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RESEARCHES OF THE INFLUENCE OF SEA BUCKTHORN ON THE FORMATION OF QUALITY PARAMETERS OF EMULSION-TYPE SAUCES

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Abstract. It is proposed to use dried sea buckthorn berries in the form of their oil extract for mayonnaise production with the aim to increase their nutritive value. Applying the method of IR spectroscopy, the features of the qualitative chemical composition of dried sea buckthorn berries, as well as their oil extract and mayonnaises prepared with the use of oil extract of dried sea buckthorn berries were determined. It is established that IR spectrums of dried sea buckthorn berries, as well as their oil extract and sauces prepared with the use of oil extract of dried sea buckthorn berries include the same set of absorption bands, which belong to the following types of vibrations: stretching of hydroxyl groups into the molecules of acids, carbohydrates, flavonoids, tocopherol at the level between 3365 $cm^{-1}$and 3400 cm^{-1} ν (OH); at the level of 3009, 1418 cm^{-1} and 723 cm^{-1} – stretching and bending vibration of –CH double bond of cis-isomers of polyunsaturated fatty acids; at the level of 2926, 2855, 1467 cm^{-1}– asymmetric and symmetric, scissor stretching ν (C–H) of the carbon skeleton into–CH_2; at the level of 1746 cm^{-1}– ν (C=O) stretchingof carboxylic and fatty acids; stretchingof ν (C–O) ester bonds and triglycerides are characterized by three peaks with maximums of 1238, 1163 and 1099 cm^{-1}. The viscosity of mayonnaises prepared with the use of oil extract of dried sea buckthorn berries of amount of 5.0 and 10.0% of the weight of raw materials was studied. It was found that the effective viscosity of mayonnaise prepared with the use of oil extract of dried sea buckthorn berries of amount of 10.0% of the weight of raw materials is 2.2 times higher than that of the reference sample while its stability matches as closely as possible to the reference sample. According to the results of laboratory testing of the recipes of mayonnaises prepared with the use of oil extract of dried sea buckthorn berries, the high quality of sauces according to sensory parameters and their compliance with the requirements of current regulations have been established. The obtained results testify to the expediency and prospects of using of dried sea buckthorn berries in the form of their oil extract of amount of 10.0% of the weight of raw materials for mayonnaise production in order to increase its nutritive and biological value, specifically the content of carotenoids, tocopherol, flavonoids, polyunsaturated fatty acids. Besides, dried sea buckthorn berries could be used as a stabilizer and emulsifier of food systems, especially of emulsion sauces.

Key words: emulsion sauce, mayonnaise, dried sea buckthorn berries, sea buckthorn fruit oil extract, emulsion, IR spectroscopy, effective viscosity.

Introduction. Formulation of the problem

The fast pace of modern life has led to the fact that a significant amount of consumers are forced to choose fast food, which, in turn, leads to the formation of poor diets with a pronounced deficiency of many vital nutrients. Against the backdrop of steady stress and lack of physical activity, this causes a decrease in the body's protective functions, the contraction of a number of diet-related diseases, premature loss of productivity and so on. Therefore, an extremely important task today is to find ways to fill human diets with so called funclional products contained a significant amount of deficient nutrients and biologically active substances [1,2].

According to statistics [3], one of the products of daily consumption of many people who prefer fast food are emulsion-type sauces, including mayonnaise, which over the past 100 years has been considered one of the most used sauces in the world [4-6] due to its high sensory characteristics, ease of preparation and significant nutritional value. It is well known that modern enterprises use phospholipids in the production of sauces, which are used in chemically modified form (for instance, compositions of mono- and diglycerides with food phospholipids). Chronic consumption of such products can lead to deterioration of health and contraction of a number of serious diseases, such as cancer, cardiovascular, gastrointestinal, allergic, etc. [7]. Considering this, finding of the ways of process improvement in emulsion-type sauce productions with the use of natural raw materials is an important scientific and practical task of the modern food and restaurant industries.

Systematic consumption of such products can lead to deteriorating health and a number of serious diseases – cancer, cardiovascular, gastrointestinal, allergic, etc.

Analysis of recent research and publications

A lot of researches conducted in Ukraine and abroad aimed to solve the problem of process improvement in mayonnaise production as well as raise their nutritive value and quality. Hydrocolloids and protein-polysaccharide complexes, plant extracts, vitamin-mineral complexes, dietary fiber, polyunsaturated fatty acids (PUFA) are used as functional ingredients for the production of emulsion products of high customer value [8-10]. The use of new ingredients in the recipes of sauces during the development of their technologies requires a comprehensive study of the impact of new components on the functional and technological properties of the main raw materials as well as justification of the viability of their applicatiion [11].

Scientific and practical interest is the development of low-calorie sauces. Meiners Mary D. and co-authors proposed recipes and technologies for low-calorie mayonnaise sauces with the use of whey protein concentrate, egg whites, polydextrose, modified starch, gums, microcrystalline cellulose, water and auxiliary ingredients such as dyes, aromatics, shugar, vinegar and oils [12]. At the same time, most of the modern consumers prefer food products and dishes that do not contain food additives and have functional properties [13,14]. That's why development of the technologies for sauces with the use of natural raw materials is taken for more preferable in the modern world.

Industrial enterprises of different countries traditionally use sunflower, soybean and corn oils as a fat base for mayonnaise production [4,15-17]. At the same time, the scientific substantiation of the use of alternative to traditional lipids, such as flaxseed oil, olive oil [18], coconut oil [19], as well as their mixtures, for the production of mayonnaises is in progress. The interest of scientists and practitioners in this area is due to the fact that this approach allows in addition to obtaining special purpose products, more efficient use of natural resources [20].

Indeed, Dyakonova A.K. and Stepanova V.S. proposed to use a mixture of flaxseed, olive and corn oils as a fat phase and skim soy flour in combination with a decoction of the muscular membrane of cucumaria and skimmed milk powder as emulsifiers [21] for the mayonnaises production. As reported by authors, high sensory characteristics, balanced composition of PUFA, high selenium content and absence of cholesterol reside in new product.

Belal J. Muhialdin and co-authors investigated the possibility of the use of cold-pressed coconut oil for the production of mayonnaises in order to obtain products with high antioxidant properties [19]. The authors found that the replacement of traditional coconut oils in mayonnaises recipes can significantly increase the antioxidant activity of the product and its resistance to fat oxidation during storage. At the same time, sauces made with complete replacement of traditional oils to coconut oil are inferior in sensory and rheological quality.

The search for alternative to traditional emulsifiers, consistency stabilizers and preservatives is an important direction in the development of the technology of mayonnaises production. Thus, Choni I.V. and Sutkovich T. Yu. substantiated the possibility of using hydrothermally processed oatmeal and pearl barley flour in the amount of 5–13% as an emulsifier in the technology of mayonnaise sauces [22], this results in a high quality product. Yurchenko S.O. and co-authors [23] proposed to use cranberry juice in mayonnaises production, and dogwood in sweet and sour sauces production with the aim to improve microbiological stability of products during the storage and increase the content of antioxidants [24].

Many researchers have studied the possibility of the use of spices variety (such as garlic, rosemary, cloves, cumin, oregano, ginger, ginger, turmeric, ginger, turmeric, turmeric, turmeric thyme, dill, parsley, etc.) in mayonnaises production with the aim to increase their taste, microbiological stability and antioxidant activity [5,11,25,26].

Deynychenko G.V. and co-authors have proved the feasibility of the use of different types of wild raw materials, including sea buckthorn berries and seaweed, for the production of sweet and sour sauces of high biological value. According to the results of studies the use of of kelp, fucus and undaria pinnate in the amount of 8; 5 and 3%, respectively, allows to obtain sauces with high iodine content [27].

Sea buckthorn in terms of throughput heads the list of wild crops with valuable nutrient composition [28]. Due to this it appears as one of the advanced types of raw materials for emulsion-type sauces production. It contains a range of biologically active substances, including fat-soluble vitamins and ascorbic acid, flavonoids, folic acid, carotenoids, betaine, choline, coumarins, glucose, fructose and phospholipids, a large number of organic acids (malic, citric, citric, coffee) and tannins. Due to this, sea buckthorn has a powerful antioxidant effect. Consumption of sea buckthorn berries helps to strengthen the walls of blood vessels and reduce their permeability, improve metabolism, rapid wound healing and tissue repair in case of inflammation [29]. The absence of the ascorbinoxidase enzyme in sea buckthorn berries helps to preserve vitamin C as much as possible during their processing [30]. It is also known that sea buckthorn powder has bactericidal properties [31], and food products with its addition are characterized by improved microbiological stability [32].

Thus, research aimed at substantiating the use of sea buckthorn in the technology of products, in particular emulsion-type sauces, is of scientific and practical interest.

The purpose of the research is to substantiate the use of sea buckthorn berries in the technology of emulsion-type sauces production. To achieve this goal, the following **objectives** were formulated:

– to analyze the chemical composition of dried sea buckthorn berries, oil extract of dried sea buckthorn berries, as well as emulsion-type sauces made with the use of oil extract of dried sea buckthorn berries using the method of IR spectroscopy;

– to study the rheological properties of emulsion-type sauces made with the use of oil extract of dried sea buckthorn berries;

– to carry out a comparative analysis of sensory quality indicators of emulsion-type sauces made by known technology and with the use of oil extract of dried sea buckthorn berries.

Research materials and methods

Ddried sea buckthorn berries produced by sole proprietor Panchuk I.M. (Vinnytsia, Ukraine) according to the technical specifications TU U 82.9-3041714518-001: 2020, sunflower oil (refined and deodorized) produced by Novo-Vodolazhsky Oil and Fat Plant LLC (Ukraine) according to the national standard of Ukraine DSTU 9442, chicken egg produced by enterprise "Interbusiness" (Ukraine) according to to the national standard of Ukraine DSTU 5028: 2008, food acetic acid of 9% concentration produced by sole proprietor Gorodysky O.M. (Ukraine) according to the technical specifications TU U 15.8-2362600968-002: 2005, white crystalline sugar obtained from sugar beets produced by ATB-Market LLC (Ukraine) according to to the national standard of Ukraine DSTU 4623 / GOST 31361 were used in the research.

Dried sea buckthorn berries before the application were ground to a powder with the use of a laboratory mill Miller-800 during 2·60 s. A powder obtained was similar to white flour namely the average size of their particles was 40 μm and there were also particles with the size up to 240 μm. Ground sea buckthorn berries were used to prepare oil extract and mayonnaises with the use of oil extract.

Sea buckthorn oil extract was prepared by mixing 10.0 g of sea buckthorn powder with 100 g of refined deodorized sunflower oil at the speed of the working body of the laboratory magnetic stirrer LMM-2 1000 rpm for one hour.

After mixing, the oil extract was subjected to filtration under normal pressure in two stages. At the first stage oil extract was filtered through the 4 layers of medical gauze of type 17 (national standard of Ukraine DSTU EN 14079: 2009). At the second stage filtration was performed with the use of a folded filter made from the filter paper.

To obtain emulsion-type sauces, all prescription ingredients were emulsified in a Braun MR 530 household blender in turbo mode for 1–2 min to form a product of homogeneous semi-thick consistency. Test samples of mayonnaises were prepared by replacing 5.0 and 10.0% of the prescribed amount of refined deodorized sunflower oil with sea buckthorn oil extract obtained as described above. Mayonnaise made without the use of sea buckthorn oil extract was used as a reference sample [33]. Recipes according to which mayonnaises were prepared are given in Table 1.

Table 1 – Recipes of mayonnaises

Raw materials	Net weight of raw materials (g) for the preparation of test samples of mayonnaises with the use of sea buckthorn oil extract in the amount of:		
	without addition (reference sample)	5.0%	10.0%
Sunflower oil	750	700	650
Sea buckthorn oil extract	–	50	100
Chicken egg	90	90	90
White sugar	20	20	20
Acetic acid 9%	120	120	120
Outcome	1000	1000	1000

The chemical composition of the chopped dried sea buckthorn berries, oil extract and mayonnaises was determined by Perkin-Elmer SpectrumOne FTIR Spectrometer with the use of potassium bromide in the range of 500 cm^{-1} to 4000 cm^{-1}. The spectra of the test samples were recorded in a thin layer between the plates with zincum selenide [32]. Sunflower oil (refined and deodorized) was used as a reference sample in the study of the IR spectra of sea buckthorn oil extracts.

Rheological properties of sauces were determined by the effective (dynamic) viscosity, which was determined with the use of a rotary viscometer Brookfield DV-II + PRO in stand-alone mode in the range of spindle speed (shear rate) 0.3–100 rpm. The calculation of the coefficient of consistency and the rate of destruction of the structure of the emulsion was performed in the MathCad system by the method of least squares by minimizing the composed function

$$J = \sum_{i=1}^{N} (B\gamma_i^{-m} - \eta_i)^2 ,$$

obtained from the formula:

$$\eta_{еф} = B \cdot \gamma^{-m} \quad (1)$$

where $\eta_{еф}$ is effective (dynamic) viscosity, mPa·s;
B is coefficient of consistency proportional to viscosity, Pa·s;
γ is shear rate, s^{-1};
m is the rate of destruction of the structure, s^0.

The thixotropy coefficient, which characterizes the ability of the macroscopic system to self-repair the structure after its destruction [34], was calculated by the formula

$$\lambda_T = \frac{B_з}{B_n} \cdot 100 \quad (2)$$

where λ_t is thixotropy coefficient, %;
V_r is the value of the coefficient of consistency, proportional to the viscosity, in reverse, Pa·s;
V_s is the value of the coefficient of consistency, proportional to the viscosity, in a straight line, Pa·s.

The influence of the content of oil extract of dried sea buckthorn fruit in the recipe on the effective (dynamic) viscosity of mayonnaise sauces was described by a statistical model of simple regression

$$B = b_0 + b_1 \cdot c, \quad (3)$$

where b_0 and b_1 are coefficients of regression,
c is the content of oil extract of dried sea buckthorn berries, %.

Coefficients of regression b_0 i b_1 determined by the method of least squares.

Sensory characteristics of emulsion-type sauces (appearance, color, odor, taste, consistency) were evaluated in view of their compliance with national standart of Ukraine DSTU 4560: 2006.

Statistical processing of experimental data was performed with the use of MathCad.

Results of the research and their discussion

Chemical composition of raw materials determines not only nutritive and biological value of food products manufactured from them, but also defines the peculiarities of behavior of semi-products during the processing as well as sensory and physiochemical quality characteristics of finished products. In this view, at the first stage of research it was considered expedient to study the qualitative chemical composition of dried sea buckthorn berries, their oil extract and sauces made with the use of oil extract of dried sea buckthorn berries.

It was found that the IR spectra of the powder obtained from dried sea buckthorn berries is characterized by the presence of specific absorption bands at 3400, 2925, 2854, 1746, 1651, 1457, 1379, 1235, 1163, 1056, 722, 608 cm^{-1} (Fig. 1).

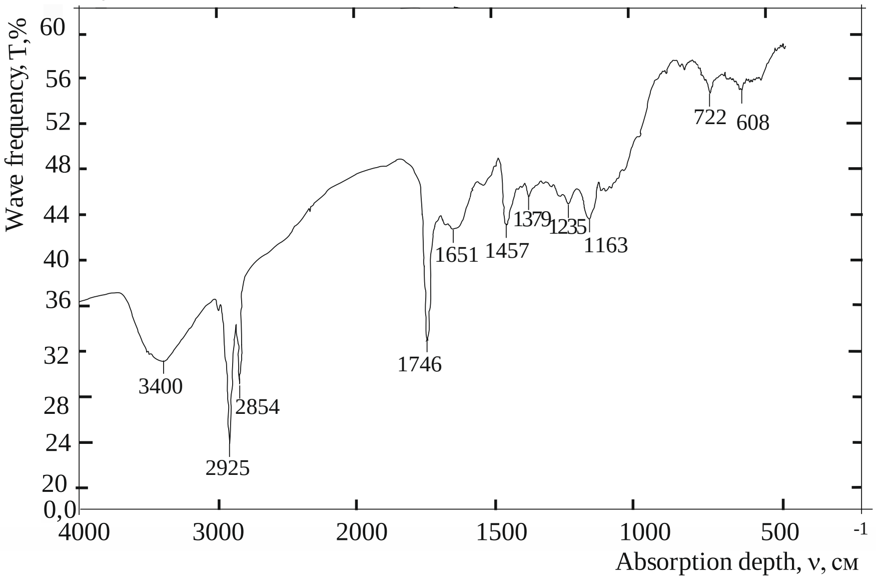

Fig. 1. IR spectra of sea buckthorn powder

This indicates that the chemical composition of dried sea buckthorn berries is represented primarily by oil rich in carotenoids, tocopherols, phospholipids, essential fatty acids, vitamins of different groups (C, B_1, B_2, PP), organic acids, sugars, flavonoids, amino acids, tannins and other biologically active substances (BAS), which correlates with the results obtained by Tudoret C. and co-authors [10], as well as Seglina D. and co-authors [30]. Against this background, it could be predicted that the use of dried sea buckthorn berries in formulations of food emulsion systems will serve to increase their antioxidant resistance, nutritional and biological value, including adjusting the fatty acid composition of the lipid component for omega-6 and omega-3 fatty acids.

The absorption bands specific to the aromatic part of flavonoids can be distinguished in the IR spectra of dried sea buckthorn powder: 3400 cm^{-1} (phenolic oxy groups with intermolecular hydrogen bonds), 1651 cm^{-1} (carbonyl group of γ-pyrone), 1457 cm^{-1} skeletal vibrations of aromatic rings). A maximum at 2925 cm^{-1} proves the presence of methoxyl groups. The presence of carbohydrates in the composition of sea buckthorn powder is evidenced by absorption bands: provided by asymmetric and symmetric valence vibrations of $-CH_2$ groups at frequencies 2854 and 2925 cm^{-1}; vibrations associated with groups C-O-H and R-O-H at 1457, 1235 cm^{-1}, 722 cm^{-1} and -OH groups at 3300–2500 cm^{-1}. Vibrations of carboxylic acid groups and their esters: valence vibrations of C=O groups at 1746 cm^{-1} and C-O vibrations at 1379 and 1235 cm^{-1} bonds.

The analysis of the IR spectra of sea buckthorn oil extract (line 1, Fig. 2) and sunflower oil, refined and deodorized (line 2, Fig. 2), revealed characteristic bands of valence vibrations of the carbonyl group (C=O bonds), in particular a strong band at 1746 cm^{-1}, which confirms the presence in the test samples of esters of higher carboxylic acids. In addition, esters of higher carboxylic acids are also characterized by valence vibrations of the -C-O bond at the region of 1200–1170 cm^{-1}. Valence vibrations C–O are evident as three peaks specific for triglycerides with maximum at 1238, 1163 and 1099 cm^{-1}. In addition, the peak at 1378 cm^{-1} is associated with fluctuations of the methyl group. The bands of vibrations 2923, 2854 and 1464 cm^{-1} can be attributed to asymmetric, symmetric and scissor vibrations of the groups $-CH_2-$. Since fragments of higher aliphatic acids are present in the test samples, vibrations at the region of 723 cm^{-1} appear in the spectra, which correspond to the pendulum vibrations of several related $-CH_2$ groups, and the band at 1163 cm^{-1} belongs to the same type of vibrations.

Unsaturated hydrocarbon chains that are part of triglycerides can be detected by the valence vibration at 3009 cm^{-1} of the group -CH = CH- for cis-isomers. The bands of deformation vibrations of the CHR = CHR′ type bonds are usually located for the trans-isomers at the range of 1310–1290 cm^{-1}, and for the cis-isomers at the range of 1420–1400 cm^{-1}. The valence vibration bands are located for both trans-isomers and cis-isomers at the range 3040–3010 cm^{-}1. The presence of bands of 1418 and 3009 cm^{-1} at the spectrum of both oil samples allows to estimate the presence of unsaturated bonds mainly in the cis-configuration. The higher intensity of these bands could be attributed to the high content of unsaturated fatty acids in sea buckthorn berries, in particular: oleic, linoleic and linolenic, as well as retinol [35].

For carboxylic acids, the vibrations of the carbonyl group are at the range of 1725–1700 cm^{-1} (acid dimers) or 1760 cm^{-1} (acid monomers). Besides, acids are characterized by vibrations of the free or bound hydroxyl group lying at the range of 3550-3500 cm-1 (free group), 3300-2500 cm-1 (wide weak band of the bound hydroxyl group), 955-890 cm-1 (any hydroxyl group). Since the characteristic bands of the hydroxyl group are absent in both oil samples, the presence of free carboxylic acids in the oil samples can be safely denied. The absence of a wide absorption band at the region of 3400–3200 cm^{-1}, specific for polyassociated hydroxyl groups, excludes the presence of free glycerol in the oil samples. A distinctive feature of sea buckthorn oil extract is the presence of bands 2679 (valence vibrations of –CH groups (OCH3 flavonoids), 2323 (extraplanar deformation vibrations of C=O group in aromatic flavonoid rings) and 2030 cm^{-1} (valence vibrations of C=C aromatic rings of flavonoids, tocopherol, carotene), that correlates with the results obtained by Martínez-Valdivieso D. and co-authors [36].

According to the interpretation of the IR spectra of emulsion-type sauces prepared with the use of the oil extract of dried sea buckthorn fruits in the amount of 5.0 and 10.0% of the prescribed amount of ingredients, it was found they contain proteins, lipids, including unsaturated and saturated fatty acids, vitamins E and A (Table 2, Fig. 3).

According to the results of comparison of the IR spectra of emulsion-type sauces (Fig. 3), it can be noted that in all samples there was approximately the same set of bands: 3399, 3009, 2926, 2855, 2139, 1746, 1647, 1548, 1465, 1378, 1240, 1163 , 1099, 723 cm^{-1}. However, with an increase of the part of the oil extract of dried sea buckthorn in sauces from 5.0 to 10.0% there has been observed an increase in bands 3009, 2923, 2853, 1746 cm^{-1}, which may indicate an increase of unsaturated fatty acids in sauces, such as oleic, palmitoleic, linoleic, linolenic, which were previously found in dried sea buckthorn berries and their oil extract (Fig. 1-2).

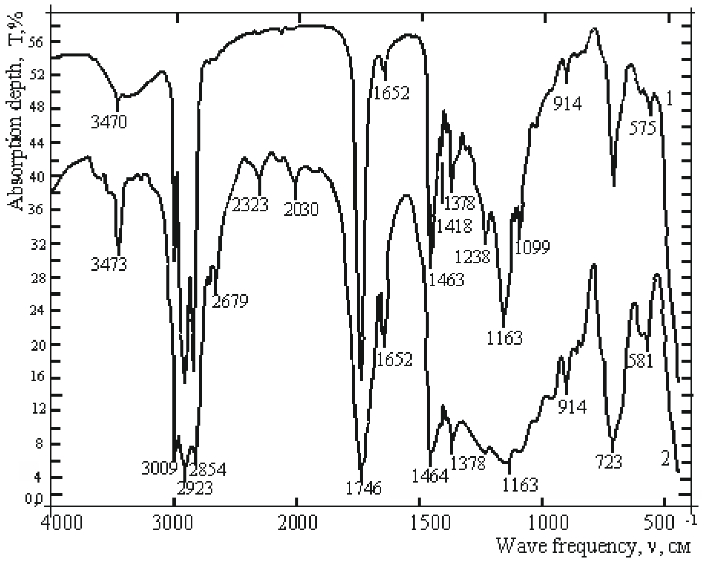

Fig. 2. IR spectra: 1 – sunflower oil, refined and deodorized (reference sample) 2 – sea buckthorn oil extract

Table 2 – Interpretation of the IR spectra of emulsion-type sauces prepared with the use of oil extracts of dried fruits of sea buckthorn

No	ν,cm^{-1}	Interpretation	Major contributions
1	3399	Phenolic hydroxyl in intermolecular hydrogen bonds, valence vibrations of the amide group	Flavonoids, water, proteins, carbohydrates, tocopherols
2	3009	Cis orientation –CH = CH–	PUFA*, MUFA**: oleic, linoleic, linolenic, palmitoleic; retinol, carotene
3	2926	Asymmetric valence vibrations of C-H bonds on saturated carbohydrates, asymmetric valence vibrations of C-H bonds in -CH_2- and -CH_3 groups	Carbohydrates, lipids, proteins, α-tocopherol
4	2855	Symmetric valence vibrations of groups – CH_2–	Lipids, carbohydrates, fatty acids: oleic, linoleic, linolenic, palmitoleic, palmitic, stearic; α-tocopherol
5	2139	Symmetric and asymmetric vibrations of C-O valence bonds	Protein
6	1746	Vibrations of the carbonyl group C=O	PUFA, MUFA: oleic, linoleic, linolenic, palmitoleic; saturated fatty acids
7	1647	Deformation vibrations of HOH free and bound water, vibrations of C=C bonds in six-membered hydrocarbon rings; carbonyl group of γ-pyrone; deformation vibrations (NH_3^+)	Water, protein, α-tocopherol
8	1549	Deformation II (NH_3^+) Deformation vibrations II (NH_3^+)	Protein
9	1465	Deformation vibrations of O-H and C-H bonds in CH_2OH groups; asymmetric deformation vibrations of groups -CH_2-	Carbohydrates, lipids
10	1418	Deformation vibrations of CHR=CHR′ bonds of cis-isomers	PUFA, MUFA: oleic, linoleic, linolenic, palmitoleic; retinol
11	1378	Deformation vibrations of C-H bonds	Carbohydrates, α-tocopherol, carotene
12	1240	Deformation vibrations of O-H and C-H bonds in saturated six-membered rings and in CH_2OH end groups	Carbohydrates, α-tocopherol
13	1163	Valence vibrations of –C–O– bonds of the esters of higher carboxylic acids in acylglycerides; valence vibrations of C–O– bonds in saturated six-membered rings and hydroxyl groups; pendulum vibrations of several bonded groups -CH_2-	Lipids, carbohydrates
14	1099	Valence vibrations of the C-O bond in CH_2OH end groups	Carbohydrates, α-tocopherol
15	914	Valence vibrations of C-O-C bond in conjugation tube of esters	Lipids
16	723	CH deformation vibrations (pendulum vibrations) in saturated six-membered rings and pendulum vibrations of several bond groups – CH_2–	Higher aliphatic acids in lipids; carbohydrates

PUFA* – polyunsaturated fatty acids; MUFA** – monounsaturated fatty acids

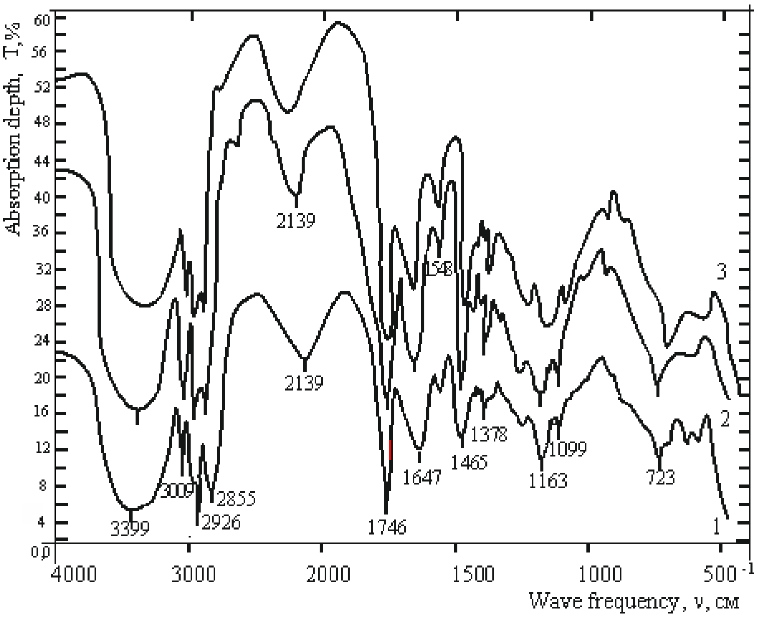

Fig. 3. IR spectra of samples of emulsion-type sauces prepared with the use of sea buckthorn oil extract in the amount of: 1 – without oil extract (reference sample); 2 – 5% of the prescribed amount of raw materials; 3 –10% of the prescribed amount of raw materials

The presence of egg protein in mayonnaises is indicated by two main absorption bands – amide I (1647 cm^{-1}) and amide II (1549 cm^{-1}), due to valence vibrations of C=O-bond (amide I) and deformation vibrations of NH-bond (amide II). In addition, the protein content in the test samples of sauses was confirmed by the presence at the IR spectrum of mayonnaises absorption band at ~ 3399 cm^{-1}.

The presence of lipids in oils and mayonnaises is confirmed by the presence of intense bands of valence vibrations of -CH groups at 2800-3000 cm^{-1}, bands at 1746 cm^{-1} (valence vibrations of C=O groups), valence vibrations of C=O groups of esters in the form of intense bands at 1163 cm^{-1} with two weaker bands at 1240 and 1099 cm^{-1}.

Therefore, with the use of IR spectroscopy it is confirmed that implementation of the oil extract of dried sea buckthorn berries for mayonnaises production in the amount of 5.0 and 10.0% of the prescribed amount of ingredients contributes to increase the content of natural antioxidants such as retinol, tocopherol and carotenoids as well as polyunsaturated fatty acids (oleic, linoleic, linolenic, palmitoleic) and their esters in sauses. Increasing of the number of molecules of diphilic structure in the oil extracts of dried sea buckthorn berries leads to the acquisition of its emulsifying properties. This allows to consider the studied mayonnaises as an additional source of deficient nutrients, as well as to predict possible changes in sensory and physiochemical parameters of the quality of sauces, including changes in color, texture, viscosity.

One of the important indicators of the quality of emulsion-type sauces is their consistency, which can be quantified by a number of rheological parameters. In this regard, at the next stage of research the effect of oil extract of dried sea buckthorn berries on the viscosity of emulsion-type sauces was studied (Fig. 4-5, Tables 3-5).

The analysis of the data presented in Fig. 4 (a), allows us to establish that all the experimental samples of sauces are characterized by a decrease in the value of effective viscosity under the increase in shear rate, while at the same shear rate, the zone of avalanche destruction in the samples, made from the oil extract of sea buckthorn, occurs under higher values of shear rate than those of the reference sample, which is the evidence of a higher density and better stability of sauces, made with the addition of the oil extract of sea buckthorn. Moreover, the experiments proved that in case the sauce is made with the addition of oil extract of dried sea buckthorn fruit in the amount of 15.0% of the prescribed amount of ingredients, the density of the emulsion increases considerably, and the technical capabilities of the device do not allow to obtain reliable information on the values of effective viscosity of such samples. The effect obtained may be due to the higher content of polyunsaturated fatty acid esters in the oil extracts of sea buckthorn, which have emulsifying properties (Fig. 2, Table 2), that correlates with the data presented in [14]. In view of the above, it is possible to draw an important practical conclusion that while developing new sauce technologies one should focus on the target effective (dynamic) viscosity of about 450 Pa·s, as further increase in this indicator indicates the formation of uncharacteristic consistency for this product type.

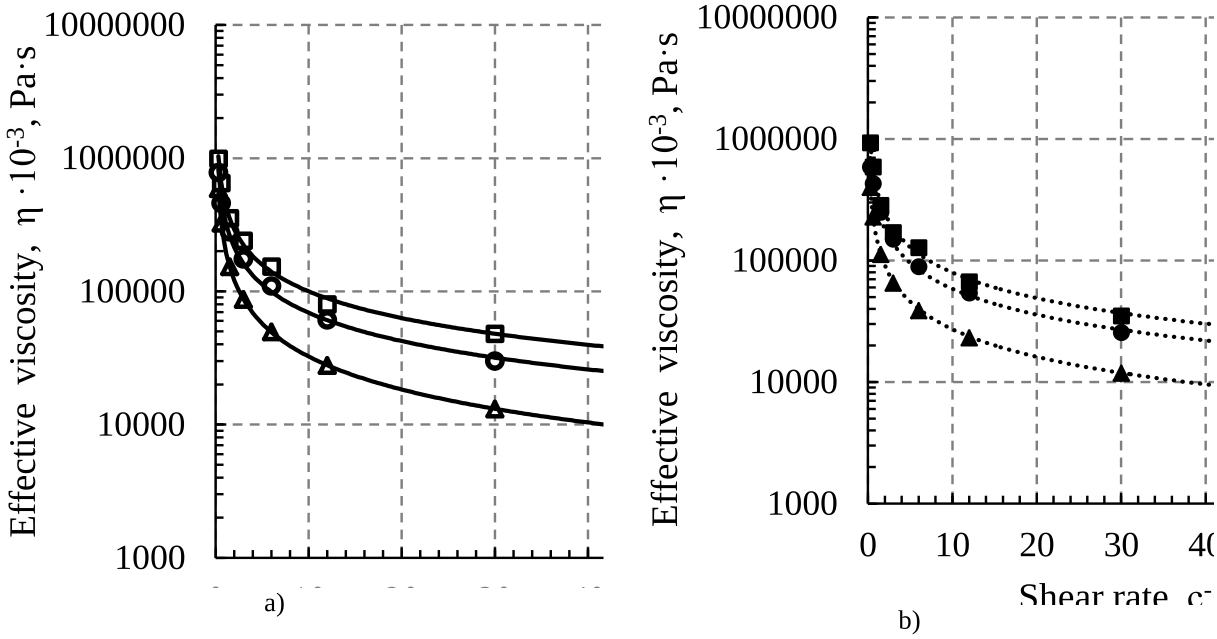

Fig. 4. Effective viscosity of emulsion-type sauces in a straight line (a) and in reverse (b)

Table 3 – The result of mathematical processing of experimental data under a forward stroke

Coefficient	The value of the coefficient for the experimental sample of the sauce made using the oil extract of dried sea buckthorn fruit in the amount of:		
	0% (reference sample)	5.0%	10.0%
The statistics for the samples of sauces under the forward stroke			
B, Pa·s	215.5	350.6	464.3
m	0.822	0.706	0.667
Coefficient of determination R^2	0.99	0.99	0.99
The statistics for the samples of sauces under the return stroke			
B, Pa·s	154.1	297.8	396.7
m	0.754	0.707	0.698
Coefficient of determination R^2	0.99	0.99	0.99

The statistical processing of the obtained experimental data (Table 3) revealed that with the increase in content of sea buckthorn oil extract in emulsion-type sauces there is, on the one hand, a natural increase in the index “The coefficient of consistency, proportional to viscosity" (B), and, on the other – a decrease in the index “The rate of destruction of the structure” (m). At this rate, the first index increases by 2.2 times, the second one decreases by 1.2 times compared to the values of these indices for the reference sample, which confirms the previously offered hypothesis of the property of oil extract of dried sea buckthorn fruit to stabilize the structure of emulsion-type sauces. To ascertain the quantitative effect of the oil extract of dried sea buckthorn fruit on the characteristic features of effective (dynamic) viscosity of the sauce samples studied, the obtained data were subjected to linear regression analysis by the method of least squares (Table 4, Fig. 5). As a result of the analysis it has been found that the increase in the content of the oil extract of dried sea buckthorn fruit in the recipe of mayonnaise sauces by 1% causes, at least in the studied area of factor space, the increase in the analytical index “The coefficient of consistency, proportional to viscosity” by 25 Pa·s (or by 2 times). At the same time, the value of the analytical index “The rate of destruction of the structure” decreases by $1{,}6 \cdot 10^{-2}$ units (or by 2%). The calculated values of the coefficients of determination (R^2) are the evidence of high reliability of the analytical equations that describe the behavior of each of the samples.

Table 4 – The result of linear regression analysis of the experimental data

Index	Coefficients of equation (3)		Coefficient of determination R^2
	b_0	b_1	
Coefficient of consistency, proportional to viscosity (B)	217	25	0.99
The rate of destruction of the structure (m)	0.810	-0.016	0.92

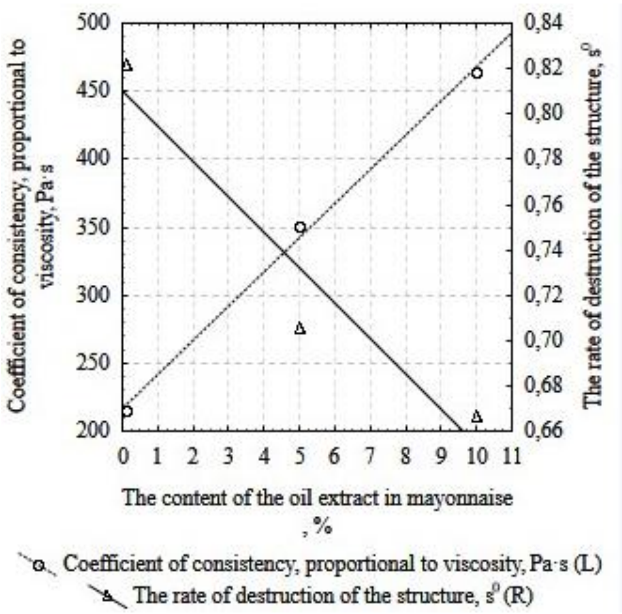

Fig. 5. Dependence of the indices of effective viscosity of emulsion-type sauces on the concentration of sea buckthorn extract

In order to ascertain the effect of the oil extract of dried sea buckthorn fruit on the ability of macroscopic systems to self-repair the structure after its destruction, a series of experiments were held to determine the effective viscosity of the experimental samples of sauces by the method of "return stroke" (Fig. 4, b, Table 3). It has been found that the properties of the studied samples in case of the return stroke remain similar to the properties determined in case of the forward stroke, and the calculated values of the coefficients of determination (R^2) are the evidence of high reliability of analytical equations, which describe the behavior of each sample. Thus, even after partial destruction of the structure of sauces under the action of rotation of the working body of the viscometer there is a tendency to improve the indices, which indirectly indicate the consistency and stability of emulsions in case of using the oil extract of dried sea buckthorn fruit in the technology of mayonnaise sauces. As a result of calculating the thixotropy coefficient (Table 5) it has been found that with the increase in the content of the oil extract of dried sea buckthorn fruit in mayonnaise sauces, the value of the index "Thixotropy coefficient", which characterizes the ability of emulsions to self-repair the structure after its destruction, increases by 13.4–15.9% compared to the control sample.

Thus, the use of the oil extract of dried sea buckthorn fruit in the recipe of emulsion-type sauces in the amount of 5.0… 10.0% of the recipe amount of ingredients allows to improve their rheological properties.

At the final stage of research, the quality of emulsion-type sauces has been evaluated by sensory parameters (Table 6).

Table 5 – The result of calculating the thixotropy coefficient

The experimental sample of the sauce made using the oil extract of sea buckthorn and the amount of:	Index		
	V_r, Pa·s	V_s Pa·s	λ_t, %
without addition (reference sample)	154.1	215.5	71.5
5.0%	297.8	350.6	84.9
10.0%	396.7	464.3	85.4

Table 6 – Sensory parameters of the quality of emulsion-type sauces

Index	**Characteristics of the experimental sample**	
	Reference sample	Sauces made with the addition of the oil extracts of sea buckthorn
Appearance and consistency	Homogeneous creamy product without delamination and impurities	
Taste and smell	The taste is slightly sour, the smell is characteristic of mayonnaise	
Colour	White or cream tint	White or cream tint

It has been found that sauces made using the oil extract of dried sea buckthorn fruit in the amount of 5.0 and 10.0% equal analog products in quality, and in terms of colour and consistency are even better. The addition of additives in the range covered does not affect the parameters of smell and taste. Thus, according to sensory parameters, mayonnaise sauce made with the addition of the oil extract of dried sea buckthorn fruit, meets the regulations, namely State Standard of Ukraine 4560:2006

Conclusion

As a result of the research, the possibility of using dried sea buckthorn fruit in the form of oil extract in the technology of emulsion-type sauces has been experimentally substantiated. Using the IR spectroscopy, it has been proven that dried sea buckthorn berries contain oil rich in carotenoids, tocopherols, phospholipids, essential fatty acids, vitamins, organic acids, sugars, flavonoids, amino acids, tannins. As the content of the oil extract of dried sea buckthorn fruit in mayonnaise sauces increases from 5.0 to 10.0%, the content of such nutrients as tocopherols, phospholipids, essential fatty acids, organic acids, vitamins C, group B, PP in sauces increases. Based on the analysis of experimental data and their mathematical processing, it has been found that the use of sea buckthorn extract in the technology of mayonnaise sauces increases their effective viscosity compared to the control sample more than twice due to the content of polyunsaturated fatty acids in the oil extracts of dried sea buckthorn fruit, which have emulsifying properties. At this rate, the value of the index "Thixotropy coefficient", which characterizes the ability of emulsions to self-repair the structure after its destruction, increases by 13.4–15.9% compared to the control sample and indicates the improved rheological properties of mayonnaise sauces with the addition of the oil extract of dried sea buckthorn. The analysis of sensory parameters of the quality of emulsion-type sauces with the addition of the extract of dried sea buckthorn fruit indicated that the new products are characterized by high quality indicators, which meet the regulations, as well as have improved consistency and attractive colour. Thus, the possibility of producing emulsion-type sauces using 5.0–10.0% of the oil extract of dried sea buckthorn fruit from the prescribed amount of ingredients without adding structure-forming agents of synthetic origin has been proved.

References

1. Krutovyi G, Zaparenko A, Borysova A. Mathematical aspects of nutrition systems projecting for dietary therapy. Food Science and Technology. 2017 Apr;11(3):10–16. DOI: https://doi.org/10.15673/fst.v11i1.291.
2. Cherevko OI, Krutovyi GA, Mychailov VM, Zaparenko GV. Proektuvannia system kharchuvannia likuvalno-profilaktychnoi dii. Ch. 3, Fundamentalni problemy stvorennia system kharchuvannia [Design of food systems of therapeutic and preventive action. Part 3, Fundamental problems of creating food systems]. Kharkiv (Ukraine): KSUFT; 2017. 219 p. Ukrainian.
3. Li L, Sun N, Zhang L, et al. Fast food consumption among young adolescents aged 12–15 yearsin 54 low- and middle-income countries. Global Health. Journal homepage [Internet]. 2020 Dec [cited 2020 Dec 31];13(1). Available from: https://www.tandfonline.com/loi/zgha20 DOI: https://doi.org/10.1080/16549716.2020.1795438.
4. Merenkova SP, Lukin AA. [Analysis of the rheological properties of vegetable and mayonnaise sauce, produced with the use of functional herbal supplements]. Scientific Journal NRU ITMO. Processes and Food Production Equipment. 2015 Nov;4:96–105. Russian.
5. Gomes IA, Gomes F dos S, Freitas-Silva O, da Silva JPL. Ingredients of mayonnaise: Future perspectives focusing on essential oils to reduce oxidation and microbial counts. Archivos Latinoamericanos De Nutrición. 2017 Sept;67(3):187–98.
6. Kishk YFM, Elsheshetawy HE. Effect of ginger powder on the mayonnaise oxidative stability, rheological measurements, and sensory characteristics. Ann Agric Sci. 2013 Dec;58(2):213–20. DOI: https://doi.org/10.1016/j.aoas.2013.07.016.
7. Yildiz F. Advances in food biochemistry [Internet]. Boca Raton: CRC Press; 2010 [cited 2019 Nov 10]. 522 p. Available from: https://gtu.ge/Agro-Lib/%5bFatih_Yildiz%5d_Advances_in_Food_Biochemistry(BookFi.org).pdf DOI: https://doi.org/10.1201/9781420007695.
8. Rodrigues EC, Ferreira AM, Vilhena JC, et al. Development of Babassu Oil Based Nanoemulsions. Latin American Journal of Pharmacy. 2015; 34(2):338-43.
9. Ribeiro EF, Morell P, Nicoletti VR, Quiles A, Hernando I. Protein- and polysaccharide-based particles used for Pickering emulsion stabilisation. Food Hydrocolloids [Internet]. 2021 Oct [cited 2020 Oct 15];119. Available from: https://www.sciencedirect.com/journal/food-hydrocolloids DOI: https://org/10.1016/j.foodhyd.2021.106839.
10. Tudor C, Bohn T, Iddir M, et al. Sea Buckthorn Oil as a Valuable Source of Bioaccessible Xanthophylls. Nutrients. 2020;12(76):1-14. DOI: https://org/10.3390/nu12010076.
11. Rojas-Grau MA, Avena-Bustillos RJ, Olsen C, et al. Effects of plant essential oils and oil compounds on mechanical, barrier and antimicrobial properties of alginate–apple puree edible films. Journal of Food Engineering. 2007 Aug;81(3):634-41. DOI: https://doi.org /10.1016j. jfoodeng.2007.01.007.
1. 12 Meiners MD, Merolla TV, Smagula MS, Bernardini DL, Harkabus EM, inventors; CPC international Inc., assignee. A low fat mayonnaise product and method for making the same. European patent application 0477827A2 US. 1992 Apr 1.
12. Elias SO, Tomasco PV, Alvarenga VO, Sant'ana AS, Tondo EC. Contributor factors for the occurrence of salmonellosis during preparation, storage and consumption of homemade mayonnaise salad. Food Res Int. 2015 Dec;78:266-73. DOI: https://doi.org/10.1016/j.foodres.2015.09.034.
13. Mirzanajafi M, Yousefi M, Ehsani A. Challenges and approaches for production of a healthy and functional mayonnaise sauce. Food Sci Nutr. 2019 Jul;7(8):2471–84. DOI: https://doi.org/10.1002/fsn3.1132.
14. Widerström E, Öhman R. Mayonnaise. Quality and Catastrophic Phase Inversion [master thesis on the internet]. Lund: Lund University; 2017. [cited 2020 Oct 15]. Available from: http://lup.lub.lu.se/student-papers/record/8916120.
15. Amin MH, Elbeltagy AE, Mustafa M, Khalil AH. Development of low fat mayonnaise containing different types and levels of hydrocolloid gum. J Agroaliment Proc Technol, 2014; 20(1):54-63.

16. Rodrigues ML. Azeite de pequi: efeito do aquecimento em temperatura de fritura e utilização como ingrediente na formulação de maionese [dissertation on the internet]. Goiânia: Universidade Federal de Goiás; 2011. [cited 2020 Oct 15]. Available from: http://repositorio.bc.ufg.br/tede/handle/tde/2261.
17. Roascio-Albistur A, Gámbaro A, Ivankovich C. Consumers' perception of olive oil-based dressings evaluated by complementary techniques: Focus group and word association. Int J Gastron Food Sci [Internet]. 2019 Dec [cited 2020 Oct 15];18(42). Available from: https://www.sciencedirect.com/science/article/abs/pii/S1878450X18300416 DOI: https://doi.org/10.1016/j.ijgfs.2019.100176.
18. Muhialdin BJ, Ying LL, Farouk A-E, Meor Hussin AS. Valorisation of Virgin Coconut Oil Application in Mayonnaise Production as Functional Ingredient. Journal of Food and Nutrition Research. 2019 Jan;7(1):65-70 DOI: https://doi.org/10.12691/jfnr-7-1-8.
19. Mardar MR, Tkachenko NA, Lozovska HM, Makovska TV. [Marketing Research While Positioning and Launching of Low-Fat Mayyonnaise, Enriched With Synbiotic Complex]. Food Science and Technology. 2016 June;10(1):3-10. Ukrainian. DOI: https://doi.org/10.21691/fst.v10i1.74.
20. Diakonova AK, Stepanova VS. [Perspective Directions of Development and Expansion Assortment Sauces Products on Emulsion Base]. Food Science and Technology. 2015 Dec;4(9):3-7. Ukrainian. DOI: https://doi.org/10.15673/2073-8684.4/2015.55862.
21. Choni IV, Sutkovych TY. [Use of Natural Stabilizers in Technology Emulsion Products]. Scientific Bulletin of PUET: Technical Sciences. 2015;1(73):54-9. Ukrainian.
22. Yurchenko SJ, Babenko VI, Bakhmach VO. [Investigation of the Properties of Cranberry Juice as a Preservative in Mayonnaise Formulations]. Vcheni zapysky tavriiskoho natsionalnoho universytetu imeni V.I. Vernadskoho Seriia: Khimichni tekhnolohii. 2019; 30(69),2(6):69-73. Ukrainian. DOI: https://doi.org/10.32838/2663-5941/2019.6-2/13.
23. Akagic A, Drkenda P, Oras A, Orazem P, Hudina M. Influence of Growing Region and Storage Time on Phenolic Profile of Cornelian Cherry Jam and Fruit. Europ. J. Hort. Sci. 2013 Jan;78(1):30-39.
24. Embuscado ME. Spices and herbs: Natural sources of antioxidants – a mini review. Journal of Functional Foods. 2015 Oct;18(B):811-19 DOI: https://doi.org/10.1016/j.jff.2015.03.005.
25. Bozin B, Mimica-Dukic N, Simin N, Anackov G. Characterization of the Volatile Composition of Essential Oils of Some Lamiaceae Spices and the Antimicrobial and Antioxidant Activities of the Entire Oils. J AGRIC FOOD CHEM. 2006 Apr;54(5):1822-8 DOI: https://doi.org/10.1021/jf051922u.
26. Deynychenko H, Lystopad T, Novik A, Chernushenko L, Farisieiev A, Matsuk Y, et al. Determining the Content of Macronutrients in Berry Sauces Using a Method of IR-Spectroscopy. Eastern-European Journal of Enterprise Technologies. 2020 Oct;5(11(107):32-42. DOI: https://doi.org/10.15587/1729-4061.2020.213365.
27. Newman JC, Malek AM, Hunt KJ, Marriott BP. Nutrients in the US Diet: Naturally Occurring or Enriched/Fortified Food and Beverage Sources, Plus Dietary Supplements: NHANES 2009–2012. The Journal of Nutrition. 2019 Aug;149(8):1404-12. DOI: https://doi.org/10.1093/jn/nxz066.
28. Rusu AV, Criste FL, Mierliţă D, Socol CT, Trif M. Formulation of Lipoprotein Microencapsulated Beadlets by Ionic Complexes in Algae-Based Carbohydrates. Coatings. 2020 Mar;10(3):302:1-14. DOI: https://doi.org/10.3390/coatings10030302.
29. Seglina D, Karklina D, Ruisa S, Krasnova I. The Effect of Processing on the Composition of Sea Buckthorn Juice. J. Fruit Ornam. Plant Res. 2006;14(2):257-264.
30. Kaur TA, Singh GB, Kapoor DN. A Review on Pharmacognostic, Phytochemical and Pharmacological Data of Various Species of Hippophae (Sea Buckthorn). International Journal of Green Pharmacy. 2017 Apr;11(1):62-75. DOI: https://doi.org/10.22377/ijgp.v11i01.874.
31. Dienaitė L, Baranauskienė R. Venskutonis PR. Lipophilic extracts isolated from European cranberry bush (Viburnum opulus) and sea buckthorn (Hippophae rhamnoides) berry pomace by supercritical CO 2 – Promising bioactive ingredients for foods and nutraceuticals. Food Chemistry [Internet]. 2021 June [cited 2020 Oct 10];348. Available from: https://www.sciencedirect.com/science/journal/03088146 DOI: https://doi.org/10.1016/j.foodchem.2021.129047.
32. Farisieiev AH, Novik HV, Savchenko AM, Honcharenko IP, inventors; Oles Honchar Dnipro National University, assignee. Sposib otrymannia maionezu pidvyshchennoi kharchovoi tsinnosti [The method of obtaining mayonnaise of increased nutritional value]. Ukrainian patent 147016. 2021 Apr 8.
33. Horalchuk AB, Pivovarov PP, Grinchenko OO, Pohozhykh MI, Polevych VV, Hurskyi PV. [Rheological methods of raw foods and automation of payments rheological characteristics]. Kharkiv; 2006. 63 p.
34. Nour V, Panaite T, Radu Corbu A, Ropota M, Turcu R. Nutritional and Bioactive Compounds in Dried Sea-Buckthorn Pomace. Erwerbs-Obstbau. 2021 Mar;63(1):91-8. DOI: https://doi.org/10.1007/s10341-020-00539-1.
35. Martínez-Valdivieso D, Font R, Del Río-Celestino M. Prediction of Agro-Morphological and Nutritional Traits in Ethiopian Mustard Leaves (Brassica Carinata A. Braun) by Visible-Near-Infrared Spectroscopy. Foods. 2019 Dec;8(1):6. DOI: https://doi.org/10.3390/foods8010006.

ДОСЛІДЖЕННЯ ВПЛИВУ ОБЛІПИХИ НА ФОРМУВАННЯ ПОКАЗНИКІВ ЯКОСТІ СОУСІВ ЕМУЛЬСІЙНОГО ТИПУ

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Анотація. Запропоновано використовувати олійний екстракт сушених плодів обліпихи в технології соусів емульсійного типу для підвищення їхньої харчової цінності. Методом ІЧ-спектроскопії визначено особливості якісного хімічного складу сушених плодів обліпихи, а також їхнього олійного екстракту та соусів емульсійного типу, виготовлених з використанням олійного екстракту обліпихи. Установлено, що в ІЧ-спектрах сушених плодів обліпихи, олійного екстракту та соусах, виготовлених з його вмістом, спостерігається ~~приблизно~~ однаковий набір смуг поглинання, які належать до таких типів коливань: валентні коливання гідроксильних груп у молекулах кислот, вуглеводів, флавоноїдів, токоферолу із максимумами за 3365 $см^{-1}$ до 3400 $см^{-1}$ ν(OH); 3009, 1418 $см^{-1}$ і 723 $см^{-1}$ – валентні та деформаційні коливання –CН подвійного зв'язку цис-ізомерів поліненасичених жирних кислот; 2926, 2855, 1467 $см^{-1}$ – асиметричні й симетричні, ножничні валентні коливання ν (С–Н) вуглецевого скелета в $-CH_2$; 1746 $см^{-1}$ – ν(C=O) валентні коливання карбоксильних і жирних кислот: валентні коливання ν(C–O) естерних зв'язків і характерні для тригліцеридів три піки з максимумами 1238, 1163 і 1099 $см^{-1}$. Досліджено в'язкість соусів емульсійного типу, виготовлених з додаванням олійного екстракту сушених плодів обліпихи в кількості 5,0 і 10,0% від маси сировини. Виявлено, що ефективна в'язкість соусів емульсійного типу, виготовлених з використанням 10,0% олійного екстракту сушених плодів обліпихи, у 2,2 рази більша, ніж у зразка порівняння. Значення показника стабільності зазначеного соусу максимально наближені до зразка порівняння. За результатами лабораторного відпрацювання рецептур соусів емульсійного типу, виготовлених з використанням олійного екстракту сушених плодів обліпихи, встановлено високу якість соусів за органолептичними показниками та їх відповідність вимогам чинної нормативної документації. Одержані результати свідчать про доцільність і перспективність використання сушених плодів обліпихи у вигляді 10%-го олійного екстракту в кількості 10,0% від рецептурної маси інгредієнтів в технології соусів емульсійного типу з метою підвищення їх харчової і біологічної цінності, а саме збагачення каротиноїдами, токоферолом, флавоноїдами, поліненасиченими жирними кислотами, а також як стабілізатора та емульгатора харчових систем.

Ключові слова: соус емульсійного типу, сушені плоди обліпихи, олійний екстракт плодів обліпихи, емульсія, ІЧ-спектроскопія, ефективна в'язкість.