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THE CHARACTERISTICS OF THE PROPERTIES OF ARTICHOKE POWDER AND ITS USE IN FOODS

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In the modern world, there is a need to enrich the daily human diet with vitamins, macro- and microelements, dietary fibers, which help to normalize metabolic processes, maintain and improve health, prevent diseases, and increase immunity. One of the most effective ways to prevent diseases associated with environmental pollution, to increase immunity is the systematic inclusion in the diet of products with protective properties, the use of enriched food with plant ingredients. Diet adjustment with fortified mass-consumption foods is one of the most effective and cost-effective interventions. Plant raw materials are of great value, primarily due to the specific combination of biologically and physiologically active components. In connection with the above, the subject of research is a biologically valuable plant product - Jerusalem artichoke powder. The aim of the work was a literary study of the physicochemical composition, functional and technological properties of Jerusalem artichoke powder and its application in the food industry. Information base of the research: scientific articles, materials of international congresses and symposiums, scientific-practical conferences, normative-technical documentation, patents, etc. Jerusalem artichoke, the scientific name Helianthus tuberosus, is a perennial herbaceous plant belonging to the genus Asteraceae sunflower. It is native to North America and is cultivated in Europe, North America and Asia to supplement the shortage of food and vegetables. Jerusalem artichoke whole powder is a white powder made from fresh Jerusalem artichoke after peeling, drying and crushing. Jerusalem artichoke is rich in nutrients. Including carbohydrates is 16. 6% (78% of which is Jerusalem artichoke polysaccharide, namely inulin). In addition, it also contains a small amount of protein, crude fiber, amino acids, vitamins and many minerals. It retains a large amount of nutrients of Jerusalem artichoke. As a dietary fiber complex, it is a very ideal functional food ingredient. It has the dual effects of dietary fiber and prebiotics and has also been officially recognized. Jerusalem artichoke whole powder has good gel properties and high nutritional value, and is widely used in dairy products, bread products, fish, meat products and biscuits. This article discusses the source, characteristics and status of the use of artichoke powder and provides links to the further development and use of artichoke powder in food products.

Key words: *artichoke powder, physicochemical characteristics, food industry, application*

ХАРАКТЕРИСТИКА ВЛАСТИВОСТЕЙ ПОРОШКУ АРТИШОКУ ТА ЙОГО ВИКОРИСТАННЯ В ЇЖІ

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У сучасному світі існує потреба збагатити щоденний раціон людини вітамінами, макро- та мікроелементами, харчовими волокнами, які сприяють нормалізації обмінних процесів, підтримці та поліпшенню здоров'я, профілактиці захворювань та підвищенню імунітету. Одним з найефективніших способів профілактики захворювань, пов'язаних із забрудненням навколишнього середовища, підвищення імунітету є систематичне включення в раціон продуктів із захисними властивостями, особливо вживання їжі збагаченої рослинними інгредієнтами. Корегування раціону за допомогою збагачених продуктів масового споживання є одним з найбільш діючих та економічно ефективних заходів. Рослинна сировина має велику цінність, насамперед завдяки специфічному поєднанню біологічно та фізіологічно активних компонентів. У зв'язку з вищевикладеним, предметом дослідження було обрано біологічно цінний рослинний продукт - порошок топінамбура. Метою роботи визначено літературне дослідження фізико-хімічного складу, функціональних та технологічних властивостей порошку топінамбура і його застосування в харчовій промисловості. Інформаційна база дослідження: наукові статті, матеріали міжнародних конгресів та симпозіумів, науково-практичних конференцій, нормативно-технічна документація, патенти тощо. Топінамбур, наукова назва Helianthus tuberosus – багаторічна трав'яниста рослина, що належить до роду соняшникових сортів айстрових. Він походить з Північної Америки і культивується в Європі, Північній Америці та Азії, щоб заповнити дефіцит їжі та овочів. Порошок топінамбура – це білий порошок, виготовлений зі свіжого артишоку після очищення, сушіння та подрібнення. Топінамбур багатий на поживні речовини. Включаючи вуглеводи – 16,6% (78% з яких – це полісахарид артишоку, а саме інулін). Крім того, він також містить невелику кількість білка, клітковину, амінокислоти, вітаміни та багато мінеральних речовин. У ньому зберігається велика кількість поживних речовин артишоку. Як харчовий волокнистий комплекс, це дуже ідеальний функціональний харчовий інгредієнт. Він має подвійну дію харчових волокон та пребіотиків, а також був офіційно визнаний. Порошок топінамбура має хороші гелеві властивості та високу харчову цінність, а також широко використовується в молочних продуктах, хлібних виробах, рибі, м'ясних продуктах та печиві. У цій статті розглянуто джерело, характеристики та статус застосування порошку артишоку та наводяться посилання на подальший розвиток та застосування порошку артишоку в харчових продуктах.

Ключові слова*: порошок артишоку, фізико-хімічні характеристики, харчова промисловість, застосування*

Formulation of the problem. In the modern world, there is a need to enrich the daily human diet with vitamins, macro- and microelements, dietary fibers, which help to normalize metabolic processes, maintain and improve health, prevent diseases, and increase immunity.

Plant raw materials are of great value, primarily due to the specific combination of biologically and physiologically active components.

Meat, dairy, flour products are food products of everyday demand, the consumer properties of which are determined by the chemical composition of raw materials.

Plant raw materials, in particular, fruits and vegetables are rich in vitamins A, C, minerals and dietary fiber, which are necessary for the human body. These nutrients can promote vision and bone growth, and have prevention and adjuvant treatment for hypertension and cardiovascular disease, anemia, and colon cancer [1]. There are many factors that affect the combination of food and plant materials. The variety of fruits and vegetables, methods of their pre-processing, added forms and amounts of addition significantly affect the appearance of the product, taste, structure, nutritional value, storage capacity [2]. In general, plant raw materials that are widely used in food production are mainly carrots [3], tomatoes [4], shiitake mushrooms [5], onions [6], celery, kelp [7], etc. and rare alfalfa [8], very little fruit. Of the fruits, apples, pineapples and plums [9] have a small number of applications.

Therefore, the study of the composition, properties of vegetable raw materials and its involvement in food recipes is relevant.

Purpose and methods. The aim of the work was a literary study of the physicochemical composition, functional and technological properties of Jerusalem artichoke powder and its application in the food industry.

Information base of the research: scientific articles, materials of international congresses and symposiums, scientific-practical conferences, normative-technical documentation, patents, etc.

Results and discussion. Jerusalem artichoke, the scientific name *Helianthus tuberosus*, is a perennial herbaceous plant belonging to the genus Asteraceae sunflower. It is native to North America and is cultivated in Europe, North America and Asia to supplement the shortage of food and vegetables. Jerusalem artichoke whole powder is derived from Jerusalem artichoke, which is a white powder made by peeling, drying and crushing fresh Jerusalem artichoke. Jerusalem artichoke tubers powder contains proteins, which is very important in the production of meat products. The balance of the composition of essential amino acids of the protein contained in the supplement approaches the "ideal protein", somewhat inferior to the latter, which allows us to conclude about its high biological value. In addition, Jerusalem artichoke powder contains carbohydrates and minerals, and the presence of organic acids has also been noted. It should be noted the minimum content of lipids in the composition of the food supplement from Jerusalem artichoke powder. The general chemical composition of the powder from Jerusalem artichoke tubers is presented in table 1 [10, 11].

Table 1

General chemical composition of Jerusalem artichoke tubers powder

Indicator name	Indicator value
Mass fraction of moisture, %	4.1
Mass fraction of proteins, %	7.0
Mass fraction of carbohydrates, %	85.0
Mass fraction of fat, %	0.7
Mass fraction of minerals, %	2.94
Mass fraction of organic acids in terms of malic acid, %	0.26

A feature of the food supplement from Jerusalem artichoke tubers is the high content of dietary fiber. The presence of dietary fiber in the powder from Jerusalem artichoke tubers in combination with proteins provides a high water-absorbing and water-retaining capacity of the additive. These properties are very important for the regulation and formation of technological characteristics of complex structured food systems, which include minced meat systems. Of particular interest among the carbohydrates contained in the supplement is inulin, which is the

highest in comparison with other carbohydrates.

Inulin reduces elevated blood glucose levels in diabetics, lowers blood cholesterol levels, promotes the normal functioning of the gastrointestinal tract, improves the absorption of vitamins and minerals in the human body (especially Ca, Mg, Zn, Cu, Fe and P) [12].

Inulin has good technological characteristics. In the food industry, it can be used as a substitute for fats, humectants and thickeners. It has been widely used in fermented dairy products, quick-frozen meat products, cakes and health foods. It can not only change the rheological and texture properties of food, but also has the physiological functions of dietary fiber and biologically active precursors. Current studies have shown that Jerusalem artichoke powder, which has a relatively simple production process, can replace inulin to a certain extent [13].

The composition of Jerusalem artichoke powder contains sufficient amounts of minerals, the data presented in table 2.

Table 2

The content of minerals in powder from Jerusalem artichoke tubers

Item name	Item content
Macronutrients, mg / 100g	
Potassium	1930
Phosphorus	510
Calcium	50
Magnesium	37
Sodium	435
Trace elements, μg / 100g	
Iron	18000
Iodine	32
Selenium	118
Flints	9900
Cobalt	21
Copper	2100
Manganese	5600
Zinc	11000

Jerusalem artichoke powder is a kind of off-white, moisture-absorbing dry powder. It has gel characteristics similar to inulin. The viscosity of Jerusalem artichoke powder solution increases with the increase of its content and decreases with the increase of temperature. When the concentration reaches 10% ~ 30%, gel begins to form. When the concentration of the whole Jerusalem artichoke powder reaches 40%, the gel index is 97.8%. When the concentration of the whole Jerusalem artichoke powder reaches 45%, the gel index of the whole Jerusalem artichoke powder Is 100%. Compared with inulin, the five parameters of viscosity, elasticity, cohesiveness, chewiness and recovery are not significantly different, and the gel strength one parameter is significantly different. The content of inulin in the whole Jerusalem artichoke powder reached 73. 70 ± 3. 65%. The oil retention, water retention and freeze-thaw stability of the whole Jerusalem artichoke powder gel increased with the increase of the content. The presence of the peel, scum, protein and other substances in the whole Jerusalem artichoke powder directly affects the light transmittance of the raw materials. In the food industry, it can be used as a fat substitute, moisturizer, and thickener substitute [14].

Jerusalem artichoke contains a lot of inulin. As a functional food material, inulin has the dual effects of dietary fiber and prebiotics. Inulin is basically not decomposed or absorbed in the mouth, stomach and small intestine when consumed, and does not affect the blood glucose level and insulin content. It can also produce propionate to inhibit gluconeogenesis, reduce plasma free fatty acid levels, and promote insulin resistance. Inulin absorbs water and expands in the stomach to form a high-viscosity colloid, which makes people less likely to feel hunger and prolongs the emptying time of the stomach. It can also form complexes with proteins, fats and other substances in the small intestine to inhibit the absorption of these substances and achieve weight loss Purpose [15, 16]. At the same time, a large number of experiments have confirmed that inulin can lower serum total cholesterol and low-density lipoprotein cholesterol, increase the ratio of high-density lipoprotein/low-density lipoprotein, and improve blood lipid status [17]. Therefore, inulin has low calories and prevents obesity; regulates blood sugar without causing blood sugar fluctuations; lowers blood lipids and prevents cardiovascular and cerebrovascular diseases. In addition, inulin can also improve intestinal function, promote the growth of probiotics, and prevent cancer [18].

Inulin can also promote the absorption of minerals and the synthesis of vitamins. Inulin can greatly improve the absorption of minerals such as Ca2+, Mg2+, Zn2+, Cu2+ and Fe2+, promote the synthesis of B vitamins and folic acid, improve the body's metabolism, improve immunity and disease resistance [19].

The whole Jerusalem artichoke powder is rich in fructose. As a natural sweetener with special flavor, fructose has a sweetness of about 1.5 times that of sucrose. Because of its high osmotic pressure, good solubility, strong moisturizing properties, no crystallization, it has good properties. The food processing performance is used to replace sucrose for food processing. Fructose does not cause blood sugar rise during the metabolism process, and does not produce lactic acid, so it does not cause muscle soreness. Therefore, fructose has the ability to enhance physical exercise capacity, endurance and promote body metabolism. It can be widely used in health food and functionality food.

In addition to the advantages of fructose, oligofructose also has good corrosion resistance. It provides a superior growth environment for bifidobacteria in the intestine. It produces organic acids and carbon dioxide during metabolism, which can improve the intestinal environment. So as to inhibit the growth of harmful microorganisms in the intestine. Fructooligosaccharides are metabolized to generate vitamins that are beneficial to health, and they also generate by-products that can activate the human immune system [20]. It can be seen that oligofructose is a material that is very suitable as a base material to make health foods and dairy products. The presence of oligofructose can make health care products and dairy products more easily absorbed by the body. Jerusalem artichoke is used in health foods, functional foods, food additives, etc. It is a very common phenomenon. In the Chinese market, medicines and health products such as "bifidus factor" all use Jerusalem artichoke as the raw material. It can be seen that the use of Jerusalem artichoke It is very extensive.

The application of Jerusalem artichoke powder in food. Among different dairy products, Jerusalem artichoke powder can be used as a good fat substitute. Jerusalem artichoke powder not only changes the rheological properties, viscosity and hardness of dairy products, but also changes the taste properties of the products, making them creamy and smooth.

Studies have shown that the addition of Jerusalem artichoke is 10%, the addition of bacteria is 8%, and the addition of sucrose is 6%, the sensory evaluation score of yogurt obtained by fermentation for 5 hours is the highest. After testing, it was found that the crude fiber, Ca, Mg, Fe, Zn, Cu, vitamin B_1, and vitamin B_2 in Jerusalem artichoke yogurt are all higher than ordinary yogurt. Jerusalem artichoke powder can replace the chemical thickeners in ordinary yogurt to increase its stability, increase the stability of the yogurt gel system, and maintain the original taste and nutritional value of the yogurt [21].

Streptococcus thermophilus is considered a “generally recognized safety (GRAS)” ingredient and is widely used in the production of some important fermented dairy products, including yogurt and cheese (such as Swiss and Limburg cheese). Jerusalem artichoke whole powder has good fermentability and can be used as a carbon source for the medium of *Streptococcus thermophilus* (CICC6071). The growth of the strain is not much different from that of the glucose carbon source medium. It can replace glucose and lactose to reduce the cost of the medium. The optimal fermentation conditions are: the concentration of carbon source is 2.1%, the fermentation temperature is 45 °C, and the inoculation amount is 10%. Under these conditions, the total number of colonies of *Streptococcus thermophilus* is 4.86×108 cfu/mL. Jerusalem artichoke has good fermentation properties [22].

Prepare the dough according to the formula of 250 g flour (including Jerusalem artichoke powder 6%), 25 g dry yeast, 22.2 g white sugar, 1.5 g refined salt, 2.5 g bread additives, and appropriate amount of water. The fermentation temperature is 38~40 °C, the relative humidity is 85%~90%, the fermentation time is 2 hours, the baking temperature is 210 °C, and the baking time is 10 minutes, which can make bread with the aroma and sweetness of Jerusalem artichoke [23].

Studies on the use of Jerusalem artichoke powder to make bread show that as the dose of

Jerusalem artichoke powder increases, the color of the bread becomes darker and the taste of Jerusalem artichoke becomes more and more obvious. The dose of Jerusalem artichoke powder has no obvious influence on the moisture content of bread. Among them, the sample with Jerusalem artichoke powder content of 2% has the highest score in the sensory evaluation [23].

Experiments have shown that 5% Jerusalem artichoke powder can be used instead of 5% mechanically separated meat to make sausages, which can improve the fat-protein ratio, increase the water retention rate by 2.9%, and increase the quality of the finished product by 4.9%. Thereby increasing its nutritional value and physical properties [24]. Jerusalem artichoke powder increases the content of minerals and amino acids in sausages, and prevents the propagation of pathogenic microorganisms, so that they extend the storage time of sausages up to six days.

Adding a low concentration of Jerusalem artichoke powder to the meatballs can improve the taste and the texture will become more elastic. Meatballs made with Jerusalem artichoke powder can improve the juiciness of the meatballs because this can increase the amount of dietary fiber that retains moisture in the meatballs. For example, in Russia, L.G. Ermosh and others add 15% Jerusalem artichoke powder to semi-finished meat products to improve the protein quality of sausages, reduce fat and digestible carbohydrates, and improve the nutritional structure of meat products [24]. Scientists E. Shentsova and others studied the use of a mixture of Jerusalem artichoke powder, hawthorn and flour, which was added to the minced rabbit at a dose of 10%, forming a composite sausage, which can be used to make rabbit meat sausage with artichoke flavor and high nutritional value [25].

With the development of society and the increasing improvement of people's living standards, more and more people are beginning to pay attention to health issues, especially in food nutrition and health. In the past, high-calorie biscuits were no longer sought after and were not suitable for consumption by people with diabetes, obesity, etc. Therefore, in order to adapt to market changes and meet market demand, in recent years, low-calorie, low-fat nutrition and health biscuits have become the research focus of various biscuit companies in the world. After research, the Jerusalem artichoke whole powder, which is rich in dietary fiber, mineral elements and vitamins, is added to the biscuit to develop a new type of Jerusalem artichoke biscuit, which is in line with the current development trend of healthy baked foods and also improves the comprehensive utilization of Jerusalem artichoke value [26]. In addition, Russian scholar Firuza Rustambekova extracted natural concentrated pectin from Jerusalem artichoke, which can be used in gel food production [27].

Conclusions. Jerusalem artichoke is known as "the most representative healthy food in the 21st century". It has certain special effects on weight loss, liver protection, and the prevention and treatment of diabetes. With the development of society, people's dietary structure is constantly changing, and the number of sub-healthy people such as "three highs" and diabetes is increasing. Natural, healthy, green and nutritious Jerusalem artichoke food will surely receive more and more attention.

As mentioned above, the former scholars are more inclined to research on Jerusalem artichoke. There are few researches on Jerusalem artichoke powder, which is relatively simple in production process and has similar properties. Inulin can replace 20-50%. The whole Jerusalem artichoke powder and inulin can replace each other. The whole Jerusalem artichoke powder has broad prospects in the food industry. In particular, the use of whole Jerusalem artichoke powder to replace fat in meat products can be further studied. Jerusalem artichoke is used in meat products, especially sausages. It has a great effect, and can also give full play to its physical and chemical properties and nutritional value. It still needs to be further deepened. Even natural foods should have a thorough understanding of their impact on the human body after they enter the human body, provide scientific basis for safe consumption, protect consumers' health, and allow consumers to consume with confidence.

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