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OBTAINING THE POWDER-LIKE RAW MATERIALS WITH THE FURTHER RESEARCH INTO PROPERTIES OF EGGPLANT POWDERS

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Наведено результати досліджень з розроблення новітніх технологічних та технічних рішень для переороблення баклажанів. Запропонована технологія вирішує проблему раціонального використання баклажанів. Завдяки інфрачервоному сушінню отримуємо якісно новий продукт, що дозволяє максимально зберегти поживні речовини. Під час термічної обробки змінюються фізико-хімічні характеристики висушеного матеріалу: густина, теплоємкість, пружність, пористість, хімічний склад та інші. Тому досліджено і представлено результати досліджень властивостей порошків з баклажан. Визначенні органолептичні, фізико-хімічні та структурно-механічні показники, що дозволяють розрахувати необхідну кількість порошку, яку можна вносити в якості добавки не впливаючи на структурно-механічні властивості готового продукту. Встановлено раціональні для відновлення регідратації порошків з баклажан умови: температура в діапазоні від 45 °С до 60 °С; тривалість набрякання 10–15 хв, співвідношення порошку та рідини 1:3 і 1:4. Досліджено вміст токсичних елементів (Свинець, Кадмій, Миш'як, Мідь, Цинк) та мікробіологічні показники (мезофільні аеробні, факультативно-анаеробні, бактерії кишкових паличок, бактерії роду Сальмонела). Встановлено відповідність вимогам, що висуваються до даного виду сировини та підтверджують безпечність розроблених порошків з баклажанів. Встановлено, що розроблений харчовий порошок має низку позитивних якостей, а саме: тривалий термін зберігання, не потребує додаткових приміщень для зберігання, легко відновлюється.

Завдяки технології інфрачервоного сушіння, що є одним із методів консервування баклажанів, підвищується продуктивність технологічного процесу виготовлення порошків. Пояснюється це тим, що за однаковий проміжок часу отримуємо в двічі більше висушеного продукту порівняно з конвективними методами. Враховуючу поживну цінність баклажанів, порошки можна використовувати у різних комбінаціях для забезпечення заданих властивостей кінцевого продукту. Це дозволить скоротити час на приготування страв, розширить асортимент продукції функціонального призначення

Ключові слова: інфрачервоне сушіння, процес сушіння, овочеві порошки, порошки з баклажанів, гідромодуль, коефіцієнт набрякання, показники безпечності

1. Introduction

Nutrition is the main factor that provides human body with energy, basic structural elements, and affects functional activity. The relevant problem at present is the provision of high-quality food products with high nutritional value to people. Given the current environmental conditions, the diet should contain biologically active substances (food fibers, pectin, antioxidants, vitamins). Therefore, there is an increasing need for food products enriched with natural ingredients that can correct the deficit of micronutrients, increase the body's resistance to adverse environmental conditions.

The main source of nutrition for the body is vitamins, fruit, and berries. The search for plant raw materials with high technological properties for its use in the production of food products with the prospect of expanding the range, improvement of organoleptic, structural-mechanical, functional-technological indicators and microbiological quality indices is a relevant task.

2. Literature review and problem statement

The development of resource-saving technologies for the production of food powders from vegetable raw materials, which provides for the fully-fledged and efficient nutrition, is relevant today. The main advantage of powders is their capability to rapidly restore in liquids; the resulting purees have properties that are only slightly inferior to the initial raw materials [1].

Thus, for example, authors of [2] propose a technology for drying cabbage by a drying method with mixed heat supply at the process temperatures of 50 °C and 70 °C, whereby the resulting raw materials have better indicators than control samples manufactured industrially. Paper [3] describes a technology and reports results of research into apple drying; the authors emphasize the maximum preservation of nutrients. A group of scientists created equipment for the industrial production of various dried products and presented the developed plant-based powders [4]. Owing to the use of the newest equipment, as researchers argue, it is possible to obtain powders with high consumer characteristics [1, 4]. However, the disadvantage of all these techniques is the cumbersome equipment and a long time of dehydration.

Based on the techniques for heat supply to a product being dried, the following types of drying are distinguished: convective, contact, radiation, sublimation, dielectric [1]. The most common ones in the production of dried raw materials are the convection and contact techniques. The advantage of convective dryers is the capability to regulate the main drying parameters, to conduct the process under optimal regimes for certain types of raw materials and to obtain dried products of high quality [4]. However, the disadvantage is the large dimensions of industrial equipment, significant energy consumption during drying, long dehydration period [5, 6].

The contact drying is based on the principle of heat transfer from the heat carrier to the product through a separating wall [7]. Such a method is typically used for drying the puree-like and liquid products [7, 8]. Therefore, this technique makes it impossible to produce powders from most plant raw materials.

The promising technology is also the infrared drying, which reduces the time of raw materials dehydration compared with traditional methods [9]. Given this, the maximum preservation of the nutrient content of the dried product takes place. Accordingly, the infrared drying provides for a faster drying rate over a shorter time, which affects porosity of the structure, and that has a positive effect on rehydration.

It is important to select an effective technique for drying the plant raw materials and to study the properties of the dried products obtained.

Each type of a raw material has its own characteristics and requires the selection of rational conditions for dehydration. Given the commodity characteristics, eggplant is no exception and requires careful study and selection of rational drying conditions.

Consequently, it is important to study the characteristics of raw materials and to develop the basic technological parameters for the drying of eggplants to obtain powders. It is known that during dehydration a variety of physical-chemical changes occur in the product [1, 4], which essentially determine its quality. Therefore, the choice of the optimal drying technique is always defined by the nature of a material and the requirements to the quality of the resulting product. Quality is the principal factor, because only when using certain techniques and modes of dehydration the best results are achieved, and the obtained product has the specified characteristics. Investigating basic technological characteristics, quality indicators, would make it possible to confirm or refute the feasibility of production of eggplant powders.

3. The aim and objectives of the study

The aim of this work is the scientific substantiation of the technology for eggplant processing into powders, and research into basic technological characteristics of eggplant powders.

To accomplish the aim, the following tasks have been set:

– to study the properties of fresh raw materials;

– to identify and substantiate the basic processing operations for eggplant drying;

– to study the nutritional value of eggplant powders;

– to examine the organoleptic, physical-chemical, and safety indicators of eggplant powders.

4. Materials and methods to study fresh and dried powdered eggplants

The research was conducted during 2016–2018 at the laboratories of Kherson State University and Kherson State Agrarian University (Ukraine). Common standard research methods are used in the paper. The chemical composition was studied according to GOST 7636-85:

– mass fraction of water – by a drying method at a temperature of 100–105 °C;

– fat – by the extraction-weight method using the Soxhlet apparatus;

– protein – by determining total nitrogen applying the Kjeldahl method;

– ash – by a weight method after mineralization of the product batch in a muffle furnace at a temperature of 500–600 °C.

Quantitative changes in the macro- and microelements were determined by the atomic absorption spectrophotometry method at the device S-115PK ("NPP Akademprybor", Ukraine) using an acetylene-air mixture. The content of mineral elements was determined by the method of an X-ray fluorescence analysis at the ElvaX-Med analyzer (Elvatech, Ukraine); the calcium and phosphorus content – by the colorimetric method; the iodine content – by the inversion voltampermetry at the device AVA-1 (OOO "UkrAnalityka", Ukraine); microbiological safety indicators (BGKP, kMAFAnM, pathogenic microorganisms, mold fungi and yeasts) – in line with standard methods [10–13]; the content of solanine – by a direct weight method [14].

For the statistical reliability, all experimental studies under laboratory conditions were performed five times. The data obtained are represented in units of the international SI system.

The content of dry soluble substances, sugars, including invert sugar and sucrose, is determined in the eggplant fruits of the Diamond variety. Selection and preparation of samples for analysis were conducted in accordance with DSTU.

5. Results of research into technological properties of the developed powders from eggplants

5. 1. Research into properties of fresh eggplants

Based on food and taste properties, eggplants are a quite valuable raw material. The benefits of eggplants are: the low calorie content; diuretic properties; the capability to normalize work of the heart; the presence of substances purifying the blood vessels from cholesterol; the content of compounds that improve the condition of the joints. According to research results, the eggplant fruits contain: proteins, carbohydrates and insignificant amounts of fats, vitamins (nicotinic acid (B5), thiamine (B1), riboflavin (B2), carotenoids). Carbohydrates are represented by monosomes (glucose, fructose), oligosaccharides (sucrose) and polysaccharides (starch, pectin, fiber). In addition, the fruits of eggplant are rich in mineral salts of phosphorus, calcium, potassium, manganese, magnesium, iron, aluminum. Of particularly large percent is the proportion of potassium salts. The content of ascorbic acid varies from 0.89 to 19.0 mg per 100 g of raw weight, depending on the variety and the region of cultivation [15–20].

The chemical composition of the eggplants grown in the south of Ukraine, namely, in the Kherson oblast (Bilozersky, Tsyurupinsky, Berislavsky regions) was investigated for determining the prospect of the raw material and the dependence of its value on soil (Table 1). This territory is characterized by temperate continental climate and is a leader in growing various crops, especially melons (watermelons, melons) and pastels (tomatoes, eggplants, vegetable pepper).

Despite the different chemical composition of soil, the indicators of the examined samples were almost the same, which is predetermined by the use of various fertilizers that are introduced in order to receive large harvests. Surveys of trade representatives and suppliers of agricultural products revealed that the share of products from Tsyurupinsky region is the largest. Therefore, in the further research, we selected samples from this area.

At first glance, eggplant is a product with a low content of essential substances, however, the in-depth studies indicate its value. For example, eggplant contains three groups of carbohydrates (g/100 g): monosaccharides (glucose – 3, fructose – 0.8), oligosaccharides (disaccharides: sucrose – 0.4), homopolysaccharides (starch – 0.9, fiber – 0.13, pectin substances – 0.14), heteropolysaccharides – mucopolysaccharides, whose basis is amino sugar and galacturonic acid. It is important to take into consideration the impact of carbohydrates on the human body; to this end, we determine the glycemic index (GI), which is the conditional value of the rate of cleavage of any carbohydrate-containing product in the human body compared with the rate of glucose splitting. This is a measure of the effect of food on the level of sugar in the blood, namely, the speed at which glucose penetrates the blood. The glycemic index reflects the ratio of glucose concentration in blood after 3...4 hours after consuming 100 g of the studied food product and the level of this indicator after consuming 100 g of white bread. This indicator is affected by: the high content of sweet carbohydrates in a product, the duration of heat treatment, and so on. The lower the glycemic index, the slower the digestion of carbohydrates. The glycemic index of eggplants is 20, hence it is a product with its low content [21]. It is known that products with a low GI are more useful to the body. Products with GI lower than 35 contribute to the effective reduction of body weight. Thus, eggplants can be recommended for eating during the day.

Table 1

Chemical composition of fresh eggplant (“Diamond” variety, crop 2017)

Indicator	Bilozerskiy region	Tsyurupinskiy region	Berislavskiy region
Water, g	91	91	91
Protein, g	1.2	1.2	1.2
Fat, g	0.1	0.1	0.1
Carbohydrates, incl:	4.5	4.8	5.1
– sucrose, g	0.4	0.4	0.4
– glucose, g	2.4	2.9	3
– fructose, g	0.8	0.7	0.8
– starch, g	0.9	0.8	0.9
Food fibers, g	2.5	2.4	2.5
Vitamins, mg/100 g			
Nicotinic acid	0.6	0.6	0.7
Beta-carotene	0.01	0.01	0.01
Acetylsalicylic acid	5	4.5	5.5
Tocopherol	0.1	0.1	0.1
Thiamine	0.04	0.04	0.04
Riboflavin	0.05	0.05	0.05
Niacin	0.8	0.8	0.8
Macroelements, mg/100 g			
Potassium	238	235	245
Calcium	15	15	16
Magnesium	9	9	10
Sodium	7	6	6
Phosphorus	34	35	35
Chlorine	47	46	46
Sulphur	15	14	15
Microelements, mg/100 g			
Iron	0.4	0.4	0.4
Zinc	0.29	0.29	0.29
Copper	0.14	0.14	0.14
Manganese	0.21	0.21	0.21

5. 2. Determining and substantiation of basic technological operations

Earlier research has established that processing and consumption utilized whole fruits of technical maturity without defects. That is why a significant proportion of defective raw materials is not sold and is left rotting in fields and landfills. As a result, there is a need to search for potential ways to process eggplants, even in the presence of defects.

The development of new resource-saving technologies resolves the problems related to the rational use of raw materials. That has not only the scientific but also a social aspect, as it forms the scientific basis for rational nutrition and thus improves the quality of life.

Drying is one of the canning techniques, so creating new food powders is a relevant task. There are many types of drying of vegetable raw materials: sublimation with the use of cryo-destruction, convective, conductive, high-frequency, dielectric, infra-red, etc. An analysis of the scientific literature has revealed various techniques for eggplant drying, developed for snacks and investigated in [9, 22], but no technology for obtaining the powders has been identified. In this context, we compared the basic technological operations (Table 2).

Table 2

Basic technological operations in eggplant drying

No.	Basic operations		
	Classical technology [9]	Prototype technology [22]	Developed technology
1	Raw material preparation, eggplant slicing into strips with a thickness of 2–3 mm	Raw material preparation, slicing eggplant in longitudinal strips of 6–8 cm in length, with a thickness of 2–3 mm	Raw material preparation, slicing eggplants into strips with a thickness of 3–5 mm
2	Pickling and aging for 10–20 min	Preparation of a 1 % salt solution with ascorbic acid	Preparation of a 1 % salt solution with citrine acid and bringing the solution to boiling
3	Washing	Aging the sliced eggplant for 20 minutes	Aging the sliced eggplant in a hot solution for 5–10 min
4	Drying at convective driers at a temperature of 40–70 °C to a 14 % humidity	Moisture removal and washing	Moisture removal
5	–	Aging in blending juices for 30 min	Drying at infrared drier at a temperature of 50–60 °C, to a 10 % humidity
6	–	Drying at a convective drier at a temperature of 70 °C during 10 min and then at a temperature of 55 °C during 5 hours	Grinding the dried eggplant into powders
7	–	–	Sieving

The proposed technology makes it possible to obtain a dried semi-finished product from eggplant, which is not inferior in its organoleptic indicators to prototypes. This, in turn, makes it possible to obtain a high-quality powder (Fig. 1).

a *b*

Fig. 1. Products of eggplant processing: *a* — dried eggplant, *b* — eggplant powder

5. 3. Study into nutritional value of eggplant powder

Drying of eggplants at infrared dryers makes it possible to maximally retain their nutrient substances.

The mineral composition of eggplant powders on average increases by 2.5–3.0 times, dominated by, mg/100g: calcium (48.5±2.0), potassium (740.4±2.0), iron (1.7±0.5), phosphorus (98.80±1.5), magnesium (26.18±2.0). All these elements are an integral part of the bone tissue, they have radiation protective and anti-anemic properties, and, therefore, are vital to humans.

The amount of vitamins of group B (B1 and B_2), PP increases by more than 10 times and is, mg/100 g: thiamine B_1 – 0.40±0.01; riboflavin B_2 – 0.5±0.06; nicotinic acid PP – 5.22±0.10.

Eggplant powders are an additional source of vitamins, which is especially important for regulating the metabolism and improving the resistance of the body to various negative environmental factors.

Vitamins are part of the enzymes that provide important metabolic processes in the body. Water-soluble vitamins of eggplant powders (PP, B_1, B_2) promote cellular metabolism.

As a summary, it can be argued that the elevated level of mineral elements, B group vitamins, niacin, in eggplant powders will contribute to the overall strengthening of the body and will enhance the protective effect of the immune system. That in turn improves resistance of the organism to adverse environmental factors.

It is evident that the addition of eggplant powders as a food additive will result in the formation of the corresponding consistency, color, flavor, and taste in the finished products. Therefore, special attention should be paid to studying the quality indicators and basic technological properties of powders.

5. 4. Study into organoleptic, physical-chemical and safety properties of eggplant powders

Basic organoleptic indicators of the functional eggplant powders are given in Table 3.

Table 3

Organoleptic parameters of functional powders

Indicator	Powder characteristics
Physical appearance	Powder-like mixture, homogeneous, without foreign impurities, the presence of easily soluble lumps is allowed
Consistency	Homogeneous
Dispersity	< 0.5 mm
Color	From light brown to brown
Aroma	Characteristic of this dry raw material, without foreign odors
Taste	Taste of dry raw material without foreign impurities

In terms of the content of toxic elements, the eggplant powder must meet the requirements specified in Table 4.

Table 4

Toxic elements content in eggplant powders

Indicator name	Acceptable level, mg/kg, not exceeding	Eggplant powders	Control method
Lead	0.5	0.1±0.02	GOST 26932
Cadmium	0.03	Not found	GOST 26933
Arsenic	0.2	Not found	GOST 26930
Copper	5.0	0.16	GOST 26931
Zinc	10.0	2.04	GOST 26934

In terms of microbiological indicators, eggplant powder must meet the requirements specified in Table 5.

Table 5

Microbiological indicators of eggplant powders

Indicator	Standard	Eggplant powders	Control method
Number of mesophilic aerobic and facultative-anaerobic microorganisms, CFU/g, not exceeding	5.0x104	<1.0·101	GOST 10444-15
Escherichia sticks (coliforms), per 0.1 g of product	Not permitted	Not found	GOST 26972
Pathogenic microorganisms, including bacteria of the genus Salmonella, per 25 g of product	Not permitted	Not found	GOST 9958

It is known that powders can be introduced to a formulation both in the dry and in the restored form [4]. However, to obtain products with high quality indicators, it is better to use the hydrated powder.

During experiment we investigated the samples in which a constant mass of powders was combined with a different amount of water in the ratios of 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, the swelling term is 5, 10, 15, 20, 30 minutes. Before using in a formulation of food compositions, eggplant powders were sieved in order to prevent lumps and foreign impurities from entering the finished meals.

In order to qualitatively evaluate the restored eggplant powder in the prepared samples, the rheological indicators (viscosity, fluidity, dynamic fluidity limit) were determined depending on the hydro module and duration of swelling, taking into consideration that puree is a disperse system [21, 23].

At the ratio of powders to water 1:1, the dynamic viscosity of the restored powder is quite high – 18.4 Pa*s, which is 26 % larger than the dynamic viscosity of control sample. An increase in the hydro module to 1:3 brings the dynamic viscosity of the restored powders closer to the indicators of fresh eggplant puree. Consequently, the dynamic viscosity of the restored powder is 6 % less than that of control at a 1:3 hydro module.

With the further increase in hydro module to 1:5 and 1:6, the dynamic viscosity indicator reduces by 35.8 % and 60.9 %, respectively. Similar changes occur to other rheological indicators of the restored powders.

To obtain a puree from eggplant powder, the powders were restored in the interval of 5 to 30 minutes.

The highest level of swelling factor is observed at the hydro module values from 1:3 to 1:4. The further increase in the ratio of powder to water does not lead to a significant swelling of the powder, which remains unchanged.

Important for the restoring of powders is the temperature of water taken for hydration. A significant increase in the capability to rehydrate in powders is observed at temperatures from 45 °C to 60 °C; the further increase in the water temperature leaves it almost unchanged. An analysis of the results obtained has showed that the swelling coefficient of eggplant powders at a temperature of 20 °C in experiments with the same restoration duration tends to increase with an increase in the ratio of water to powder.

At a ratio of powder to water 1: 2, the swelling factor was 2.7 %, while at 1:4 and 1:5, it was 3.8 %.

With an increase in the temperature to 40 °C and 60 °C, the same pattern is observed. Namely, at 1:2 – 3.5 % and 3.8 %, and at 1:5 – 4.1 % and 4.7 %.

Equally important is the indicator of the content of dry dissolved substances in the liquid remaining after centrifugation of the restored powder.

As a result of hydrothermal treatment of powders, the quantity of dry dissolved substances is also increased. This is confirmed by data from the scientific literature on that the pectin substances and hemicelluloses, which are part of cell walls, undergo destruction with the formation of soluble substances.

In the process of industrial processing and as a result of technological operations, the restored powders accumulate plant pectin in the system beyond the cells [24]. The result of the restoration is the formation of gel, which gives the puree made from eggplant powder the appropriate consistency.

With an increase in the duration of rehydration from 5 minutes to 30 minutes and at an increase in water temperature to 60 °C, the water-retaining capability of the puree made from eggplant powder increases, which indicates the ability of the restored powder to retain moisture after centrifugation. When the temperature of water for restoration rises to 80 °C, the capability of powders to retain moisture decreases.

Similar changes occur to other rheological indicators. During the first 10 minutes of heat treatment, fluidity increases by 5.5 %, and over a heat treatment time of 20 and 30 minutes – by 7.8 and 9.3 %.

The difference in the plastic viscosity of the samples is apparently explained by the elevated content of soluble pectin in compositions in the first 10 minutes of heat treatment.

The restoration of powders results in the extraction of soluble substances, mainly due to diffusion. In all cases, the loss of soluble substances reaches a maximum in 10–15 minutes. The further increase in the duration of rehydration to 30 minutes or longer causes a decrease in water absorption capacity; it becomes the same as it was at the beginning of the process.

During study, it was found that viscosity of the restored powders increases with increasing temperature and reaches its maximum value under temperature regimes from 45 °C to 60 °C and at a 1:3 hydro module.

The lower the hydro module, the higher the temperature that is required so that the viscosity of the restored powder approaches its maximum value.

The duration of rehydration, that is, the time required for the restoration of powders, is also one of the main components. Since viscosity reaches its maximum value in the range from 45 °C to 60 °C, in order to study the effect of the duration of swelling on restoration of of eggplant powders, these very samples were taken, with hydro modules of 1:3, 1:4, 1:5, 1:6. Restoration was conducted over 5–30 minutes [23].

It was established that an increase in viscosity is observed over the first 10–15 minutes. With an increase in the duration of swelling to 30 minutes, the viscosity of the obtained puree is not changed significantly.

Consequently, according to the research results, it was established that the rational temperature for restoring the eggplant powders is the temperature in the range of 45 °C to 60 °C with a swelling time of about 10 to 15 minutes, at a ratio of powder to liquids of 1:3 and 1:4.

The powders developed have a number of positive qualities compared with fresh raw materials. The most important is that due to technological operations, the removal of harmful ingredients (solanine) was achieved and the concentration of functional ingredients did occur. It is important that the shelf life is 12 months and there is no need for additional storage space. Powders take up little space and are easily transported. Owing to its good restorative properties, dried eggplant can be used in various combinations to provide for the desired properties of the resulting product. That would reduce the time for cooking, expand the range of functional products.

6. Discussion of results of studying the eggplant powders quality

Eggplant is a product that is rich in solanine, which has a harmful effect on the body. Therefore, it is important to maximally remove it from the raw product. According to the classical technology there is an uneven treatment of eggplant with salt and as a result we obtain products with a high content of solanine and of dark color. Given this, the optimal treatment of raw materials is by applying a solution of salt, while adding citric acid will maintain a bright color. Treatment with a hot solution makes it possible to maximally accelerate the removal of solanine from the fruits of eggplant. The aging of eggplants in boiling water for 10 minutes can deactivate most enzymes. It is important to note that the vegetative forms of microorganisms are killed, which ensures the sanitary-hygienic safety of food powders during storage. Drying at temperatures up to 60 °C makes it possible to maximally retain the vitamin content of the finished product.

To determine the more rational technology, the examined samples were dried at convective and infrared dryers in the same temperature range. According to data obtained, when drying the fruits treated with a hot solution of salt with the addition of citric acid, duration of the product dehydration, compared with the cold solution, decreases by 10 %. It is important to note that when drying at an infrared dryer, the dehydration time of the product decreased by 50 %. This is explained by the fact that at the expense of infrared radiation the heating of all zones is achieved simultaneously. During drying, the structure of eggplants is retained and there is complete sterilization, namely, the destruction of all microorganisms, while preserving the useful properties of the product that is dried. Thus, it is established that this technique makes it possible to more efficiently utilize energy resources and maximize the nutrient content.

The applied technology of infrared eggplant drying has a number of advantages compared to convective and make it possible to obtain a quality product in a shorter time. The proposed drying technology ensures better quality in the dehydration of raw materials, while relatively low temperatures (50–60 ºC) helps maximally retain vitamins and microelements.

Compliance with these conditions makes it possible to obtain a high-quality product with high consumer characteristics.

An important indicator of the quality of powders is the dispersity; for the developed eggplant powders, it is less than 0.5 mm. The obtained powders have the organoleptic properties that allow using them in a wide range of culinary products and meals as an additive to the formulations of compositions. The resulting dispersity of powders can be used for a variety of food systems. The restored eggplant powder has the taste and color of the original raw material, indicating its high quality (Table 3).

The eggplants, dried in this way, satisfy the safety requirements for food products in terms of the content of toxic elements (Table 4) and microbiological indicators (Table 5).

Particular attention should be paid to the technological properties of eggplant powders. An important factor affecting the quality of products when designing new formulations is studying the technological properties. Compliance with conditions for the rehydration of dried raw materials will minimize the loss of nutrients during restoration of powders. The most optimal for restoration is the temperature in the range from 45 °C to 60 °C with a duration of swelling about 10–15 minutes, at a ratio of powder to liquid of 1:3 and 1:4. These parameters will make it possible to obtain quality products with high technological indicators.

The prospect for the further research is to determine the ways for the further use of eggplant powders and to create new meals with the predefined properties to normalize the activities of the human body. Determining and studying the impact on the structural-mechanical properties and the chemical composition of the developed products define the direction of further research.

7. Conclusions

1. It was established that eggplants are a low-calorie raw material containing: proteins – 1.2 g, fats – 0.1 g, carbohydrates – 4.8 g. In addition, the fruits of eggplant contain the necessary mineral salts of: phosphorus (35 mg/100 g), calcium (15 mg/100 g), potassium (235 mg/100 g), manganese (0.21 mg/100 g), magnesium (9 mg/100 g), iron (0.4 mg/100 g). The glycemic index of eggplants is 20, which indicates a product with its low content.

2. The technology of eggplant powder production has been developed. The difference from the prototype is that during preparation of eggplant, its processing and aging last for 10 minutes in a 1 % salt hot solution, with citric acid. The use of infrared drying reduces the time of the product dehydration, compared to convective, by 50 %. This technique made it possible, by aging the eggplants in boiling water for

10 minutes, to deactivate most of the enzymes, retain the light color, reduce the drying time by 50 %, compared to the convective drying, and obtain a high-quality eggplant powder at a temperature of 50–60 ºC.

3. The drying of eggplants at infrared dryers makes it possible to maximally retain nutrients. The mineral composition of eggplant powders is, mg/100 g: calcium (48.5±2.0), potassium (740.4±2.0), iron (1.7±0.5), phosphorus (98.80±1.5), magnesium (26.18±2.0). All these elements are an integral part of the bone tissue, they have radiation-protective and anti-anemic properties, and, therefore, they are vital to humans. The amount of vitamins is, mg/100 g: thiamine B_1 – 0.40±0.01; riboflavin B_2 – 0.5±0.06; nicotinic acid PP – 5.22± 0.10.

4. According to the organoleptic indicators, eggplant powders are a homogeneous powder-like mixture, of light brown to brown color, with a dispersity of up to 0.5 mm. In terms of the content of toxic elements and microbiological indicators, the eggplant powder meets the requirements for this type of a raw material. It was established that the optimal conditions for restoring the eggplant powders are a temperature in the range from 45 °C to 60 °C with a swelling time of about 10–15 minutes, at a ratio of the powder to liquids of 1:3 and 1:4.

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