**Review of Nutritional Attributes of GOOD OIL (Cold Pressed Hemp Seed Oil)**

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**Summary**

Cold-pressed hempseed oil is a locally grown and produced oil with a healthy balance of fatty acids being low in saturated fatty acids and being an excellent source of both n-6 and n-3 (popularly referred to as omega-6 and omega-3) fatty acids, free from trans fatty acids. It is a natural source of gamma-linolenic acid. It can be used for a wide variety of every day uses for food preparation but is not suitable for deep-frying (deep-fried food is generally not a healthy way to prepare food). Even consumed in small amounts (10ml) per day it will make a substantial contribution to the intake of essential fatty acids which are required for health.

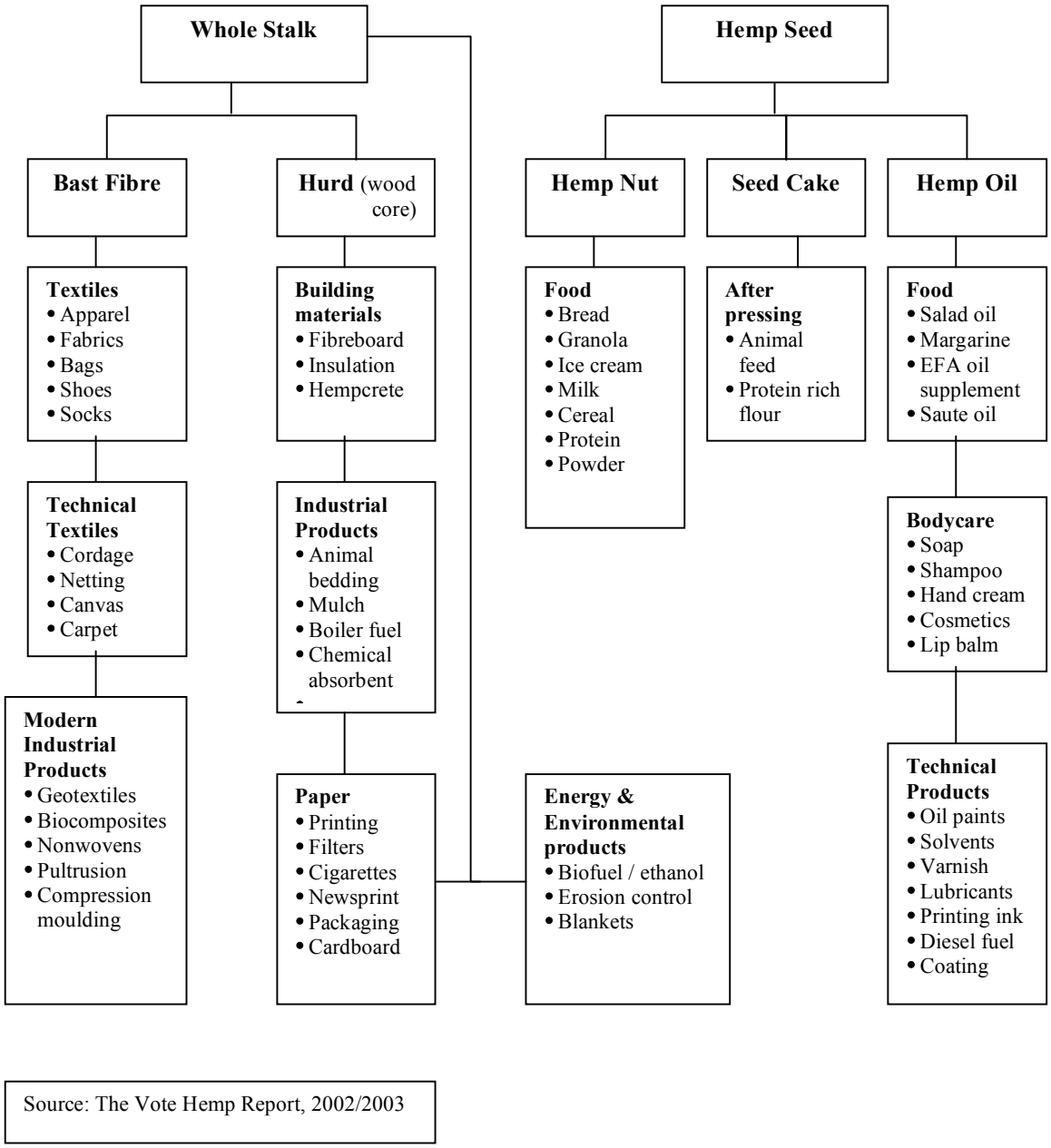
## Introduction

*Cannabis sativa,* or 'cultivated cannabis' has been used by man throughout recorded history as a foodstuff, fuel, fibre and for its pharmaceutical and psychoactive properties. Hemp is the common name for plants of the genus Cannabis. Russo's review on the history reports that the use of hemp fibre in China dated back 12,000 years. The ancient Egyptians used cannabis in medicinal preparations with hemp fibres and pollen grains discovered within ancient tombs and mummified remains.

Industrial hemp, grown for non-drug purposes, is used in a variety of ways, for paper, textiles, biodegradable plastics, food and fuel, and is often promoted as an alternative 'green' plant product. Specific varieties of the plant are approved by the EU and UK Home Office for cultivation under licence and legally must not have tetrahydrocannibol (THC) content greater than 0.02% in the plant. The THC is predominantly in the leaf, rather than in the seed. No pesticides or herbicides can be used for hemp cultivation.

Whole hemp seed contains approximately 20-25% protein, 20-30% carbohydrate, 25-35% oil, 10-15% insoluble fibre and a mix of minerals, iron and zinc. The oil is typically extracted from the hemp seed using a two-step process of extraction and filtration. This is exemplified by the process used to separate 'GOOD OIL'. Prior to this and immediately on harvesting, the seed is dried to between 6%-8% moisture, the seed temperature during drying is kept below 40ºC, this reduces the risk of mould contamination of the seeds. At the oil mill, the seeds are cleaned by aspiration and sieving and cold pressed in a progressive pressure screw press with the oil temperature maintained below 40ºC. The cold pressing method minimises degradative changes in the oil compared to methods using higher temperatures or solvents. The crude oil is left to settle to allow heavy sediment to separate, the supernatant is transferred to settling tanks to allow the fines to separate for seven days. The clear oil is then passed through a 200 micron filter.

Figure 1. Modern Uses of Industrial Hemp




Source: The Vote Hemp Report, 2002/2003

## Nutrient content

Analytical data reported for the fatty acid composition of hemp seed oil from *Cannabis sativa L* show that it contains 70-80% polyunsaturated fatty acids (PUFA) with ~10% saturated fatty acids. The proportion of PUFA varies according to where it is grown, higher proportions are found in more Northern latitudes. In common with other oils high in polyunsaturated fatty acids such as sunflower oil it is susceptible to oxidation if left exposed to air and is best stored at room temperature in dark bottles. It can be used as general purpose oil for cooking but is unsuitable for deep frying). Cold pressed hemp oil has flavour that makes it suitable for use in salad dressing (i.e. balsamic vinegar and hemp seed oil). It also can be used as an oil to dip bread in as with olive oil instead using yellow fat spreads such as butter or margarine.

Hemp-seed oil is less stable than olive oil but its stability is higher than predicted from its fatty acid composition (Sapino *et al,* 2005). This may well be due to the presence of naturally occurring antioxidants in hemp seed oil such as gamma-tocopherol, a form of vitamin E that is abundant in seed oils.

Hemp seed oil is a rich source of polyunsaturated fatty acids which are present mainly as linoleic acid (18:2n-6; LA) and alpha-linolenic acid (18:3*n-3*ALA). In Europe other major seed oils are rapeseed (canola) and sunflower oil. Globally palm oil and soybean oil are the major vegetable oil crops, both these originate outside the EU, with most palm oils coming from Indonesia and Malaysia and soy bean oil from the USA and South America. Olive oil production is mainly from Europe and production has increased substantially in Spain recently owing to increased consumer demand (McKevith, 2005). Unlike most culinary vegetable oils such as rapeseed and olive oil, hemp seed oil contains significant amounts of γ-linolenic acid (GLA,18:3n-6) and stearidonic acid (18:4n-3); typically about 4% and 2% respectively. Table 1 shows the fatty acid profile of hemp and other seed oils. Considerable similarities can be seen between hemp and blackcurrant seed oil and borage oil. Evening primrose oil contains a higher proportion of GLA but is not used as a culinary oil but is used in dietary supplements as a source of GLA often blended with borage oil (often referred to as star-flower oil). The typical amount of GLA in a one a day supplement is about 500mg oil which provides about 40mg of GLA. For comparison 10ml of hemp seed oil would provide about 300mg of GLA.

**Table 1. Fatty acid composition of oils**

| | | Saturated | MUFA | PUFA | Linoleic 18:2n-6 | GLA 18:3n-6 | ALA 18:3n-3 | Stearadonic 18:4n-3 | n-6 | n-3 | n-6:n-3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Culinary oils* | | | | | | | | | | | |
| Hemp seed oil | 99.9 | 7.31 | 10.57 | 75.96 | 53.82 | 3.31 | 17.19 | 1.63 | 57.13 | 18.82 | 3.1 |
| Walnut oil | 99.9 | 9.10 | 16.40 | 69.90 | 58.40 | 0.00 | 11.50 | 0.00 | 58.40 | 11.50 | 5.1 |
| Rapeseed oil | 99.9 | 6.60 | 59.20 | 29.30 | 19.70 | 0.00 | 9.60 | 0.00 | 19.70 | 9.60 | 2.1 |
| Soya oil | 99.9 | 15.60 | 21.20 | 58.80 | 51.50 | 0.00 | 7.30 | 0.00 | 51.50 | 7.30 | 7.1 |
| Wheatgerm oil | 99.9 | 18.50 | 16.70 | 60.40 | 55.10 | 0.00 | 5.30 | 0.00 | 55.10 | 5.30 | 10.4 |
| Corn oil | 99.9 | 14.50 | 29.90 | 51.30 | 50.40 | 0.00 | 0.90 | 0.00 | 50.40 | 0.90 | 56.0 |
| Olive oil | 99.9 | 14.30 | 73.00 | 8.20 | 7.50 | 0.00 | 0.70 | 0.00 | 7.50 | 0.70 | 10.7 |
| Borage oil | 99.9 | 14.41 | 24.68 | 56.24 | 35.27 | 20.64 | 0.33 | 0.00 | 55.91 | 0.33 | 169.4 |
| Sesame oil | 99.7 | 14.60 | 37.50 | 43.40 | 43.10 | 0.00 | 0.30 | 0.00 | 43.10 | 0.30 | 143.7 |
| Palm oil | 99.9 | 47.80 | 37.10 | 10.40 | 10.10 | 0.00 | 0.30 | 0.00 | 10.10 | 0.30 | 33.7 |
| Grapeseed oil | 99.9 | 10.91 | 18.91 | 65.71 | 65.42 | 0.00 | 0.29 | 0.00 | 65.42 | 0.29 | 225.6 |
| Hazelnut oil | 99.9 | 7.80 | 76.50 | 11.20 | 11.10 | 0.00 | 0.10 | 0.00 | 11.10 | 0.10 | 111.0 |
| Safflower oil | 99.9 | 9.70 | 11.90 | 74.00 | 73.90 | 0.00 | 0.10 | 0.00 | 73.90 | 0.10 | 739.0 |
| Sunflower oil | 99.9 | 12.00 | 20.50 | 63.30 | 63.20 | 0.00 | 0.10 | 0.00 | 63.20 | 0.10 | 632.0 |
| Peanut oil | 99.9 | 20.00 | 44.40 | 31.00 | 31.00 | 0.00 | 0.10 | 0.00 | 31.00 | 0.10 | 310.0 |
| Coconut oil | 99.9 | 86.50 | 6.00 | 1.50 | 1.50 | 0.00 | 0.00 | 0.00 | 1.50 | 0.10 | 15.0 |
| *Exotic oils* | | | | | | | | | | | |
| Blackcurrant seed oil | 99.9 | 8.20 | 11.30 | 75.16 | 45.41 | 14.63 | 12.45 | 2.67 | 60.04 | 15.12 | 4.0 |
| Borage oil | 99.9 | 14.41 | 24.68 | 56.24 | 35.27 | 20.64 | 0.33 | 0.00 | 55.91 | 0.33 | 169.4 |
| Evening primrose oil | 99.9 | 7.70 | 10.63 | 77.05 | 68.81 | 8.12 | 0.12 | 0.00 | 76.93 | 0.12 | 641.1 |
| Linseed/flaxseed | 99.9 | 9.4 | 20.2 | 66 | 12.7 | 0 | 53.3 | 0 | 12.7 | 53.3 | 0.2 |

Analysis for hemp seed oil conducted on Good Oil at King's College London, data from the Composition of Foods TSO, US Food Tables

## Nutritional properties

In common with other oils, hempseed oil provides 9 kcal/g. Compared with other culinary oils it is low in saturated fatty acids. Current national and international dietary recommendations for the prevention of cardiovascular disease advocate decreasing the intake of saturated fatty acids in order to lower blood cholesterol concentrations. Replacing fats with a higher polyunsaturated fatty acid content will result in a lower serum cholesterol concentration and a reduction in the ratio of total/HDL cholesterol. A reduction in the ratio of total/HDL cholesterol is associated with a reduction in risk of cardiovascular disease. There have been relatively few studies comparing hempseed oil with other culinary oils but Schwab et al (2006) compared the consumption of 30g hempseed oil with 30g of flaxseed oil taken for 4 weeks in the diet of 14 healthy young men and women. Both oils were well tolerated by the subjects. They found the ratio of total/HDL cholesterol fell on the hempseed oil compared with the flaxseed oil.

Hempseed oil is an excellent source of the two essential fatty acids required by humans. There are two families of essential fatty acids required by humans derived from linoleic acid (LA) and alpha-linoleic acid (ALA) respectively. Generally in Western diets there is an abundance of linoleic acid mainly from vegetable oils but the sources of ALA are more limited. Neither LA nor ALA can be made in the body and so are required in the diet. The minimum requirement in order to avoid deficiency of these fatty acids is 1% of the energy intake for linoleic acid and 0.2% of the energy from ALA (Department of Health Dietary Reference Values Report 1990). However, higher intakes of these fatty acids are associated with a decreased risk of cardiovascular disease (WHO 2003). The EURODIET consensus conference recommended a population intake of 2g of ALA per day. The use of hempseed oil as a culinary oil assuming an intake of about 10ml/day would virtually meet this recommendation.

LA and ALA give rise to two separate families (n-6 and n-3 respectively) of less saturated derivatives often referred to as long-chain polyunsaturated fatty acids (LCP). These LCP perform a number of important physiological roles in the body. These are needed as structural components of the membranes and they are also involved in regulating a number of body processes including smooth muscle contraction, inflammation, cellular repair and haemostasis. LA is needed to make dihomogammalinolenic acid (20:3n-6) and arachidonic acid (20:4n-6) which are important for making prostaglandins, which are a class of compounds involved in signalling between cells. Arachidonic acid is also needed to make anandamides which are compounds involved in the endocannibinoid receptor system and regulates behaviour. ALA is needed to make DHA which is required for normal visual and brain function. The capacity to make LCP from the parent fatty acids is dependent mainly on the activity of an enzyme called delta-6 desaturase. It has been argued that individuals vary in their capacity to make LCP. Indeed a recent genetic study conducted at the Institute of Psychiatry (Caspi et al. 2007) has found that a polymorphism in this enzyme is related to childhood intelligence. The consumption of pre-formed LCP in the diet has a different effect from consuming the parent fatty acids and can overcome any metabolic block in their synthesis. In this respect hempseed oil is of interest in that it contains gamma-linolenic acid (18:3n-6) and stearadonic acid (18:4n-3) which are the delta-6 desaturase products for linoleic and linolenic acid respectively. The consumption of these fatty acids may have health benefits as has been previously claimed for evening primrose oil. Stearadonic acid may share some of the properties of eicosapentaenoic acid (20:5n-3; EPA) a component of fish oil and is likely to contribute to meeting physiological requirements for long-chain n-3 fatty acids.

There is a complex interplay between the n-3 and n-6 fatty acids (Mozafarrian et al. 2005). However, both the intake of n-6 and n-3 are associated with a decreased risk of cardiovascular disease (Colditz et al 1999; Oh et al.,2005). There is currently debate about there being an optimal ratio of *n-6:n-3* fatty acids with several theoretical concerns discussed in a recent paper (Harris, 2006). For example the resulting effects of increasing levels of ALA or decreasing levels of LA are very different, but may not alter the relevant n-6:n-3 ratio. Moreover, as consumption of ALA has significantly different effects compared to intake of the long chain n-3 PUFA eicosapentanoic acid (EPA) and docosahexanoic acid (DHA), the ratio alone is now thought to be of limited value. A recent Food

Standards Agency Workshop report (British Journal of Nutrition, in press) recommended that rather than the ratio of n-6:n-3 in the diet, more attention should be paid to the effects of absolute amounts of the individual n-6 and n-3 fatty acids in the diet.

It is difficult to define an 'optimal balance' of fatty acids in an oil as it has to be considered in the context of the overall diet. However, hempseed oil does commend itself as an oil that is low in saturated fatty acids and has a healthy balance of both the n-6 and n-3 fatty acids There is some limited evidence that it may have beneficial effects on platelet aggregation and cardiac function (Richard et al 2007; Al-Khalifa et al.2007) but this is not convincing evidence.

**Potential health benefits**

The presence of gamma linolenic acid may offer health benefits with regard to effects on skin smoothness, pre-menstrual tension and relief of aches and pains associated with arthritis. There is a large body of literature in this area mainly derived from work with evening primrose oil. There is some limited research suggesting a favourable effect of hemp seed oil on skin in patients with atopic dermatitis (Calloway et al. 2005). However, the scientific validity of many of the studies is open to question. In terms of dietary sources of GLA, it would appear that hemp seed oil if used in the diet on a regular basis, say at an intake of 10ml a day, would provide an intake equivalent to that provided by 6 capsules of evening primrose oil. This level of intake is still relatively low about 300mg and most of the studies which showed anti-inflammatory effects of GLA have provided intakes in excess of 2g/d.

**Other components of hempseed oil**

Hempseed may contain other compounds such as naturally occurring antioxidants including gamma-tocopherol and phytosterols. Further characterisation of the non-saponifiable fraction of the oil may be worthwhile.

Although the varieties used for the production of hemp oil only contain traces of THC, this may still be a consumer concern as it is well known that consumers are concerned about any detectable amount in foods even if it is below the levels that has biological effects. A potential concern by consumers regarding the use of hempseed oil as a culinary oil is a belief that it may contain traces of THC. This is unlikely to be helped by reports in the scientific literature of individuals testing positive for THC after consuming hemp products (Lehmann *et al* 1997). Such reports have to be tinged with some scepticism. An assessment was undertaken of the impact of regular consumption of hemp foods on urinary levels of THC metabolites, a study compared four doses of THC (ranging from 0.09 to 0.6mg/d), that were representative of levels commonly found in hemp seed products and could be achieved by dietary intake. The highest THC intake of 0.6 mg/day was equivalent to the consumption of approximately 125mL of hemp oil containing 5 micrograms/g of THC or 300 g of hulled seeds at 2 micrograms/g, concentrations typical in Canadian hemp seed products (Leson *et al*, 2001). At a daily THC dose of 0.6 mg for 10 days, one urine specimen (out of the 15 tested) screened positive at the 50-ng/mL cut off. The highest THC-COOH level found by GC-MS in any of the specimens was 5.2 ng/mL, well below the 15-ng/mL confirmation cut-off used in drug testing programs. The conclusion from this research is that at levels of intake likely to be consumed 10-20ml, THC is unlikely to be detected

**Trans Fatty Acids**

There currently is much concern regarding trans fatty acids in the diet as these have been linked to increased risk of cardiovascular disease (Kris-Etherton et al. 2007). The evidence is based mainly on studies in the USA where substantial amounts of soybean oil are partially hydrogenated. In the UK, trans fatty acids are derived mainly from ruminant products (butter, milk, tallow) as partially hydrogenated fats are not widely used because of the high availability of palm oil. It has recently been found that trans fatty acids can be formed during high temperature deoderisation of oils rich in linolenic acid.(Ackman & MAg, 1998). Most refiners are aware of this issue and have modified

production methods to minimise levels of trans fatty acids. However, for labelling purposes they state that the product contains less than 1% trans fatty acids. Consumer groups are particularly sensitive to issues regarding trans fatty acids. Cold-pressed hemp seed oil is free from trans fatty acids. Analysis of Good Oil for trans fatty acids by gas-chromatography mass-spectroscopy at King's College London was unable to detect any trans fatty acids.

## Vegetarian/Vegan Issues

Cold-pressed hempseed is acceptable to vegetarians and may be of particular value to vegans as they tend to have low levels of long-chain n-3 fatty acids in their blood (Sanders, 1999;Rossell et al. 2005) because of the absence of EPA and DHA from their diet and a relatively high use of high linoleic acid oils. The Food Standards Agency has recently published guidelines of the labelling of foods suitable for vegans and vegetarians.

## Sustainability and Environmental Issues

Hemp is a very sustainable and beneficial crop to the environment. It is planted late in spring and does not use pesticides or herbicides. Hemp provides an excellent habitat for wildlife during the summer and on the fallow ground over the winter months, providing valuable feeding grounds for birdlife. The long Tap Root is excellent for soil structure and conditioning. The fast growing crop is a very efficient carbon sequester. Hemp requires no weed control during the growing period (either mechanical or chemical) and therefore reduces fuel consumption on the farm. Before harvest, the leaves of the plant senesce, returning valuable natural P&K to the soil for future plant nutrition. Every aspect of the plant is used. Nothing is wasted.

## Future Research

Further information on the non-fatty acid components of hempseed oil may be helpful in particular plant sterols, tocopherols and flavonoids.

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