STUDIES ON USING HEMP SEED AS FUNCTIONAL INGREDIENT IN THE PRODUCTION OF FUNCTIONAL FOOD PRODUCTS

L. APOSTOL[1]

[1]*University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania, National Research & Development Institute for Food Bioresources – IBA Bucharest, 5, Baneasa Ancuta Street, District 2, 020323, Bucharest, Romania;*
[1]*Correspondent author:apostol_livia@yahoo.com.*

Abstract: *The paper studies the possibilities of using hemp seeds for functional ingredients in food products. Here is a brief history of the concept of functional food, a synthesis of Categories of Health Mentions (Function) and Examples of functional ingredients. Importance of hemp seed in human nutrition rezults especially from the content of saturated and unsaturated fatty acids in hemp seed oil. Hemp seeds are an important source of oil, of high nutritional value, the content of linolenic acid being 56.35% and the one in alpha-linolenic, 17.30%. Total content in unsaturated fatty acids exceeds 85%. Here is a comparison between the content of omega 3 and omega 6 from different sources, a protein characterization and a statistics of the main hemp producers highlighting the significant contribution of hemp seeds as a functional ingredient in this regard.*
Over the past decade, there has been a significant change in the scientific approach adopted by many food scientists on the relationship between sensory attributes and physico-chemical properties on the one hand and the physiological performance of food on the other. In particular, there has been an increase in awareness of the complex relationship between the structure of foods and their nutritional performance.
To date, most research on functional foods has focused on the nutritional composition of the food product and to a lesser extent on the effects of adding a bioactive compound to the texture and product quality. Demonstration of success and efficiency of incorporation of bioactive components into selected food matrices is important for the marketing of new bioactive components and functional food ingredients.

Keywords: *functional food, hemp seed, antioxidant.*

1. History of the functional food concept

The modern concept of functional food for the population was generally proposed by the Japanese academic society in the early 1980s. Studies and research were conducted to identify those healthy components, ultimately resulting in the concept of "functional foods" . Since 1984, large-scale research has been carried out on food functions under the aegis of the Ministry of Education, Science and Culture of Japan [2].

A number of Japanese researchers in the fields of food science, nutrition, pharmaceuticals and medical sciences have participated in these research and many interesting features of food components have been identified with regard to their physiological functions [2, 3].

The results of these research have led to the world's first policy to allow the marketing of foods with certain health promotion functions. These special foods have been called FoSHU (Foods for Specific Healt Use). The FoSHU system was introduced in Japan in 1991 by the Ministry of Health and Social Protection as a regulatory system to approve the mentions of the effects of food on the human body. In this regulatory system, FoSHU is classified as a special food group between medications and regular foods.

The first FoSHU products were approved in 1993 and included hypoallergenic rice and low-phosphorus milk for certain categories of patients. Since the FoSHU should not include medical requirements such as "prevent," "cure" or "treat" human diseases, the products

mentioned above were subsequently transferred from the FoSHU category to another category called "food for the disease" [11]. Despite some regulatory errors in the initial stages, the FoSHU system has been encouraging the Japanese food industry to develop functional food.

The FoSHU concept was introduced in the journal Nature in 1993, and since then, the term functional food has been recognized internationally [15].

In 2001, the FoSHU criteria were integrated into the "Health Nutrition Foods" System (FHC). FHC is the Japanese regulatory system for health food products and is made up of two categories: FoSHU and Nutrition Food Products (FNFC;) [16].

FNFC allows use of these functional requirements for nutrients such as vitamins and minerals. Twelve vitamins (vitamin A, B1, B2, B6, B12, C, D, and E, biotin, pantothenic acid, folic acid, niacin) and five minerals (calcium, iron, magnesium, copper, zinc) were permited for FNFC. Labeling of nutritional functions for these vitamins and minerals is allowed because the benefits of taking these items from food have been recognized internationally, based on scientific pedagogy. The maximum and minimum daily nutrient doses for an individual were determined as the standard daily dose. Therefore, an FNFC product should contain a quantity of nutrients between the designated upper and lower limits [16].

Since March 2013, 1037 FoSHU products have been listed. Table 1 shows the approved FoSHU categories in Japan; These include foods that (1) improve gastrointestinal health, (2) promote the health of teeth and gums, (3) increase mineral absorption, (4) promote bone and power health, (5) reduce blood pressure, (6) Lower blood glucose levels, (7) lower cholesterol levels in the blood, and (8) lower blood triglyceride levels and reduced fat accumulation in the body.

Table 1. *FoSHU categories and their corresponding functional ingredients [11]*

Categories of Health Mentions (Function)	**Examples of functional ingredients**
Promotes bowel health	Dietary fibers, oligosaccharides, bacteria
Promotes the health of teeth and gums	Tea polyphenols, milk proteins, funoran, isoflavones, calcium
Improves the absorption of minerals	Casein phosphopeptide, poly-γ-glutamic acid
Promotes the health of bones and power	Milk proteins, isoflavones, vitamin K2
Lowers blood pressure	Food protein peptide derivative, γ-amino butyrate, acetic acid, chlorogenic acid
I lower blood glucose levels	Non-digested dextrin, wheat albumin, tea polyphenols, fermented soybean extract
Reduces cholesterol levels in the blood	Soy protein, chitosan, low molecular weight alginate, phytosterol, tea catechins, methyl cysteine sulfoxide
Reduce the level of neutral lipids in the blood and body fat	Polyphenol conjugates, non-digested dextrin, catechins, conglycinin, n-3PUFA

The underlying mechanisms for current FoSHU products are diverse. Even in the same health claims, various functional substances with different mechanisms of action may be included.

2. Importance of hemp seed in human nutrition

Cannabis sativa L., is a plant from the Cannabaceae family, known as 'hemp', it has been cultivated for thousands of years in Asia, Africa, Europe and has an important source of textile fibers in traditional medicine for the production of oil and food products [4].

In the twentieth century, hemp cultivation was banned for human consumption in many countries due to the presence of a phytochemical component considered to be a drug, delta-9-tetrahydrocannabinol (THC) [12].

The two varieties of hemp cultivated worldwide are *Cannabis sativa* L and *Cannabis sativa indica.* The major difference between the two types of plants is the appearance and amount of delta-9-tetrahydrocannabinol (THC). Usually, hemp (*Cannabis sativa* L) contains under 0,3% THC, while varieties of *Cannabis indica*, grown for use as a drug may contain from 2% to over 20%THC. Today in the European Union, 26 hemp varieties with low levels of tetrahydrocannabinol (THC), are certified to be cultivated (Directive 2002/53 / CE, Article 17). *Cannabis sativa* L. the non-drug variety and its seeds (hemp seed) are a significant source of dietary oil, fiber, minerals and protein.

Oil extracted from hemp seeds is recognized as an important source of essential fatty acids and is used as an ingredient for body creams, detergents and soaps. Recent clinical studies have identified

hemp seed oil as a functional food, and studies on animal feed have demonstrated the usefulness of hemp seeds as an important nutrient resource [4, 12].

Hemp seed oil is rich in polyunsaturated fatty acids (linoleic and alpha-linoleic) that can reduce cholesterol and blood pressure levels and provide immune support [13]. Moreover, hemp seeds are also rich in protein [10]. The two main hemp proteins are albumin (33%) and edestina (65%), which have very similar structures to blood proteins, so they have a slight digestibility. In addition, hemp seeds contain essential amino acids, including a high level of arginine amino acid [4].

From a nutritional point of view, it is known that there is a balance in the daily consumption of omega-3 acids and omega-6 fatty acids, and that of these, the only ones essential for human health are linolenic acid (LA, 18: 2n -6), an omega-6 fatty acid, and alpha-linolenic acid (LNA or ALA, 18: 3n-3), an omega-3 fatty acid. The optimal LA and LNA ratio for human nutrition is considered by some researchers, 2:1, according to nutritional studies [14], other studies have suggested that this ratio is 1: 1 [5, 14], or after other researchers is about 3 parts LA to one part LNA, probably the best estimation [6].

The optimal ratio of LA and LNA of 3: 1 suggested by nutritional studies is very similar to that of the two essential fatty acids in hemp oil, even though hemp oil is not considered to be an important source of hemp oil. These essential fatty acids for human nutrition, since no nutritional research has been carried out on hemp in the last 65 years.

In table 2 It is possible to compare the typical unsaturated fatty acid profiles of the most common food oils with high levels of both LA and LNA (hemp, rapeseed, soybean and flax seed oils). It can be seen that hemp seed oil is recommended for human consumption in terms of the ratio of omega 3 fatty acids to omega 6.

Table 2. *Content of omega 3 and omega 6 from different sources*

Product	**LA**	**LNA**	**LA/LNA Report**
Hemp seed oil	55	20	2.8
Rape seed oil	22	12	1.8
Soybean oil	51	7	7.3
Linseed oil	15	61	0.3

Table 3. *Fatty acid content of hemp seeds [17]*

Component	Value
Oil content, %	28,7
Saturated fatty acids	
Palmitic acid (C 16:0)	6.96
Stearic acid (C 18:0)	2.74
Arachidic acid (C 20:0)	0.77
Total saturated fatty acids	**10.47**
Unsaturated fatty acids	
Oleic acid (C 18:1 ω 9)	13.64
Linolenic acid (C 18:2 ω 6)	56.35
Gamma-linolenic acid (C 18:3 ω 6)	1.35
Alfa-linolenic acid (C 18:3 ω 3)	17.30
Stearidonic acid (C 18:4 ω 3)	0.50
Eicosenoic acid (C 20:1)	0.39 NS
Total unsaturated fatty acids	**89.53**

In table 3 the content of saturated and unsaturated fatty acids in hemp seed oil is presented. It can be seen that hemp seeds are an important source of oil, of high nutritional value, the content of linolenic acid being 56.35% and the one in alpha-linolenic, 17.30%. Total content in unsaturated fatty acids exceeds 85%.

Hemp seeds also contain a considerable amount of protein, which is considered "complete" in the sense that all essential amino acids are present in important nutrients.

In table 4 the values of amino acid content of hemp seeds are presented.

These proteins are made up of about one third albumin, an important protein that is also found

in egg white and human blood, and two-thirds of ED, another important globular protein of similar character. Unlike soybeans, which contain trypsin, inhibitory factor, the hemp seeds are easily digestible for the human body. Vitamins and minerals of biological importance are found in hemp seeds. Hemp seeds have an important fiber potential.

From the above, it can be seen that industrial hemp seeds (Cannabis sativa L.) offer quality nutrients, especially amino acids, which could be extracted for use as substances with therapeutic potential in the management of chronic human diseases. Recently the have been conducted studies of antihypertensive properties and the antioxidant effect of protein hydrolysates in hemp seeds [9].

[1] have performed biological tests to determine the sequence of active peptides from hemp seeds that produce antioxidant and antihypertensive effect. In vitro and in vivo studies in rats have shown that isolated peptides from hemp seeds have the potential to be used as antioxidant and antihypertensive agents.

3. Consumption of products with hemp seed intake

As mentioned earlier, hemp (Canabis sativa L.) has its origins in Asia and has been known for millennia. According to Dewey [7], hemp was first grown for fiber and later for seed. Its cultivation began in China in 2800 BC. From China it spread to India and Persia, and then came to Europe. In the middle ages, hemp has been extensively cultivated in Europe for its use as fiber, and its seeds have been cooked with other cereals for consumption.

Table 4. *The content of protein substances of hemp seeds [17]*

Component	**Value**
Protein content, %	24,8
Amino acids,% dry matter	
Essential	
Arginine	2.23
Phenylalanine	0.92
Histidine	0.56
Isoleucine	0.81
Leucine	1.41
Lysine	0.77
Methionine	0.09
T hreonine	0.70
Valine	0.96
Total	8.44
Nonessential	
Alanine	0.92
Asparagine	1.96
Cysteine	0.24
Glycine	0.86
Glutamine	3.17
Proline	0.41
Serine	0.98
Tyrosine	0.52
Total	9.06
Total amino acids	17.50

It seems that for the first time the hemp was cultivated in America by Spaniards who started cultivating it in Chile since 1545 [8]. Approximately 100 years later it was introduced in the US, in New England [7]. Although hemp has been grown since antiquity, today it is not a large oil crop, with the production of hemp seeds worldwide at around 53,354 tons in 2008 (Table 5).

Production of hemp seed has decreased since 1970, with the exception of China, which is the main producer of hemp seeds. In Europe, the countries still producing hemp seeds are: France, Ukraine, Hungary, Russia, Poland and Romania (Table 5).

Table 5. *Large producers of hemp seeds between 1961-2008 (tons) FAOSTAT 20/02/2010*

Country	1961	1970	1980	1990	2000	2008
Chile	3000	2500	1100	1100	1100	1300
China	27 000	48 000	42 000	25 000	26 000	45 000
France	900	523	2680	1100	5500	5500
Hungary	1309	524	1664	1191	50	450
Italy	855	40	3	0	0	0
Polond	4000	2000	280	98	15	20
Romania	400	1200	1800	3000	25	100
Russia	-	-	-	-	250	331
Spain	2171	45	146	17	8	8
Ukraine	-	-	-	-	1500	600
URSS	30 000	20 000	10 000	2700	-	-
RFS Yugoslavia	2500	1500	177	196	-	-
EU	11 648	5817	6855	5445	5598	6078
In the world	79 748	80 448	64 741	35 291	34 591	53 354

Worldwide, the oilseed market is dominated by soybean oil, rape and sunflower oil (Fig.1).

A hemp cultivation strategy for seed production is diametrically opposed to that of its cultivation for fiber production, since, historically speaking, hemp cultivation has been made, primarily for the production of fiber. In China, roasted hemp seeds are sold in markets, but large quantities of them are exported (not fried) as feed for birds. In the eastern part of Europe, hemp seed oil has been used as a substitute for butter, usually by those who could not afford dairy products. As a result, "hemp" seed oil was developed as a delicacy in these regions [4]. At the end of the 1930s, hemp seed oil was used as a base in the paint industry.

Since hemp seeds have a pleasant hazelnut flavor and can easily be incorporated into nutritious foods, a current of hemp-derived food has recently developed in Western Europe.

Briefly, information on the potential of hemp seed products has not yet been attracted and, for a few years, in-depth studies have been published and recognized on the nutritional benefits of hemp seed.

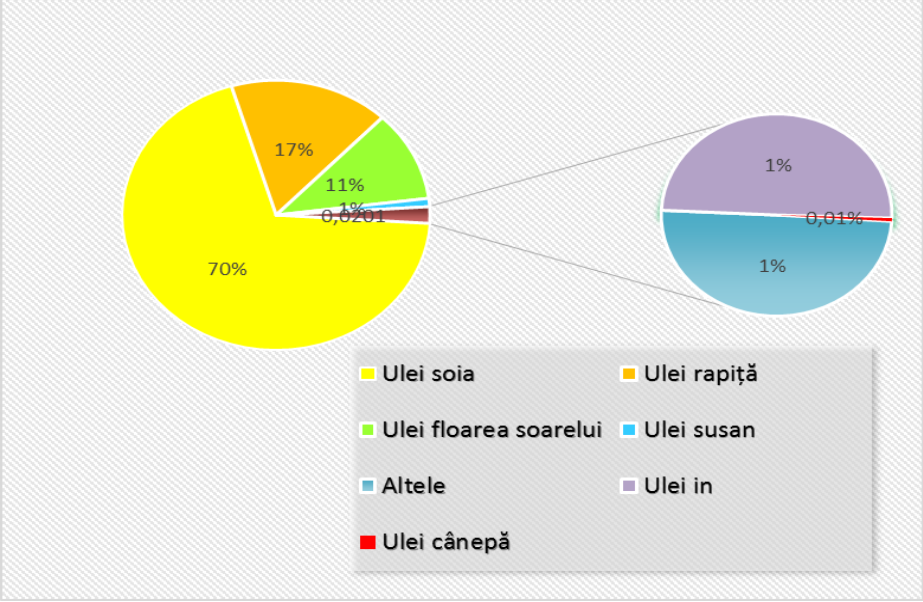

Fig.1. *Oil production from different sources of oil in 2008 (tons) [10]*

Thanks to these researches in recent years, consumers in Europe and North America who are concerned about health and the quality of their diet have already created a significant demand for hemp seed oil. In Romania hemp seeds are very little used (table 5) especially for oil, which is used as a raw material for obtaining food supplements.

Conclusions

In the context of economic and social progress, human health is becoming an increasingly important personal and social value.

Because of the costs associated with curative medicine, prevention of emerging health problems is very important. That is why we need a new orientation in the study of the relationship between man and food.

The purpose of these scientific researches was to identify solutions to improve the nutritional level of the population by developing new functional bakery products with the potential to be consumed daily by a large segment of consumers.

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