New production technology for healthy nutrition using local raw materials

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Abstract. The article deals with the issue of efficient processing of local plant materials. The possibility of using the pulp of Michurinskaya pumpkin grown in Belgorod region for producing candied fruit is discussed. The product is characterized by high organoleptic characteristics. Results of the physical and chemical studies and microbiological analysis are consistent with the standardized indicators. The functional properties of the candied fruit were identified and described.

1 Introduction

The production of candied fruit from local vegetables which are cheaper and more affordable raw materials than fruit and berry products in many regions of the Russian Federation is of interest. Candied fruit belongs to fruit and berry confectionery products. They are in high demand due to preventive and therapeutic properties.

In the face of changes in the labor organization and everyday life, aggressive environmental impacts and socio-economic factors influencing the health of the population, the role of new generation foods is increasing. They provide the body with substances for growth and active life and stimulate its protective functions [1-4].

In the candied fruit production industry, the use of pumpkin fruit is promising. The vegetable is widely used in diet and baby food. Regular consumption of pumpkin helps to normalize metabolism and remove toxins from the body. Besides, it accumulates a large amount of pectin substances which increases the beneficial properties of candied fruit [5].

The climatic conditions of Belgorod region are favorable for growing vegetables. In 2018, the gross yield of vegetables grown on fields and under cover amounted to 2,596.4 thousand center's, which is 6.5 % more than in 2017 (in 2017, it was 2,438.7 thousand centners), or 10.6 % of vegetable production in the Central Federal District (24,383.0 thousand centners) and 1.8 % – in the Russian Federation (136,852.8 thousand centners).

Vegetables are produced by households – 65.4 %, agricultural organizations – 31 %, peasant (farmer) enterprises, including individual entrepreneurs – 3.6 %.

In 2018, the gross yield of vegetables increased compared to 2017: in households – by 0.8 % (or by 12.7 thousand centners), in agricultural organizations – by 24.1 % (or by 156.1 thousand c.). At the same time, the indicator decreased by 10.5 % (or by 11.07 thousand centners) in peasant enterprises

As for the types of vegetables, the largest indicator belonged to tomatoes – 488.1 thousand centners and cucumbers – 461.6 thousand centners. Cabbage ranked third with an indicator of 406.7 thousand centners. The gross of pumpkin was 123.9 thousand centners, or 5 %, from the total gross yield of vegetables grown in Belgorod region (Fig. 1).

In 2018, the gross yield of pumpkin in farms of all categories increased by 33.2 thousand centners, or 36.7 % (in 2017 – 90.6 thousand centners).

Pumpkin production amounted to 10.4 % of the gross yield of vegetables grown in the Central Federal District (1,186.4 thousand centners) and 1.9 % in the Russian Federation (6,300.1 thousand centners). Among the regions of the Central Federal District, Belgorod region (123.9 thousand centners) ranked third, Voronezh region ranked first (536.6 thousand centners) and Lipetsk region ranked second (151.0 thousand c.) with a yield of 119.8 c/ha (Fig. 2).

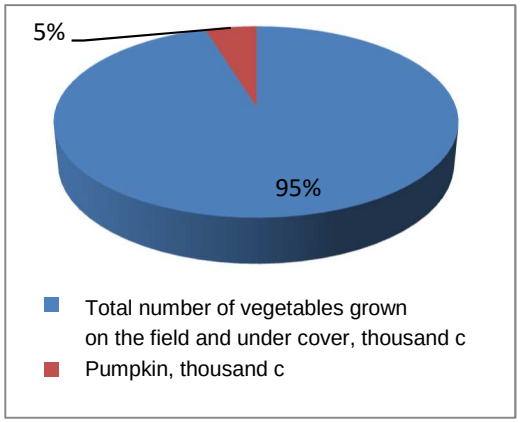

Fig. 1. The share of pumpkins in the production of vegetables grown under cover and on the field in Belgorod region (2018)

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The main share pumpkin fruit was produced by households (99.9 %). The remaining 0.1 % were produced by agricultural organizations.

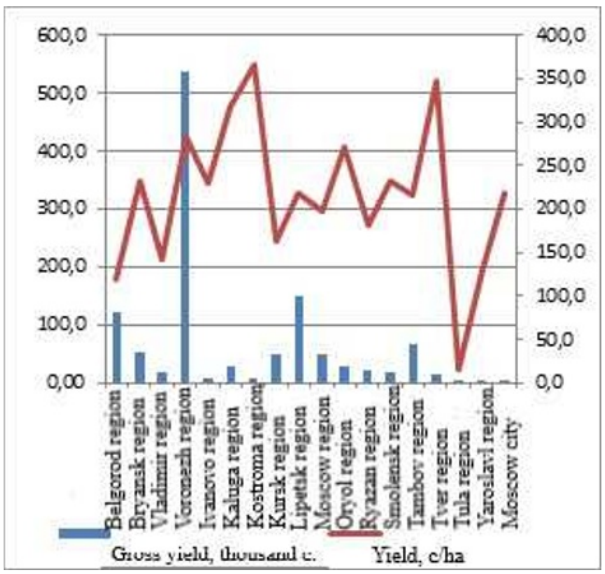

Fig. 2. Production and productivity of pumpkins in various farms of Belgorod region (2018)

It is known that to keep pumpkin fresh without a specially equipped room is quite problematic. Various microbes and enzymes damage the fruit. Therefore, it is important to preserve pumpkin using modern methods of technology for processing perishable raw materials with the full preservation of nutritious and palatability of the final product.

One of such methods is the use of sugar [6].

The aim of the research is to produce natural candied vegetables with maximum biologically active substances of the original plant material with improved taste and present the finished product.

To achieve it, the following tasks were solved:

- to evaluate the appropriateness of using the pulp of pumpkin Michurinskaya in the manufacture of candied fruits;
- to develop a technological scheme for the production of candied fruits using rosehip syrup, sea buckthorn or ginger syrup;
- to determine the nutritional value and taste of the finished product.

2 Methods

The studies were carried out in accordance with the current standards and special techniques.

For the production of candied fruit, healthy pumpkin fruits, matured in a state of biological ripeness, are used (GOST 7975-68). Table vegetable varieties having a smooth bark, dense non-fibrous pulp with a thickness of more than 3 cm, dark yellow or bright orange are taken. The preference is given to pumpkin fruits with a dry matter content of more than 13 % and sugars of more than 7.5 % [2].

The requirements corresponded to the fruits of pumpkin Michurinskaya grown in Belgorod Region (Fig. 3).

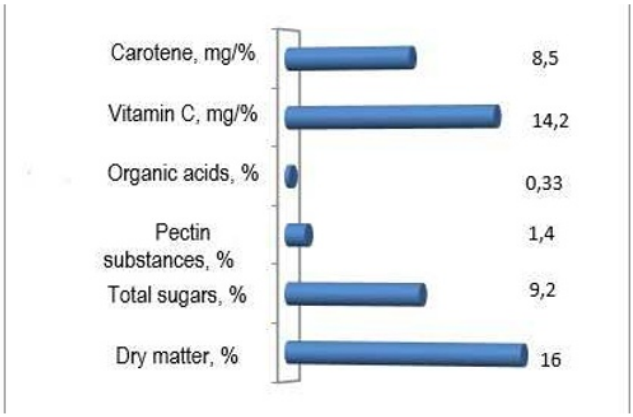

Fig. 3. Biochemical composition of Michurinskaya pumpkin

In the conditions of widespread use of mineral fertilizers, in order to protect public health, it is necessary to control the process of accumulation of toxic elements in vegetables [7].

The studies have shown that the pulp of Michurinskaya pumpkin contains heavy metal ions in the amount which is significantly lower than their maximum permissible levels established by the Sanitary Rules and Regulations (SanPin 2.3.2.1078-01).

For lead, the indicator is 1.7 times lower, for cadmium – 1.4 times lower, for arsenic and mercury – 1.3 times lower (Table).

Table 1. The content of heavy metal ions in the pumpkin pulp

Plant material	Content mg/kg			
	Pb	**As**	**Cd**	**Hg**
Michurinskaya pumpkin pulp	0.3± 0.015	0.15± 0.0075	0.021± 0.001	0.015± 0.0007
	MCL			
	0.5	0.20	0.030	0.020

All types of pumpkins are characterized by easy digestibility, high antioxidant activity due to carotenoids and pectin, and a low concentration of nitrates. These properties allow you to use the vegetable in the diet of adults and young children [8].

The levels of maximum permissible concentrations of nitrates are established by the Sanitary Rules and Regulations (SanPin 2.3.2.1078-01). For pumpkin, the indicator should not exceed 200 mg/kg [9].

During the growing season, the fruits of pumpkin Michurinskaya, grown in Belgorod region, accumulated 51.2 mg/kg of nitrates, which is below the permissible level 4 times.

It was concluded that the plant material was environmentally friendly and can be used for producing candied fruits.

The production of natural candied fruit is organized in accordance with SanPiN 2.3.2.1078-01.

The fruits were washed under running water. Then, the pumpkin pulp was peeled, cut to cubes with edges of no more than 40 mm.

Candied fruit production was carried out according to traditional technology (option 1): pumpkin cubes were covered with sugar syrup, kept for 2 hours until the juice was heated, aged for 4–5 hours, brought back to a boiling vessel, cooled, and, without sprinkling with sugar, evenly put on the working surface of the convection dryer (Fig. 4).

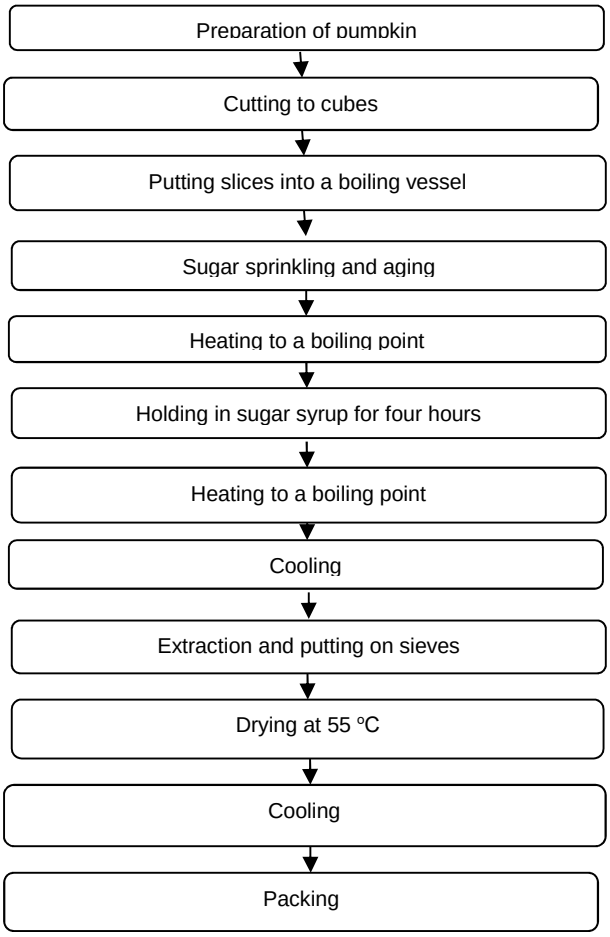

Fig. 4. Technological scheme for the production of candied pumpkin

To increase the nutritional value and improve taste and aroma properties of candied fruit at the stage of repeated exposure, 150 g rosehip syrup (option 2), or ginger syrup (option 3), or sea buckthorn syrup (option 4) were added.

The choice of syrups is due to their beneficial effect on the human body.

To enrich pumpkin candied fruits with vitamin C, tannins and increase the antioxidant properties, rosehip syrup was added [10, 11].

Sea buckthorn accumulates biologically active natural components: vitamins and fats, organic acids, carotene, flavonoids, volatile, and valuable trace elements. To provide the product with preventive and curative functions, rose hip syrup was replaced with sea buckthorn syrup [12].

In order to stimulate digestion, saturation with flavonoids, B vitamins, essential oils and to provide the product with refined aroma and spicy taste, in version 4, sea buckthorn syrup was replaced with ginger syrup [13, 14].

Product readiness was determined visually by color of the slices which became transparent.

3 Results and discussion

Biochemical parameters were determined for the finished product. Their analysis showed that the choice of syrup had a noticeable effect on the quality (Fig. 5).

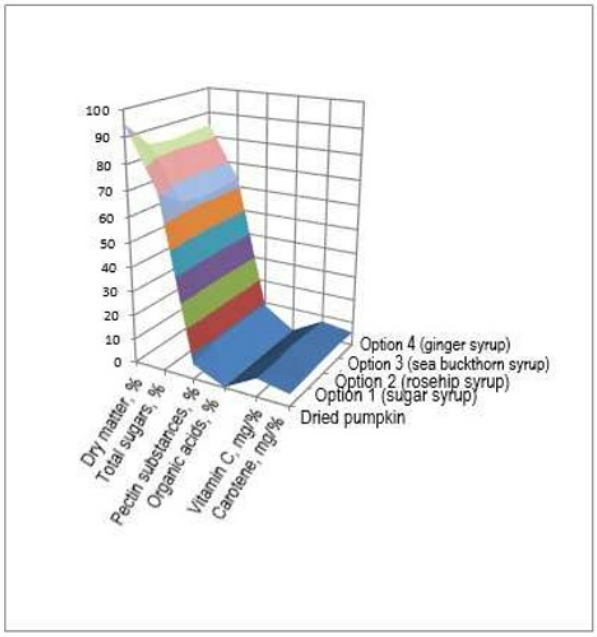

Fig. 5. Biochemical composition of dried pumpkin and candied fruit

One of the main chemical quality indicators – the solids content – varied from 83.6 % (option 2) to 84.9 % (option 1), which is due to different rates of moisture. The sum of sugars makes up the bulk of candied solids. In the samples, the value ranged from 62.1 % (option 2) to 64.3 % (option 1).

When processing pumpkin into candied fruit, carotene losses amounted to 27–36 %. However, its content was very high: from 5.4 (option 1) to 6.2 mg / 100 g (option 3), which amounted to 108–124 % of the daily needs of an adult (5 mg / 100 g in accordance with the guidelines for rational nutrition (MP 2.3.1.2432-08)). 81-93 g candied fruit is enough for its complete replenishment.

The concentration of vitamin C decreased by 38–49 %. Its content in candied fruit samples varied from 7.4 (option 1, option 2) to 8.8 mg / 100 g (option 3), or 8–10 % of the physiological daily need for vitamin C (90 mg in accordance with the guidelines for rational nutrition (MP 2.3.1.2432-08)).

The content of pectin substances varied from 8.8 % (option 1) to 9.5 % (option 3), which was 44–47.5 % of the physiological daily need for an adult (20 g in accordance with the guidelines for rational nutrition (MP 2.3.1.2432-08)). 211 to 227 g candied fruit is sufficient for its complete replenishment.

A high level of carotene and pectin substances in the samples was osberved (GOST R 52349-2006).

To assess taste, a commission consisting of five independent experts was created. They used a scale developed by V.S. Vatchilo and and E.S. Zemlyakova [1].

The comprehensive assessment of organoleptic properties of the candied fruits showed (Fig. 6) that ginger syrup makes it excellent; when adding rosehip syrup or sea buckthorn syrup, the taste is good.

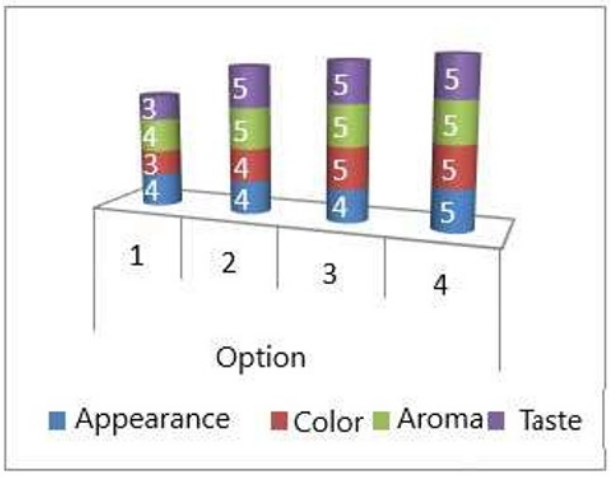

Fig. 6. Organoleptic properties of candied pumpkin

The candied fruit had natural color. There were no crust, lumps of crystallized sugar, signs of excessive digestibility, burning or drying out.

Samples 2 and 3 were characterized by softness and low ductility.

Sample of 4 had a more dense consistency.

As part of the sanitary-epidemiological assessment, a microbiological analysis of the product was carried out. The samples met the requirements established by the Sanitary Rules and Norms (SanPin 2.3.2.1078-01): KMAFAnM – no more than 1 · 103 CFU / g; BGKP (coliforms) – not found in 1.0 g; yeast – no more than 50 CFU / g; mold – no more than 50 CFU / g.

The applied production conditions ensured the hygienic safety of the product, which allows us to conclude about the right choice of time, temperature, concentration of sugar syrup and additional syrups.

The candied fruit as an independent food product can expand the market while reducing transportation costs, expanding the range of candied fruits in the market.

The syrup from pumpkin slices can be used for producing jam or other fruit products [6, 15, 16].

4 Conclusion

The candied fruits produced from pumpkin Michurinskaya grown in Belgorod region were characterized by a high nutritional value, excellent and good organoleptic properties. It can be used for mass consumption in order to enrich the diet with carotene and pectin substances.

To meet the daily physiological need for these biologically significant substances, 211 g of candied fruits made using buckthorn syrup are required. They were characterized by excellent organoleptic properties, had a viscous consistency. The results of the microbiological analysis corresponded to the standardized indicators.

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