The study of physalis varieties for pickling purposes

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Abstract. Physalis is a rare vegetable crop. Its fruits have high palatability and are characterized by a rich biochemical composition. They contain sugars, organic acids, macro- and microelements, ascorbic acid and other vitamins. The fruits of physalis contain pectin, which has a beneficial effect on the human body, removing radionuclides and salts of heavy metals. Three varieties of physalis were studied. The main selection criteria were taste, yield, chemical composition and suitability for growing in the Central Chernozem region. According to the results, the Korolek variety retains high organoleptic and nutritional properties after pickling.

1. Introduction

In the Russian Federation, the development strategy for the food production industry for the period up to 2020 is aimed at providing the population with high-quality food products for ensuring a balanced diet at the level of physiologically recommended consumption standards.

The fruit and vegetable industry, along with other food industries, is one of the main sectors of the national economy; it plays an important role in supplying food products containing required components, minerals and vitamins. [8]

Processed fruit and vegetable products make it possible to smooth out seasonal fluctuations in the consumption of fruits and vegetables, increase or decrease the calorie content of food products, and increase the nutritional value and digestibility of processed products. The food industry focuses on expanding the range of food products, including canned ones, using new types of raw materials and developing new non-traditional production technologies.

Given the current economic situation, it should be assumed that large industrial enterprises will continue to be the basis for processing fruit and vegetables. In order to overcome the unfavorable trends, it would be necessary to recognize all large enterprises as monopolists providing services for processing fruit and vegetables and apply antitrust laws to their activities. The conceptual basis for regulating the production of final fruit and vegetable products should be the development of an effective mechanism of state and municipal regulation. The integrated approach involves the distribution of sales revenues between agricultural, processing and trading enterprises.

The fruit and vegetable canning industry is one of the main sectors of the food industry that can significantly reduce the loss of agricultural products and improve the food supply of the population. [9, 12]

Canning production involves the use of the most diverse and very unstable raw materials of plant origin. The multicomponent and wide assortment of canned products, strict requirements for their
quality and sterility, as well as the desire to preserve initial properties of the original products complicate the task. In recent years, a number of important measures have been taken to develop the raw material base of the fruit and vegetable canning industry: the priority national project “Development of the agricultural sector” has been implemented, the Federal Law “On the Development of Agriculture” has entered into force; in accordance with this law, the State Program for the Development of Agriculture and regulation of agricultural markets, raw materials and food has been developed.

In 2020 (compared with 2015), the production of canned fruit and berries will increase 1.6-1.7 times with an average annual growth rate of 4.3-5.5%. The capacity utilization rate will reach 85%. The projected production volumes of canned fruit and vegetables will allow (taking into account permissible imports) for improving the nutrition of the population in accordance with rational norms and solve the main tasks identified by the Food Security Doctrine of the Russian Federation. [7, 9, 11]

One of the most common methods is pickling. This is one of the ways of preserving food raw materials based on the action of acetic acid which suppresses the vital activity of many pathogenic microorganisms. [1,2]

Physalis vulgaris (Physalis alkekengi) is a cross-pollinated herbaceous plant, a species of the genus Physalis (Physalis) of the nightshade family. Physalis is a perennial herbaceous rhizome plant up to 90 cm high. Annually it forms new, angular, slightly curved erect, bare or slightly pubescent shoots. At the base, the stems become lignified. It has a powerful, branched root system with numerous creeping hard processes. It grows in width. The leaves are light green, oppositely located, oval, serrated along the edge.

The flowers are solitary, develop in the axils of the leaves along the entire length of the shoots, five-lobed, orange, red or green.

The fruit is a fleshy, two-nest rounded berry with a sticky oily surface weighing 15-100 g. In a ripe form, the color is light yellow, green or purple. Seeds are very small, lenticular in shape, smooth, light or dark brown. They retain viability for four years. The fruits are covered with sepals forming a cup with triangular denticles. After flowering, the cup that encloses the fruit grows into a wrapper that protects the fruit.

The fruits of physalis glutinous or vegetable (Physalis ixocarpa Brot.), Pubescent, strawberry (Physalis pubescens L.) and Peruvian (Physalis peruviana L.) are consumed. In the Central Chernozem region of Russia, physalis vegetable is the most common.

Physalis vegetable is the most cold-resistant culture. Its shoots can withstand temperatures down to -3°C. The culture is photophilous, drought resistant, loves light organic soil; it is not damaged by the Colorado potato beetle and late blight.

Its beneficial properties are due to the unusual chemical composition. It contains various types of active substances, including saponins, flavonoids, polyphenols, tannin, cryptoxanin, vitamin C, citric acid, as well as the natural constituents of palmitic and stearic acids.

Physalis fruits contain: solids - 10%, sugar - 4.5%, fiber - 2%, organic acids (citric, malic, tartaric and succinic) - 0.7-1.4%, 45-100 mg of ascorbic acid, 0.1 g of carotene, 0.45 g of pectin and other gelling substances, minerals, and protein- 2.5%.

In addition, physalis fruits are an excellent natural alternative to multivitamin preparations. Physalis contains beta-carotene, alpha-carotene, E and K. Of the water-soluble vitamins, it contains vitamins C, B1, B2, B3 (PP), B4, B5, B6 and B9.
The mineral composition of physalis is as follows: salts of calcium, sodium, magnesium, phosphorus, potassium, etc. The calorie content in 100 g of a physalis fruit is 32.

The unique chemical composition of fruits, high and stable crop yields in the conditions of the Central Chernozem Region make it possible to grow and process physalis in order to obtain a finished product with high nutritional and taste qualities. [5,12]

2. Materials and methods
The studies were carried out in the conditions of the Department of Technology for storage and processing of agricultural products and the laboratory of biological analyzes of Voronezh State Agrarian University using the generally accepted methods. The object was 3 varieties of physalis - Confectioner, Jam and Korolek.

When studying the chemical composition of fruits of fresh and pickled physalis, the following methods were used: mass fraction of moisture - GOST 28561-90; crude ash - GOST 26226-95, titratable acidity - GOST ISO 750-2013, total sugars - GOST-32167-2013; the mass fraction of vitamin C - GOST 24556-89; the mass fraction of phosphorus - GOST 26657-97, calcium - GOST 26570-95 [3,4].

3. Results and Discussion
The selection of physalis varieties in the conditions of the Central Chernozem Region is determined by high productivity, good taste and suitability for pickling (Fig. 1).

Jam. It is included in the State Register of the Russian Federation for cultivation in open ground and under film shelters. Mexican variety. It is recommended for canning, pickling, producing jam. Mid-season ripening. Fruit ripening occurs on the 120-130 days after full germination. The plant is tall. The leaf is green, large. The first flower is located over the 6th knot, the next one - in the bosom of each leaf. The flower is orange. The fruit is flat-round, the color of the unripe fruit is light green, the ripe fruit is cream. The mass is 25-40 g. It is grown without growth regulators. Shade resistant.

Confectioner. The variety was selected by the All-Russian Research Institute of Selection and Seed Production of Vegetable Crops. It is approved for use throughout the Russian Federation in 1990. It is recommended for cultivation in open ground; it is resistant to short-term frosts.

The variety is presented by non-standard, determinant, semi-spreading plants, 60-80 cm high, moderately branched.

The leaf is light green, of a elongated ovoid shape, glossy, smooth, slightly corrugated, without stipules. Single flowers are 10x18 mm in size. Pedicel has no articulation.

The fruit is flat-rounded, light green; in its biological ripeness, it is yellow. The skin is covered with a slightly sticky substance. The base of the fruit is flat, the top is smooth. The nest is weakly expressed. The number of sockets is 4-5. The mass of one fruit is 28-41 g. The fruits have good taste.

It is a mid-early variety. The period from full germination to the ripening is 116 days. Fruits are stored for 2-3 months not losing quality characteristics.

The variety is resistant to bacterial rot.

Korolek. It is included in the State Register for the Russian Federation for cultivation in open ground (winter or early spring sowing in the ground or using seedlings). It is recommended for garden plots, home gardens and small farms for preparing jam, candied fruit, dry wine, as well as for pickling).

Early ripe. The physalis ripens on the 90-95 days after full germination. The plant is non-stamped, determinant, upright, medium-branched and medium-leafy, 60-80 cm high. The leaf is obovate, medium-sized, light green, smooth, without stipules. The bookmark of the first flower is low.

The fruit is round, dense. The color is light green and green, the color of the ripe fruit is light yellow and yellow. The fruit weight is 60-90 g. The taste of fresh fruits is sweet and sour. The dry matter content is 6-9%, the content of pectin substances is 14%. Productivity is 5 kg per one plant.

The variety value: early ripening, large weight of fruits, high content of pectin substances, cold resistance.
The varieties of physalis were grown on three plots of 5 m$^2$ each. The yield of physalis was as follows:
1. Confectioner - 3.9 kg / m$^2$;
2. Jam - 3.5 kg / m$^2$;
3. Korolek - 4.2 kg / m$^2$.

The highest yield of physalis fruits was observed in Korolek - 20.0% higher compared to Jam variety, and 7.7% - compared to Confectioner variety.

Physalis was marinated according to the technological instructions in laboratory conditions based on the recipe for slightly acidic marinades which involves the use of a marinade filling, consisting of vinegar extracts of spices (cinnamon, cloves, bay leaves, allspice), salt, sugar and water.

The pickling process included the following technological stages: washing $\rightarrow$ blanching $\rightarrow$ putting into a glass jar $\rightarrow$ marinade preparation $\rightarrow$ pouring the marinade $\rightarrow$ locking the cans with varnished lids $\rightarrow$ sterilization $\rightarrow$ holding [6.10]

The inspection was carried out in order to remove unsuitable fruits (immature, overripe, damaged). Waxing was removed from the surface by blanching or scalding the fruits with hot water at 90 °C for 5 minutes. When packing in containers, the following ratios were observed: 60% of the fruit and 40% of the marinade filling. Sterilization was carried out at 100 °C for 20 minutes. The exposure time of the finished product is 1 month.

Before pickling, the main physicochemical parameters were determined. The results are presented in Table 1

| Indicator                  | Confectioner | Variety | Korolek |
|----------------------------|--------------|---------|---------|
| Mass, g                    | 44.2         | 43.5    | 91.5    |
| Dry matter content, %      | 9.62         | 7.47    | 10.83   |
| Acidity, %                 | 2.2          | 4.9     | 2.6     |
| Pectin content, %          | 2.8          | 1.7     | 8.7     |
| Phosphorus content, mg %   | 61.5         | 38.3    | 33.9    |
| Calcium content, mg %      | 52.4         | 34.4    | 64.0    |
| Vitamin C content, mg %    | 13.2         | 11.1    | 15.9    |

Table 1 shows that Korolek is the best variety by all the indicators. The pectin content is more than 3 times higher than in Confectioner variety, and more than 5 times higher than in Jam variety. Pectin has
antioxidant properties and is able to bind and remove radionuclides and salts of heavy metals from the human body.

The average weight of Korolek fruits is more than 2 times the mass of the fruits of other varieties. According to the content of solids and vitamin C, the difference is less significant; however, Korolek fruits are leaders. Vitamin C is one of the vital biologically active substances which participates in redox processes that positively affect the nervous system, increase the resistance of the human body to adverse environmental influences. With a lack of this micronutrient, metabolism is impaired and permeability of the capillary vessels increases. Therefore, the presence of ascorbic acid in food increases the resistance to various diseases and strengthens capillaries.

The highest acid content was observed in Jam fruits.

Table 2. Qualitative indicators of pickled physalis

| Indicator                        | Confectioner | Jam  | Korolek |
|----------------------------------|--------------|------|---------|
| Dry matter content, %            | 8,11         | 6,23 | 9,36    |
| Acidity, %                       | 4,8          | 5,4  | 5,0     |
| Pectin content, %                | 2,1          | 0,9  | 7,7     |
| Phosphorus content, mg%          | 52,5         | 30,8 | 26,6    |
| Calcium content, mg%             | 14,5         | 27,0 | 46,7    |
| Vitamin C content, mg%           | 0,9          | 0,9  | 3,1     |

In all varieties of physalis, there was a decrease in the content of the main indicators, with the exception of acidity due to the use of acetic acid.

4. Conclusion

The study of technical indicators of physalis allowed us to distinguish the productive and large-fruited variety (Korolek) with an average fruit mass of more than 90 g.

The marinade from Korolek fruits is characterized by a high content of solids, pectin, vitamin C and has a good taste.

Vegetable processing canneries can use Korolek fruits as a raw material for the production of slightly acid pickles.

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