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Tatiana Nikitchina,
Tatiana Manoli,
Tetiana Lebedenko,
Viktoriia Kozhevnikova

DETERMINATION OF COMMODITY CHARACTERISTICS OF EMULSION BASED ON LOW-METHOXYLATED PECTIN FOR DISHES OF THE «EAT HEALTHY» SYSTEM IN THE RESTAURANT SERVICE

The object of research is emulsions based on low-methoxylated apple pectin for dishes of the «Eat Healthy» system in the restaurant industry. The subject of the research is the commodity characteristics of emulsions for dishes of the «Eat Healthy» system. In the course of the study, methods were used to determine commodity characteristics based on sensory and physicochemical analysis. The proposed ingredient composition of emulsions based on low-methoxylated apple pectin makes it possible to form not only high consumer qualities, but also to provide the target product with functional health properties. The sorption activity of pectin makes it possible to bind and remove heavy metals, radionuclides from the body; removal of strontium isotopes has a high activity. As a highly hydrophilic, biocompatible biopolymer of plant origin, it provides a high viscosity of the structure at low concentrations, has a pronounced neutral, pleasant sour taste. Low-methoxylated apple pectin is one of the most common hydrocolloids, which is used in the technology of products with therapeutic, prophylactic, sorption, bactericidal properties. In addition, low-methoxylated pectin substances are a harmless and economical material, and can be considered as an alternative to antibiotics and synthetic preservatives to prevent bacterial spoilage and extend the shelf life of health food for public catering with high consumer properties. The influence of the technological properties of low-methoxylated pectin in the formation of commodity characteristics for food products based on emulsions in healthy food products of restaurant establishments of different styles and concepts has been determined. Samples of food emulsions were studied using different amounts of low-methoxylated pectin as a stabilizer to obtain a sedimentation-stable emulsion system. The use of low-methoxylated apple pectin in the composition of food emulsions increases the aggregate stability of the product, functional and merchandising characteristics. On the basis of a complex quality indicator, the optimal parameters of the emulsion formulation were determined. High-quality consumer characteristics are ensured due to the size of uronic particles up to 0.78–0.81 μm in size.

Keywords: *commodity characteristics, complex organoleptic indicators, healthy nutrition, low-methoxylated apple pectin, food emulsions.*

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1. Introduction

The main directions of the development of modern technologies in restaurant establishments are the search for new gastronomic concepts in Eat Healthy dishes in accordance with the requirements and requests of consumers. Products based on emulsifiers are especially popular. Emulsifiers are added to food products in order to create and stabilize emulsions and other food dispersed systems. They are responsible for the mutual distribution of the two phases that ensure the consistency of the food product, its plastic properties, viscosity and the feeling of «fullness» in the mouth. Emulsions greatly simplify the technological process. So, to improve the nutritional value of bread and bread products, fats are introduced into the dough in the form of emulsions. Sauces, which are one of the main seasonings for meat, fish and vegetables, are also emulsions formed when products (flour, fat and broth or milk) are mixed under certain conditions [1–3].

To create emulsions, stabilizers (emulsifiers) are used, such as proteins, phosphatides, lecithin. Excess intake of fats from food leads to obesity through the deposition

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of non-emulsified fats for the future. It is undesirable to emulsify fat during the preparation of first courses, seasonings. When emulsified fats are cooked, they are easily hydrolyzed (liquefied) and free fatty acids give the dishes the taste of fat and the smell of soap. The use of low-methoxylated pectin in food emulsion avoids deterioration of consumer properties of products and provides them with a functional direction [4, 5].

Emulsions are obtained by a two-stage procedure: the primary one is formed using an ionic emulsifier of low esterified pectin, which promotes the formation of small water-lipid droplets, and the secondary one, when an oppositely charged pectin is added, which is adsorbed on the surface of the droplets and forms a two-layer membrane. The subsequent technology of obtaining an emulsion system consists of five stages: preparation of the emulsifier, dissolution in water, preparation of the oil phase; obtaining a hydrophilic-lipophilic emulsion and its homogenization [6, 7].

The use of low-methoxylated pectin as a stabilizer in the preparation of water and oil phases is investigated. The conditions for dissolution of the emulsifier in the corresponding phase, the speed and intensity of mixing of the components to obtain a coarse emulsion, and the modes of operation of the homogenizer to control the particle size are determined. A commodity assessment of the studied emulsions for optimal taste perception by the consumer is conducted [8, 9].

Based on the basic analysis of theoretical information and experimental studies in the technology of fat processing and obtaining new dishes of the «Eat Healthy» trend, modern trends and principles of obtaining emulsion products for a healthy diet with the use of low-methoxylated apple pectin were determined. The direction of obtaining stable emulsions at the stage of the emulsification process was determined, namely, the selection of ingredients and technological parameters of the process with the determination of consumer properties. Substantiation of the composition of formulations and the development of a method for obtaining emulsion food products based on natural raw materials is one of the areas of current innovation [10, 11].

2. The object of research and its technological audit

The object of research is emulsions based on low-methoxylated apple pectin for dishes of the «Eat Healthy» system in the restaurant industry. *The subject of research* is the commodity characteristics of emulsions for dishes of the «Eat Healthy» system.

One of the most problematic areas is the formation of an assortment of emulsified healthy food products characterized by high consumer properties. Traditional products based on emulsions have the following disadvantages: high fat content, use of synthetic emulsifiers and emulsion stabilizers, not in line with the «Eat Healthy» trend.

3. The aim and objectives of research

The aim of research was to study the commodity properties of the emulsion for food products of the «Eat Healthy» system in the restaurant industry based on low-methoxylated apple pectin.

To achieve the aim, the following objectives have been set:

1. Determine the ratio of the amount of the water stabilizer and the oil phase to obtain a particle size of the system less than 1 μm to ensure the stability of the emulsion.

2. Justify the formulation of emulsions on the basis of physical and chemical quality indicators.

3. Investigate by microscopy the particle size distribution of the obtained emulsions in order to predict the stability of the emulsions.

4. Conduct a study of the commodity properties of the emulsion with the determination of a complex quality indicator based on the scores of the sensory analysis method.

4. Research of existing solutions of the problem

Modern conditions for the development of the restaurant industry set the task of developing and introducing competitive and cost-effective technologies for culinary products while improving their taste characteristics, consumer properties, improving quality, nutritional value and expanding the range. Much attention is paid to the development of new technologies for the production of healthy food products and the improvement of existing technologies by enriching these products with substances that give the products functional qualities, especially for dishes with the use of emulsions [11, 12]. However, they did not consider the issue of expanding the range of exactly emulsion culinary products of the «Eat Healthy» system of the restaurant industry.

Works [13, 14] are devoted to the study of the antioxidant properties of biopolymers as components of health-improving products, however, there is an unresolved issue of creating stable emulsions. In the works [15, 16], studies are given that made it possible to develop derivative sauces, which makes it possible to expand the range and regulate the energy value of rations. However, these works do not pay attention to the health properties of sauces. Also the difference is the nature of the structurant.

The authors of the work [8, 17] considered the prospects for the use of ionotropic polysaccharides in the technology of emulsion sauces with controlled organoleptic and structural-mechanical properties. The expediency of using low-esterified pectin substances as part of a dry functional mixture based on corn starch after hydrothermal treatment is also shown. But the question remains of the effect of particle size on the turbidity of the emulsion.

The authors of works [11, 18] investigated sterically stabilization as the main mechanism for stabilizing drops based on citrus pectin, confirms the expediency of using these hydrocolloids in the technology of emulsified products. However, the assortment direction and functional properties of the finished product have not been determined.

The problem lies in the creation of an aggregately stable emulsion, that is, it is capable of keeping the size of the dispersed phase droplets unchanged over time and resisting coalescence. Low-methoxylated pectin from apple pomace is used as a stabilizing and emulsifying component in the production of oil emulsions.

Studies have shown that low-methoxylated apple pomace pectin contains a galacturonic acid residue with multiple branches. It has a weak smell and taste of the apples from which it is produced.

The polygalacturonic chain of low-methoxylated pectin consists of D-galacturonic acid residues in pyranosium form,

linked by a 1,4-α-glycosidic bond with related substances: pentosans, hexosans, etc., which is characterized by strong branching, which ensures high-quality emulsifying properties. With water, the powder of low-methoxylated pectin from apple pomace is easily hydrated, making it possible to obtain 55–65 % aqueous solutions [13].

Low-methoxylated pectin with a degree of esterification of at least 28 % dissolves in cold water and forms a structured strong film. It has a water-holding capacity and forms a layer of emulsifier molecules on the surface of the droplets, which has increased viscosity and elasticity, and prevents droplets from merging. When an emulsion is obtained in the technological system «oil – low-methoxylated pectin – Ca^{2+}», thermodynamic equilibrium is achieved, which corresponds to the development of the system when an ionic calcium solution is introduced into the technological medium of oil and pectin with the formation of a certain spatial structure. In oil-in-water emulsions of low methoxylation, pectin from apple pomace plays the role of an emulsifier and stabilizer [19].

Low-methoxylated pectin from apple pomace is stable in acidic environments and does not undergo hydrolysis even at pH=2.0, which ensures their stability. It swells easily and dissolves slowly in cold water and quickly in hot water [11].

In order to avoid separation of the emulsion and precipitation, it is achieved by the stabilization of the high-molecular fraction of the low-methoxylated pectin molecule and by the forces of electrical repulsion due to the presence of uronic acids on each dispersed fat globule.

Thus, the results of the literature analysis allow to conclude that low-methoxylated apple pectin can be considered as a promising structure-forming agent in the technology of health-improving emulsion products with controlled functional properties.

5. Methods of research

To solve the objective, the following methods were used:
– rheological with a PCE-RVI 2 V1L viscometer manufactured by PCE Instrument, Germany;
– microscopic with a microscope LeicaDM4, Germany (250x, 550x, 750x);
– turbidimetric turbidity meter AMTAST AMT21, USA;
– expert method based on the totality of all assessment points, taking into account the selected weighting factors [19].

6. Research results

The use of low-methoxylated apple pectin in the composition of the emulsion is primarily due to their structure-forming ability. They form structures that influence the rate of absorption of substances in the small intestine and the duration of transit through the gastrointestinal tract. Low-methoxylated apple pectin is a prebiotic and has a positive effect on human physiology:
– reduces the content of glucose and cholesterol in the blood;
– stimulates microflora;
– participates in the regulation of energy metabolism of cells, promotes the use in the composition of emulsified health-improving products [8].

At the same time, food emulsions must meet certain merchandising characteristics, meet the requirements of visitors to restaurants of the Eat Healthy brand. Particular attention was paid to the integrity of the multiple composition, the stability of particle size over time and the movement of substances across the interface. The resulting emulsion is formed from microdroplets consisting of an oil or water center surrounded by a mixed film in which surfactant and co-surfactant alternate.

Low-methoxylated apple pectin is dissolved in water at a temperature of 25 °C under the condition of constant high-speed mixing and oil is added, obtaining a coarse emulsion with a particle size of 2–3 μm and a dispersion medium viscosity of 25–35 Pa·s. Then, homogenization is carried out to prepare the actual emulsion with a dispersion phase size of 0.1–1.0 μm. With this size of fat particles, the coalescence of liquid droplets is minimized, but there is a strong turbidity. For research, samples of food emulsions were prepared using different amounts of low-methoxylated apple pectin (Table 1).

Table 1

Low-methoxylated apple pectin emulsion formulations

Name of ingredients	Mass fraction, %	
	Recipe 1	Recipe 2
Sunflower oil	40	30
Low-esterified apple pectin	10	15
Water	48	54.7
Calcium lactate	0.2	0.3
Total	100	100

The emulsifying property of the formulation compositions was provided by mixing on a high-speed mixer with the gradual addition of sunflower oil, followed by the use of a rotary homogenizer.

Physicochemical indicators of the studied emulsions for different formulation compositions are shown in Fig. 1–3.

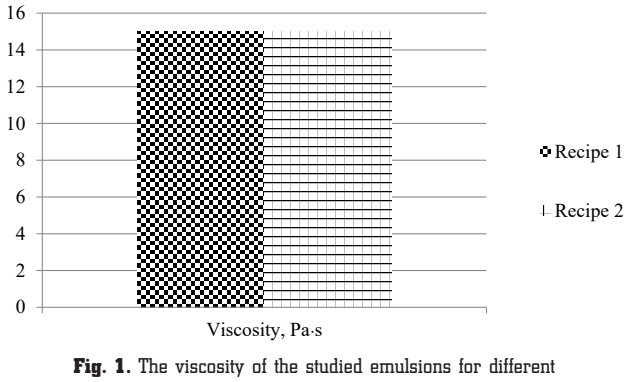

Fig. 1. The viscosity of the studied emulsions for different recipe compositions

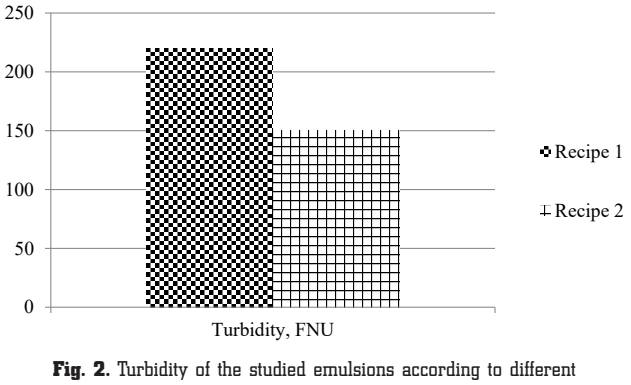

Fig. 2. Turbidity of the studied emulsions according to different prescription compositions

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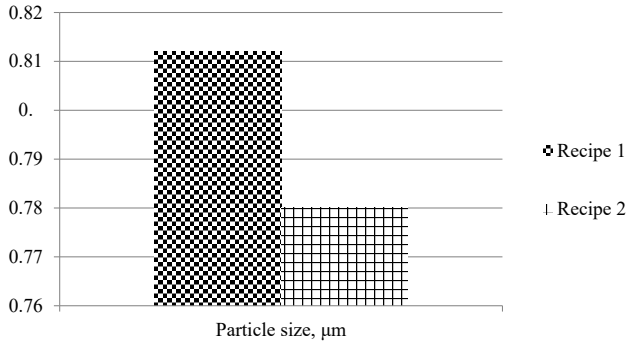

Fig. 3. Particle size of the studied emulsions for different formulation compositions

According to the obtained characteristics of the investigated emulsions according to formulation 2, the particle size is less and less than the turbidity of the emulsion at the same viscosity.

A complex indicator was used to assess the quality of public catering products. The quality features of the products offered include consistency, appearance, fluidity, color. For each of the selected indicators, a weighting coefficient was calculated. The weighting parameters of individual quality indicators were determined by an expert method, proceeding from the condition that the sum of all weighting factors for the emulsion is a constant value and is taken equal to one [20]. The weighting coefficient of each individual indicator is in the range from 0 to 1. The weighting factors were determined by the method of ranking indicators according to their significance for the consumer. The experts ranked single quality indicators (Table 2).

The complex quality indicator was determined using the scoring method of sensory analysis. For the work of the experts, a 5-point scale was used with the characteristics of the characteristics of the product according to five degrees of quality, which made it possible to solve scientific problems in finding a rational formulation of emulsified products that would ensure the preservation of consumer characteristics. Generalization of tasting assessments of product quality is carried out by the averaging method. To characterize the spread of the aggregate of assessments of individual experts, statistical indicators of their consistency were calculated.

To characterize the spread of expert assessments, the standard deviation was determined for each unit indicator using the formula:

$$S = \sqrt{\frac{\sum_{i=1}^{n} X_i^2}{n} - X^2}, \quad (1)$$

where $\sqrt{\sum_{i=1}^{n} X_i^2 / n}$ – sum of squares estimated by experts, points; X^2 – square of the average value of the indicator estimates, points.

The standard deviation S characterizes the consistency of expert opinions with the homogeneity of the analyzed samples. If S on a 5-point scale is not more than ±0.5 points, the assessment is unambiguous; if the deviation is ±1 or more, the assessment is not uniform, which indicates low training of experts. If the opinions of the experts were consistent, the complex quality indicator Q was calculated using the formula:

$$Q = \sum_{i=1}^{n} X_i \cdot K, \quad (2)$$

where $\sum_{i=1}^{n} X_i$ – sum of experts' assessments for a specific indicator of one sample of products, score; K – weight coefficient.

The results of sensory assessment and the calculation of the integrated quality indicator are shown in Table 3.

For the merchandising characteristics of the obtained emulsions, a 5-point scale was used. When compiling, it was taken into account that the zone of positive assessments should be at least 80 %. The approbation was carried out on the developed formulations in accordance with the methodology [20]. According to the data of statistical processing of the results of sensory studies, the emulsion by phone number 2 showed the best complex organoleptic score, which was 4.65 points. These results allow to conclude about the effectiveness of the developed formulation of emulsions.

Table 2

The results of expert determination of the importance of product properties

No.	The name of the properties of the emulsion	Importance (*Ni*) on a five-point scale	Weight coefficient (*Ki*)
1	Consistency	4	0.4
2	Appearance	4	0.4
3	Fluidity	1	0.1
4	Colour	1	0.1
Sum		$\sum Ni = 10$	$\sum Ki = 1$

Table 3

Statistical processing of the results of expert evaluation by the sensory characteristics of the test samples

No.	Indicators	Taster scores (*Xi*)											*K*	∑*Xi*	*X*	X^2	*S*	*X*·*K*	*Q*
1	Consistency	5	3	3	4	4	4	3	4	4	5	5	0.4	44	4.00	16.00	0.74	1.60	4.21
	Appearance	4	4	4	5	5	4	4	4	5	5	5	0.4	49	4.45	19.84	0.50	1.78	
	Fluidity	4	4	5	5	3	4	3	3	5	3	5	0.1	44	4.00	16.00	0.85	0.40	
	Colour	4	5	4	4	5	4	3	4	4	5	5	0.1	47	4.27	18.26	0.62	0.43	
2	Consistency	4	3	4	5	5	5	5	5	5	4	4	0.4	49	4.45	19.84	0.66	1.78	4.65
	Appearance	5	5	5	5	4	5	4	5	5	5	5	0.4	53	4.82	23.21	0.39	1.93	
	Fluidity	4	5	5	5	5	5	5	5	5	5	5	0.1	54	4.91	24.10	0.29	0.49	
	Colour	4	5	5	5	5	4	4	5	3	5	5	0.1	50	4.55	20.66	0.66	0.45	

Note: *K* – weight factor; *X* – average assessment of the tasters by individual indicators; *S* – standard deviation characterizing the consistency of expert opinions with the homogeneity of the analyzed samples; *Q* – complex indicator of quality

7. SWOT analysis of research results

Strengths. The strength of this research is that natural structure-forming agents are used – low-esterified apple pectin, which provides therapeutic and prophylactic properties of sauces for restaurants from the «Eat Healthy» system.

Weaknesses. The weaknesses of this research are associated with the final indefinite shelf life, since they do not provide for long-term storage.

Opportunities. Additional opportunities when using the above results in the restaurant industry – allows to develop the «Eat Healthy» brand to attract a wider range of consumers.

Threats. The developments proposed in this research are of a practical nature, however, they require additional calculations of a feasibility study to attract investments in advertising healthy food in restaurant establishments.

8. Conclusions

1. To create stable emulsions, it is proposed to use low esterified apple pectin. The ratio of the amount of the water stabilizer and the oil phase was determined to obtain a particle size of the system less than 1 μm, equal to 1:2.

2. Determination of turbidity 150–220 FNU, viscosity 15 Pa·s showed that if the amount of stabilizer is insufficient, a small amount of particles larger than 1 μm can be formed. This can lead to delamination during long-term storage.

3. Microscopy of the emulsifier fractions showed that a particle size in the range of 0.78–0.812 μm provides a stable emulsion.

4. The complex quality indicator based on the points of the sensory analysis method allowed to determine the rational formulation of the emulsion, contains 30 % sunflower oil, 15 % low esterified apple pectin with the addition of 0.3 % calcium lactate as a source of calcium ions. Such an emulsion composition is characterized by a high commodity assessment of organoleptic (complex quality indicator – 4.65 points) and physicochemical indicators (turbidity indicator 150 FNU and particle size within 0.78 μm).

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✉ ***Tatiana Nikitchina,*** *PhD, Associate Professor, Department of Bioengineering and Water, Odessa National Academy of Food Technologies, Odessa, Ukraine, ORCID: http://orcid.org/0000-0002-1034-3483, e-mail: nikitchinati@ukr.net*

Tatiana Manoli, *PhD, Associate Professor, Department of Meat, Fish and Seafood Technology, Odessa National Academy of Food Technologies, Odessa, Ukraine, ORCID: http://orcid.org/0000-0001-9121-9232*

Tetiana Lebedenko, *Doctor of Technical Sciences, Professor, Department of Hotel and Catering Business, Odessa National Academy of Food Technologies, Odessa, Ukraine, ORCID: http://orcid.org/0000-0001-8385-4674*

Viktoriia Kozhevnikova, *PhD, Associate Professor, Department of Hotel and Catering Business, Odessa National Academy of Food Technologies, Odessa, Ukraine, ORCID: http://orcid.org/0000-0003-2275-7437*

✉ *Corresponding author*