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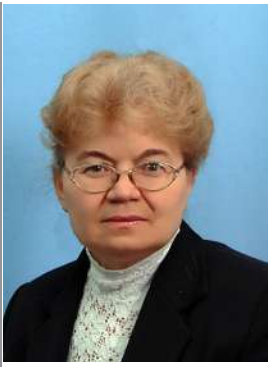

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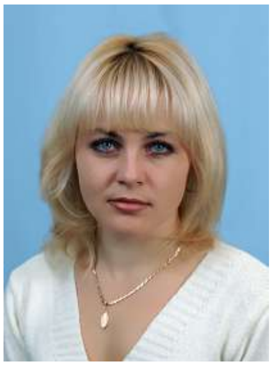

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УДОСКОНАЛЕННЯ ТЕХНОЛОГІЇ ВИРОБНИЦТВА ЖЕЛЕ ЧОРНОСМОРОДИНОВОГО

Встановлено, що компоненти хімічного складу соку чорносмородинового – вміст кислот (2,3 %), pH (3,4), пектинових речовин (1,15 %) перевищують мінімальні значення показників, за яких в присутності цукру утворюється желе, а сік є відмінною сировиною для його виробництва. Запропоновано удосконалену технологію виробництва желе чорносмородинового. Суть технології полягає у додаванні в попередньо приготовлене желе з різним вмістом сухих розчинних речовин (50, 55, 60, 65 %) осмотично зневоднених шматочків плодів яблук, вишні, черешні, абрикоси, аґрусу у кількості 10 та 15 % від загальної маси готового продукту. За органолептичною оцінкою продуктів встановлено найкращий варіант – желе чорносмородинове з вмістом сухих розчинних речовин 65 % та додаванням 10 % осмотично зневоднених шматочків плодів яблук. Обґрунтовано, що осмотичне зневоднення плодів необхідно проводити за наступних умов: цукровий розчин концентрацією 70 %, тривалість витримки 12–18 год., співвідношення маси плодів і маси цукрового розчину 1:1. Розроблено та затверджено нормативно-технічну документацію: технологічну інструкцію на виробництво та технічні умови для контролю якості запропонованого виду продукту.
Ключові слова: *чорна смородина, осмотичне зневоднення, шматочки плодів, желе, технологія*

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IMPROVEMENT OF PRODUCTION TECHNOLOGY OF BLACK CURRANT JELLY

It was established that the components of chemical composition of black currant juice – content of acids (2.3 %), pH (3.4), pectin substances (1.15 %) exceeded the minimum values of parameters in which jelly is formed together with sugar and juice is excellent raw material for its production. Improved technology of production of black currant jelly is offered. The essence of the technology is in adding osmotically dehydrated pieces of apples, red cherries, yellow cherries, apricots, gooseberries in quantities of 10 and 15 % of the total weight of finished product to a pre-prepared jelly with different content of dry soluble substances (50, 55, 60, 65 %). The best variant – black currant jelly with content of dry soluble substances of 65 % and with adding of 10 % of osmotically dehydrated pieces of apples by organoleptic assessment of the products was determined. It was substantiated that osmotic dehydration of fruits should be carried out under the following conditions: sugar solution at a concentration of 70 %, duration of maturing to 12–18 hours, ratio of the weight of fruit and weight of sugar solution of 1:1. Normative and technical documentation such as technological instruction for production and technical specifications for quality control of proposed type of product was developed and approved.
Keywords: black currant, osmotic dehydration, fruit pieces, jelly, technology.

Problem formulation. People of Ukraine know very well about nutritional value and taste, curative and dietary properties of black currant fruit. It is a source of favorably balanced sugars, organic acids, delicate fiber, mineral and other substances. Black currant has a high content of vitamins, especially ascorbic acid – from 50 to 350 mg/100 g. Its fruit contains exclusively valuable polyphenolic substances that have the properties of vitamin P, as well as folic acid, and pectin. The latter is able to absorb and successfully removes heavy metal ions and radioactive compounds from the body, as well as cholesterol, bile acids, urea, bilirubin, and it also has bactericidal, anti-allergic and positive effect on metabolism.

Since nutrition is a major factor for health and life expectancy of a person, the search for biologically valuable raw materials of natural origin is constantly being carried out, which will provide the body with useful substances and contribute to the prevention and treatment of diseases.

These criteria correspond to the fruits of black currant. However, ability to provide people with healing fresh fruits is limited by the biology of their growth, development, and ripening. One can solve the problem by using canning methods. The classic assortment of canned fruits from the black currant is well known – preserves, jam, confiture, rubbed or ground with sugar currant, compote, jelly. A promising trend for today is the expansion of the range of products by incorporating into their formulation ingredients that improve appearance, aroma, taste, consistency and biological value [1–5].

Analysis of recent researches and publications. Osmotic dehydration of fruits is of particular importance in the development of modern technologies and quality improvement of the product. Concentration (dehydration) is an important technological process in the production of preserve, jam, jelly. Water, contained in plant raw material (75–85%), should be removed, replacing by sugar.

Diffusion-and-osmotic method of moisture removing is connected with a change in its aggregate state when heated. In this case, phase transformation of water causes irreversible changes in structure and chemical composition of raw material, which in the end, leads to worsen of product quality. Just only the drying process often makes the product uncomfortable by consistency.

The method of osmotic dehydration is based on the use of osmotic processes in the system of fruit-concentrated solutions of sucrose. Osmotic potential will be realized in such system at the boundary of solution-semipermeable membrane. This method of osmotic dehydration has advantages over evaporation because it occurs without phase transformations.

The process of osmotic dehydration is influenced by the following factors as nature of osmotically active substance, its temperature and concentration, ratio between the syrup weight and fruits weight, syrup circulation in the process of dehydration.

Osmotic dehydration of fruits and berries in the technology of fruit concentrated cans was used in the works of different authors. It should be noted that E.N. Diachenko [6] offered osmotic dehydration in sugar syrups, infra-red and convective drying of pre-osmotically dehydrated or blanched fruits in the production technology of concentrated compote to remove moisture from the fruits. Pham Tkhy Be Nam [7] suggested osmotically dehydration of the fruits with their subsequent drying, and Makhmud Byn Makhmud Abdula [8] proposed technology of fruit cans of apples and raspberry using concentrated apple juice and a 70% solution of sucrose as an osmotically active substance.

N.Ya. Orlova [9] studied the process during freezing and storage and established the following patterns: the intensity of osmotic dehydration significantly exceeded (from 4 to 10 times) the intensity of sugar diffusion in the fruit. The higher sugar concentration in the solution, the more dehydrated fruits, the more sugar diffused into their tissues. The intensity of osmosis and diffusion process was directly dependent on the duration of fruits keeping in osmotic solutions and peculiarities of the anatomical structure, chemical composition of the fruits, and degree of their ripeness. Apples and peaches were characterized by the greatest outcome of moisture among seed and stone fruits, the smallest outcome – quince and plums. The ratio of fruits and syrup by weight did not significantly affect the processes of osmosis and diffusion.

The weight of the fruits after the osmotic treatment was reduced by 30–50 % compared with the initial, the number of dry soluble substances in the fruits increased to 22–39 %, vitamin C – up to 200 mg per 100 g. Quality assessment of partially osmotically dehydrated semifinished and frozen fruits by a complex of organoleptic, physical-and-chemical and biochemical indicators showed the expediency of using of solutions with a sucrose concentration of 70 % for osmotic dehydration. The optimal duration of pip fruits keeping in solutions of 70 % sucrose was 18 hours, and 12 hours for stone fruits. The ratio of fruits and syrup by weight was 1:1.

Thus, proposed methods of osmotic dehydration of raw materials are promising, energy-saving technologies, which ensure obtaining of new types of products with high biological value, maximally preserve the native microstructure and organoleptic properties. Using of modern technologies and non-traditional raw materials will help to improve existing and introduce new ones in order to expand the assortment and ensure consumers' requirements.

One of the favorite concentrated canned fruit is jelly. This is a semi-solid, jelly-like product made by boiling fruit or berry juice with sugar [10–15]. Jelly formation is a colloidal phenomenon and depends on the content of pectin, sugar, acid, as well as concentration of hydrogen ions (pH).

Pectin is the largest complex macromolecule in nature, consisting of a base – a chain of residues of D-galacturonic acid linked to α-1,4 bonds to which a large number of fibers are attached. The molecules of pectin have the form of "molecular brush with different hair". It creates various forms of pectin substances. Free carboxyl groups of galacturonic acids give esters with alcohol (the process of esterification), which determines the mechanism of gel formation.

Jelly solidity is determined by concentration of pectin, because fibrils plexus cannot be strong under its poor amount that run through the mass of gel filled with sugar syrup.

Acid makes jelly more solid due to fibrils strengthening. Fibrils are weak and do not contain proper amount of inter-fibrillar syrup if environment acidity is too low. However, if acidity is too high, there is a phenomenon of syneresis in jelly [16, 17].

There is a direct connection between the active acidity (pH) and the ability of raw material to become of jelly-like substance. Optimal concentration of hydrogen ions when jelly is formed is pH of 3.46. Minimum values of the content of pectin and acid in the raw material are determined, with the help of which in the presence of sugar a jelly is formed: the content of pectin and total acidity should be not less than 1 % each, pH 3.2–3.5 [6, 14, 15].

The aim of the research was to improve production technology of black currant jelly for enlarging a range of concentrated fruit cans, the special feature of which is adding of osmotically dehydrated pieces of other fruits to the finished product. Research tasks were: studying the process osmotic dehydration pieces of fruits different cultures; improving the technology production of jelly from black currants for the use of osmotically dehydrated fruit.

Methods and conditions of the research. The objects of research were the fruits of black currant and canned ones. During the research, we determined in fruits and cans the following: content of dry soluble substances (DSS) by refractometric method (refractometer RPL-3M), titrating acids by titrimetric method, sugars (glucose, fructose, sucrose) by ferricyanide method, ascorbic acid by iodometric method, tanning and dyeing substances by a quantitative method [18]; pectin substances by Ca-pectat method [19]; active acidity by pH-150 apparatus; organoleptic estimation of fresh fruits by a five-point system and canned products by a thirty-point system. Mass of samples for analysis was 2 kg. Fruits of black currants of Mynai Shmyriov variety were taken.

Fruits of black currants were previously frozen to produce juice [20]. They were grounded after defrosting and heated to a temperature of 50–55 °C and we received juice by pressing. Juice output was 55 %.

The study of conditions of osmotic dehydration (syrup concentration – 70 %, exposition – 12–18 hours) of pieces of apples, red cherries, yellow cherries, apricots, gooseberries were carried out by the content of dry soluble substances in fruits.

We used GOST 656-79 "Fruit and natural berries juices. Technical specifications" for black currant juice; OST 10.157-88 "Fruit and berry jelly. Technical specifications" for black currant jelly and technological instructions for production of canned products during the development of normative documentation for a new type of canned food "Black currant jelly with apples" and the assessment of the quality of canned food.

Research results. Chemical composition of received black currant juice is presented in Tab. 1. The content of the components of the chemical composition depend on the weather conditions of the growing year and varied significantly. This was especially true in 2005, when the greater content in the juice of dry soluble substances was by 7 %, including sugars by 6–10 %, organic acids by 9–19 %, pectins by 4–9 %, and tannins and coloring matters by 1,5, ascorbic acid by 1,2–1,7 times. At the same time, for such substances, the pH of the juice is lower by 6–13 %. The difference in the chemical composition of the juice of different years of production significantly influenced the C-vitamin and R-vitamin value of the products.

It was used the most modern method of the preparation of black currant jelly with fruits adding. In this regard, osmotic dehydration of fruits was used which was based on the use of processes in the system fruits – concentrated sugar solutions.

Moisture-keeping ability of the raw materials during osmotic dehydration depended on the shape, nature and level of bonds solidity of water with material.

Method of osmotic dehydration in a solution of sugar syrup was tested on many types of fruits – apples, red cherries, yellow cherries, apricots, gooseberries. The best results were achieved during processing of apples which was confirmed by other studies [21–24]. Selected raw material was characterized by instability of cytoplasmic membranes to mechanical damage and gave juice well, and more amount of moisture in apple fruits was in an osmotically-bound form (61,1 %).

According to the studies [10, 25–30], concentration of sugar solution of osmotically active substance should be 70 %, since the process of dehydration proceeded more actively under these conditions. At the same time, ratio of fruits mass to syrup mass should be 1:1, that is, the variant with effective use of syrup and ensuring of full fruits dipping in it.

It was found in the studies [24] that the process of osmotic dehydration of apples increased with rising the temperature of the solution of osmotically active substance.

Table 1

Chemical composition of black currant

Year	Content of dry soluble substances, %	Content of titrating acids, %	pH	General content of sugars, %	Content of tanning and dyeing substances, %	Content of pectin substances, %	Content of ascorbic acid, mg/100 g
2004	12,0	2,1	3,6	8.0	0,19	1,10	95,4
2005	12,8	2,5	3,2	8.8	0,28	1,20	166,3
2006	12,0	2,3	3,4	8.3	0,25	1,15	135,8
LSD_{05} %	*0,7*	*0,4*	*0,2*	*0.9*	*0,03*	*0,19*	*17,1*
Average	12,2	2,3	3,4	8.4	0,24	1,15	132,5

Table 2

Change in the content of dry soluble substances under osmotic dehydration of fruits pieces of different ultures, %

Raw material	Before osmotic dehydration	Average	After osmotic dehydration	Average
Apples	9,0	10.0	41.2	40.0
	11,0		38,8	
	10,0		40,0	
Red cherries	10,4	11,2	35,8	34,5
	11,8		33,5	
	11,4		34,2	
Yellow cherries	13,6	14,1	29,3	28,0
	14,5		27,0	
	14,2		27,7	
Apricots	11,2	12,0	35,6	34,0
	12,5		32,6	
	12,3		33,8	
Gooseberries	9,3	10,0	28,1	26,5
	10,4		25,6	
	10,3		25,8	
LSD_{05} %	*0,5*	–	*1,8*	–

Thus, it took 48 hours to reduce apples weight by 60 % at solution temperature of 20 °C of osmotically active substance, and 24 hours at the temperature of 50 °C. Other researchers [21] believes that the optimal duration of maturing the seed fruits in sugar solutions with a concentration of 70 % is 18 hours, and 12 hours for stone fruits.

In our studies, solution of osmotically active substance at a temperature of 20–25 °C with exposition of apple fruits in it for 18 hours, 12 hours of stone and berry cultures was taken.

According to Tab. 2, the content of dry soluble substances, on average over the years of research, was 10 % in apple and gooseberry fruits while it was a little higher in fruits of other cultures: 11,2 % for red cherries, 12,0 % apricots, 14,1 % for yellow cherries.

The intensity of the processes of osmosis and diffusion was directly dependent on the duration of fruits keeping in osmotic solution, special features of anatomical structure and chemical composition of fruits. Increase of the content of dry soluble substances in apple fruits up to 40 %, red cherries and apricots up to 34 %, yellow cherries up to 28 % and gooseberries up to 26,5 % occurred in the process of dehydration.

It can be supposed that the difference in the content of dry soluble substances in fruits after osmotic dehydration depends to a certain extent on their ability to give juice, because the lowest juice giving of 46 % in fruits of yellow cherry and gooseberry, while in others – 56–61 %.

Received osmotically dehydrated pieces of fruit were used to add them to previously prepared black currant jelly with different content of dry soluble substances – 50, 55, 60, 65 %. Moreover, proportion of fruits in finished product was 10 and 15 %. Organoleptic assessment of received products made it possible to choose the best variants.

The highest indexes had jelly from black currant with apples – 26,1–27,0 points, a little lower points were in a product with apricots – 24,8–25,3 and with gooseberry – 24,6–25,5 points, products with cherries got the lowest points of 24,0–24,4.

In addition, jelly with 10 % of fruit content from the product weight received a higher estimation which varied depending on the type of product – from 24,0 to 27,0 points (Tab. 3).

We have developed a new type of product for the production: «Black Currant Jelly with Apples». Its advantages lay in high biological value, improved organoleptic parameters, economic and social expediency of an extended assortment of canned fruits from black currant.

The peculiarity of the product technology consists of the preliminary preparation of sliced pieces of apples in the size

Table 3

Organoleptic estimation of black currant jelly with adding the pieces of fruits, points

Type of product	Mass part of fruits in jelly, %	Organoleptic estimation, point
Black currant jelly with apples	10	27,0
	15	26,1
Black currant jelly with red cherries	10	24,4
	15	24,0
Black currant jelly with yellow cherries	10	24,0
	15	24,0
Black currant jelly with apricots	10	25,3
	15	24,8
Black currant jelly with gooseberries	10	25,5
	15	24,6
LSD_{05} %		*3.3*

Table 4

Recipes and norms of raw material consumption for the production of jelly

Type of product	Raw material	Content of dry soluble substances, %	Yield of fruit, %	Recipe in parts (without adding pectin)	Cost requirements per 1000 kg jelly, kg	
					not pasteurized	pasteurized
Black currant jelly	black currant fruit		63		1352	1276
	juice black currant	10,0		133	852	804
	sugar is white	99,85		100	637	601
Black currant jelly with Apples	black currant fruit		45*		1684	1589
	juice black currant	12,0		133	774	715
	apples	10,0		118**	190	180
	apples are osmotic	40,0		131		
	syrup after osmotic dehydration	40,0		119		
	sugar is white	99,85		92	616	582

* Separation of black currant juice was carried out from pre-frozen fruits, chopped to muscle, heated to a temperature of 50–55 ° C.

** The initial proportion of pieces of apples is necessary for osmotic dehydration.

Table 5
Physical-and-chemical indexes of black currant jelly made by known and proposed methods, mass part

Type of product	Dry soluble substances, %	Acidity, %	Sugars, %	pH	Sugar-and-acid index	Pectin substances, %	Tanning and dyeing substances, %	Ascorbic asid, mg/100 g
Black currant jelly	65,0	1,48	63,0	4,15	42,6	1,12	0,29	186,5
Black currant jelly with Apples	65,0	1,28	65,5	4,20	51,2	1,46	0,36	195,4
LSD_{05} %	–	*0,2*	*1,2*	*0,2*	*5,3*	*0,28*	*0,03*	*8,4*

of 5x5 mm by osmotic dehydration in 70 % of sugar syrup for 18 hours (temperature 20–25 °C), and then separation from the syrup and drying at 70 °C for 15 min.

This syrup, after the separation of pieces of apples, and after the correction of sugar content of the formulation, can be used during the preparation of jelly.

To make the product you need to take fruits of technical maturity – fresh and intact, subjected to inspection, unusable specimens must be removed, and then fruits are sorted by pomological varieties, ripe, size (calibration) for individual groups.

These fruits are washed in running water, and then the stalk, calyx and seed nest are removed, the fruits are peeled, and cut into pieces (5x5 mm). To prevent darkening of the pieces, fruits need to be kept in 0,5–1,0 % acid solutions (lemon or walnut) not longer than 30 minutes.

A 70 % syrup is obtained in boiling water by dissolving white sugar for one hour; it needs to be left for a while, and then filtered through a dense cloth or sieve number 20.

Slices of apples are loaded in containers made of non-corrosive metal and poured by 70 % sugar syrup (the ratio of syrup to fruits is 1:1), the temperature of the syrup should be of 20–25 °C; and then the fruits are left for 18 hours.

Prepared pieces of apples on the sieve are separated from the syrup until it is completely drained; and then dried for 15 minutes at a temperature of 70 °C. For the production of jelly, black currant juice is filtered. In this case, the suspended particles of the peel are removed. The juice is loaded into a vacuum apparatus or double-wall boiler, sugar added according to the formulation. Boil until the content of dry soluble substances in jelly pasteurized is 60 %. Boiling lasts no more than 30 minutes.

In the black currant jelly add bits of apples subjected to osmotic dehydration in accordance with the formulation (Tab. 4). The mass is boiled to the content of dry soluble substances in the product of 65 %. Boiling lasts no more than 20 minutes. Without letting it cool, the product is packed in a hot condition into containers, and sealed hermetically.

Black currant jelly with apples having 65 % of dry soluble substances, pasteurized according to the regimens for the classical black currant jelly. In the autoclave, the product is cooled to 60 °C. After that, it must be kept in a horizontal position for the day for gelling and final cooling. Black currant jelly with apples should be stored according to such conditions – temperature 0–20 °C, and relative humidity of air no more than 75 %.

The evaluation of the quality of black currant jelly with apples showed that the product meets the standards in terms of physical and chemical indicators and does not give ground to the classical jelly. Along with this, mass fraction of pectin substances in it is higher by 30 %, tannins and colorants by 24 %, and ascorbic acid by 5 %. Tasting properties of the product have significantly improved due to an increase in the sugar-acid index by 20 % (Tab. 5).

The combination of sour-sweet black currant jelly with sweet slices of apples harmonized taste, aroma and improved the appearance of the product. This provides significant advantages to our new type of canned food and greatly expands the interest of consumers.

Production of jelly by the proposed method significantly improves its organoleptic characteristics – appearance, aroma, taste that is connected with harmonious combination of sour-and-sweet black currant jelly with sweet pieces of apples.

Conclusion. To expand the range of canned black currant, it is expedient to use jelly. It can be varied by adding to the product pre-osmotically dehydrated pieces of apples, cherries, black cherries, apricots and gooseberries in quantities of 10 % by weight. According to the organoleptic evaluation of the products, black currant jelly with apples takes advantage, and after it – black currant jelly with apricots, gooseberries and cherries.

Osmotic dehydration of apple pieces must be carried out under the following conditions: sugar solution at a concentration of 70 %, duration of storage – 12–18 hours at a temperature of 20–25 °C, ratio of mass fruit and mass of sugar solution is 1:1.

Technological process of «Black currant jelly with apples» production should be carried out according the developed technological regulation for production of black currant jelly with apples (Technological Instruction of Ukraine 15.3–00493787–001:2006 (ТІ У in Ukrainian, in the text)), quality should be controlled according to Technological Conditions of Ukraine 15.3–00493787–001:2006 (ТУ У in Ukrainian, in the text).

Technology of production of «Black currant jelly with apples» was developed, set out in the approved technological regulation, originality of which is confirmed by a patent (No.12233, 2006).

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