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Unleashing the power of Hemp seeds (Cannabis sativa seeds): A Review on its benefits.

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Abstract*: Cannabis sativa (CS) seeds are commonly known as hemp seeds, marijuana seeds, hemp nuts. Cannabis sativa belongs to family Cannabaceae. The primary metabolites present in hemp seeds includes proteins, carbohydrates, fats. The seeds exceptional balance of omega-3 & omega-6 fatty acids, alongside γ-linolenic acid, supports heart health, reduces inflammation, and promotes immune function. The high-quality protein content, complete with all essential amino acids, makes hemp seeds an excellent plant-based alternative. Additionally, hemp seeds antioxidant properties, fibre content, and potential anti-inflammatory effects make them a valuable adjunct in managing various health conditions. This review aims to explore the multifaceted benefits of hemp seeds, highlighting their potential as a sustainable and nutritious food source, as well as their therapeutic applications in supporting overall well-being as research continues to uncover the full potential of hemp seeds, their popularity and versatility are set to grow, making them an exciting area of exploration for industries and individuals alike.*
Keywords*: Cannabis sativa, Cannabinoids, Fatty acids, Nutrition*

INTRODUCTION

Traditional medicine remains one of the world's oldest treatment methods, dating back to ancient times. Many indigenous communities worldwide continue to employ traditional remedies passed down orally from generation to generation. [1] In historical records, the Hindus of India are noted as the earliest prominent users of cannabis, which spread beyond India with Indo-Aryan culture. The plant grows naturally in China, Southern Siberia, and Persia. It is referred to as vijaya in sanskrit and bhang in hindi. [2] Industrial hemp (Cannabis sativa L.) cannabis strain which has low delta-9-tetrahydrocannabinol (THC). THC is known for its psychoactive properties, which frequently drives users to feel high. In the United States, industrial hemp has less than 0.2% THC, while marijuana has between 10 and 30% THC level on dry weight basis. Industrial hemp is a variety of cannabis sativa L. that does not have any behavioural or psychotropic effects. [3] A dioecious annual plant belonging to the Cannabaceae family is Cannabis sativa L. This family includes 170 species. Hemp is a plant containing 70 active cannabinoids. [4] Cannabis sativa L., often known as industrial hemp, has been grown for thousands of years throughout China, Asia & Europe, principally for use in textiles. Recent research has demonstrated the hemp plant's (Cannabis sativa L.) nutritional, therapeutic, and social benefits. [5, 6, 7] The two main plant-based protein sources in 2020 were soy and wheat, with 57.6% and 36.8% of the complete food sector, respectively. [8] Nevertheless, these two sources which are vital for addressing human nutritional needs and becoming more prone to allergic reactions. [9] Among the top eight food allergens, soy and wheat are responsible for 90% of all documented food allergy responses. [10,11] Hempseeds are a considerable protein source, accounting for approximately 30% of their content. [12,13] In the food and nutraceutical industries, they are becoming more and more well-known as a beneficial substitute plant-based protein source. It also comprises of considerable quantities of starch (up to 25%) and oil (nearly 30%). [12, 14] More than 90% of fatty acids in hempseed oil are polyunsaturated [15,16]. Additionally, hemp seeds include carbohydrates (20-30%), vitamins, insoluble fibre (10-15%) & minerals like sulphur, calcium, phosphorus, iron, potassium, zinc & magnesium. [12,17] The plant's distinct features render it a highly profitable and long-term crop. There are over 25,000 hemp-based products accessible in marketplaces throughout the world. [18,19] The seeds of hemp and oil are used in a variety of food production processes, which is projected to drive market expansion. Growing demand from the personal care and cosmetics sectors, as well as increased knowledge of the nutritional benefits of hempseed and hempseed oil, will support market expansion.[20]

Figure 1: Cannabis sativa plant

Figure 2: Leaves of C. sativa

Figure 3: Seeds of hemp (cannabis sativa seeds)

Table 1: Botanical description of hemp (Cannabis sativa L.) [21]

Kingdom	Plantae
sub-kingdom	tracheobionta
Division	magnoliophyte
super division	Spermatophyta
sub class	Hamamelididae
Class	magnoliopsida
Family	cannabaceae
Order	urticales
Genus	cannabis
Species	Sativa
binomial Name	cannabis sativa

PHYSICAL PROPERTIES OF HEMP SEEDS

Understanding hemp seed's physical properties is crucial for designing tools for managing, gathering, processing, and preserving the seed. Various types of washing, grading, and separating equipment are constructed around the physical qualities of nuts(seeds).[25]

Table 2: physical properties of hemp seeds (Cannabis sativa L.). [6,7,23]

Physical Properties	Description
Shape & size	Small seeds, oval shape, slightly flattened & asymmetric, approximately 3-4mm in length.
color	Brown, pale gray and light brown.
Texture	Interior part: creamy and soft, Exterior part: shell is hard and thin.
Smell	Pleasant nutty smell.
taste	Nutty and slightly sweet in taste.
hardness	Hemp seeds outer shell is hard and it needs to processed to access the exterior soft and edible part.
markings	On the outer surface they have natural darker stripes but vary in intensity.

Hemp has a deep root system, has a widespread distribution, grows quickly, produces a lot of bio-mass, and is very resistant to environmental stress.[24] Hempseeds, harvested three to four months after sowing, [7,22] and are essential components of the hemp plant (Cannabis sativa L.). Hemp seeds include an endosperm and two cotyledons and are protected by a thin pericarp having two layers.[41]

Cannabis seeds germinate between 12 hours and 8 days. Two to four days after germination, the seed coat cracks apart to reveal the root and two cotyledons, which are round embryonic leaves. The plant's most vulnerable stage, the seedling phase, lasts one to four weeks and calls for high to medium light intensity, mild humidity levels & sufficient but not extreme moisture in soil. During the vegetative phase, it keeps growing vertically and generating new leaves. The sex is beginning to unveil itself, and the root system is expanding lower. During the pre-flowering stage, the number of branches and nodes produced by the plant grows dramatically. The flowering period, which lasts between six and twenty-two weeks, requires less light.[2]

Ethnomedicinal Use of Hemp (Cannabis sativa L.)

The earliest pieces of the cannabis plant that people likely collected were its fruits, which are typically referred to as "seeds." Cannabis seeds have historically played a significant role in human diets throughout Asia and are still eaten in a variety of ways, including raw, roasted, pickled, ground, parched, and pressed for oil. [27]

According to one Mahayana Buddhist narrative, the Gautama Buddha lived off of one hemp seed per day during the six years of austerity that preceded his enlightenment.[28]

Since ancient times, seeds have been utilized to heal many illnesses. Their carminative, antiemetic, and antiepileptic qualities, as well as their ability to relieve neurological discomfort, were among the reasons they were utilized in Arab medicine. [29] Cannabis seeds were prescribed by traditional Chinese medical practitioners for gastrointestinal and genitourinary issues, [31] and they were also used to treat constipation and stubborn vomiting. [30] In the Kumaon districts of Uttarakhand, ground seeds are roasted with specific regional vegetables to create a warming effect; to make salt (Pahadi namak), broiled seeds are grounded with salt and green chillies. Green coriandum leaves, salt, sugar, green chili, and boiled seeds of Punica garnatum are combined to make Chatni. Fresh leaves are crushed with three or five black pepper seeds and used to insect bites.[32] The local names for cannabis, "Bhangalu" and "Bhangau," may come from their root word "Bhang." The inhabitants are aware of two different kinds of cannabis: "Ghar-Bhangau," which is cultivated, and "Kath Bhangau," which is wild.[33]

MEDICINAL USE [34, 35]

The juice of crushed leaves, when placed into the ear, reduces earache and, when mixed with sugar, is applied to cuts. Leaf paste is applied in piles. Young leaves are used to make tiny pellets, which are then submerged in water and consumed to treat intestinal worm-related stomach ache. The leaves are thought

to have anthelmintic properties. An edible oil is produced from the seeds, which is then used topically to treat burns on the skin and rubbed to ease muscle aches.

Nutrient profiling of Hemp seeds (Cannabis sativa L.)

Hempseed, a non-drug kind of Cannabis, has not been widely examined for its nutritional benefits. However, for thousands of years, the ancient world relied on Cannabis sativa L. seeds for sustenance. [12] Hempseeds were technically mentioned as nuts, they typically contain over 25% protein and 30% oil and even contains mentionable amounts of fibre which is dietary, minerals and vitamins. Since hempseed oil has over 80% polyunsaturated fatty acids (PUFAs), it is an excellent source of two essential fatty acids: α-linoleic acid (18:2 omega-6) and α-linolenic acid (18:3 omega-3). Hemp seed oil normally has an omega-6 to omega-3 ratio (n6/n3) of 2:1 to 3:1, which considered as optimal for human health. In addition, hemp seed oil contains γ-linolenic acid (18:3 omega-6) & stearidonic acid (18:4 omega-3), which are the metabolites of the two essential fatty acids. [12] Because of its nutritional content and therapeutic properties, hemp seeds have also been shown to relieve dermatological conditions, enhance cardiovascular health, reduce constipation issues, and improve GI disorders.[43]

Table 3: The nutritional composition (%) of dehulled Seed, whole hempseed & Seed meal (Finola cultivar seeds 100g) [45]

Nutri-ents	dehulled Seed	whole Seed	seed Meal
oiL	044	036	011
proteiN	033	025	034
carbohydrateS	012	028	043
moisture	005	006	005
ash	006	005	007
energy (KJ/100g)	2093	2200	1700
total dietary fibre	007	028	043
digestible fibre	006	006	016
non-digestible fibre	001	022	027

HEMP SEED AS A PROTEIN

According to investigations on hempseed proteins dating back to the early twentieth century, edestin (legumin) and albumin (spherical storage protein) are frequent components of hemp seeds, accounting for about 82% of its total protein composition. [39,40] It's important to keep in mind that a protein's amino acid composition, digestibility, and bioavailability all affect how nutritious it is. This is especially true of hempseed proteins. Protein digestibility and amino acid bioavailability are closely related because they both deal with how well a protein is broken down and how well its components the amino acids are taken up by the digestive system and subsequently incorporated into the body. [41] Hemp protein contain all nine essential amino acids, with arginine and glutamic acid being the most abundant. sulphur containing amino acids are also found in moderation. Clinical research on arginine indicates that it helps with foetal development, ammonia detoxification, and reducing insulin resistance. Additionally, glutamate is vital because it plays a critical role in the brain as a neurotransmitter.[42] In some food products, hemp protein can be used in place of other proteins due to its minimal allergenicity when compared to the majority of other plant proteins. Hempseed protein products are becoming more popular as alternatives to wheat, whey, casein and soy protein.[43]

HEMP SEED FATTY ACIDS

Due to their unique fatty acid composition, which may be recovered via cold pressing from the seed itself, hemp seeds are a very nutritious food that can be eaten raw or processed to produce oil. [12,46] Linoleic acid (18:2 omega-6) & linolenic acid (18:3 omega-3) are present in the extracted hemp seed oil, in a 5:1-3:1 ratio, and its ingestion is intended to give cardiac protection and improve lipid profiles. Linolenic acid, an ingredient in hemp seed oil, has anti-inflammatory properties as well as immunoregulatory, [47, 48] and studies indicates that the composition of fatty acids enhances the function and appearance of skin. [49] EFAs are fatty acids that are obtained from diet because they are not produced by humans. Their vital

role in our everyday diet was recognized as early as the 1930s. [50] Linoleic acid (LA) & α-linolenic acid (LNA) are important fatty acids that are particularly abundant in hemp seed oil. [12,46] Hempseed oil contains large levels of γ-linolenic acid & stearidonic acid, both of which are byproducts of LA and LNA. [12] Inflammation is a contributing factor of chronic diseases such as diabetes, cancer, cardiovascular disease, osteoarthritis & Alzheimer's. [51] Nutritional benefit of γ-linolenic acid from hempseed oil is highlighted by the fact that GLA-rich diets have been proven to reduce inflammation, and these two polyunsaturated fatty acids have potential anti-inflammatory, antithrombotic, and antiarrhythmic properties.[52]

HEMP SEED MINERALS

Minerals are classed as macro-elements (>50 mg/day) like phosphorus, potassium, magnesium, calcium, and sodium, or micro-elements (<50 mg/day) like iron, copper, zinc, manganese, boron, silicon, molybdenum. [41] Generally speaking, the mineral profile of seeds is greatly influenced by the plant variety, fertilizer type, fertilizer use, mineral oil composition, and environment. Other authors that examined the mineral profile of hemp seeds cultivated in various nations, with the exception of Siano and colleagues, [53] found similar and comparable results. [54, 55, 12, 56] The main macro elements included in hempseeds were sodium, magnesium, calcium, phosphorous. Copper, iron, zinc & manganese were discovered to be in-trace elements. Hempseeds, in particular, had a higher concentration of P, the most abundant mineral, than oil seeds, such as linseeds (Linumusitatissium L.) and Niger seeds (Guizotia abyssinica (L.f) class.) which are regarded as good source of phosphorus (average P content of 461.35 mg/100g and 784.64 mg/100g, respectively). Interestingly, the high potassium content combined with a relatively low sodium content, results in a high K/Na ratio, which is thought to be responsible for the beneficial heart health advantages. It promotes a high potassium intake, which is inversely associated to accumulation of blood platelets and stroke incidence.[57] Magnesium also helps with heart function and wellness, therefore a lack of it might cause cardiac malfunction. The mineral content of hemp seeds is comparable to that of walnuts, which are a source of mg. Interestingly, hemp seeds contained up to 955mg/100g calcium & 240mg/100g iron. [54] In order to meet the daily requirements of a vegetarian diet, hemp may be helpful for sources of calcium that are adequately rich. [60,61]

Table 4: Vitamins & Minerals of Hemp seeds[45]

vitamins & minerals	Values (mg/100g)
Vit. E	90
α-tocopherol	05
γ-tocopherol	85
thiamine	0.4
riboflavin	0.1
Phosphorus	1160
potassium	859
magnesium	483
calcium	145
iron	14
sodium	12
manganese	07
zinc	07
copper	02

HEMP SEED DIETARY FIBRE AND CARBOHYDRATES

From the seed carbohydrate matrix can be found from dietary fibre. In the ratio of 4:1 in both the solvent insoluble and soluble most of the fibre resides in the hull of the hemp seeds. (61) Insoluble fibre seems to be abundant in hemp, making it one of the best dietary sources. Nevertheless, industrial transformation techniques (like extrusion) that subject seeds to high temperatures and pressures have a tendency to break down the polysaccharide structure by raising the ratio of soluble to insoluble fibre. (63) The amount of fibre in the diet can vary between 27 to 34%. (8,64) Fibre's benefits to human health have been thoroughly

documented. [65-68] The intestine lumen's microbiota produces short-chain fatty acids (SCFAs), which have immunomodulatory and anti-inflammatory qualities and can improve intestinal and general health, which at least partially mediates their effects. [69-71] Given that Western nations have seen a reduction in fibre consumption due to a preference for processed and high-calorie foods, hemp seeds can help full-fill the required dietary fibre. A well-designed vegetarian diet, however, typically offer sufficient consumption of fibre. [72,73] Hulled seeds may increase the amount of other nutrients, such as protein and fat fractions, in a vegetarian diet by improving digestibility and eliminating fibre and anti-nutrient molecules from the hull, thus improving protein bioavailability. This implies that whole hemp seeds or hulled hemp seeds should be chosen based on a person's nutritional needs.

PHYTO CONSTITUENTS/ CHEMICAL COMPOSITION (CANNABIS SATIVA L. AND ITS CONSTITUENTS)

Table 5: Cannabinoids: Total 66 has been identified and divided into 10 subclasses as mentioned below: [74-78]

S.NO.	Phytochemical present	Class (10 subclass)	Chemical constituent	Actions
1.	cannabinoids (66 total present)	cannabigerol	cannabigerolic acid cannabigerolic acid mono methyl ether cannabigerol cannabigerol mono ethyl ether cannabigerovarinic acid cannabigerovarinic	Antibiotic Antibiotic Antifungal Anti-inflammatory Analgesic
		Cannabichromene	Cannabicgromenic acid Cannabichromene Cannabichromevarinic acid Cannabichromenevarin	Anti-inflammatory Anti diabetic Antifungal Analgesic
		Cannabidiol	cannabidiolic acid cannabidiol cannabidiol mono methyl ether cannabidiol-C_4 cannabidivarinic acid cannabidivarin cannabidiorcol	antibiotic anxiolytic anti-psychotic analgesic anti-inflammatory antioxidant antispasmodic

		Delta-9-tetrahydocannabinol class	δ-9-tetracannabinolic acidA δ-9-tetracannabinolic acidB δ-9-tetrahydrocannabinol δ-9-tetrahydrocannabinol – C_4 δ-9-tetracannabinolic acid δ-9-tetrahydrocannabinol-C_4 δ-9-tetrahydrocannabivarinic acid δ-9-tetracannabivarin δ-9-tetrahydrocannabiorcolic acid δ-9-tetrahydrocannabiorcol δ-7-cis-iso-terahydrocannabivarin	euphoriant analgesic anti-inflammatory antioxidant antiemetic analgesic euphoriant
		cannabielsoin	Cannabiesloic acid A Cannabiesloic acid B Cannabielsoin	Same as THC
		Cannabicyclol	Cannabicyclolic acid Cannabicyclol Cannabicyclovarin	
		Cannabinol and cannabinodial	Cannabinolic acid Cannabinol Cannabinol methyl ether Cannabinol-C_4 Cannabivarin Cannabinol-C_2 Cannabiorcol Cannabinodiol Cannabinodivarin	Sedative Antibiotic Anticonvulsant Anti-inflammatory

		Cannabitriol	Cannabitriol 10-Ethoxy-9-hydroxy-δ-6a-tetrahydro-cannabinol 8,9-Dihydroxy-δ-6a-tetrahydro-cannabinol Cannabitriolvarin Ethoxy-cannabitriovarin	
		Miscellaneous Cannabinoids	Dehydro-cannabifuran	
		tetrahydrocannabinol		

NON-CANNABINOID-TYPE-CONSTITUENTS:

Terpenoids: total of 140 terpenoids are present in cannabis

Flavonoids: total of 23 flavonoids are present

Table 6: Non-cannabinoid-type-constituents

S.No.	Phytochemical present	Chemical constituents
1.	Terpenoids [79]	Myrcene Limonine Linalool Trans-ocimene β-pinene α -pinene β-caryophyllene δ-3-carene trans- γ-bisabolene trans- α-farnesene β-fenchol β-phellandrene α-humulene Guajol α-guaiene α-eudesmol Terpinolene α-selinene α-terpinol Fenchone

		Camphene Cis-sabinene hydrate Cis-ocimene β-eudesmol β-selinene α-trans-begamotene γ-curcumene Borneal Cis-β-farnesene γ-curcumene cis- γ-bisabolene α-thujene Epi-α-bisabolol Ipsdienol α-ylangene β-elemene α-cis-bergamotene γ-muurolene α-cadinene α-longipinene Caryophyllene oxide
2.	Flavonoids [79]	Apigenin Luteolin Kaempferol Quercetin
3.	Alkaloids [79]	Cannabisativine Anhydrocannabisativine

PHARMACOLOGICAL PROPERTIES OF HEMP SEED OIL (CANNABIS SATIVA L.)

Table 7: pharmacological properties & cosmetic uses of hemp seed oil.

S NO.	Pharmacological action	Activity due to presence of
1.	Anti-oxidant [80-82]	fatty acids like γ-linolenic acid (GLA) & vitamin A, C & E are present in hemp seed oil.
2.	Anti-bacterial [80,83,84]	Tannins are present in hemp oils and also because of Δ9-THC and CBD
3.	Muscle tension and pain relief [85-88]	α Linolenic acid soothes joint pain
4.	Psoriasis [89-91]	Phyto-cannabinoids
5.	Lichen planus [91,92]	Omega-3 treats Lichen planus

COSMETIC USES		
1.	Moisturizing and inflammation soothening [80,93-96]	Omega-6-fatty acid and prostaglandin for soothening of inflammation
2.	Eczema and Atopic dermatitis [94,97,98	Vitamin E and carotene
3.	Anti-aging property [93,99]	Linoleic acid and oleic acid
4.	Acne [85,102,100,101]	Fatty acids
5.	Natural U.V protectant [103]	SPF rating of 6

APPLICATIONS OF HEMP SEEDS

Hemp is used to made wide range of commercial & industrial goods. Industrial hemp includes fibre and oilseed hemp. Globally, marketplaces provide about 25,000 goods made from hemp. Rising demand from the health care and cosmetics sectors, as well as growing awareness of the nutritional benefits of hempseed and hempseed oil, will support market expansion. (18,19) Hemp stem fibres can be used to make textiles, while the plant's vegetative biomass can be utilized to make ethanol and building materials. Hemp contains deep tap roots that allow for efficient water absorption and carbon storage, as well as improved soil structure.[41] The market expansion is anticipated to benefit from increased manufacturing of hand and body lotions, shampoos, bath gels, soaps, massage oils, ultra violet skin protectors, and a variety of hemp-based goods. The leaves, seeds, and stalks are used to make a variety of items, including furniture, food, medicine, textiles, paper, construction materials, and cosmetics. [104] Hemp's high oil content and healthy unsaturated fatty acid makeup (omega-6 and omega-3) make it a popular addition in skincare products. The aforementioned acids are often used in skin care business & also have an effect on immune cell activation and a range of cellular membrane functions. [105] In addition to lowering artery-clogging cholesterol and blood pressure, hemp oil can aid with inflammatory conditions including arthritis. [106] Topically, hemp oil is applied to burns, open wounds, and skin conditions like psoriasis and neuro-dermatosis. [107] Food safety & standards authority of India (FSSAI) 5th amendment regulations (2021), which were published in the gazette of India: extraordinary, November 15, 2021, part III, section 4 states that "hemp seed, hemp seed oil, and hemp seed flour shall be sold as food or used as an ingredient in a food for sale." This is the one piece of good news for India. This would boost the nation's economy in addition to helping Indian farmers in rural regions.[104] Because of its connection to medical cannabis, industrial hemp was illegal. Although they are grown differently and have different phytochemical compositions, the exact same plant species, Cannabis sativa L., is the source of both hemp & medical cannabis. [108]

CONCLUSION

Hemp farming for its nutritional and therapeutic properties since antiquity. Despite previous government limitations that hindered the scientific investigation and growth of industrial hemp, hemp has demonstrated potential for use in food and nutraceuticals since it was recently legalized with strict production standards. Numerous studies have demonstrated that hemp's nutritional and biologically active content assists in preventing and treating a number of ailments, suggesting that it might be a helpful functional dietary component. The phytochemicals included in hemp seeds make it crucial to be involved in research and the cosmetics business. Researchers are also conducting additional studies to improve cannabis-based skin care products and cosmetics. Hemp seeds contain a variety of compounds that have different pharmacological effects such as eczema, anti-oxidant, anti-microbial etc.

FUTURE PROSPECTIVE

Future research should focus on other beneficial phytochemicals found in the industrial hemp plant like isoprenoids & polyphenols. The effects of hemp polyphenols & isoprenoids on the shelf life, health benefits & sensory appeal of manufactured goods are unknown. Overall, hemp business is gaining momentum on a global scale. To realize the financial potential of industrial hemp as a sustainable supply of functional food ingredients with added value & nutraceuticals, regulatory organizations must distinguish it from medical marijuana.

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