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

**Abstract**

Hemp, also called Cannabis sativa L., belongs to the Cannabaceae family. It tends to be consumed around the world differently as hulled seed or dehulled kernel, along with its by-products like oil, flour, and protein powder. Hemp seeds claim to have all essential amino acids (AAs), with a high concentration of methionine and cysteine, which are comparatively low in vegetable proteins. Hempseed oil contains high polyunsaturated fatty acids (PUFAs) content in comparison to low saturated fatty acids (SFAs). It also has been proved that consumption of hemp seed tends to improve insulin sensitivity; reduce appetite and lower 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.) is the best source and substitute for milk for lactose intolerant people. The main focus of this review is about the 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 called, Cannabis sativa L., belongs to the Cannabaceae family. According to the authors, the Cannabis genus has three different species, named Cannabis Sativa, C. indica, and C. ruderalis (Pollio, 2016).

Hemp and its products have gained popularity in the last few years. The primary difference is in the content of delta-9- tetrahydrocannabinol (THC) the principal 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 high in vitamin E, minerals, antioxidants, and fiber. The B vitamin content is similar to that of other grains. However, what sets hemp seeds different is the quality and ratio of protein and fatty acids.

Hemp seed protein consists of 65% high-quality edestin protein, the most stable protein of any plant source, with the remaining 35% coming from albumin protein and essential amino acids. Hemp seeds are rich in all essential amino acids (AAs), with a high concentration of methionine and cysteine, which are usually low in vegetable proteins.

When compared, hemp seeds and soy protein are similar in terms of nutritional profile (Tang et al., 2006). Hemp has a 3:1 ratio of omega-6 to omega-3 fatty acid (FA). Unlike fish, hemp is mercury-free and 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 another name known as a complete food source due to its high nutritive profile. It is consumed as whole seed or dehulled kernel or as by-products like oil, flour, and protein powder. It contains approximately 25–35% lipids with a unique fatty acids (FAs) composition; 20–25% proteins which are easy to digest along with all essential amino acids; and 20–30% carbohydrates, which constitute insoluble dietary fiber. In contrast, hempseed is also abundant in natural antioxidants and other bioactive components such as tocopherols, carotenoids, and phytosterols (Irakli et al., 2019).

1. **Fat content**

**Table 1: Hempseed nutritional characteristics (mg/100g)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |

 **[Source: Barbara Farinon *et al.,(2020)”*The seed of industrial hemp (Cannabis sativa L.): Nutritional Quality and Potential Functionality for Human Health and Nutrition” ]**

Hempseed oil is rich in polyunsaturated fatty acids (PUFAs) content and comparatively low in saturated fatty acids (SFAs). Approximately, hempseed oil contains 90% unsaturated fatty acids, consisting of 70% to 80% PUFAs. The monounsaturated fatty acid (MUFA) present is Oleic Acid. The amount of OA in hempseed oil is more than in chia seed (7%) (Da Silva Marinelli et al., 2014) and low in linseed (15%) (Teh et al., 2013). Among PUFAs, Linoleic Acid (18:2, n-6, LA) is the most abundant FA in hempseed oil. The second prominent PUFAs is α-linolenic acid (18:3, n-3, ALA). Thus, hempseed oil claims to be a rich source of two Essential Fatty Acids.

1. **Protein content**

The protein composition of hempseed varies from 20 to 25% according to variety and environmental factors. The ratio can increase in particular hempseed by-products such as dehulled seed, hempseed meal, and flour. (Mattila et al., 2018).
Mattila and colleagues (Mattila et al., 2018) observed that in hempseed the proteins are mostly situated in the inner layer of seed. Thus, the increase in the protein content of processed products is due to removing components of seed, such as the hull, leads to a 1.5 times increase in protein and oil. More proteins can be achieved when both hull and oil are removed. Their removal leads to products with high protein content and low-fat content. (House et al., 2010).
Research about the hempseed proteins highlighted the presence of two main proteins- storage protein albumin, a globular protein, and edestin, a legumin. (Tang et al., 2006)
Amino acid composition observed in hempseed proteins claims (1) that hempseed proteins contain all essential amino acids and (2) that the most potent amino acid is glutamic acid (3.74–4.58% of whole seed) followed by arginine (2.28–3.10% of whole seed). In comparison to both casein and soy proteins, hempseed proteins have a good amount of sulfur-containing amino acids.
Overall, hempseed is considered a rich-protein source with a protein content higher in comparison to other protein-rich products, such as quinoa (13.0%), chia seeds (18.2–19.7%), buckwheat seeds (27.8%) and linseeds (20.9%). Therefore, the protein fraction of hempseed is easily digestible and has a good ratio of EAAs. (Mattila et al., 2018) .

1. **Carbohydrate and dietary fibre content**

The carbohydrate content of hempseed ranges between 20-30%. Only a few literature reports analysed the total carbohydrate and fibre of hempseed. Among these, Callaway (Callaway, 2004) found that the 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 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 of dietary fibre, 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 is proven to improve insulin sensitivity; reduce appetite and food intake, thus decreasing the risk of obesity and diabetes; and 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.

1. **Mineral content**

###  The major macro-elements found in hempseeds were phosphorous (P), potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na), along with the in-trace elements, iron (Fe), manganese (Mn), zinc (Zn), and copper (Cu) have been reported (Lan Y et al., 2019).

### The amount of P resulted was higher 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 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). Interestingly, the high K amount with a relatively low Na content leads to a high K/Na ratio, which is believed to have cardioprotective effects as it promotes a high K intake related to blood platelet aggregation and stroke. The amount of K in hempseeds is similar to walnuts (Mg range: 381–443 mg/100 g). Among the in-trace elements, Fe is considered important in human health and is a 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 could be used to enrich cereal food products, reducing iron deficiency. In the same study, the authors have also calculated the per cent 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 varieties represent an excellent source, especially of Fe, Mn, Cu, Zn, P, and Mg. In the Hungarian Hlesiia cv, removal of the hull 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 distributed evenly in both the seed’s kernel and hull.

### HEMP SEED MILK

1. **Overview of hemp seed milk**

Hemp milk tends to be a better source of calcium, iron, vitamin A, magnesium, and zinc than soy, rice, almond and cow’s milk.

**Table 2: Comparison of Calorie (kcal) of different milk varities**

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

### [Source: Umme Salma Vahanvaty, (2009), Hemp Seed and Hemp Milk The New Super Foods, ICAN: Infant, Child, & Adolescent Nutrition]

**Table 3: Comparison of Macronutrient 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 |

### [Source: Umme Salma Vahanvaty, (2009), Hemp Seed and Hemp Milk The New Super Foods, ICAN: Infant, Child, & Adolescent Nutrition]

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 |

### [Source: Umme Salma Vahanvaty, (2009), Hemp Seed and Hemp Milk The New Super Foods, ICAN: Infant, Child, & Adolescent Nutrition]

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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% |

### [Source: Umme Salma Vahanvaty, (2009), Hemp Seed and Hemp Milk The New Super Foods, ICAN: Infant, Child, & Adolescent Nutrition]

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

A serving of unflavoured and unsweetened hemp milk provides 60 calories, less than cow’s milk. Hemp milk contains 3 grams (g) of protein per serving, in comparison to cow’s milk which provides 8 g. Hemp milk is higher in monounsaturated and polyunsaturated fats than cow’s milk (Curl, S et al., 2020). A cup of unsweetened hemp milk has less potassium, but similar amounts of sodium and calcium (when fortified) as cow’s milk.

**Table 6: Nutrient Profile Comparison of hemp milk compared to fat-free, low-fat, and whole 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 |

###

### (Source: Curl, S *et al.,(*2020), Plant-Based Milks: Hemp,Food Science and Human Nutrition Department, UF/IFAS Extension. )

### 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 the food and nutraceutical industry providing a source for the fortification of various nutrients. Thus, hemp seed is the best source for infants, athletes, cardiovascular disease patients and lactose intolerant people.

### References

1. A Pollio (2016), The Name of Cannabis: A Short Guide for Nonbotanists, Cannabis and cannabinoid research, <https://doi.org/10.1089/can.2016.0027.>
2. CH Tang, Z Ten, XS Wang (2006), Physicochemical and Functional Properties of Hemp (Cannabis sativa L.) Protein Isolate, Journal of Agricultural and Food Chemistry, <https://doi.org/10.1021/jf0619176.>
3. Tianpeng Chen, Jianxiong Hao, and Lite Li (2010), Analytical Characterization of Hempseed (Seed of Cannabis sativa L.) Oil from Eight Regions in China,Journal of Dietary Supplements , <https://doi.org/10.3109/19390211003781669.>
4. Maria Irakli ,Eleni Tsaliki ,Apostolos Kalivas,Fotios Kleisiaris,Eirini Sarrou andCatherine M Cook (2019), Effect οf Genotype and Growing Year on the Nutritional, Phytochemical, and Antioxidant Properties of Industrial Hemp (Cannabis sativa L.) Seeds, <https://doi.org/10.3390/antiox8100491.>
5. Yang Lan, Fengchao Zha, Allen Peckrul, Bryan Hanson, Burton Johnson, Jiajia Rao, Bingcan Chen (2019), Genotype x Environmental Effects on Yielding Ability and Seed Chemical Composition of Industrial Hemp (Cannabis sativa L.) Varieties Grown in North Dakota, USA, Journal of the American Oil Chemists' Society, <https://doi.org/10.1002/aocs.12291.>
6. Pirjo Mattila, Sari Mäkinen, Merja Eurola, Taina Jalava, Juha-Matti Pihlava, Jarkko Hellström & Anne Pihlanto (2018), Nutritional Value of Commercial Protein-Rich Plant Products, Plant Foods for Human Nutrition, <https://doi.org/10.1007/s11130-018-0660-7.>
7. James D. House, Jason Neufeld, and Gero Leson( 2010), Evaluating the Quality of Protein from Hemp Seed (Cannabis sativa L.) Products Through the use of the Protein Digestibility-Corrected Amino Acid Score Method, Journal of Agricultural and Food Chemistry, <https://doi.org/10.1021/jf102636b.>
8. José Ignacio Alonso-Esteban, María Esperanza Torija-Isasa, María de Cortes Sánchez-Mata (2022), Mineral elements and related antinutrients, in whole and hulled hemp (Cannabis sativa L.) seeds, Journal of Food Composition and Analysis, <https://doi.org/10.1016/j.jfca.2022.104516.>
9. Sarah Curl, Daniela Rivero-Mendoza, and Wendy J. Dah (2020), Plant-Based Milks: Hemp, Food Science and Human Nutrition Department, UF/IFAS Extension.
10. Cary Leizer BA,David Ribnicky PhD,Alexander Poulev PhD,Slavik Dushenkov PhD &Ilya Raskin PhD (2015), The Composition of Hemp Seed Oil and Its Potential as an Important Source of Nutrition, <https://doi.org/10.1300/J133v02n04_04.>
11. Umme Salma Vahanvaty, (2009), Hemp Seed and Hemp Milk, The New Super Foods?, ICAN: Infant, Child, & Adolescent Nutrition.