SOME NUTRITIONAL ADVANTAGES OF WALNUTS

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Abstract

Walnuts contain between 63 and 70% oil, more than 90% of this oil contains unsaturated fatty acids and the oleic 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. Earlier experiments have outlined 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 range in content of these important constituents and this range therefore provides the opportunity to investigate the different nutritional effects of each main constituent. Initial analysis showed that Rex, a New Zealand selected walnut contained the highest level of polyunsaturated fatty acids of any cultivar. To characterise the effect of this cultivar in the human diet, 60g of Rex walnuts were fed as a daily addition to the diet of volunteers. The blood profile of cholesterol, HDL-cholesterol and triglycerides were monitored before and after the addition of walnuts to the diet. Initial analysis showed that the dietary supplement had a positive effect on 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 and these results confirm that walnuts are a healthy addition to the diet.

Résumé

Les noix contiennent entre 63 et 70 % d'huile qui est composée à plus de 90 % d'acides gras insaturés et dont le contenu en acide oléique varie de 12 à 20 %. Des phytosterols et de la vitamine E sont aussi dissous dans la fraction lipidique et constituent avec l'acide oléique les composés nutritionnels le plus intéressants de la noix. Des expériences passées ont signalé l'effet positif de la consommation de noix sur la diminution du taux de cholestérol dans le sang mais ritionnel complet des noix. Les cultivars cultivés en Nouvelle-Zélande montrent de grandes variations quant au contenu de ces importants constituants et ces différences fournissent donc l'opportunité d'étudier les effets nutritionnels de chaque principal constituant. Les premières analyses ont montré que Rex, une variété -Zélande, était parmi les cultivars étudiés, le plus riche en acides gras polyinsaturés. Pour caractériser l'effet de ce cultivar dans le régime alimentaire humain, 60 gr de noix de Rex ont été ajoutés journellement dans la nourriture de volontaires. Leur composition sanguine en cholestérol, HDL cholestérol et triglycérides était mesurée avant et après l'addition de noix dans leur régime alimentaire. Les résultats ont
avait un effet positif sur la plupart des volontaires. Il est vraisemblable que cet effet était dû à l'apport d'acides gras insaturés, de phytostérols et de vitamine E fournis par les noix et ces ent que les noix sont un complément, gage de santé, dans l'alimentation humaine.

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1. Introduction

Walnut kernels (*Juglans regia* L.) 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 triacylglycerols; free fatty acids, diacylglycerols, monoacylglycerols, 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. Lower linoleic and linolenic acid content oils may have 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).

1.1. Fatty acids

As interest in tree nuts, especially walnuts, is now growing it is important that the composition of the nuts commonly grown in each country should be investigated. 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.* 1999). 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 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.*, 1999) on a wider range of walnut cultivars confirmed that the total oil ranged from 64.2 - 68.9% and linolenic acid content varied between 10.7 and 16.2 %. This study showed that another key constituent, vitamin E also varied among cultivars grown at the same location in the same year.

Ruggeri *et al.* (1996) were the first to present the chemical composition of named cultivars of walnuts and these data highlight the range of composition among different cultivars. While it is clear that walnuts have a positive role in human nutrition it will not be easy to identify which constituents have the more important effects. It is possible that some cultivars may have a better effect on human metabolism because of their different nutritional composition.

1.2. Tocopherols

Walnut kernels contain about 60% lipids and a large proportion of these lipids are unsaturated ; the oxidation of unsaturated lipid is linked to the appearance of unpleasant odours and flavours. The vitamin E isomers which are present, provide some protection against oxidation of the lipids. The measurement of vitamin E isomers is important due to their antioxidative effect and their 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; no β tocopherol was identified in their samples. The tocopherol content of New Zealand nuts (Table 2) ranges from 290-435 µg/g oil. The New Zealand selected cultivar Rex had the lowest total vitamin E content while Dublin's Glory had the highest of all the cultivars. The proportion of individual vitamin E isomers remained constant in all the nuts.

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1.3. 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, and estimated absorption appears to be less than 5% (Raicht *et al.*, 1980). 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 occur directly from inhibition of cholesterol absorption (Heinemann *et al.*, 1993, Ling and Jones, 1995). The levels found in walnuts (Table 3) would exert a positive effect on human metabolism. It is interesting to note that the levels found in different cultivars grown under similar conditions vary considerably. This suggests that it may be possible to select some cultivars with more positive nutritional features than others.

1.4. 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 and possibly the tocopherol content (Sabaté *et al.*, 1993, Abbey *et al.*, 1994). These experiments 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 (Sabaté *et al.*, 1993, Abbey *et al.*, 1994). The experiments carried out by Sabaté *et al.*, (1993) and Abbey *et al.*, (1994) showed the positive effect of addition of walnuts 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.*, 1999). It is important to identify these differences in locally grown cultivars and to identify which fatty acids give the best nutritional qualities.

Regular consumption of nuts has been associated in a prospective cohort study 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% reduced risk of coronary heart disease relative to those who never consumed nuts. A similar reduction in relative risk was observed in a cohort of women (Hu *et al.*, 1992) from the Nurses' Health Study (Colditz *et al.*, 1997).

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% (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.*, 1999).

Recently in New Zealand we have carried out an experiment where students were fed a supplement of 60 g walnuts per day for two weeks. 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 aged 19- 25 years and in contrast to many other walnut experiments, the subjects did not have known hypercholesterolaemia. 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 for males and a mean fall from 5.03 to 4.72 mM 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). 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 ($p< 0.05$). The HDL-cholesterol levels were not significantly altered by the treatment (Table 4). It is interesting to note that the magnitude of the change in blood parameters is not great but it has an interesting

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distribution. Close inspection of the data suggest 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 where only 50% responded and gave an overall mean lowering of 18% blood cholesterol. 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. Overall there was a significant (p=0.03, R^2 adj 26%) regression for magnitude of the reduction in cholesterol relative to the initial level. Using 4.6 mM as the cut off point those within this lower group had a 1.5% reduction when eating the nuts, those above this level (mean 5.6 mM) had a significantly greater average reduction in blood cholesterol level (9.3%).

This experiment shows that 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 are 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.

2. Conclusions

Nuts may protect against coronary heart disease through a number of mechanisms (Sabaté *et al*., 1993, Fraser, 1994) and up to eight constituents might contribute to the positive nutritional benefits of nuts (Hu *et al*., 1998). Most nuts are rich in arginine, a precursor of nitric oxide, a potent vasodilator which can inhibit platelet adhesion and aggregation (Sabaté and Fraser, 1993). Walnuts contain about 10% linolenic acid which has been associated with reduced risk in several prospective studies, possibly due to antithrombotic and antiarrhymic effects of α-linolenic acid (Dolecek 1992, Ascherto *et al*., 1996). Other proposed benefits of nuts include their high content of magnesium, copper, folic acid, protein, potassium, fibre and vitamin E (Hu *et al*., 1998).

The complete composition of walnuts grown in different parts of the world is not fully elucidated. New Zealand grown walnuts have distinctive nutritional profiles and some cultivars may prove to have a greater positive metabolic effect than other cultivars. It may be possible, by carrying out a range of supplementing experiments, to identify which components have the greater effect. At present it only possible to say that a number of constituents in walnuts have a positive effect on human metabolism and the levels vary between cultivars.

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Tables

1. Mean total oil and fatty acid composition of walnuts grown at Lincoln, Canterbury (Savage *et al.*, 1999).

Origins and Sélection	Total oil (%)	16:0	18:0	18:1	18:1Δ11 (%)	18:2	18:3	20:1
European & US								
Esterhazy	64.2	7.47	1.63	17.44	0.68	58.83	13.54	0.12
G139	64.2	6.65	1.40	16.46	0.71	61.98	12.71	0.14
G120	65.3	7.73	2.05	19.58	0.69	57.09	12.45	0.12
Tehama	67.6	7.61	1.35	19.54	0.81	57.88	12.38	0.14
Vina	66.9	6.46	1.43	17.94	0.68	58.03	15.07	0.11
New Zealand								
Rex	67.7	6.59	0.07	12.66	0.81	62.48	16.17	0.11
Dublin's Glory	66.2	7.76	0.08	18.95	0.85	57.01	13.10	0.12
Meyric	68.9	7.30	0.08	18.09	0.85	58.43	13.31	0.11
Stanley	64.9	6.72	0.08	20.36	0.63	59.24	11.18	0.11
McKinster	66.4	6.22	0.06	18.71	0.77	61.31	10.65	0.06
150	65.2	7.15	0.06	17.39	0.74	60.45	12.65	0.12
151	64.5	6.75	0.06	16.20	0.71	61.72	12.71	0.14
152	67.6	6.84	0.06	14.35	0.58	61.64	15.21	0.10

Trace amounts of 14:0, 16:1, 20:0 and 22:0 were present in all cultivars; these fatty acids made up <0.2% of the total fatty acids.

2. Mean total and individual tocopherol contents (μg/g oil) of walnuts grown at Lincoln, Canterbury (Savage *et al.*, 1999).

Origins and selections	α	β	γ	δ	Total
European & US					
Esterhazy	25.5	5.2	343.2	62.1	436.0
G139	18.1	3.5	288.3	32.4	342.4
G120	25.2	5.8	327.2	45.0	403.2
Tehama	26.1	5.3	273.6	37.3	342.3
Vina	24.0	3.5	300.9	48.5	376.9
New Zealand					
Rex	14.8	3.7	233.9	37.8	290.2
Dublin's Glory	28.7	4.2	355.0	47.0	434.8
Meyric	27.7	4.7	304.9	48.2	385.6
Stanley	28.5	1.0	328.6	44.8	402.8
McKinster	23.3	4.2	265.2	29.6	322.2
150	20.2	3.1	206.9	38.3	268.5
151	20.1	8.2	284.6	42.1	355.0
153	20.6	6.8	267.2	28.0	322.6

3. Mean composition of desmethylsterols (μg/g lipids) of oil extracted from walnut cultivars grown in New Zealand.

Origins and Sélections	Cholesterol	Campesterol	Stigmasterol	Sitosterol	Δ5-Avenasterol	Δ7-Avenasterol	cycloartenol	24-methyl	citrostadienol	Total
European & US										
Esterhazy	11	75	8	1369	155	7	123	46	55	2061
G139	12	79	4	1526	176	8	188	54	84	2408
G120	17	74	3	1487	173	8	160	61	64	2230
Tehama	16	108	12	1655	237	18	195	100	61	2733
Vina	9	109	6	1890	219	15	251	72	62	2855
New Zealand										
Rex	6	97	12	1801	275	18	228	67	40	2796
Dublin's Glory	13	84	7	1466	189	13	173	53	74	2284
Meyric	8	88	4	1508	174	8	168	57	57	2242
Stanley	10	81	6	1278	160	6	178	53	66	2237
McKinster	12	72	5	1264	200	7	134	47	66	2030
150	15	72	3	1476	131	10	139	56	70	2108
151	15	88	10	1437	205	15	232	62	94	2464
153	11	71	8	1262	176	11	236	48	64	2092

4. Effect of consumption of walnuts on serum lipid parameters. Blood samples were taken prior to the start of the supplementation trial (basal value) and after the consumption of walnuts for two weeks (treatment value).

Number and gender	Sample	Cholesterol mM	Triglycerides mM	HDL-Cholesterol mM	LDL-Cholesterol mM
16 males	Basal value	4.88	1.07	1.43	3.46
	Treatment value	4.53*	0.89*	1.34	3.33
	Mean reduction	7.2%	16.8%	6.3%	3.6%
11 females	Basal value	5.03	1.46	1.37	3.65
	Treatment value	4.72*	0.91**	1.39	3.32*
	Mean reduction	6.2%	37.7%	-1.5%	9.0%

Significant difference between paired initial and treatment values P< * = 0.05,** = 0.01.