosclerosis (or hardening of the arteries)– a disease where fat containing material, which includes cholesterol, accumulates on the inner walls of the arteries.

Atheromatous (plaque) – Fatty material, mostly cholesterol covered with fibrous connective material embedded in the artery walls.

Antiarrhymic – A compound that stops the heart developing an irregular rhythm, lack of oxygen ti the heart because of atheroma (fatty deposits) is the coronary arteries is one of the causes.

Vasodilator – a compound that widens the blood vessels (a good thing if the vessels are beginning to become blocked with fatty plaques).

Prospective studies (Prospective cohort study) – A group of people are studied right from when they start an intervention (a new drug a change of diet etc) and their body parameters are monitored at intervals and the results are compared to a control group of people who carry on as normal.

Myocardial infarction –(heart attack) – blood flow to part of the heart muscle is cut off by a fatty plaque and that area of heart muscle dies.

Epidemiological study – is a study of a population rather than an individual, usually to study illnesses or accidents, fatalities or the risks and benefits of treatment.

Cross-sectional survey – this is a study that looks at a population having an intervention and looks at how many have benefited or are adversely affected compared with a group not involved with the intervention.

Tocopherols (vitamin E) – vitamin E is in fact a group of compounds called tocopherols different amounts of these are found in different foods. Walnuts contain high levels of γ-tocopherol while hazel nuts contain high levels of α-tocopherol

Sterols - these are compounds made by plants, sitosterol is the one most commonly found in foods. Sterols prevent cholesterol from being absorbed, this is a good feature.

Monounsaturated fatty acids – These are fatty acids that contain only one double bond, the best known is oleic acid (18:1) which is found in high levels in olive oil. Monounsaturated fatty acids are good thing to have in the diet.

Polyunsaturated fatty acids – These contain usually two or three double bonds in their structure. They are good to have in foods but the presence of these extra double bonds make the food more unstable and less likely to store well for a long period of time. Linolenic (18:2) and Linolenic (18:3) are the most common polyunsaturated fatty acids.

LDL (**Low density lipoproteins)** - are lipoprotein fractions in the blood used to transport fats around the body- lowering the LDL fraction is a good objective).

Walnut (NZ grown) - a high quality nut with an excellent taste, which should only be sold to discerning people.