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Nutrition and health benefits of hemp-seed protein (*Cannabis sativa* L.)

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Abstract
Hemp-seed, the seed of *Cannabis sativa* L. with its excellent nutritional value and superior digestibility has drawn great interest in both scientific, nutritional research and industrial fields.The seed of *Cannabis sativa* L. is considered as an important source of nutrition and is normally referred to as hemp, which is not deliberated at length for its nutritional prospective in recent years, nor comprehensively utilized, by the industrial processes and food markets during the 21st century. The common misperception associated with Hemp and hemp-seed is as narcotic components. Lack of awareness and perception of nutritional values, medicinal effect and health benefits has ignored the super food Hemp Seed. The objective of this paper is to provide an updated summary of the research on hemp-seed protein and to fill the knowledge gap in the exploitation of potential nutritional, medicinal, and health benefits of this emerging protein source. Basic objectives of this paper is to create awareness about the super food against myth associated with it and disseminating information, conducting and coordinating research, promoting the use of nutritional and industrial hemp, and to support the cultivation, processing, and use of Industrial Hemp in India for economically empowerment of village women in hilly areas.

Keywords: hemp-seed, nutritional value, health benefits, proteins

Introduction
One survey (*unpublished*) was conducted by Anamika (2020) among 100 undergraduate students who have been studying Nutrition as a course on Hempseed's nutritional values and health benefits. A significant numbers were not aware about its nutritional and health benefits. About 99 percent of students have a perception of only as *Ganja* seed with psychoactive and drug. The result was not at all surprising, since it is the perception of our society that reflects even among students of nutrition. Hemp is many times confused with the cannabis plants that serve as sources of the drug marijuana and the drug preparation hashish. The common perception of Cannabis is mainly associated with narcotic properties. Basic objectives of this paper is to create awareness about the super food against myth associated with it and disseminating information, conducting and coordinating research, promoting the use of nutritional and industrial hemp, and to support the cultivation, processing, and use of Industrial Hemp in India for economically empowerment of village women in hilly areas.

The increasing demand for plant proteins, along with the rising awareness of the nutritional and functional roles of dietary proteins, prompted the nutrition and food industry, nutritionist, dietician to explore nontraditional protein sources. The dietary requirements of human beings are not for protein only, but for specific amounts of indispensable or essential amino acids (building blocks of protein). Hemp seed is nutritious. It contains more critical fatty acids than any other source. Hemp is second only to soybeans in complete protein content (but is more digestible by humans), is high in Vitamin-B group. It is also a good source of dietary fiber. Hemp seed cannot be used as a drug as it is not psychoactive. Hemp-seed protein with its excellent nutritional value and superior digestibility has drawn great interest in both scientific and industrial fields. There is a very thin line, between use, misuse and abuse of a substance, so it is with HEMP. Hemp, (*Cannabis sativa*), also called industrial hemp, plant of the family Cannabaceae cultivated for its fibre (bastfibre) or its edible seeds. Hemp is sometimes confused with the cannabis plants that serve as sources of the drug marijuana and the drug preparation hashish. General sensitivity of Cannabis is mainly related to narcotic properties. The lack of awareness is hardly surprising. Considering, how India is yet to come at par with global Hemp markets such as USA, Israel, Netherlands or China - both from a knowledge and perspective of way of thinking. Awareness, myth and perception on HEMP can be observed in research also.

Number of publications reported in the Scopus system containing the term “hemp protein” in the title, abstract, and keywords within the years 1960 to 2000 was only 37. However, because of the high nutritional value, hemp-seed protein has drawn increasing attention in scientific research, and this is well reflected in the progressive increase in the number of scientific publications related to the term “hemp protein”. During 2010 to 2018, there were 270 publications reported in Scopus. It is our responsibility to draw that line between awareness and perception, use and abuse of HEMP (*Cannabis sativa*) for nutritional values and health benefits.

Hemp (*Cannabis sativa* L.) is subdivided into two key sub-varieties: *Indica* and *Sativa*. The *Indica* species is known to have higher quantum of THC i.e. tetrahydrocannabinol (chemical responsible for most of marijuana's psychological effects), while *Sativa* comprises more of CBD or cannabidiol which consists of nutritional and medicinal properties. Because of *Indica* species, the *Cannabis sativa*, though they did not face any major hurdles from a policy point of view, they did come across from a mindset perspective in a market, that is yet to mature as far as understanding and awareness on Hemp is concerned. Of course, there were the usual naysayers too, who said ‘*log kyakahenge’* [what will people say] backed up with statements that hinted on mass popularization with rising awareness of the nutritional and functional roles of dietary proteins “HEMPSEEDS”.

Prior to 2013, Hemp (Cannabis) was rarely mentioned or raised as an appealing opportunity for new industrial and medicinal development horizons, primarily due to the pre-determined stigma, surrounding the recreational use of Cannabis combined with the fear of industrial and medicinal cannabis being misused and re-directed to the illicit Cannabis market.

India had formulated a policy to allow cultivation of non-narcotic cannabis in 1985 but the policy remained unimplemented as the country did not lay down proper procedures for its cultivation and the stigma associated with mindset and the fear of being misused as narcotics drug.

Uttarakhand, incidentally, become the first State in the Indian subcontinent to allow commercial cultivation of Hemp crop. In 2018, the State Government had sanctioned license to the Indian Industrial Hemp Association (IIHA) to grow the fiber on 1000 hectares. Uttarakhand state has also highlighted interesting facets when it came to the use of Hemp seeds. For instance, in the Kumaon region of Uttarakhand, they mix ‘*chutney’* made of hemp seeds, as a part of daily meals, as it is rich in taste and helps to keep warm in the weather. The Hemp fiber is also used to make rope to tie the cattle in some part of the hilly region of the Kumaun.

What Are Hemp Seeds?

Hemp hearts, or hemp seeds, are the seeds of the hemp plant, or *Cannabis sativa*. They are technically nuts but are referred to as seeds or hearts. This super food is consumed for its omega-3 and omega-6 fatty acids and its antioxidant effects. Hemp seeds are an excellent source of nutrients, especially unsaturated fatty acids and essential amino acids. According to the Unites States Department of Agriculture (USDA), 28 grams (about 2 tablespoons) of hemp seeds contains about: 161 calories, 3.3 grams carbohydrates, 9.2 grams protein, 12.3 grams fat, 2 grams fiber, 2.8 milligrams manganese (140 percent DV),15.4 milligrams vitamin E (77 percent DV), 300 milligrams magnesium (75 percent DV), 405 milligrams phosphorus (41 percent DV), 5 milligrams zinc (34 percent DV), 3.9 milligrams iron (22 percent DV), and 0.1 milligram copper (7 percent DV).

Besides, an excellent source of nutrition and nutritional value researchers agree that hemp seeds have incredible health benefits like Excellent 3:1 balance of omega-3 and omega-6 fatty acids, which promote cardiovascular health; High in GLA (Gamma-linolenic acid), an essential omega-6 fatty acid that’s been proven to naturally balance hormones and “Perfect protein” not only containing all of the 20 amino acids, but also, each of the nine essential amino acids, that human bodies cannot produce. Researches also show that the benefits of hemp seeds include their ability to alleviate constipation, support cardiovascular health, improve dermatological issues and ameliorate gastrointestinal diseases due to its nutritional value and medicinal effects. So the Hemp Seeds be treated as super food. This may be the reason during 2010 to 2018, there were 270 publications reported in Scopus on Hemp protein.

Nutritional Values of Hemp Seed

Nutrition is provided by the nutrients present in food. Nutrients can be defined as the chemical constituents of food that must be supplied to the body in suitable amounts. They perform specific functions in our body and are required in different amounts. The nutrients like carbohydrates, protein, fat and water are required by our body in greater amounts and are called macronutrients. Vitamins and minerals are micronutrients and required by our body in smaller amounts. Intake of nutrients in proper amounts helps in maintaining a proper nutritional status.

Due to Hempseed's well recognized nutritional value, food manufacturers have developed a wide range of retail products from hemp, such as nuts, oil, protein flour, energy bars, granola, hemp nut butter, pasta, and ice cream (Leson, 2006) [3]. A recent emphasis has been on hemp protein, which is used not only as a nutritive additive but also as a functional ingredient in formulated foods to enhance the product quality attributes. The low allergenicity of hemp protein when compared with most of other plant proteins also permits it as a substitute for other proteins in some food products. The use of hempseed protein products as an alternative to the commonly used casein, whey, wheat, and soy protein is on a rise. For instance, some studies have shown that hemp protein products can be used as value added ingredients in the production of bread with increased protein and macro and microelement contents, and lower baking loss and baking time (Korus *et al.*, 2017(b) [2], Lukin & Bitiutskikh, 2017 & Pojić *et al*., 2014) [4, 5]. The color of hemp-seed protein products can range from light tan to dark brown, depending on the pH condition used during processing and the temperature involved in the final product drying. The key to keeping hemp protein competitive in the plant protein market is to assure its nutritional value, functionality, safety, and acceptabiblity sensory characteristics. According to Callaway, 2004 hemp seeds contains about Vitamin E(90mg/100g), α-Tocopherol(5mg/100g), γ-Tocopherol (85mg/100g), Thiamine(B1)(0.4mg/100g), Riboflavin(B2) (0.1mg/100g), Phosphorus(P) (1.160mg/100g), Potassium(K)(859mg/100g), Magnesium(Mg)(483mg/100g), Calcium(Ca) (145mg/100g), Iron(Fe) (14mg/100g), Sodium(Na)(12mg/100g), Manganese(Mn) (7mg/100g), Zinc(Zn) (7mg/100g), Copper(Cu)(2mg/100g) vitamins and minerals with nutritional values.

Medicinal Values and Health Benefits of Hemp-seed

Nutritionist, Dieticians, Food Scientists and Industry associated with nutrition advocates medicinal values and health benefits of hemp-seed. Many of the medicinal values and health benefits are scientifically established and some need to be further research on culture specific population. The following few are medicinal and health benefits of hemp-seed.

1. Rich in GLA

Gamma-linolenic acid (GLA) is an essential structural block for some prostaglandins -hormone-like chemicals in the human body that help smooth muscles, control inflammation and body temperature. GLA is also vital to other body functions. Research published in the *European Journal of Pharmacology* indicates that GLA-supplemented diets attenuate inflammatory responses. GLA and GLA-rich foods like hemp seeds have also been observed to help people with ADHD (Attention deficit hyperactivity disorder), Breast pain, Diabetes and diabetic neuropathy, Heart disease, High blood pressure, Multiple sclerosis, Obesity, Premenstrual syndrome, Rheumatoid arthritis and Skin allergies.

2. May Alleviate Arthritis and Joint Pain

Various researches have shown that hemp hearts and hemp seed oil can be significantly helpful in relieving rheumatoid arthritis symptoms. One study published in the *Journal of Ethnopharmacology* took a look at hemp seed oil's effects on arthritis. Researchers found that hemp seed oil treatment lowered the survival rate of MH7A rheumatoid arthritis fibroblast-like synovial cells. It was found that hemp seed oil has anti-arthritic effects. It can also help patients suffering from anti-arthritic symptoms.

3. Aid Weight Loss

According to a systematic review published in the *Journal of the American College of Nutrition*, fiber intake is associated with a lower body weight. Consumption of hemp seeds works as a natural appetite suppressant. Adding these seeds, and other high-fiber foods, to daily meals will help to curb excess hunger. It is to some extent due to the fiber content, which promotes satiety and in turn aids weight loss. This can likely be due to satiety and energy intake after eating a meal high in fiber.

4. Improves Digestive Health

Hemp seeds robust immune system. A study published in the *American Journal of Gastroenterology* found that hemp seed pill treatment was effective for relieving functional constipation. Due to its high insoluble and soluble fiber compositions, hemp hearts provide more than enough bulk to keep gastrointestinal system regular.

5. Boosts Hair, Skin and Nail Health

Hemp seed benefits for skin and hair. It goes a long way in improving dry, red, flaking skin. Mostly it is used in high-end cosmetic products; hemp oil is oftentimes included in lip balms, lotions and soaps. The oil in hemp seeds penetrates the inner layers of the skin and promotes healthy cell growth. In fact, researchers studying the effects of oil extracted from hemp hearts on atopic dermatitis, or eczema, a skin condition that causes inflammation and dry skin, found that patients' symptoms improved a lot with the use of the hemp seed oil. Since the hemp oil is also good for skin disorders, such as psoriasis and eczema, it's also a good idea to add the plant's seeds to diet to maximize these benefits. One can also use as a homemade skin cream after combining hemp seed oil, Shea butter and essential oils like lavender.

6. Reduces Inflammation

Hemp seed helps to naturally reduce inflammation levels and strengthen the immune system because of its perfect fatty acid profile of omega-3 fats and Gamma-linolenic acid (GLA). Research published in *American Chemical Society Omega* indicates that hemp seed has immunomodulating, antioxidant and anti-aging effects.

7. Heart Health

Some of the prominent elements in building a healthy heart include fiber, plant-based protein, healthy fats and eating less sugar. Ingredients of hemp seeds help in doing all of these things for a healthy heart. Researches on animals and humans strongly suggest that hemp seeds can improve cardiovascular health. It can also improve high blood pressure. One to two tablespoons of hemp seeds in a morning smoothie can help to naturally lower blood pressure, reduce LDL cholesterol, raise HDL cholesterol and improve triglycerides (Source: https://draxe.com/nutrition/7-hemp-seed-benefits-nutrition-profile/).

How to Use Hemp Seeds

These days, one can find hemp seeds in most grocery stores and health food stores in metro cities and e-market place like Amazon. They have a typical mild nutty taste. Hemp seeds are used to make several products, including the following:

Hemp nut butter: The seeds are also ground and made into hemp nut butter, which one can consume like one would peanut or almond butter.

Hemp milk: Much like almond milk, one can use hemp milk as a dairy-free alternative. Hemp milk is a tasty and nutrient-rich addition to any smoothie recipe.

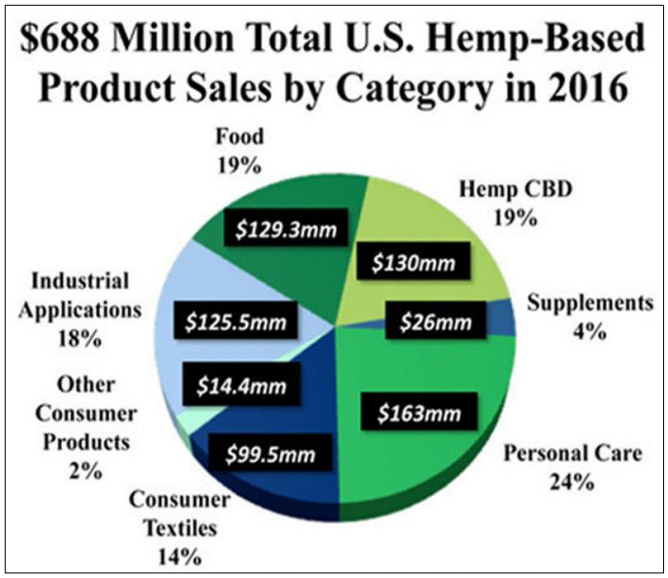
Hemp-seed oil: Hemp-seed oil is on the grocery store shelves, too. It's best to use hemp-seed oil as finishing oil rather than as cooking oil. Drizzle it on salads and pastas or other dishes. One can also use hemp seed oil topically to moisturize your skin, reduce signs of aging and boost hair health.

Hemp protein powder: This is an excellent plant-based protein powder that supplies omega-3s, essential amino acids, magnesium and iron.

How to make healthy, attractive diets?

Hemp seeds are sensitive to heat and light. It's also best to store them in a cool, dry place or in the fridge. There are quite a few ways to use the seeds and the butter, milk and oil that's made from them. Here are some ideas:

- Add hemp seeds to smoothies or grind them up and sprinkle them on yogurt, cereal or other meals.
- Make this Tropical Acai Bowl Recipe that's made with mango and hemp hearts.
- Try recipes that incorporate hemp hearts, like this Pecan Coconut Balls.
- Combine hemp protein powder with your favorite milk (like almond or coconut milk) to make a plant-based protein shake for before or after workouts.



Source: Hemp Business journal and vote hemp estimates (consumer sales)

Fig 1: Uses of hemp in various industries

Conclusion

Hemp-seeds, as plant material protein, are becoming an important emerging alternative protein source in the food and nutrition industry. Since the interest of consumers worldwide for ingredients derived from natural sources is ever growing, the demand for hemp-seed protein is expected to grow rapidly. Although research has made progress in recent years in understanding the chemical composition, nutritional and health benefits, processing, properties, and functional behavior of hemp-seed proteins in food processing, much remains unknown about it. For example, many of the minor protein components present have not been characterized. Furthermore systematic research is required to establish the medicinal effects and health benefits of hemp-seeds. Policy formulation, adaptation by the Government and awareness campaign by civil societies needed to overcome the myth and misconception lying on it. Basic and applied research is essential to the development of this valuable natural and traditional plant protein source and broadening its market potential in the food industry. Extensive research is also required to see the health benefits of users and others in the *Kumaon* region of Uttarakhand, where hemp seeds were made of as a part of daily meal ‘mix chutney’.

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