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The use of pectin substance in sauce production technologies

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Abstract

Functional food, in particular emulsion sauces, is a new promising trend in modern food industry. Traditionally, sauce manufacturers use starch, which has a number of negative aspects in storage. That is why the possibility of creating a functional sauce based on pectic substances employed as thickening and structuring agent has been investigated. The study used apple, citrus and beetroot pectins in powdered form. Organoleptic, biochemical, physical and chemical tests have been undertaken to confirm their compliance with the requirements of regulatory and technical documentation. To determine the possibility of using pectins as structuring agents and stabilizers, three formulations of tomato sauces differing by pectin type were developed, and the starch-based ketchup formulation was used as a reference. Six samples with different concentrations of pectin have been analyzed to determine the optimal pectin content in the sauce. It was established that the structure-forming and thickening properties of all samples of pectins are better than those of starch at the same concentration (0.5%). The best structure-forming properties have been demonstrated by beetroot pectin. All laboratory samples of tomato sauces complied with the requirements of regulatory documentation. Consequently, the use of pectins, as an alternative to starch in sauces, allows not only to create a functional product, but also significantly reduce the amount of structuring agent in the formulation. Thus, it is advisable to add the beetroot pectin to any kind of tomato based sauce.

Keywords: apple pectin, citrus pectin, beetroot pectin, tomato sauce, functional product

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INTRODUCTION

Currently, the effectiveness of physiologically active components in functional food is scientifically substantiated. The daily food, including sauces, is the most promising in this regard.

Sauce manufacturers commonly use starch, as well as fruit and vegetable purees, as thickening and structuring agents. The use of starch in sauces has some shortcomings: even after a short storage period, water that is physically bound to polysaccharides appears on the surface; the system loses continuity, which leads to a sharp deterioration in the quality of finished product. Thus, the pectin appears to be a promising alternative as a structuring and thickening agent.

LITERATURE REVIEW

Pectic substances are anionic natural polysaccharides obtained from the cell walls of higher plants. They are biocompatible and non-toxic to the human body (Zidihanova et al. 2018).

Pectins have a wide range of physiological effects, so they are used in many sectors of food industry as a complexing, gelling agent, a biologically active additive that has a detoxifying and antibacterial effect, as well as a technologically auxiliary additive for lightening soft and low alcohol beverages (Mescheryakova et al. 2016). In addition, pectic substances are widely used in medicine and in sutained-release preparations, as part of biomaterials to prevent adhesions after surgical interventions (Konovalova 2017). There are numerous studies confirming the anti-tumor and anti-metastasis activity of pectic substances (Sokol et al. 2008).

Due to a wide range of physiological effects and technological properties of pectins, a current line of action for the food industry is the isolation of pectin and its technological applications in order to create functional food products for therapeutic and prophylactic purposes.

THEORETICAL FOUNDATIONS

The diversification of functional emulsion products is an essential component of the concept of healthy nutrition in Russia (Inyukina et al. 2016). In this regard, the goal of the research work is the development of the formulation of a functional tomato sauce with enhanced

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nutritional and biological values based on pectin substances. To achieve this goal, the following tasks were set:

1. Analysis of physical, chemical and analytical indicators of pectin samples;
2. Determination of the biochemical properties of vegetable raw material.
3. Development of ketchup formulations with different structuring agents.
4. Determination of organoleptic and physico-biochemical parameters of tomato sauce samples and choosing the pectin.
5. Determination of optimal pectin concentration in tomato sauces.
6. Analysis of viscosity indicators and sensory evaluation of samples in order to choose the best formulation.

It is assumed that pectic substances will prove to be a technological alternative to starch and starch products. Entering pectin into sauces will allow creating new functional products with therapeutic and prophylactic effects.

METHODS

Objects of Study

Citrus powdered pectin (manufactured by Copenhagen Pectin A/S, Denmark), apple powdered pectin (manufactured by Herbslreith & Fox KG, Germany).

Equipment

The following equipment have been used: analytical balances Acculab ALC-210d4, bench-top centrifuge EBA-20, dry-block thermostat TSO-1/80 SPU, electric stove «Lazur», round vacuum drying oven 2V-151, glass capillary rheometer VPG-1, Brookfield viscometer вискозиметр DV-E, desiccator, muffle furnace PM-8, pH-meter with a glass electrode LP-3, refractometer IRF-454ВБ2М, spectrophotometer UNICO 2800, photoelectric colorimeter KFK-2-UHL 4.2., Chizhova device.

Methodology

During this study, the following methods were used:

1. Methods of analyzing the objects of research: determination of pectin powders organoleptic characteristics, determination of solubility, mass fraction of free and methoxylated carboxyl groups by titrimetric method, determination of the mass fraction of pectic acid, ballast substances, determination of gelation point of 1% pectin solution, determination of sorption capacity of pectin invitro, determination of viscosity, ash-content, pH and moisture content determination with the use of Chizhova device.
2. Methods of analyzing prototypes of tomato sauces: determination of organoleptic indicators, mass fraction of dry substances by refractometric method, determination of titrated acidity, determination of ascorbic acid content by Tilman method, determination of carotenoids and reducing sugars content using the Bertrand method, micromethod for determining proteins using the biuret reaction, determination of hemicellulose, cellulose by direct method, determination of moisture content by TGA method, determining of the pH and viscosity of tomato sauces

Table 1. Sensory analysis of pectin powders

Sensory characteristics	Apple pectin	Citrus pectin	Beetroot pectin
Aggregate state		powder	
Color	beige	beige	gray-brown
Taste		--	
Odor		--	

At the first stage of the research, the aggregative state, color, taste and smell of powdered pectic substances of citrus, apple and sugar beet raw materials were determined. The following quality indicators of pectin were defined using physicochemical tests: the humidity was determined by the accelerated method with the use of Chizhova device, the hydrogen indicators of pectin containing solutions were measured, and the viscosity was determined with a glass viscometer. In addition, the solubility and gelation point of 1% pectin solution was determined.

The next step was to determine the analytical indicators of pectic substances. One of the most important characteristics of pectins is the degree of etherification; therefore, the mass fraction of free and methoxylated carbonyl groups were determined. Another important property of pectin is complexing ability. The sorption capacity of pectins with heavy metal salts was defined.

The ash content in pectin powders was determined using the combistion method. The weight fraction of pectic acid and ballast substances in pectin substances were also established.

At the second stage of research, the formulation of tomato sauce with the addition of pectin was developed. Three formulations of tomato sauces, differing by the type of pectin, were developed. The formulation of starch containing ketchup was used as a reference. To determine the optimal content of pectin, 6 samples with different concentration of pectin substances were obtained. The samples subsequently underwent organoleptic analysis and physico-chemical tests.

DISCUSSION AND RESULTS

Table 1 shows the results of sensory analysis.

The data of table prove that the pectin substances under study comply with the requirements of GOST 29186.

The main physicochemical properties of pectins are shown in **Table 2**.

It can be noted that all the samples of pectins have a good solubility in water, since their degree of esterification is more than 36%. The largest amount of

Table 2. Physicochemical properties of pectins

Properties	Apple pectin	Citrus pectin	Beetroot pectin
Moisture content, %	14.00	12.75	14.20
Solubility, g/100 ml			
- water	0.88	0.93	0.65
- alkali (1N NaOH)	0.38	0.41	0.23
- acid (1N HCl)	0.58	0.87	0.77
Gelation point of 1% solution, ^{0}C	70.00	82.00	**51.00**
Ash-content, %	3.00	4.00	2.00
Etherification degree, %	66.00	75.00	48.00
Weight ratio of methoxylated carboxylic group, %	8.10	8.80	3.50
Weight ratio of acetylated carboxylic group, %	1.50	1.70	0.90
Weight ratio of free carboxylic group, %	8.80	7.80	**9.20**
Weight ratio of ballast substances, %	13.00	14.90	15.80
Pectic acid,%	46.00	45.00	40.00
pH of 1% solution	3.20	3.00	4.20
Viscosity of 1% solution, mm^2/s^2	4.10	2.80	3.30
Salt adsorption, % (pH=1.2)			
- lead	28.00	21.00	**42.00**
- copper	22.00	19.00	**31.00**
- cadmium	23.00	17.00	**33.00**
Salt adsorption, % (pH=8)			
- lead	34.00	23.00	**47.00**
- copper	30.00	26.00	**40.00**
- cadmium	30.00	27.00	**39.00**

Table 3. Physicochemical properties of tomato sauces

Parameter	Sample number			
	1	2	3	4
Dry substances, %	30.80	32.00	33.10	**32.40**
Moisture content, %	68.87	67.26	66.20	67.13
Titratable acidity inacetic acid equivalent, %	1.03	1.06	1.01	1.07
Vitamins, mg/100 g: - vitamin C	0.19	0.21	0.18	**0.23**
Carotetoids in β-carotene equivalent, mg/100g	13.62	19.16	14.23	**19.71**
Total protein, mg/100g г	113.00	98.00	104.00	**115.00**
Hemicellulose, %	25.30	35.00	28.70	31.70
Reducing sugars, g/100g	4.90	7.20	6.50	**8.70**
Fiber, %	3.02	2.90	2.60	**3.60**
pH	4.35	4.05	4.10	**4.60**
Viscosoty, Pa*s	8.83	27.52	16.64	24.64

ballast substances is observed in beetroot pectin, and the smallest - in apple. At the same time, the amount of ballast substances does not exceed 30%, which is in line with the requirements of GOST 29186 (2004). Citrus pectin has the least ability to bind metals, the medium binding ability has been demonstrated by apple pectin, and the best metal binder is beetroot pectin. Analysis of the objects of study allowed developing new formulations of tomato sauces, and finding the optimal concentration of pectin in order to achieve an acceptable viscosity and consistency. This was made possible by introducing 0.5% of different types of pectin and starch, and from 0.25 to 1.5% of one type of pectin to the sauces. Starch was added to sample No. 1, apple pectin - to sample No. 2 formulation, citrus pectin was added to sauce No. 3, and beetroot pectin was added to sample No. 4.

The organoleptic indicators of all samples comply with the requirements of GOST 17471 (2014). The results of physicochemical testing are presented in **Table 3**.

It can be seen that stabilizing and thickening abilities of beetroot and apple pectins are better than that of citrus pectin. The structuring and thickening properties of all samples containing pectins are better than those of starch based at the same concentration. Consequently, the use of pectins in sauces not only allows to create a new functional product, but also significantly reduces the amount of structuring agent in the formulation. It is clear from the above, that beet pectin is the best of pectin- and starch-based samples, so it would be useful to add it to the composition of ketchup. The formulation of tomato sauce with beetroot pectin is shown in **Table 4**.

Table 4. The formulation of beet pectin ketchup

Ingredients	Quantity, g per 100 g of ketchup
Water	46.00
Tomato paste, 30%	31.65
Granulated sugar	18.55
Table salt	1.40
Vinegar 70%	0.70
Citric acid	0.22
Potassium sorbate	0.10
Ground black pepper	0.05
Paprika powder	0.05
Chili powder	0.03
Beet pectin	1.25

CONCLUSIONS

Our study permitted to make the following conclusions:

1. The organoleptic, physicochemical and analytical tests have shown that beet pectin has the best properties;
2. It has been established that all the tested samples of pectin powders have better stabilizing and structuring properties than starch;
3. The sample of ketchup containing beet pectin has the highest nutritional and biological value, which allows to recognize it as the best tomato sauce among the tested ones.
4. The pectic substances are an excellent and promising alternative to starch and starch products, allowing to create new functional food that will play the preventive health care role.

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