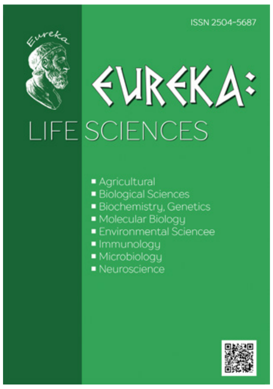

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THE NEW METHOD OF PROCESSING OF CAROTENE-CONTAINING VEGETABLES FOR THE PRODUCTION OF NANOPRODUCTS USING COMBI-STEAMERS AND FINE-DISPERSED COMMINUTION

Raisa Pavlyuk
Department of Technology Processing of Fruits, Vegetables and Milk
Kharkov State University of Food Technology and Trade
333 Klochkivska str., Kharkov, Ukraine, 61051
ktppom@ukr.net

Viktoriya Pogarska
Department of Technology Processing of Fruits, Vegetables and Milk
Kharkov State University of Food Technology and Trade
333 Klochkivska str., Kharkov, Ukraine, 61051
viktoria.pogarskaya@ukr.net

Ludmila Radchenko
Kharkov Trade-Economic Colledge of
Kyiv National University of Trade and Economics
202 Klochkivskaya str., Kharkiv, Ukraine, 61045
kharkiv@htek.com.ua

David Tauber Roman
Academy of Hospitality and Catering in Poznan
19 Nieszawska str., Poznan, Poland, 61-022
wshigua@i.ua

Nadiya Timofeyeva
Department of Technology Processing of Fruits, Vegetables and Milk
Kharkov State University of Food Technology and Trade
333 Klochkivska str., Kharkov, Ukraine, 61051
kdp2010@yandex.ua

Tatyana Kotuyk
Department of Technology Processing of Fruits, Vegetables and Milk
Kharkov State University of Food Technology and Trade
333 Klochkivska str., Kharkov, Ukraine, 61051
kotyuk.tatyana@mail.ru

Abstract

The aim of the work is elaboration of the principally new method of deep processing of carotene-containing vegetables (CCV). For attaining this aim was used the complex effect of steam-thermal processing and fine-dispersed comminution for preservation and extraction of biologically active substances from the raw material and getting products of nanosized form. There was also used the new generation of equipment: combi-steamer and dine-dispersed comminutor.

There was elaborated the new method of deep processing, alternative to cryogenic one. This method is based on the complex effect of steam-thermal processing and fine-disperse comminution using the modern equipment (combi-steamer and fine-dispersed comminutor) that is used at enterprises of restaurant business. This method allows use biological potential of the raw material more fully (2…3 times more) and get the foodstuff in nanoform.

It was shown, that at steam-thermal processing of vegetables (carrot, pumpkin) in combi-steam antioxidant enzymatic processes flow with less intensity (3…4 times less) than at blanching.

It was established, that at the steam-thermal processing in combi-steamer in 10 minutes in carotene-containing vegetables takes place not only conservation of β-carotene but also increase of its mass fraction in 2…2,5 times (comparing with initial raw material). Mechanism of this process is connected with fact that carotenoids are transformed from the hidden state (frms associated with biopolymers) into free form that is fixed by chemical methods.

It was also established, that after steam-thermal processing and fine-dispersed comminution of carotene-containing vegetables at preparation of puree takes place the significant increase of extraction of ascorbic acid and β-carotene comparing with initial raw material that is for pumpkin 2 and 3 times more and for carrot 1,7 and 2,5 times more, respectively.

It was established, that complex use of the new equipment at steam-thermal processing of vegetable raw material in combi-steamer with fine-dispersed comminution gives a possibility to get puree, which quality is approximated to the one of puree, received using cryogenic processing of product (especially, by the content of β-carotene and other biologically active substances (BAS).

Keywords: carotene-containing vegetables, steam-thermal processing, fine-dispersed comminution, products in nanoform.

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1. Introduction

The aim of the work is elaboration of the principally new method of deep processing of carotene-containing vegetables (CCV). For attaining this aim was used the complex effect of steam-thermal processing and fine-dispersed comminution for preservation and extraction of biologically active substances from the raw material and getting products of nanosized form.The was also used the new generation of equipment: combi-steamer and dine-dispersed comminutor.

Kharkov state university of food technology and trade (KSUFTT, Kharkov, Ukraine) together with Kharkov Trade-Economic Colledge of Kyiv National University of Trade and Economics, Municipal enterprise “Combine of child food” (Kharkov, Ukraine) and Academy of hospitality and catering in Poznan city (Poland) elaborated principally new method of the deep processing of vegetable raw material without using cold. The new method, alternative to cryogenic processing, allows not only maximally preserve, but also more fully use biological potential of vegetable raw material and transform BAS and polymers from the associated state in nanoform. This method is based on the process of non-enzymatic catalysis-mechanolysis (destruction of nanocomplexes that contain biologically active substances in hidden form) in steam-thermally processed vegetable raw material that leads to getting product in nanosized form.

As innovation in the work it was offered to use the complex effect on carotene-containing vegetables at steam-thermal processing and fine-dispersed comminution using the new generation of highly effective modern equipment – combi-steamer and activator – homogenizer-comminutor [1–4].

2. Materials and methods of research

2. 1. Studied materials and equipment used in experiments

The study was carried out at the department of technology processing of fruits, vegetables and milk of KSUFTT (Kharkov, Ukraine) in laboratory of “Innovative cryo- and nanotechnologies of vegetable additives and wellness products”. The steam-thermal processing was carried out in combi-steamer UNOX SPA of XVC series (Italy) that has 70 programs that differ by temperature regimes, intensity of steam supply, circulation or blowing by air (**Fig. 1**).

As objects of research there was used carotene-containing raw material – carrot (**Fig. 2**) and pumpkin (**Fig. 3**) and fine-dispersed puree of carrot and pumpkin in nanosized form (**Fig. 4**).

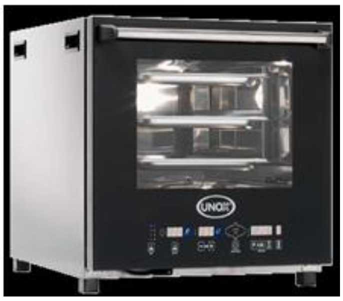

Fig. 1. Combi-steamer UNOX SPA of XVC series (Italy)

Fig. 2. Initial raw material (carrot)

Fig. 3. Initial raw material (pumpkin)

Fig. 4. Nanoproduct of carrot after steam-thermal processing and fine-dispersed comminution

At elaboration of principally new method of vegetables processing there was carried out comparison of effect of the different types of steam-thermal processing in combi-steamer and blanching on traditional equipment (blancher) on carotene-containing raw material (carrot and pumpkin) on the basic enzymatic, biochemical and mechanochemical processes. The steam-thermal processing of CCV samples (carrot, pumpkin) was carried out at such regimes: temperature in combi-steamer – 105 ºC, in product – 70…75 ºC, regime of steam creation – 100 % (that corresponds to the maximal amount of steam). In parallel there was carried out the thermal processing of raw material by blanching on traditional equipment (blancher – double boiler Kaiserhoff KH-8000, Germany). Blanching was carried out by immersion in boiling water at t=100 ^{o}C during 10 min, 20 min and 30 min. The steam-thermal processing was carried out during 30 minutes with samples collection each 5 minutes. The fine-dispersed comminution was carried out in activator – homogenizer-comminutor.

2. 2. Methodologies of determination of parameters of studied samples

The comparison of quality of initial vegetable raw material and products of it was carried out by enzymatic activity of oxidant enzymes (peroxidase, polyphenol oxidase), content of β-carotene mass fraction, low molecular phenol compounds and L-ascorbic acid. The content of aforesaid substances is the one of assessment criteria of the raw material quality, accepted in international practice [1, 2, 5, 6]. For assessment of samples quality there were used standard methods (especially, the methods of determination of mass fraction of β-carotene, L-ascorbic acid, phenol compounds, flavonol glycoside) excluding the method of enzymatic activity determination. The methods of determination of aforesaid substances are given below.

Determination of carotene-content (especially β-carotene) was controlled by colorimetric Muri method after exclusion of carotene from product by organic solvent and purification of carotene from concomitant color substances using column chromatograpy.

Determination of L-ascorbic acid was carried out by the method of visual and potentiometric titration by solution of 2,6-Na dichloroindorphenol.

Determination of the general quality of low molecular phenol compounds was carried out by colorimetric method of Folin-Denis.

Determination of the sum of flavonol glycosides was carried out by colorimetric method, based on the flavonols property to change the absorption spectrum at presence of aluminum salts and at pH change. Maximal flavonol absorption is within 350…390 nm. In alkaline medium or at presence of aluminum salts the light absorption displaces by 20 nm and more to the longer waves. This ability is used at determination of flavonol glycosides by Muri method by reaction of 2 % $AlCl_3$. The calculation of flavonol glycosides was carried out by rutin.

Determination of enzymatic activity (peroxidase and polyphenol oxidase) was carried out by the conventional method of M. Mikhlin and Z. S. Bronovitska, based on the quinone ability to oxidize ascorbic acid.

3. Results of research

It was established, that at the steam-thermal processing of carotene-containing vegetables in combi-steamer (at aforesaid regimes) in 10 minutes takes place not only conservation of β-carotene but also increase of its mass fraction in 2…2,5 times comparing with initial raw material. It takes place at the expense of carotene release from the hidden state (forms associated with biopolymers) into free form that is fixed by chemical methods of research. The same regularities are established also at blanching. It is also established, that the losses of vitamin C at thermal processing of carotene-containing vegetables in combi-steamer are 2 times less that at blanching. Thus, after 20 minutes of thermal processing in combi-steamer the mass fraction of L-ascorbic acid was preserved in 65…80 %, whereas after blanching – in 40…50 %.

It was also revealed, that after steam-thermal processing and fine-dispersed comminution of carotene-containing vegetables at preparation of puree takes place the significant increase of L-ascorbic acid and β-carotene extraction that is comparing with the raw material: for pumpkin – 2 and 3 times more, for carrot – 1,7 and 2,5 times more. It was elucidated the mechanism of this process, connected with mechanical destruction and mechanical cracking (destruction) of nanocomplexes of biopolymer-carotenoid, biopolymer ascorbic acid. At the same time there takes place the release of hidden associated forms of carotene and L-ascorbic acid of nanoassciates and nanocomplexes with proteins, polysaccharides, tanning substances and other in free form. These substances are controlled by the chemical methods of research [7, 8].

It was established, that complex use of the new equipment at steam-thermal processing of vegetable raw material in combi-steamer with fine-dispersed comminution gives a possibility to get puree, which quality is approximated to the one of puree, received using cryogenic processing of product, by the biologically active substances (BAS) content (**Table 1**).

Thus, for example, the mass fraction of β-carotene in 100 g of fresh pumpkin is 8,5 mg, in fine-dispersed puree – 26,5 mg in cyopuree – 32,2 mg. Mass fraction of β-carotene in 100 g of fresh carrot and fine-disperse puree of it is 9,2 mg and 24,6 mg, respectively, in cryopuree – 28,8 mg in 100g.

Thus, it was established, that after steam-thermal processing and fine-dispersed comminution of carotene-containing vegetables at preparation of puree takes place the significant increase of extraction of L-ascorbic acid and β-carotene that is for pumpkin 2 and 3 times more and for carrot 1,7 and 2,5 times more, respectively. The results of researches demonstrated the high effectiveness of the use of new generation of equipment for steam-thermal processing and fine-disperse comminution of carotene-containing vegetables that allowed get the half-finished products and ready products in nanosized form with unique BAS content characteristics that were earlier impossible to be gotten using traditional methods of the vegetable raw material processing and existing equipment [9, 10].

Table 1
Comparative characteristic of carotene of other BAS content in fresh, steam-thermally processed carotene-containing vegetables, fine-dispersed steam-thermally processed puree and nanostructured cryopuree of them (≥3)

Product	Mass fraction (mg in 100 g)			
	β-carotene	L-ascorbic acid	Phenol compounds (by chlorogenic acid)	Flavonol glycosides (by rutin)
Fresh carrot	9,5±0,3	8,2±0,2	146±1,5	50,2±1,8
Carrot steam-thermally processed in combi-steamer	19,4±1,8	7,0±0,3	120,4±1,4	40,2±0,9
Fine-dispersed steam-thermally processed carrot puree	24,6±2,0	15,2±0,9	200,6±3,2	85,4±2,4
Nanostructured carrot cryopuree	28,8±2,5	29,7±1,5	262,6±2,8	105,8±2,8
Fresh pumpkin	8,5±0,3	9,8±0,2	128,4±1,8	45,4±1,2
Pumpkin steam-thermally processed in combi-steamer	20,0±3,4	8,2±0,2	95,8±2,0	39,2±0,5
Fine-dispersed steam-thermally processed pumpkin puree	26,5±4,2	16,5±1,8	210,6±3,5	78,8±1,6
Nanostructired pumpkin cryopuree	32,2±2,6	19,7±1,0	210,6±2,8	98,6±1,8

4. Conclusions

It was established, that complex use of the new equipment at steam-thermal processing of vegetable raw material in combi-steamer with fine-dispersed comminution gives a possibility to get puree, which quality is approximated to the one of puree, received using cryogenic processing of product (especially, by the content of β-carotene and other BAS).

The probation in production conditions of ME "CCF", SPF "KPC", "CRYOS PLUS" (Kharkov, Ukraine) and production of experimental samples of nanoproducts of carotene-containing vegetables prove the expediency of using the new method of deep processing at getting nanoproducts using the new generation of equipment at enterprises of restaurant business and trade. Thus, the aforesaid method of the deep processing of vegetable raw material allows reveal more fully the biological potential of carotene-containing vegetables that can be useful not only in food production but also at getting the natural carotenoid pharmpreparations and additives for immunoprophylaxis of population and so on.

Among the aforesaid methods the most laborious and expensive are traditional methods of the vegetable raw material processing (blanching, boiling, frying and other). It is known, that at their use at the vegetable raw material processing take place the significant wastes (15…30 %) and losses of biological potential of vegetable raw material, not used by people. At that almost half of vegetables harvest is lost at its processing and production of different foodstuff.

The new method of deep processing of carotene-containing vegetables is principally new (unique, cheaper, less laborious), it not only preserves all valuable biologically active and food substances but also allows reveal the biological potential more fully, extract its hidden BAS, associated with biopolymers, into free soluble form. At the same time this method gives a possibility to transform the part of difficultly soluble biopolymers in soluble form – nanoform that is better assimilated by human organism (2,5…3 times better) [1, 2, 4].

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ABSTRACT AND REFERENCES

TECHNOLOGY AND EQUIPMENT OF FOOD PRODUCTION

DEVELOPMENT OF TECHNOLOGY OF USING SUBSTANDARD EGGS IN FARM POULTRY FEEDING (p. 4-14)

Bogdan Iegorov, Nina Vorona, Alla Makarynska, Olena Voietska Tatiana Bordun

Theoretically and experimentally, there was substantiated the expediency of enriching grain raw material in the composition of feed with the protein of animal origin due to a substantial reduction of nutritional and energy value of the grain components that are produced in Ukraine, often with violation of agrotechnology. The possibility to use valuable substandard egg mass for feeding agricultural poultry was proved. This will allow solving the problem of utilizing defective eggs.

A technological way of producing the extruded feed additive was developed, which implies obtaining the preceding mixture of crushed corn and egg mass without shell of substandard chicken eggs in the 1:1 ratio in a frame mixer for 180 s, mixing the preceding mixture with corn grit, which remained in the blade batcher for 120...180 s, and the extrusion of the resulting highly homogeneous mixture. The rational parameters of technological process of the extrusion of the feed additive were established: pressure in the working zone of the extruder is 2...3 MPa, power consumption of the electromotor is 4.0...4.5 kW, product temperature at the outlet of the extruder is 110...120 °C, duration of the process is 60...120 s, diameter of the hole of the matrix is 10 mm. The optimum amount of the egg mass in the mixture is 10 %. The influence of the extrusion process on the quality and nutritional value of the extruded feed additive was defined. During the extrusion process, the 3,1 % loss of crude protein content was observed, the starch content decreased by 26.8 %, in this case, the content of water-soluble carbohydrates increased by 6 times. During the storage of the extruded feed additive for 3 months, bacterial semination decreased by 7 times.

Biological assessment of efficiency of the improved technology of the production of extruded feed additive was defined on laboratory animals, and it was found that the extruded feed additive is characterized by high biological value, so in the tested group the daily average gain of live weight of rats was 25,4 % higher, and the conversion of feed was 20.3 % lower than in the control group.

Keywords: extruded feed additive, production technology, enrichment of grain raw materials, substandard eggs.

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EXPLORING THE COLOR OF PLANT POWDERS USING COMPUTER COLORIMETRY (p. 15-20)

Alexandra Niemirich, Oksana Petrusha, Oksana Vasheka, Lyudmila Trofymchuk, Natalia Myndrul

The question of using a new method of color measurement with the use of contemporary digital computer technology was considered, which implies obtaining, under certain conditions, digital image of the tested sample. The plant powders, explored in the work, contain a number of pigments, which determine both the color of the powder and the color of culinary products, in composition of which they are included.

When measuring color coordinates of the powders, their restoration with water was conducted, in this case, the restored samples have lower lightness in comparison with the native powder. The difference of change in the value of color coordinate L on average decreases by 20 %.

The measurement of color of prepared meals, which was made with the use of plant powders, showed that they have lower saturation in comparison with the powders, since the pigment concentration decreases. In this case, other ingredients of meals shift the magnitudes of color coordinates of lower magnitudes of saturation and lightness towards the lightness of native powder. The exception is the powder from sea buckthorn, the pigments of which are manifested poorly in the restored state.

The accessibility of the method makes it possible to use it for evaluating quality, controlling technological process of preparing meals and culinary products using traditional and innovative ingredients, including vegetable and fruit-and-berry powders.

Keywords: color coordinates, computer colorimetry, index of yellowness, plant powders, digital image, color.

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THE EFFECT OF CRYOMECHANODESTRUCTION ON ACTIVATION OF HETEROPOLYSACCARIDE-PROTEIN NANOCOMPLEXES WHEN DEVELOPING NANOTECHNOLOGIES OF PLANT SUPPLEMENTS (p. 20-28)

Raisa Pavlyuk, Viktoriya Pogarska, Katerina Balabai, Vadim Pavlyuk, Tatyana Kotuyk

The regularities and mechanisms of the effect of deep processing of plant raw materials were established, such as finely dispersed grinding in developing nanotechnology of obtaining frozen nanopuree and nanopowders on the transformation of bound amino acids of protein to free soluble form by мechanolysis of molecules of protein (by 45...55 % to separate α-amino acids). We discovered the mechanism of mechanodestruction of protein molecules and its nanocomplexes with other biopolymers and BAS, which is linked to mechanocracking.

In the deep processing of plant raw materials, in particular, Jerusalem artichoke, which is based on the comprehensive action of cryogenic «shock» freezing, freeze drying and finely dispersed grinding processes when obtaining nanopowders, the processes of cryodestruction, mechanodestruction and mechanochemistry occur that lead to the fuller extraction of BAS from the raw material (by 1.8...2.3 times more than is in the original raw material) and destruction of biopolymers (inulin, proteins) to their monomers.

It was found that the freezing and cryomechanodestruction lead to the transformation of chemical substances of Jerusalem artichoke (cryomechanochemistry) and transformation, in particular, conformational changes of protein molecules: reduction of radius of the volume of a protein molecule, radius of its nucleus, and also to a decrease in the indicator of filling the nucleaus with hydrophobic remains of amino acids. In addition, the shape of protein molecules changes.

We proposed and designed cryogenic nanotechnology of finely dispersed frozen nanopuree and nanopowders from Jerusalem artichoke with prebiotic properties. It was shown that nanosupplements exceed the known world analogues in the content of BAS and dispersed composition. In addition, a large part of the substances (both BAS and biopolymers) is in the nanodimensional form.

Keywords: deep processing of raw materials, cryomechanodestruction, finely dispersed grinding, Jerusalem artichoke, nanocomplexes, nanopowders, nanopuree.

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THE STUDY OF BIOLOGICALLY ACTIVE SUBSTANCES OF CHAENOMELESAND THE PRODUCTS OF ITS PROCESSING (p. 29-35)

Galyna Khomych, Yuliia Levchenko, Aleksandra Horobetc, Anzhela Boroday, Nataliia Ishchenko

The importance of developing food products of improved biological value to ensure the healthy nourishment of the population was analyzed. The prospects of using plant raw materials as a source of biologically active components were shown. The chemical composition of chaenomeles fruit and of the products of its processing was determined. The biological value of the components of the fruit was explored, and it was found that maximum amount of L-ascorbic acid is contained in the pulp of the fruit and that maximum amount of phenolic substances is contained in the peels of the fruit. With the help of chromatographic studies, it was established that the products of chaenomeles processing have significant content of organic acids, among which malic, quinic, citric and succinic acids were identified, malic acid is dominant amomg them. The sugars, found in the fruit of chaenomeles, are represented by fructose, glucose and saccharose, among them fructose and glucose prevail. The raw material contains procyanidins, hydroxycinnamic acids, flavones and flavan-3-ols, among them procyanidin trimmer, chlorogenic acid, rutin and epicatechine dominate, which have high antioxidant properties. In the products of chaenomeles processing, 48 types of aromatic compounds were identified, among which prevail alcohols, acids, ethers and unsaturated carbohydrates that give products of chaenomeles processing unique aroma and predetermine their antibacterial properties.

The products of chaenomeles processing (juice, puree) are a valuable source of organic acids; they were used as a natural regulator of acidity and as an antioxidant in manufacturing products from flour yeast dough. Puree fromchaenomeles contains a significant amount of pectic substances and was used in the production of fruit sauces as a structuring agent. An increase in the organoleptic and physical and chemical indicators in fruit sauces and flour products with the use of products of chaenomeles processing was established.

Keywords: chaenomeles, chemical composition, chromatograms, procyanidin, aromatic substances, sauce, flour products.

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DEEP PROCESSING OF CAROTENE-CONTAINING VEGETABLES AND OBTAINING NANOFOOD WITH THE USE OF EQUIPMENT OF NEW GENERATION (p. 36-43)

Raisa Pavlyuk, Viktoriya Pogarskaya, Ludmila Radchenko, Roman Tauber, Nadiya Timofeeva

We proposed and designed a new method of deep processing of carotene-containing vegetables – alternative to cryogenic treatment, based on the comprehensive action of steam thermal treatment and finely dispersed grinding on raw materials using a new generation of equipment that is applied in restaurant business, which makes it possible to more fully utilize biological potential (2...3 times higher than in the original raw materials).

It was found that during deep (steam convection) processing of carotene-containing vegetables (carrot and pumpkin) with the use of modern steam convection equipment, the fermentative processes proceed with less intensity than during traditional method of thermal treatment – blanching by immersion in boiling water. The quantitative indicator of the maximum fermentative activity during treatment of the carotene-containing vegetables in a combi steamer, compared to blanching, is 2–4,5 times less for polyphenol oxidase, by 3 times for peroxidase. It was demonstrated that the complete inactivation of oxidative enzymes during thermal treatment of carotene-containing vegetables in a combi steamer occurs earlier than during blanching and takes place in 20 minutes, which is 10–15 minutes faster than at blanching. The complete inactivation of oxidative enzymes during blanching of carotene-containing vegetables occurs in 30–35 minutes.

It was demonstrated that, compared with fresh raw materials, during thermal treatment of carotene-containing vegetables (carrot, pumpkin) in a combi steamer (under the above-mentioned modes), not only the preservation of β-carotene is achieved in 10 minutes, but also the increase in its mass by 2...2,3 times that occurs due to the release from the hidden state (forms, associated with biopolymers) to free form that is registered by the chemical methods of research. It was found that the loss of vitamin C during thermal treatment of carotene-containing vegetables in a combi steamer is much lower than at blanching. Thus, after 20 minutes of thermal treatment in the combi steamer, the mass fraction of L-ascorbic acid remained by 65...80 %, while after blanching by 40...50 %.

It was also demonstrated that after steam thermal treatment and finely dispersed grinding of carotene-containing vegetables when making puree, a significant increase in the extraction of L-ascorbic acid and β-carotene occurs in comparison to the original raw materials, which is 2 and 3 times larger for pumpkin, respectively, and for carrot – 1,7 and 2,5 times, respectively.

It was found that the comprehensive application of steam thermal treatment of vegetable raw materials in a combi steamer with finely dispersed grinding makes it possible to obtain puree, the quality of which is close to the quality of the puree, obtained using the cryogenic product treatment (in particular, the content of β-carotene is 2,5...3 times during steam thermal treatment and is 2,8...3,5 times during cryogenic treatment).

Keywords: deep processing, carotene-containing vegetables, steam thermal treatment, finely dispersed grinding, steam convection furnace, products in the nanoform.

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DETERMINATION OF TOTAL ANTIOXIDANT CAPACITY IN MARMALADE AND MARSHMALLOW (p. 43-50)

Sergey Gubsky, Maiia Artamonova, Natalia Shmatchenko, Inna Piliugina, Elena Aksenova

Creation of functional foods with various plant additives as a preventive means of population antioxidant protection programs is an important task, the solution of which is impossible without a preliminary assessment of antioxidant properties of food components – plant material. For this purpose, the antioxidant capacity of plant additives of apples, quince, grapes, pumpkins, carrots, rose hips, sea buckthorn, Sudanese rose, black chokeberry, obtained by cryogenic technologies and products with them – fruit jelly and marshmallow was investigated by galvanostatic coulometry. It was found that the TAC of cryopastes increases in the row: pumpkins<carr ots<quince<apples<grapes from 25 to 550 C/100 g. The TAC of cryopowders increases in the row: grapes<black chokeberry<Sudanese rose<sea buckthorn<rose hips from 663 to 4400 C/100 g. The values correlate with the content of the main classes of antioxidants in these cryoadditives. It was determined that marmalade with the addition of carrot and pumpkin cryopastes has the lowest bromine TAC. Additional introduction of cryopowders in marmalade samples with cryopastes in an amount 1.5 % increases the TAC of marmalade by 3.5–10 times. It is shown that the use of water-alcohol extracts as additives with the addition of 1 % citric acid provides the samples of marshmallow with more pronounced antioxidant properties.

The calculations, based on the additive scheme show that the functional properties of the products are due to the antioxidant properties of the additives.

Keywords: antioxidant, coulometry, plant additive, cryogenic technology, cryopaste, cryopowder, marmalade, marshmallow.

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THE STUDY OF NANOPARTICLES OF MAGNITITE OF THE LIPID-MAGNETITE SUSPENSIONS BY METHODS OF PHOTOMETRY AND ELECTRONIC MICROSCOPY (p. 51-61)

Alexandr Alexandrov, Iryna Tsykhanovska, Tatyana Gontar, Nicholas Kokodiy, Natalia Dotsenko

With the aid of the methods of photometry and electronic microscopy, we studied the sedimentation and aggregative stability of the lipid-magnetite suspensions (LMS). Different LMS were obtained. All suspensions are sufficiently stable over time. The best results in stability were displayed by suspensions, in which the ratio Fe_3O_4:SAS=0,02:0,35 g or 0,04 mass %:0,70 mass % and 0,025:0,35 g or 0,05 mass %:0,70 mass %. We determined size of the particles of magnetite with SAS. The order of mean particle size is defined – it amounts to <d>~76 nm.

It was found that in the course of time (0–48,0 h) and with an increase in the wavelength (210–1000 nm), a gradual increase in the coefficient of transmission is observed from 25 % (210 nm) to 71,9 % (1000 nm) at 0 hours of exposure of the suspension: from 27,5 % (210 nm) to 81,2 % (1000 nm) at the maximum period of exposure of the suspension (48 hours).

The indices of LMS are determined: concentration of the particles – N=1,43 1012 cm^{-3}, in 48 hours the concentration decreased by 20 % (N=1,19·1012 cm^{-3}); r=38 nm, n=1,48, κ=0,01. The distribution function of the particles by size is rather narrow and symmetrical, which indicates that the system of the synthesized nanoparticles is homogenous with a low degree of polydispersity.

The UV spectra of LMS and their components were taken and analyzed. The comparison of the spectra of transmission of suspensions with different degree of dilution testifies to chemical identity of the samples.

The kinetic dependences of the coefficient of transmission for the suspensions with different concentration of magnetite (Fe(ov.).), were examined, based on which we calculated the effective mean radius of the particles of the stabilized magnetite: 76–168 nm. The mean radius of the particles in the lipid suspension of magnetite without stabilizer (r_{eff})=400 nm. Visually, LMS manifested high aggregation stability at the total time of sedimentation reaching several tens of hours.

It was established that LMS can be used as the biologically-active and food supplements, which possess the comprehensive action: beneficial biological effect on the human organism; due to the presence of bivalent iron in magnetite and capacity to form transition complexes with oxygen and peroxide radicals (and hydroperoxides), they manifest antioxidant activity, which leads to improvement in the quality and lengthening of the period of storage of the products that contain fat. Furthermore, LMS due to Fe^{2+} of magnetite can be recommended as the source of easily assimilated iron and as the anti-anemic means. Therefore, the introduction of LMS to the food products increases its quality, nutritional and biological value.

Keywords: magnetite, photometry, electron microscopy, dispersibility, size and effective mean radius of particles, stabilization, magnetite suspension, surface active substance (SAS), sedimentation and aggregative stability.

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SUBSTANTIATON OF SELECTING THE METHOD OF PRE-COOLING OF FRUITS (p. 62-68)

Marina Serdyuk, Dmitrij Stepanenko, Svitlana Baiberova, Nonna Gaprindashvili, Alina Kulik

The research is devoted to the scientific substantiation of the feasibility of combination of pre-cooling the fruits and their treatment by antioxidant compositions before prolonged storage, as well as determining the optimal modes and methods of carrying out the given technological operation. The objects of research were the fruits of apple varieties Aydared, Golden Delicious, Simirenko Renet, Florin, the fruits of pear varieties Izyuminka Crimea and Conference, the fruits of plum varieties Voloshka and Stenley. Pre-cooling was conducted in three ways: by cold air in conventional storing chambers, by cold air in the chambers of intensive cooling and hydro-cooling in the solutions of antioxidant compositions. As a result of the studies, it was found that the most intensive method of pre-cooling is cooling by air at temperature minus 2...minus 4 °C and airflow velocity 3 m/s. Under such circumstances, general period of cooling to a temperature 0 °C of the apple fruits and pear fruits is about 2 hours and the plum fruits – slightly longer than 1 hour. The velocity constant of reduction in the intensity of breathing and heat release of fruits during intensive cooling exceeded the velocity constant of the analyzed indices during slow cooling by 4.3...6.6 times and during hydro-cooling by 1.2...1.6 depending on the type of fruit. Along with this, high speed of air motion increased the natural weight loss of fruits during cooling. The quantitative value of this indicator during intensive method was maximum and varied in the range of 0.56 % for the pear fruits to 0.44 % for the plum fruits. Combined method, which implies initial pre-cooling in the working solutions of antioxidant compositions and further cooling by the intensive method, was characterized by high velocity constant of reduction in the intensity of breathing and heat release of the fruits and low level of the natural loss weight. In this case, the quantitative value of the weight loss varied in the range from 0.005 % for plum fruits to 0.014 % for the apple and pear fruits.

Keywords: pre-cooling, antioxidants, hydro-cooling, intensity of breathing, heat release of fruits, weight loss.

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