CURRENT STATE OF USE OF JERUSALEM ARTICHOKES AS A FUNCTIONAL INGREDIENT IN THE PRODUCTION OF FUNCTIONAL FOOD PRODUCTS

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Abstract: *The paper presents first conceptual functional food and a classification of the main categories of functional foods. Next, it is presented the importance of Jerusalem artichokes in human nutrition prin compozitia chimica. Jerusalem artichoke contains, besides other valuable minerals, an impressive amount of organic (natural) silicon, up to 8%, of the dry matter. After current research, silicon is part of the group of elements necessary for normal growth and development of animal and human organism, being considered an indispensable mineral. It is necessary for the synthesis of collagen - protein from connective tissue. Silicon enters the elastin composition of the blood vessels, and when the silicon content in the body is low, there is a decrease in the elasticity of the artery walls and increase in their permeability. The inulin content of the Jerusalem artichokes is up to 80% of the dry matter.*
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.
According to a working definition adopted in a European Consensus document in 1999:
A food may be considered as "functional" if it is satisfactorily demonstrated to beneficially affect one or more target functions in the body, beyond the appropriate nutritional effects, in a manner that is relevant to a good state of Health and well-being and / or reducing the risk of disease. The degree of knowledge of a functional ingredient influences the perception and acceptance of functional foods by consumers. In this sense, functional foods can be interpreted as the carrier of functional ingredients with certain health benefits. Existing studies suggest that products containing certain functional ingredients will be more successful on the market if the consumer is aware of the ingredients inherent in a healthy life.

Keywords: *fortified food, conventional healthy food, dietary fiber;*

1. Outlining the concept of functional food

Although legislation regulates health and nutrition claims used to promote functional foods, there are still different opinions in this area [13]. Specifically, specialists and authorities have not reached a consensus on their definition. The concept of functional foods involves reforming the nutritional composition of foods to meet the physiological needs of consumers. Intervention on the composition of conventional foods is done in three directions [3, 13]:

• enriching content in .... (For example, foods rich in dietary fiber, or fortified foods with calcium or magnesium);

• decreasing content in ... .. (eg foods with low salt or saturated fat content);

• replacing the component ... with (for example, sugar is replaced by low glycemic sweeteners such as inulin). Foods falling within one of these directions have been scientifically evaluated and may be accompanied by references to their specific beneficial effects on health. A definition of work was adopted in 1999 in a European Consensus:

• *a food can be considered a "functional food" if it is satisfactorily demonstrated that it affects one or more of the target organisms in the body beneath the appropriate nutritional effects in a way that is good health and well-being and / or reducing the risk of disease. Functional foods must remain food and must show their effects in the amounts that can normally be expected to be consumed in the diet: these are not pills or capsules, but they are part of a regular food product "* [4].

Currently, other terms are used in this context, without mutually excluding them, such as:

• *fortified food* - conventional food, which is enriched with a nutrient that is beneficial to health (European Commission, 2010);

• *nutraceutical product* - synonymous with functional food (Nutraceutical Institute, UK);

• *reformulated food* - a conventional food whose composition has been modified to reduce the sugar, saturated or trans fat or salt content for a healthy diet. In some contexts, reformulation may include fortification (European Commission, 2005);

• *food product rich in nutrients* - any conventional product whose consumption is recommended in a healthy diet (eg. cereals, fruits, vegetables) without necessarily having scientific evidence on these recommendations. If there is scientific evidence, such products may contain nutrition claims (eg. fiber rich, sources of vitamin K); (European Commission, 2010);

• *conventional healthy food* - a nutritionally modified conventional product (eg. low-fat, non-fat), which contributes to a healthy diet [22];

The definition of the functional food formulated in the FUFOSE project (1998) is considered to be the most complete and appropriate for the subject of this thesis, namely:

"A functional food is defined as that food if it is scientifically demonstrated that it generates health benefits in general or specific to a health problem through its nutritional content as part of a healthy diet without being medicated or supplemented. "

In conclusion, functional foods should be considered as foods that are attractive to consumers by means of health and nutrition claims, provided that these claims are scientifically proven in accordance with the legislation in force. Other terms of interest for the topic addressed are defined, in accordance with Regulation (EC) No. 1924/2006 on nutrition and health claims associated with food, as follows:

"nutrient" means the proteins, carbohydrates, fats, fibers, sodium, vitamins and minerals listed in the Annex to Directive 90/496 / EEC and substances belonging to one of the categories concerned or are compounds of one of the categories concerned;

"mention" means any message or representation that is binding on us under community or national legislation, including representation in the form of images, graphical or symbolic representation, of whatever form, which asserts, suggests or implies that a food has great features;

"nutrition claim" means any requirement that suggests, affirms or implies that the food has special beneficial nutritional properties due to:

- the calorific value it delivers, supplies it to a high or low level or does not supply it; and / or

- the nutrients or other substances it contains, contains them to a high or low degree, or does not contain them;

"health claim" means any claim that states, suggests or implies that there is a relationship between a category of food, a food or one of its constituents and health;

"reference to reducing the risk of disease" means any health claim that states, suggests or implies that a risk factor in the development of a human disease is significantly reduced by the consumption of a food category, a food product or one of the constituents thereof;

"other substance" means a substance other than a nutrient that has a nutritional or physiological effect.

In view of the above, the following conclusions can be drawn:

According to the Japanese Ministry of Health and Social Protection, functional foods are expected to have certain health benefits, and have been allowed to wear a label claiming that a person using them for a specified health use can expect an improvement in health through their consumption. This category includes:

• foods that are expected to have a particular health effect due to relevant constituents or foods from which allergens have been removed;

• foods that have a plus or removal effect that have been scientifically evaluated and allowed to make claims about their specific beneficial effects on health.

In this overall context, the EC organized a concerted action involving a large number of the most prominent European nutrition and related scientists employed by the EU - to study functional food sciences [11].

"Target function" refers to genomic, biochemical, physiological, psychological, behavioral functions or which are relevant to maintaining a well-being and health or reducing the risk of disease. Modulation of these functions should be assessed quantitatively / objectively by measuring biochemical markers (eg. metabolite, specific proteins, hormones, enzymes, etc.) or physiological parameters (eg measuring blood pressure, heart rate, gastrio-intestinal transit time measurement, etc.) or changes in physical and intellectual performance with objective parameters.

2. Classification of functional foods

A distinctive feature of FoSHU is that commercially available FoSHU products include a wide variety of common foods, such as beverages, yoghurt, rice, noodles, bread, cereals, biscuits, margarine, cooking oil, mayonnaise, sausage and fish paste which can be incorporated into daily meals.Following the introduction of the FNFC into the FHC system in 2001, FoSHU was classified in 2005 in four groups: "*Standardized FoSHU*", "*FoSHU with Reduction of Risk of Illness*", "*FoSHU Qualified*", and "*Frequent FoSHU*" [10]. For example, undigested dextrins and certain oligosaccharides are recognized as functional ingredients that promote bowel health and are already used in many FoSHU products. In such a case, foods containing these ingredients at suitable concentrations may be homologated as FoSHU standardized because they are considered to have sufficient scientific evidence to support claims.

Table 1. *FHC Classification 2005 [10]*

Medicine	Food with Health Claims (FHC)					So-called healthy foods	Common foods
	Foods with functional nutrition claims (FNFC)	Foods with specific health use (FoSHU)					
		Common	Standardized	Foods with reduced illness risk	Qualified		

The 2005 FoSHU review also allowed manufacturers to apply for few foods with less scientific evidence for the FoSHU system. Foods that do not have sufficient scientific evidence can be approved as FoSHU qualified if they have a certain efficacy. FoSHU with the indication of disease risk reduction were introduced by MHLW, with the agreement of the Codex Committee under the aegis of the World Health Organization / Food and Agriculture Organization. The first EU funded project between 1994 and 1998 was the FUFOSE project (*Functional Food Science in Europe*) (ILSI, 1998).The impact of this project has been beneficial both for food research activities and for the functional food industry, which since then has been steadily increasing, although the European Food Safety Authority (EFSA) legislation is relatively strict on the approval of foods with nutrition and health claims.

3. The importance of Jerusalem artichokes in human nutrition

Jerusalem artichoke (*Helianthus tuberosus* L.) is a perennial plant of the Asteraceae family, originating in North America. Man used this plant for more than 2,000 years BC, and in the first millennium before Christ the spice went into Indian farming. In Europe, the plant was brought by French sailors in the seventeenth century. Due to the similarity with the sunflower, which was also brought to Europe in North America, the Jerusalem artichokes are known in Italy as "artichokes" or "sun artichokes".

In Russia the Jerusalem artichokes was brought from China, but not as a vegetable, but as a medicinal plant under the name of "Chinese Potatoes".

Table 2. *Composition of Jerusalem artichoke tubers [8]*

Analyzed part	Dry substance	% dry matter				
		Protein	Fat	Extracted unsolved substances	Ash	Cellulose
Airpart	18,00	10,00	1,80	55,80	14,50	18,10
Tubers	119,20	11,40	1,00	78,00	5,80	4,20

In Romania the name of this vegetable is "nap". Over the past two decades, a renewed interest for Jerusalem artichokes has begun and its introduction into various agro-climatic areas.

This increased interest in Jerusalem artichokes is related to the emergence of new aspects of its use, apart from the food industry, namely in biotechnology and therapeutic area. Jerusalem artichoke has a rich composition of biologically active substances (Table 2).

Jerusalem artichoke has a high mineral content [2, 19, 20] and a high inulin content [14]. This plant exceeds, from the point of view of the mineral content, many of the frequently consumed vegetables (potato, carrot and beet) (Table 3).

Table 3. *Mineral content of Jerusalem artichokes [8]*

Mineral elements	mg/100g dry matter						
	Fe	Mg	Ca	Mn	K	Na	Si
Content	10,10	44,00	78,80	31,70	1382,50	17,20	8000

As shown in Table 3, Jerusalem artichoke contains, besides other valuable minerals, an impressive amount of organic (natural) silicon, up to 8%, of the dry matter. After current research, silicon is part of the group of elements necessary for normal growth and development of animal and human organism, being considered an indispensable mineral [8]. It is necessary for the synthesis of collagen - protein from connective tissue. Silicon enters the elastin composition of the blood vessels, and when the silicon content in the body is low, there is a decrease in the elasticity of the artery walls and increase in their permeability [8]. The inulin content of the Jerusalem artichokes is up to 80% of the dry matter [8]. As source of inulin, Jerusalem artichoke has the following efects: laxative, collagogue, diuretic, spermatogenic, stomach and tonic effects, its tubercles being used in traditional medicine in diabetes and treatment of rheumatism. Inulin is a natural polysaccharide that contains 95% fructose. This belongs to the carbohydrate class called fructans. Inulin is composed of fructose units having a terminal glucose molecule, being a non-reducing polyglucid. The amount of inulin from the Jerusalem artichoke depends on the species, the plant maintenance and the climate [16].

In recent years, independent researchers conducted by various research teams have shown that its chemical composition, rather than the high content of inulin, has a beneficial influence on the gastrointestinal system [15] have developed a method of extracting inulin from the Jerusalem artichoke (*Helianthus tuberosus* L.). Samples of inulin extracted in an aqueous medium without the addition of organic solvents were fermented with prebiotic bacteria *Lactobacillus paracasei*. In parallel, commercial inulin samples obtained from chicory (*Cichorium intybus*) were fermented. From the data obtained from these investigations it can be concluded that fermented inulin samples obtained from Jerusalem artichoke had very good in vitro prebiotic activity, even higher than the commercial inulin samples obtained from chicory. This indicates that inulin obtained from Jerusalem artichoke may be considered a possible prebiotic ingredient. Its valuable composition in biologically active substances of Jerusalem artichoke makes this plant a promising prospect for the food industry, in dietetic nutrition and as a raw material for the preparation of dietary supplements.

Table 4. *The Jerusalem artichoke production between 1961-2011 (tons) Source:FAOSTAT/2015*

Țara/Continentul	1961	1970	1980	1990	2000	2011
Italia	416.900	670.800	597.700	487.000	512.946	474.550
Asia	10.600	15.966	11.945	33.438	80.504	149.339
Europa	692.809	1.060.147	1.032.894	1.045.612	899.845	747.501
EU	696.409	1.065.227	1.036.739	1.048.512	902.965	750.054
Franța	160.000	125.820	102.544	97.118	63.605	50.589
Grecia	24.000	43.127	44.450	33.594	31.000	38.000
Israel	1.300	6.400	1.450	5.763	4.905	2.419
Argentina	18.000	67.600	58.800	72.000	74.075	100.891
SUA	23.133	30.436	42.664	50.547	45.900	45.314
Mexic	0	0	80	546	2.988	3.193
Mondial	855.442	1.276.057	1.254.405	1.333.471	1.317.527	1.541.383

4. Consumption of products with Jerusalem artichoke intake

For three thousand years, man has known Jerusalem artichoke and since ancient times has been attracted to the unique power of the plant that allows him to survive in the extreme conditions of the environment and to produce large crops compared to other tuber plants.

From the data presented in table 4 it is noticed that in Europe, the US and worldwide, with only a few exceptions, the peak of the production was in 1990. In Romania, the production of Jerusalem artichoke reported, started in 1999.

In Romania, the production of Jerusalem artichoke, according to FAOSTAT data, has been reported since 1999, with a peak of 2,474 tonnes in 2004, after that it fell to 589 tonnes in 2011 (Tabel 5).

Table 5. *The Jerusalem artichoke production in Romania Source:FAOSTAT/2015*

România	1999	2004	2006	2007	2009	2011
Tone	1.500	2.474	2.200	1.656	1.446	589

Jerusalem artichoke comes from America and is widely grown in temperate areas. However, the cultivation of this plant is not in line with its potential [9]. Jerusalem artichoke is grown mainly for its edible tubers, which vary in size and shape. Some tubers are similar to potatoes, small, round and knotty, while others are long, large and smooth [18]. These are consumed raw, cooked or as potatoes. They were consumed as basic food or emergency food in Western Europe during the Second World War, and are currently very known and consumed vegetables [9]. Jerusalem artichoke is also used as animal feed.

Jerusalem artichoke falls into the category of commercial energy crops because it is a plant that is suitable for high density crops with high production yield and can be successfully used as biomass for fuel or for obtaining ethyl alcohol [5].

In Romania, at the Buzau Vegetable Research and Development Resort, researchers have set up an experimental Jerusalem artichoke lot and research is being carried out to develop a technology for obtaining Jerusalem artichoke liquid sugar. At a canning factory in Romania, Jerusalem artichoke is used as a raw material for obtaining a sweet, organic product, namely the jam of Jerusalem artichoke. In the manufacture of food supplements only S.C. Hofigal Export Import S.A. uses Jerusalem artichoke as raw material.

As can be seen in table 5, in Romania the Jerusalem artichoke culture is not developed to the potential of this plant. Due to the large stems, which in some varieties exceed 3 meters in height, this plant can also be successfully used to create protection curtains to protect crops more sensitive to cold winds, or to prevent evaporation of soil moisture. Stems can also be used to produce pellets for thermal plants.

Recent analysis of literature has revealed a massive interest in bakery products enriched with functional ingredients; Technological improvements have been made to develop more such products [1].

Thus, it has been studied the addition of several ingredients to improve the nutritional value of wheat flour, such as coconut meal fibers, mango skins, as a source of antioxidants [1, 7], soy proteins [17], potato skin [21], and guar gum [23].

The high content of dietary fiber, especially of inulin, makes Jerusalem artichoke tubers fit, especially for cream soups and purees. Inulin, mixed with water, creates a gel network that gives a smooth and creamy texture [6, 12]. Jerusalem artichoke tubers are commonly used in European restaurants, but their use in the food industry is limited. Tubers have the potential to become a valuable ingredient for food production. New scientific evidence about its functionality in the bakery industry will promote wider use of these tubers [2].

Taking into account these studies, Jerusalem artichoke (*Helianthus tuberosus* L.) could also be used to increase the fiber and dietary minerals content of wheat flour. Only a few studies have been conducted in this area.

Conclusions

Recent analysis of literature has revealed a massive interest in bakery products enriched with functional ingredients;

Technological improvements have been made to develop more such products. Jerusalem artichoke (Helianthus tuberosus L.) could also be

used to increase the fiber and dietary minerals content of wheat flour.

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