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RESEARCH OF HALF-FINISHED FROZEN BERRY PRODUCTS

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Abstract

The great significance of berries in human's diet is determined by the biologically active substances in them. Good quality is one of the main issues in every stage of freezing. It is necessary to research suitability of different berries cultivars to freezing, as well as influence of freezing on quality of the final product. Food quality and safety issues depend on the quality of raw stuffs and half-finished products. Research was carried out at the University of Agriculture, strawberries and blackcurrants grown in Latvia were used in the research. The freezing dynamics of fruits is characterised by temperature measurements in a layer and on its surface. Experience shows that only few products need very quick freezing, such us berries, whose quality is largely influenced by freezing rate. The aim of the research is the quality evaluation of processed products made of fresh and frozen berries. Desserts prepared from berries are products, quality of which depends on the storage conditions of half-finished products. The nutritive value of biologically active substances is retained, while the organoleptic indices worsen only a bit. The objective characterization of physical properties of products allowed to evaluate quality and to incorporate it into technological regimes of the treatment. Also new information was gained on the freezing processes that are mutually interconnected. It provides scientifically practical evidence for some technological developments of qualitative improvement in berry freezing methods and their usage range.

Keywords: human's diet, quality, quick freezing, dessert.

Introduction

Fruits and berries are considered as a commercially important and nutritionally essential food commodity due to providing not only the major dietary source of vitamins, sugars, organic acids, and minerals, but also other phytochemicals including dietary fiber and antioxidants with health-beneficial effects. In addition, fruits and vegetables provide variety in color, shape, taste, aroma, and texture to refine sensory pleasure in human's diet (Kader, 2002).

Practically it is not possible to preserve berries for a long time therefore it is necessary to consider their processing. The new developed product – frozen fruit and berry half-finished products of high readiness – will increase the range of existent products. Recently more and more innovations enter the manufacture of food products and one of them is food hydrocolloids. They are food additives, which are used to carry out certain functions of food products. At present one of the branches of food production, where there are many unused applications of food hydrocolloids, is fruit processing, which by all means occupies a remarkable part of food industry in Latvia. Research shows that freezing is one of the best methods of fruit and berry preservation. In fruit and berry processing frozen fruits and berries as raw materials are increasingly being used. Therefore research into the freezing impact on the quality of further food processing is essential. Up to now relatively few investigations have been carried out on the impact of freezing on the quality of the further processing fruits and berries (Aboltins et al., 2007). Quality of production is of great importance in application of new technologies in catering enterprises. Food quality and safety issues depend on the quality of raw stuffs and half-finished products. Raw and frozen berries are likely to be contaminated with bacteria, which may include food poisoning bacteria. Even when produced under hygienic conditions raw foods must be considered potentially hazardous. The HACCP approach was used for the potential hazard identification and risk assessment in all steps of berries processing. It aims to identify problems before they occur and establish measures for freezing temperature and storage time for their control at stages in production that are critical to ensuring safety of final product. Control is based on results of scientific investigations. The three main aspects influencing safety of frozen berries: quality of raw material; the used processing method; storage conditions, involving storage temperature and time, packaging method (Notermans et al., 2005; Sprenger, 2005). The nutritive value of biologically active substance is retained while the organoleptic indices worsen only a bit. The objective characterization of physical properties of products allowed evaluating quality, to incorporate this into the technological regimes of the treatment. Therefore research of freezing impact on the quality of further food processing is essential. Up to now relatively few investigations have been carried out on freezing impact on the quality of further processing berries. The aim of the research is the quality evaluation of processed products, which are made of fresh and frozen fruits and berries. During frozen storage berries maintain their typical sensory properties, nutritional value and their texture better than after other types of processing (Ancos et al., 2000). However, only small portions of berries are consumed unprocessed after frozen storage, mostly they are further processed in different products and even further processed in catering technologies. Food quality and safety issues is another aspect of the quality in raw stuffs and half – finished products.

Materials and Methods

The study was done in Institute of Horticulture at the Latvia University of Agriculture. Research object: puree from fresh strawberries – 'Polka', 'Honeoye' and blackcurrants 'Selechenskaya' and 'Zagadka' grown in

Latvia. An actual berry puree freezing temperature was -25 °C– -30 °C, the layer thickness was 100 mm. For the determination of the layer density weight-volume method was used. Puree from the same berries was made also immediately after harvesting.

The technology of the puree making was the following: berry sorting, extrusion of puree (mechanically through sieve), adding sugar (30%) and homogenising, putting into containers (500 g), air-freezing at -25 °C, stored 3 and 6 months at -18±2 °C.

Content of vitamin C was used as an index of quality during freezing. The content of ascorbic acid was determined by titration with 0.05 M iodine solution. Alternative hypothesis is accepted with 99% probability ($p<0.0001$) – the mean of the fourth index of samples 1–4 is less than the mean index of samples 5–8. It is indicated by the t-test.

Multivariate ANOVA without replications was performed to test the significance of the influence of freezing. Addition of structurisers – gelatine 6 g per 100 g maturation in water 30 min., dissolves by heating to 60 °C, cooling to 40 °C, adding to puree. Jellies were made from frozen puree after thawing.

The most important attribute of gelatine is its gel strength when determined by the standard method. This is the force in grams required to press a 12.5 mm diameter plunger 4 mm into 112 g of a standard gelatine gel at 10 °C. Several penetrometer type instruments have been adapted to determine Bloom Strength (Cole et al., 2000).

A frequent question is how to substitute gelatine of one Bloom Strength for gelatine of another. As a guide one can say:

$$C \times B^{½} = k$$

$$\text{or } C_1(B_1)^{½} \div (B_2)^{½} = C_2,$$

where: C = concentration; B = Bloom Strength; k = constant, however, there are other considerations besides gel strength which can invalidate such a substitution calculation.

For example, in a gummy formulation, the texture using 250 Bloom gelatine is far shorter than when 180 Bloom gelatine is used.

Data was processed using 2-factor nonlinear regression analysis method. The second row two-argument function $Z = Z(x, y)$ is examined and using the least square method such coefficients α_1 of the function are searched, with which the square difference between the distances of experimental data and appropriate theoretical data would be minimal. Since the impact of the factors is nonlinear, application of the first row – argument function would be incorrect. To evaluate the compliance closeness of the theoretical coherence, determination coefficient η^2, describing the compliance of obtained theoretical coherence with experimental data, is calculated. To process experimental data mathematical programme packages MathCad and Matlab were used.

Results and Discussion

The new products are developed on the bases of plant raw materials. These raw materials are not much researched; cultivars with high content of anthocyanins, flavonoids, carotenoids, and ascorbic acid are not selected. In order to improve continuous supply of Latvian inhabitants with locally produced good quality products of fruits and berries, it is necessary to carry out their complex study (Kampuse et al., 2003).

Therefore for each kind of product appropriate conditions have to be chosen for freezing, as also the state of products before freezing has to be taken into consideration to diminish to the minimum the harmful influences on their quality. An advanced preservation method – freezing is used, which enables obtaining a product with a high content of biologically active substances. It is provided by vitamins, enzymes and other substances included in berries, preservation of which is possible by using positive properties of quick freezing. Biologically active substances very quickly change into less valuable substances if the products are continuously or incorrectly treated (Kampuse et al., 2003).

Good quality is one of the main challenges in every stage of freezing berries. On the basis of worked out functional analysis of freezing, it is possible to optimize regulation possibilities of heat processes for a particular kind of berries. Freezing and storage in frozen condition substantially change content of the most labile vitamin of berries – vitamin C, what proves that maximum loss after freezing of blackcurrants does not exceed 20%. The most important changes after frozen storage are losses of water soluble vitamins (ascorbic acid, panthotenic acid) (Fellows, 1996).

To increase the storage time of production and not cause serious qualitative changes, it is necessary to determine the important question: how the freezing temperature and storage time influences preservation of the product. For the qualitative aspect using losses of vitamin C as the basis of measurement found that changes of vitamin C in prepared berries puree depended on storage time and temperatures. These measurements are shown in a contour plot (Fig. 1). Apparently the least loss of vitamin C is found at storage temperatures between -26 to -21 °C, that can be connected with the transformation of most part of water into ice and lowering the temperature of the frozen product at this temperature limit occurs the radical changes of product quality.

By mathematical processing of experimental data correlation has been obtained between loss of vitamin C in puree depending on the storage time of the puree t (months) and storage temperature T (°C).

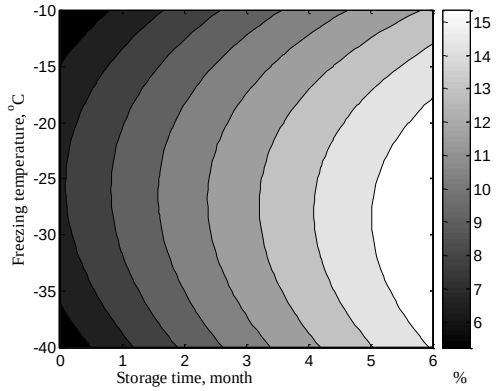

Figure 1. Influence of the freezing temperature and storage time on the preservation of strawberries puree

Thus loss of vitamin C (%) in strawberries puree during storage is characterised by correlation:

$$z = 1.5 \cdot t - 0.05 \cdot t^2 - 0.51 \cdot T - 0.01 \cdot T^2 - 0.012 \cdot t \cdot T + 1.06,$$

where: t - storage time (month); T - storage temperature (°C); z - loss of vitamin C (%).

Analyzing the obtained measurements it is apparent, that storage time plays an important role in the lessening of the content of vitamin C. The interconnection of storage time and the temperature of storage where in berries it is positive (i.e. goes down the level of vitamin C). The contour plot shows the correlation between storage temperature T, storage time t and the loss of vitamin C in berries. The amount of loss depends on the temperature of storage. The duration of storage doesn't considerably influence loss of vitamin C; it does only at lower temperature.

The new developed product – frozen half-finished fruit and berry products of high readiness – will increase the range of existent products. Food hydrocolloids are food additives, which are used to carry out certain functions of food products. Researchers showed that it is possible to store berry purees in frozen condition with no essential quality changes in comparison with fresh purees because essential difference between fresh and frozen puree was not established. Freezing was used in the research both, for continuous storage of berries, and preparation of jellies made of fresh berries, as half-finished products of high readiness. If a gelled jelly is frozen, the product will suffer from syneresis and on thawing the clear jelly will disintegrate with much exuded water. However, if water containing 0.5% gelatine is frozen, the water will freeze as millions of small discrete crystals, instead of forming a single solid block of ice. Gelatine is an amphoteric protein with isoionic point between 5 and 9 depending on raw material and method of manufacture. The only other animal product containing hydroxyproline is elastin and then at a very much lower concentration, so hydroxyproline is used to determine the collagen or gelatine content of foods (Barbosa-Canova et al., 2000).

Range of goods or services will increase related to development of many more appealing new products concerning texture and flavours. At the same time it would provide the consumer with a healthy product, because hydrocolloids are nature polymers with certain functions.

Widely applied gelatine was used in researches as it is more studied. Whereas for the mass with only gelatine added firmness of the product increases by increasing gelatine concentration (Fig. 2). The results indicate that the best solidity of the product is gained with only gelatine added of concentration 45 g per100 g of fruit mass. Researchers showed that mathematical correlation is possible between jelly forming ingredients what is indicated by the high determination coefficient $\eta^2 = 0.93$ and correlation expression:

$$p = 173 - 7.45 \cdot g + 0.12 \cdot g^2 + 6.7 \cdot s - 0.034 \cdot s^2 - 0.17 \cdot s \cdot g,$$

where: p – impact of the substance in jellies, %; s – sugar, g; g – gelatine, g.

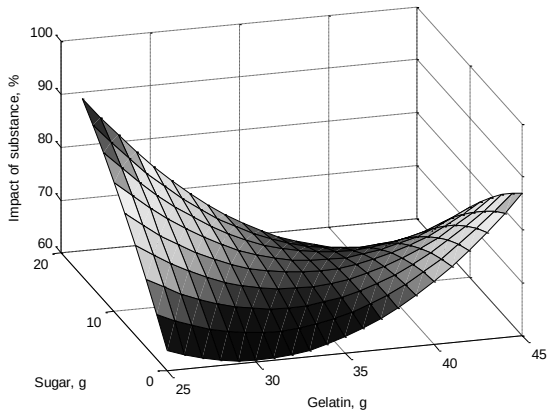

Figure 2. Impact of sugar and gelatine on jellies

The results of the research indicate that concentration of gelatine content influences the texture of the product. It is established that gelatine forms a very stabile disperse phase which provides higher stability during freezing and retains the shape of the product after thawing. Taking into consideration that nature of gelatine containing products rely on Hooke's law, concentration and temperature parameters are considered in the research. Polymer carbohydrates and proteins, included in the content of products, taking part in formation of jellies, if they are hydrated up to a particular level, are considered in the technological process. Researches show that the most efficiency is gained with sugar content 9–16 g at gelatine content 25–27 g per 100 g, when impact of substance in jellies reaches more than 80%.

Fruit jelly is a kind of half-finished product little used in practice, which is connected with the limited proportion of resources and equipments. By adding not only gelatin but also sugar to the fruit mass, solidity of the product decreases. Whereas for the mass with only gelatin added firmness of the product increases by increasing gelatin concentration. The results indicate that the best solidity of the product is gained with only gelatin added of concentration 45 g per 100 g of fruit mass.

Ice formation in food products takes place at relatively low temperature and products stored at the temperature

-18 °C are not yet fully frozen. Products containing higher concentration of small molecular sugar at low temperature contain more unfrozen water because quick frozen carbohydrate solutions as well as most of biological products are characterised by non-equilibrium formation of ice crystals with its specific concentration of solution (Kampuse et al., 2007). This is ascertained taking into consideration such storage temperature which is the temperature practically used also in Latvia. Substantial diversity was established in the blackcurrant jellies made of fresh and frozen berries, what proves that freezing of raw material influences quality of blackcurrant jellies.

Range of goods or services will increase related to development of many more appealing new products concerning texture and flavours. At the same time it would provide the consumer with a healthy product, because hydrocolloids are nature polymers with certain functions. In fruit and berries processing frozen berries as raw materials are increasingly being used. Half-finished products containing biologically active substances, healthy berry products requiring minimal expenditure of time and energy in order to reach adequate consumption quality are researched. On the bases of the research carried out it will be possible to develop technological instructions and regulations for the cultivars approbated in Latvia indicating the volume of natural mass losses, treatment and storage conditions, as well as economic effect for successful establishment of commercial orchards. As a result of the research a data base will be developed for technical and informative indices, which will enable to improve the technological process of storage, ensuring quality maintenance of berries and biological properties by minimal losses.

Conclusions

Development of the new product foresees reduction of these losses to the utmost already at the initial stage of the process, what is connected with correct preparation and storage of raw materials.

The results of the research indicate that concentration of the gelatine content influences the texture of the product. Further researches are necessary for the optimum usage of the product texture in order to enable use of fresh and frozen berries.

Frozen mousse contained significantly less vitamin C than fresh and frozen berries. It means that more ascorbic acid retains when frozen currants are kept as whole berries, not processed in mousse.

The obtained mathematical expression indicates that efficiency of sugar decreases if it is added more to the mass, with gelatine it is contrary – the more it is added, the efficiency increases; although by adding both, the efficiency decreases. It means that the limit has to be found, up to which this addition is with the positive character.

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