### A Review on Hemp (*Cannabis sativa* L) Seed & its milk

**Abstract**

Hemp also known as *Cannabis sativa* L., is a plant belonging to the *Cannabaceae* family. It is consumed around the world differently as (whole, hulled seed) or dehulled (hempseed kernel), along with its processing products like oil, flour, and protein powder. Hemp seeds contain all 9 essential amino acids (AAs), with a high concentration of sulphur-containing AAs (methionine and cysteine), which are usually low in vegetable proteins. Hempseed oil contains high polyunsaturated fatty acids (PUFAs) content and low saturated fatty acids (SFAs). It also has been proved that consumption of hemp seed tends to improve insulin sensitivity; reduce appetite and food intake and can lower the blood total cholesterol and low-density lipoprotein (LDL). The major macro-elements found in hempseeds are phosphorous (P), potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na). Thus, hemp seed (Cannabis Sativa L.) finds a best source and substitute for milk and also for lactose intolerance people. The main focus of this review is about the health benefits of Hemp seed and its seed milk.

**Keywords:** Polyuunsaturated Fatty Acid, Monounsaturated Fatty Acid, low-density lipoprotein, Anti-carcinogenic, Gut microbiota.

**Introduction**

Hemp also known as *Cannabis sativa* L., is a plant belonging to the *Cannabaceae* family. According to authors, the Cannabis genus has three different species,named *Cannabis Sativa*, C. indica, and C. ruderalis (Pollio , 2016).

Hemp and its by-products (both food and non-food) have gained in popularity over the last few years. The primary difference is in the content of delta-9- tetrahydrocannabinol (THC) the principal psychoactive compound found in marijuana. Industrial hemp contains only about 0.3% to 1.5% of THC, whereas marijuana contains 5% to 10% or more of THC.

Hemp seed is rich in vitamin E, minerals, antioxidants, and fiber. The B vitamin content is not much different from that of other grains. However, what makes hemp seeds different is the quality and proportion of the protein and fatty acids, respectively.

Hemp seed protein is composed of 65% high-quality edestin protein, the most potent protein of any plant source, with the remaining 35% provided by albumin protein and essential amino acids. Hemp seeds contain all 9 essential amino acids (AAs), with a high concentration of sulphur-containing AAs (methionine and cysteine), which are usually low in vegetable proteins.

Hemp seeds are similar to soy protein in terms of nutritional profile (Tang *et al.,* 2006). Hemp’s 3:1 ratio of omega-6 to omega-3 fatty acid (FA) makesit an alternative for vegans. Unlike fish, hemp is mercury free and also contains the super-polyunsaturated gamma linolenic acid (GLA; omega-6) and stearidonic acid (omega-3) (Li D et al., 2006).

### Hemp seed- nutritional features

Hempseed has commonly been called as complete food sources due to its high nutritive profile. It is consumed as whole, hulled seed or dehulled (hempseed kernel),or as processing products like oil, flour, and protein powder. It typically contains 25–35% lipids with a unique fatty acids (FAs) composition; 20–25% proteins which is easy to digest and also rich in essential amino acids; 20–30% carbohydrates, which constitutes to the dietary fibre, mainly insoluble.

In addition, hempseed is rich in natural antioxidants and other bioactive components such as tocopherols, carotenoids, and phytosterols (Irakli *et al.,* 2019).

1. **Fat content**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Moisture** | **Fat** | **Protein** | **CHO** | **Total DF** | **Insoluble DF** | **Soluble DF** | **Ash** | **Ref** |
| 1.1-7.2 | 26.9-30.6 | 23.8–28.0 | n.a. | n.a. | n.a. | n.a. | 5.1–5.8 | 64 |
| 4.1–4.3 | 32.8–35.9 | 24.3–28.1 | 32.5–37.5 | n.a. | n.a. | n.a. | 4.9–6.1 | 30 |
| 6.7±0.5 | 34.6 ± 1.2 | 25.6 ± 0.6 | 34.4 ± 1.5 | 33.8 ± 1.9 | 30.9±1.5 | 2.9±0.4 | 5.4 ± 0.3 | 34 |
| 4.0–9.2 | 25.4–33.0 | 21.3–27.5 | n.a. | n.a. | n.a. | n.a. | 3.7–5.9 | 17 |
| 6.5 | 35.5 | 24.8 | 27.6 | 27.6 | 22.2 | 5.4 | 5.6 | 6 |
| 8.4±0.02 | 33.3 ± 0.1 | 22.5 ± 0.2 | n.a. | n.a. | n.a. | n.a. | 5.9±0.03 | 41 |
| 7.3 ± 0.1 | 24.5 ± 2.0 | 24.8 ± 1.1 | 38.1 ± 2.5 | n.a. | n.a. | n.a. | 5.3 ± 0.6 | 53 |

Table 1: Hempseed nutritional characteristics (mg/100g) according to articles

Hempseed oil is contains high polyunsaturated fatty acids (PUFAs) content and low saturated fatty acids (SFAs) . More specifically hempseed oil contains 90% unsaturated fatty acids, of which from 70% to 80% is PUFAs. The monounsaturated fatty acid (MUFA) is Oleic Acid. Generally, the amount of OA in hempseed oil is higher than chia seed (7%) (Da Silva Marineli et al., 2014) and comparably low in linseed (15%) (Teh et al., 2013). Among PUFAs, Linoleic Acid (18:2, n-6, LA) is the most representative FA in hempseed oil. The second prominent PUFAs is α-linolenic acid (18:3, n-3, ALA). Hence, hempseed oil is a rich source of these two fatty acids which are known as Essential Fatty Acids (EFAs).

1. **Protein content**

The protein content of whole hempseed can vary from 20 to 25% according to variety and environmental factors. This amount can further increase in some hempseed-processed products such as dehulled seed and hempseed meal or cake (also called hempseed flour), that is, the remaining fraction of hempseed obtained after expelling its oil fraction (Mattila *et al.,* 2018).

Mattila and colleagues (Mattila *et al.,* 2018) demonstrated that in hempseed the proteins are mostly located in the inner layer of the seed, in fact they found only a low quantity of total proteins in the hull. Therefore, the increase in the protein content of processed products can be explained as a consequence of protein concentration after removing some component of the whole seed that totally or almost lacks in protein, such as the hull, where most of the fibre is located and the removal of which leads to a 1.5 times increase in both protein and oil amount.

More proteins are also present when both hull and oil (the major component of whole hempseed) are removed. Indeed, their removal leads to obtaining the hempseed-processed product with the highest protein (up to over 50%) and the lowest fat content (even less than 10%, based on the type of extraction methods used) (House *et al.,* 2010).

Research about the hempseed proteins originated from the early 20th century and highlighted that the two main proteins of hempseed are the storage protein albumin, a globular protein, and edestin, a legumin. This latter is the most abundant component, constituting about 82% of total hemp protein content.(Tang *et al.,* 2006)

Amino acid composition obtained for hempseed proteins by various authors, are in good agreement and highlighted (1) that hempseed proteins contain all essential amino acids (EAAs) required by humans, and (2) that the most abundant amino acid is glutamic acid (3.74–4.58% of whole seed) followed by arginine (2.28–3.10% of whole seed). Moreover, soy proteins and casein are considered good sources of amino acids for infants. From this comparison, it emerged that hempseed proteins have a good amount of sulphur-containing amino acids, higher than both casein and soy proteins.

Furthermore, in comparison to soy proteins, the amino acid content of hempseed proteins was higher or similar, except for aspartic acid, glutamic acid, and lysine that resulted in being higher in soy proteins, whereas, if compared to casein, the amino acid content of hempseed proteins was higher or similar, except for tyrosine, leucine, methionine, and lysine that were more abundant in casein.

Among EAAs, only three (isoleucine, lysine, and phenylalanine) resulted in being lower in hempseed proteins in comparison to casein, while the others appeared to be higher or similar and the proportion of EAAs to the total amino acids for hempseed proteins resulted in being higher than soy proteins and similar to casein (House *et al.,* 2010) (Tang *et al.,* 2006).

Overall, whole hempseed can be considered a rich-protein source containing a protein amount higher or similar than other protein-rich products, such as quinoa (13.0%), chia seeds (18.2–19.7%), buckwheat seeds (27.8%) and linseeds (20.9%). Thus, nutritionally, the protein fraction of hempseed is highly digestible, has a good profile of EAAs required for infants. (Mattila *et al.,* 2018) .

1. **Carbohydrate and dietary fibre content**

The total carbohydrate content of hempseed can range between 20 and 30%. Actually, only a few literature reports analysed the total carbohydrate and fibre of hempseed. Among these, Callaway (Callaway, 2004) found that the total carbohydrate content of the whole hempseed belonging to the Finola *cv* amounted to 27.6 g/100 g of seeds, whereas Mattila and colleagues (Mattila *et al.,* 2018) by analysing the nutritional value of some commercial protein-rich seeds, among which is hempseed, found that the total carbohydrate content of whole hempseed was similar to those found in the whole flaxseed (34.4 ± 1.5 g/100 g of seeds and 29.2 ± 2.5 g/100 g of seeds, respectively). Callaway found a Total Dietary Fibre content (TDF) of 27.6 g/100 g of seeds (Callaway, 2004), demonstrating that the entire carbohydrate fraction consisted in dietary fibre, whereas in the study of Mattila and co-workers (Mattila P et al., 2018), the TDF of hempseed amounted to 33.8 ± 1.9 g/100 g of seeds, representing the 98% of the total carbohydrate.

In particular, it has been shown that it can improve insulin sensitivity; can reduce appetite and food intake, thus decreasing the risk of obesity and diabetes; and can lower the blood total cholesterol and low-density lipoprotein (LDL); moreover, because of the dietary fibre resists to digestion in the small intestine, it reaches the large intestine, where it is fermented by the gut microbiota, to produce short chain fatty acids with anti-carcinogenic and anti- inflammatory properties . In this context, it should be taken into account that the use of whole hempseed (as it or defatted) would be more appropriate since almost all the fibre is located in the hempseed hull.

1. **Mineral content**

In general, the mineral profile of seeds can widely vary based on environmental condition, mineral soil composition, the use or not of fertilizers, the type of fertilizer if used, as well as the plant variety. The major macro-elements found in hempseeds were phosphorous (P), potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na), whereas among the in-trace elements, iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) have been reported (Lan Y *et al.,* 2019).

Particularly, the amount of P, the most abundant mineral found in hempseeds, resulted in being higher also than that found in niger seeds (*Guizotia abyssinica* (L.f.) Cass.) and linseeds (*Linum usitatissimum* L.), which are oilseeds like hempseeds and are considered optimal phosphorous’ sources (P average content, 784.64 mg/100 g and 461.35 mg/100 g, respectively) (José Ignacio Alonso-Esteban, 2022).

The level of K in hempseeds is in general higher compared to that found in linseeds (568.91 mg/100 g) (José Ignacio Alonso-Esteban, 2022), and is equivalent to that observed in hazelnut (863 mg/100 g), thought to be an optimal source of this macro-element. Interestingly, the high K amount along with a relatively low Na content, leads to a high K/Na ratio, which is believed to be related to cardio protective effects as it promotes a high K intake considered to be inversely related to blood platelet aggregation and stroke incidence.

The amount of this mineral in hempseeds results in being similar to walnut (Mg range: 381–443 mg/100 g) which is one of the most important sources of Mg . Among the in-trace elements, Fe is of particular importance considering its essential role for human health and its widespread dietary deficiency.

Lan and co-workers (Lan *et al.,* 2019) highlighted that the hempseed’s Fe content is much higher than cereal grains, and for this, hempseeds could be used to enrich cereal food products, ameliorating iron deficiency. In the same study, the authors have also calculated the percent contribution of minerals per serving of hempseeds (30 g of seeds) to Reference Daily Intake (RDI) for adult males from age 19 to 30, finding that the highest % RDI supplied by hempseeds of the analysed industrial hemp *cvs*, was for Fe and Mn (average % RDI, 46.68 and 169.14, respectively), concluding that all analysed varieties represent an excellent sources especially of Fe, Mn, Cu, Zn, P, and Mg. Additionally, it has been shown an increase in the content of some minerals in hempseed kernel after dehulling.

Particularly, in the Hungarian Hlesiia *cv*, hull removal led to an increase in phosphorous (1.5 times), iron (1.25 times), and zinc (2 times) . Whereas Mattila and co- workers (Mattila *et al.,* 2018) observed that whole hempseed held 30–65% fewer macro- elements and Zn among in-trace elements in comparison to hemp hulls, whilst Cu and Mg were more evenly distributed in both the seed’s kernel and hull.

### HEMP SEED MILK

1. **Overview of hemp seed milk**

|  |  |
| --- | --- |
| **Milk** | **Calorie(kcal)** |
| Hemp milk | 130 |
| Soy milk | 80 |
| Rice milk | 120 |
| Almond milk | 50 |
| Whole cow’s milk | 150 |

Hemp milk appears to be a better source of calcium, iron, vitamin A, magnesium, and zinc than soy milk, rice milk, almond milk, and cow’s milk. Although not graphically represented, there is no significant difference in the content of B vitamins between all kinds of milk.

### Table 2: Calorie (kcal) comparison of different milk varities

|  |  |  |  |
| --- | --- | --- | --- |
| **Milk** | **Carbohydrate(g)** | **Fat(g)** | **Protein(g)** |
| Hemp milk | 20 | 3 | 4 |
| Soy milk | 4 | 5 | 7 |
| Rice milk | 23 | 2.5 | 1 |
| Almond milk | 6 | 2.5 | 1 |
| Whole cow’s milk | 11 | 8 | 8 |

**Table 3: Macronutrient comparison of different milk varities**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Milk** | **Vitamin A** | **Vitamin D** | **Vitamin E** | **Vitamin K** |
| Hemp milk | 18% | 20% | 13% | 0 |
| Soy milk | 10% | 25% | 25% | 0 |
| Rice milk | 10% | 25% | 0 | 0 |
| Almond milk | 20% | 25% | 25% | 0 |
| Whole cow’s milk | 5% | 24% | 1% | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Milk** | **Calcium** | **Iron** | **Phosphorous** | **Magnesium** | **Zinc** |
| Hemp milk | 40% | 15% | 43% | 19% | 9% |
| Soy milk | 35% | 40% | 15% | 15% | 0 |
| Rice milk | 30% | 4% | 15% | 0 | 0 |
| Almond milk | 30% | 2% | 15% | 0 | 0 |
| Whole cow’s milk | 29% | 1% | 22% | 6% | 7% |

### Table 4: Comparison of % daily value (DV) of fat-soluble vitamins

**Table 5: Comparison of % daily value (DV) of minerals**

1. **Nutrient profile for Hemp seed milk**

A serving of unflavoured and unsweetened hemp milk provides about 60 calories, less than a serving of cow’s milk. Hemp milk provides about 3 grams (g) of protein per serving, whereas cow’s milk provides 8 g. Hemp milk is higher in monounsaturated and polyunsaturated fats than low-fat and fat-free cow’s milk (Curl, S *et al.,* 2020). A serving of unsweetened hemp milk contains no carbohydrate, whereas sweetened varieties may contain more than 20 g per serving, most of which is added sugar (Curl, S *et al.,* 2020). A cup of unsweetened hemp milk provides less potassium, but similar amounts of sodium and calcium (when fortified) as cow’s milk.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Unsweetened hemp milk (1 cup)** | **Fat-free(skim) milk (1 cup)** | **Low-fat (1%)****milk (1 cup)** | **Whole milk (1 cup)** |
| Energy(kcal) | 60 | 83 | 102 | 150 |
| CHO (g) | 3 | 8 | 8 | 8 |
| Protein (g) | 4.5 | 0 | 2.4 | 8 |
| Total Fat (g) | NR | 0.1 | 1.5 | 4.5 |
| Saturated fat (g) | 0 | 12 | 12 | 12 |
| Fibre (g) | 0 | 0 | 0 | 0 |
| Total sugar (g) | 0 | 12 | 13 | 12 |
| Vitamin A (mcg) | NR | 149 | 142 | 112 |
| Vitamin B12 (mcg) | NR | 1 | 1 | 1 |
| Vitamin D (mcg) | 2 | 3 | 3 | 3 |
| Calcium (mg) | 257 | 298 | 305 | 276 |
| Sodium (mg) | 110 | 102 | 107 | 105 |
| Potassium (mg) | 100 | 381 | 366 | 322 |

###  Table 6: Nutrient profile of hemp milk compared to fat-free, low-fat, and whole cow’s milk (Curl, S *et al.,* 2020)

### Conclusion

### The use of plant proteins, less costly in terms of resources and with a much lower environmental impact, is an interesting alternative to meet future societal and environmental challenges.With vast applications, the hemp seed is the object of numerous fundamental studies in both food and nutraceutical indurty providing a source for fortificationof various nutrients. Thus, hemp seed finds a best source for infants, athletes, cardiovascular disease patients and substitute lactose intolerance people.

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