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The integrated technology of functional products of grapes

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A B S T R A C T

The study aimed to obtain grape jam and compote according to modern requirements, based on the method of osmotic dehydration and the use of deionized grape concentrate as a sugar substitute.

Nutritional and functional properties are important for the estimation of the grape cultivar. From this point of view, Alphonse Lavallée has been chosen, which is dark-skinned and is used mainly as a table cultivar; it is obtained in France by the cross-breeding of Hamburg muscat and the Georgian cultivar Colchian kharistvala.

The deionized concentrate of grape with SS content 70 B is used as an osmotic agent; the duration of the process is 5 hours: the initial temperature is 40 oC, duration 1 h, at the next stage - 30 oC; the mass ratio of the osmotic agent and grapes is 1:1.

The results of osmotic dehydration of grape are: weight reduction WR= 26.0%, solid gain 4.1%; water loss WL=30.1%, the amount of soluble solid substance that went into osmotic solution is 1.8%.

To produce a jam, the deionized concentrate of grapes has been added to dehydrated fruit, mass ratio 60:40.

In the case of compote, the syrup is added to the dehydrated fruit, which is obtained by diluting the osmotic agent with water, a concentration is 5.0... 7.0%, mass ratio 60:40.

As a result, the product contains more fruit, less free sugar, the energy value is reduced, anthocyanins are preserved better.

Keywords: Grape, Osmotic dehydration, Jam, Compote, Anthocyanins, Free sugar.

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Introduction

According to the available information, the grape has the potential to maintain human health - it suppresses the development of chronic diseases; it is distinguished by a unique combination of phenolic compounds; therefore, it is characterized by strong antioxidant activity and antimicrobial properties. It is believed that grapes and products derived from them should be included in the daily ration. The main thing is to use this opportunity properly [1-4].

The interest in respect of anthocyanins has significantly increased in recent decades. They may play an important role in the preservation of health with the point of view of prophylaxis - obesity, cardiovascular diseases, inflammatory processes. The anticarcinogenic action should be specially noted [4]. Due to the content of anthocyanins grapes are considered one of the most important cultures in the world [3, 5].

The results of the research confirm that it is expedient to use the whole fruit - skin, flesh, pip. In such case, except for antioxidants, contents of fibrous substances is also important, which promote normal functioning of the digestive system [1,6]. The mentioned is enforced by the fact that high attention is paid to the consumption of table grape [7-9].

The beneficial properties of the processed products are determined not only by the object but also by the technology of processing. In particular, the use of free sugar; this factor should be taken into consideration.

World Health Organization recommends a significant limitation of free sugar that should be <10% of total energy consumption (2000 kcal). It is to be mentioned that this does not extend to sugars being in fruit and vegetables [10,11]. The recommendations of the World Health Organization and the requirements of the European Union are to be taken into consideration. Technology is important - more content of fruit and reduced quantity of sugar already means high quality [12, 13].

The deionized concentrate of grapes may be used as a natural sweetener [14, 15]. It is to be mentioned that grape concentrate contains almost equal quantities of glucose and fructose.

Grape juice is considered as a prophylactic product in respect to chronic diseases, despite the high content of sugar [16, 17]. It appears to retain a function of natural sugar on the background of biologically active substances. The deionized concentrate of grape has a similar function. From this point of view, it is important to use the method of osmotic dehydration, based on which a concentration of natural sugar in fruit increases.

The project is based on trends existing in Europe. Since 2012 a production of jam, compote, confiture, etc., has been significantly increased. The essence of technology is more fruit, less sugar [17].

Now an old recipe of jam regarding sugar has been changed. Food producers on the international level take into consideration the conclusions of the World Health Organization and the demands of consumers. Therefore, a preference is shown to a reduction of sugar content: instead of 65%, a concentration is 40-55% [13, 18].

The importance of compote is multifaceted, and its technology makes it possible to produce modern processed products that take into account the following changes: reduction of energy value, increasing of relative content of the fruit, use of sugar substitutes.

Osmotic dehydration is the process by which water is partially removed from plant tissue. For this purpose, the fruit is placed in a hypertonic (osmotic) solution and is in direct contact with it. There are three types of mass exchange: a motion of water from tissue to an osmotic solution, a going of an osmotic substance from solution to tissue, the diffusion of own dry substance from tissue to solution [19-23].

This is an important means of reducing fruit mass, based on which this method has gained great interest and is widely used as an effective method of pre-processing, mainly in drying and freezing technology. It should be noted that the osmotic agent, its concentration, processing time, and temperature are different in each specific case.

The study aimed to obtain grape jam and compote according to modern requirements, based on the method of osmotic dehydration and the use of deionized grape concentrate as a sugar substitute.

Objects and methods

Nutritional and functional properties are important for the estimation of the cultivar. From this point of view Alphonse Lavallée, which is a dark-skinned grape and is used mainly as a table cultivar has been chosen; it is obtained in France by the cross-breeding of Hamburg muscat and the Georgian cultivar Colchian kharistvala.

The research comprises two stages. Firstly the parameters of osmotic dehydration have been determined, the obtained material became the basis of estimation of jam and compote from the nutritional and functional points of view.

Grapes harvested at the optimal stage of ripeness were subjected to the experiment. It was washed, inspected, and placed in an enameled container in the amount of 500 g, the procedure was repeated five times.

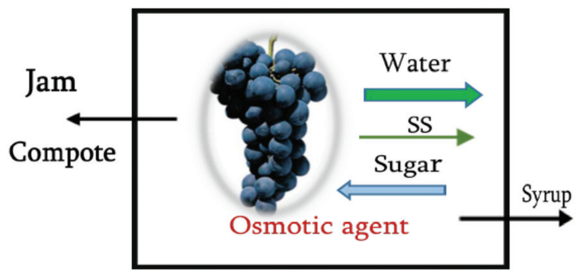

Fig.1. *Osmotic dehydration of rapes*

The deionized concentrate of grape with SS content 70 °B is used as an osmotic agent; the duration of the process is 5 hours, initial temperature 40 oC, duration 1 h, at the next stage – 30 oC; the mass ratio of the osmotic agent and grapes is 1:1.

The kinetics of the process of osmotic dehydration has been evaluated according to the following parameters:

weight reduction $\mathbf{WR(\%)} = \frac{M_0 - M}{M_0} \mathbf{100}$

dry substance gain $\mathbf{SG\,\%} = \frac{MS - M_0 S_0}{M_0} \mathbf{100}$

water loss $\mathbf{WL\ (\%) = WR + SG}$

M_0 – the initial mass of the sample, g;

M –the mass of the sample after dehydration, g;

S_0 – the initial quantity of a solid in the sample, g;

S – the content of a solid in the sample after dehydration, g Osmotic dehydration data:

$$WR(\%) = \frac{500-370}{500} 100 = 26.0$$

$$SG(\%) = \frac{370*22.5-500*16{,}609}{500} 100 = 4.1$$

WL (%) = 26.0+4.1=30.1

To obtain jam, a deionized concentrate of grape is added to the dehydrated fruit (SS 70 °B), ratio 60:40, triple boiling each time for 3 min, with 2-3 hours of delay in the middle.

In the case of compote, the syrup is added to the dehydrated fruit, which is obtained by diluting the osmotic agent with water. The mass ratio 60:40, the concentration of the solution 5÷7.0%, pasteurization.

To evaluate the basic data of grape, osmotic dehydration process, qualitative parameters of jam and compote, the following has been determined: soluble solids by refractometer, titratable and active acidity using pH meter, sum quantity of anthocyanins by using a spectrophotometer, the wavelength 520 nm. Degustation was conducted by 20-mark system: very good 18.1- 20; good - 15.1-18; satisfactory – 13.1-15.

Results and discussion

The grape cultivar Alphonse Lavallée deserves attention due to its sensory properties. Fruits of the same size harvested during the optimal period of ripening were subjected to the experiment. It meets the requirements for table grape varieties in terms of chemical and phytochemical data.

The information of the used object is important for the evaluation of the results. The characteristics of Alphonse Lavallée are presented in Table 1.

Table 1. *Chemical and phytochemical data of grapes*

SS, °B	Titratable acidity, g/100 g	pH	Monomeric anthocyanins, mg/100 g
17.0	0.51	3.7	55.2

The initial data give a basis to obtain products with positive effects as a result of osmotic dehydration.

The process of osmotic dehydration, which as a rule is aimed at removing a certain amount of water, also has other consequences: a migration of the osmotic agent from the solution to the fruit and diffusion of small amounts of soluble solids (SS) from the raw material. The mentioned indicators determine the expediency of using grapes and osmotic solution. The results are given in Table 2.

Table 2. *The results of osmotic dehydration of grapes, %*

WL	WR	SG
30.1	26	4.1

Osmotic dehydration results in increasing in grapes of soluble solid substance 22.5°B, and as a result of additional transition of sugar from osmotic solution amounted to 28.1 °B (Fig. 2).

1 - SS of grapes under dehydration;

2 - SS of grapes under dehydration and transition of sugar in fruit;

An example is considered when SS of grapes is 16.7 ˚B.

$$X_1 = \frac{100 \cdot a.}{100-\mathrm{WR}} \qquad X_1 = \frac{100 \cdot 16{,}7}{74} = 22.5°B$$

X_1 – the content of SS in grapes as a result of dehydration, ˚B;

α – the initial parameter of SS of grapes, ˚B;

(100-WR) – mass of grapes as a result of dehydration, g.

$$X_2 = \frac{100 \cdot SG}{100-WR} \qquad X_2 = \frac{100 \cdot 4.1}{74} = 5.6°B$$

X_2 – increasing of SS in grapes as a result of transition of sugar from osmotic solution, ˚B

X= X1 +X2 ; X = 22.5+ 5.6= 28.1 ˚B.

X - SS of grapes under dehydration and transition of sugar into fruit, ˚B

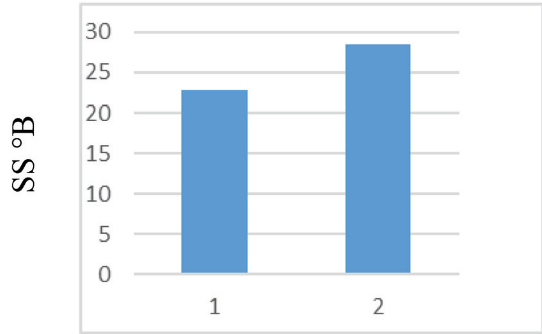

Fig. 2. *Change of SS of grapes in the process of dehydration*

$X_3 = \frac{b \cdot 100}{100+WL} - SG, \quad X_3 = \frac{70 \cdot 100}{130.1} - 4.1 = 49.7\ ˚B$

X_3 – concentration of osmotic solution after removal of a certain quantity of water and as a result of transit of water from fruit.

b – the initial concentration of the osmotic solution, ˚B;

The actual indicator of the osmotic solution, 51.5 ˚B

$X_4 = 51.5 - X3, \quad X_4 = 51.5 - 49.7 = 1.8$˚B.

X_4 - the quantity of SS, transited from grapes - 1.8˚B.

After statistical calculation, it has been revealed that one variant of dehydrated grapes, where SS is 28.1 ˚B, insignificantly differs from average data – 27.9 °B (Tab. 3).

As a result of dehydration, the amount of solid in the grapes increases - mainly sugar and also soluble fibrous substance, the percentage of the insoluble fibrous substance also increases. Other changes are also noted: the amount of anthocyanins reaches 70.7 mg / 100 g (Table 4). However, a small portion transits to the osmotic solution, as a result, the solution turns pink. Even though organic acids transit into the osmotic solution, increasing acidity is mentioned in grapes.

Table 3. *Statistical data in dehydrated grapes in respect of SS ˚B*

min	max	n	M	±σ	±m	V, %
26.4	29.5	5	27.9	1.17	0.524	4.20

It seems that migration of minerals occurs in osmotic solution, as a result, the quantity of combined acids decreases, and that of free acids - increases, respectively, pH is changed (Table 4).

Table 4. *Chemical and phytochemical data of grapes after osmotic dehydration*

SS, °B	Titratable acidity, g/100 g	pH	Monomeric anthocyanins, mg/100 g
27.9	0.74	3.5	70.7

As a result of conducted processes, natural sugar and the quantity of anthocyanins have increased. A jam and compote have been prepared from the obtained matter.

The energy value as compared with the product obtained by the existing technology is low to some extent: 55.0°B and 68.0°B. Dehydration of grapes and a short period of making jam determines a relatively greater content of anthocyanins 51.3 mg/100 g (Table 5).

A compote mainly contains natural sugar, in this case, SS is 18.7, a positive change is also observed in terms of anthocyanins. Dehydration increases the concentration in grapes; thus this parameter is relatively high in compote (Table 5).

* mass ratio of dehydrated grapes is 60, initial parameter 16.0÷17.0 °B ;

* * lemon acid is added.

Table 5. *Chemical and phytochemical data of products of grapes*

Product	SS, ˚B	Titratable acidity, g/100 g	pH	Monomeric anthocyanins, mg/100 g
Jam	55.0	0.56	3.5	51.3
Compote	18.7*	0.70**	3.4	42.0

A quality of jam and compote from the marketing point of view is focused on sensory indicators. The obtained products are also important from this point of view. The estimation has been conducted according to the 20-point system: jam 19.2 ± 0.35; variation coefficient 7.3%; compote 19.0 ± 0.25, variation coefficient 4.0%.

The transition of a soluble solid from the fruit to the osmotic solution gives it an attractive pink color, it can be successfully used in various products: iced tea, cocktail, lemonade, etc. In our case, it is used to make a compote. 5-7% solution is prepared for this purpose.

Conclusion

The technology of making jam and compote based on osmotic dehydration of table grapes is discussed;

This method holds an important place in the technology of drying and freezing - it has been shown that its use is suitable for making jams and compotes;

The functional nature of grape jam and compote obtained by integrated technology is determined by the following factors: the relative portion of fruit is increased, the amount of natural sugar is increased, a significant part of anthocyanins is preserved, the deionized grape concentrate is used as a sugar substitute;

The energy value of jam is reduced as compared with the existing technology. The quantity of SS is 55˚B. In the case of a compote, a positive change is also mentioned in this respect. SS may be regulated, <20˚B.

The presented technology of jam has the advantage of energy-saving efficiency due to the reduction of the boiling period.

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