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INVESTIGATION OF THE PHYSICO-CHEMICAL PARAMETERS OF THE «GELAMIL» SERIES STARCHES IN THE TECHNOLOGY OF MASHED SOUPS

The object of research is the technologies for the production of puree soups using modified starches of the «Gelamil» series. One of the main requirements for the quality of the technology of puree soups is the creation of a fluid, uniform, finely ground texture, which plays a special role in the organoleptic characteristics of this type of product. The texture of the product can be adjusted by adding liquid boiling modified starches. Starches of the «Gelamil» series are represented by potato starch with a reduced viscosity and are characterized as air-flowing gelling potato starch, that is, starch, the solution of which gives a low viscosity at high temperatures, and when solidified – a dense gel.

Hydrodynamic changes in the parameters of starch paste based on starches of the «Gelamil» series, depending on the temperature and type of starch, have been established. It was determined that starch paste based on starches of the «Gelamil» series, in comparison with native potato starch, have a low temperature of maximum viscosity from 47±2 °C to 57±2 °C, and thus form a paste with a viscous-flowing texture. The effective viscosity of starch paste was investigated depending on the starch content. It has been experimentally established that regulation of the starch content makes it possible to create starch paste according to different textural properties. For viscous-thinned dispersions, the starch concentration is from 1.0 to 3.0 %. For viscous-flowing dispersions having a long texture, the starch concentration is 3.5 to 5.0 %. For viscous-flowing dispersions having a short texture, the starch concentration is 5.5 to 7.0 %. For the content of native potato starch in the system of more than 5.0 %, a dense paste with a short texture is formed. It was found that for a starch paste based on starches of the «Gelamil» series, the separation of the liquid phase occurs due to 2:00 in an insignificant amount. A lot of components and model systems based on vegetable, legume purees and starch paste have been investigated. It has been determined that, depending on the type of vegetable and legume raw materials, the use of starches of the «Gelamil» series of different types and concentrations depends.

Keywords: *starches of the «Gelamil» series, starch paste, effective viscosity, multicomponent model systems.*

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1. Introduction

A special place among the first courses is occupied by mashed soups. These soups have a homogeneous consistency, therefore they are used in baby and medical nutrition, since they have a positive effect on the functioning of the gastrointestinal tract, and make it possible to diversify the diet of the elderly. And also because this dish is easy to digest and high in calories [1].

The process of making pureed soups is lengthy and requires additional involvement of special equipment to ensure a uniform consistency and a given dispersion. Inadmissible defects are delamination, insufficient sedimentation stability of the system. Based on this, the use of food additives – modified starches in the technology of mashed first courses is an urgent task today. For a stable structure of soups-puree can be used liquid-boiling modified starch «Gelamil» [2, 3]. So, *the object of research* is the technology of production of soups puree using modified starches of the «Gelamil» series. *The aim of research* is to study the physicochemical parameters of starches of the «Gelamil» series.

2. Methods of research

To study the rheological properties of starches of the «Gelamil» series, starch «Gelamil 120», starch «Gelamil 140 SAV», starch «Gelamil 3501» were chosen; native potato starch was taken as a control.

Starch suspensions were obtained by suspending dry sieved starch with drinking water at a temperature of 20±2°. Starch paste was obtained by heating starch suspensions at an appropriate temperature and duration.

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The rheological characteristics of the starch suspension upon heating were determined on the Brabender amylography (Germany) [4]. The initial temperature of the dispersions was 25 °C, the increase in heating temperature was 1.5 °C per minute. The viscosity of the dispersions was expressed in conventional units of amylograph (Brabender units) from 0 to 1000.

The effective viscosity of starch paste was determined using a constant voltage viscometer VPN-0.2 (Ukraine) [5].

Dynamic or effective viscosity was determined by the formula:

$$\eta = k \cdot U \cdot T \cdot A, \quad (1)$$

where k – constant of the measuring node, Pa/V; U – voltage, B; T – period of rotation, s; A – coefficient of the measuring unit.

The shear rate was determined by the formula:

$$\gamma = \frac{1}{T \cdot A}, \%. \quad (2)$$

Shear stress τ was determined by the formula:

$$\gamma = k \cdot U. \quad (3)$$

To compare the viscosity of two or more objects, the viscosity was compared with the same shear rate, which was selected in the region of maximum viscosity of an extremely intact structure or minimum viscosity of a destroyed structure.

3. Research results and discussion

The group of companies «KMS» (Denmark) [6, 7] produces a series of innovative starches «Gelamil», which are characterized by high technological stability and maximum stability.

Starches of the «Gelamil» series are represented by potato starch with a reduced viscosity and are characterized as air-flowing gelling potato starch, that is, starch, the solution of which gives a low viscosity at high temperatures, and when solidified – a dense gel. The decrease in viscosity, which is the result of oxidation or acid hydrolysis of starch, is due to the fact that the starch chains are separated, for example, made shorter. As a result, starch has the following properties compared to ordinary potato starch, starch can be used at a higher concentration, increased ability to bind water and form a gel, as well as increased stability and purity of solutions [7].

An important characteristic of starch paste (SP) of modified starches is the range of starch gelatinization temperature, in which the temperature of the beginning of gelatinization and the temperature of the peak of gelatinization are distinguished (Table 1).

It can be seen from the studies (Table 1) that after modification, the temperature of the onset of gelatinization decreases and is inversely proportional to the average size of the fragments of the starch molecule.

Due to the oxidation of starches of the «Gelamil» series, a large number of hydroxyl groups accumulate, so the temperature of the beginning of gelatinization decreases. Thus, the initial gelatinization for starches «Gelamil 120» (G 120) and «Gelamil 140 SAV» (G 140 SAV) is 56±1 °C, and for starch «Gelamil 3501» (G 3501) – 47±2 °C. At the peak of gelatinization, research starch reaches, respectively, a temperature of 69±1 °C.

Table 1

Rheological properties of starch paste

No.	Name of starch paste	Temperature of the beginning of gelatinization, °C	Temperature of peak gelatinization, °C
1	SP based on native potato starch (control)	76±2	85±2
2	SP based on G 120 starch	55±2	70±2
3	SP based on G 140 SAV starch	57±2	70±2
4	SP based on G 3501 starch	47±2	68±2

Note: SP – starch paste; G 120 – Gelamil 120; G 140 SAV – Gelamil 140 SAV; G 3501 – Gelamil 3501

The data obtained show that the modification of starch significantly affects the value of the starch gelatinization temperature – it decreases. Therefore, for various technological modes of production of mashed soups, it is possible to use these starches as substitutes for native starches, since they have a lower temperature for reaching maximum viscosity, and at the same time form a paste of the required texture.

It should be noted that by varying the starch concentration, systems with different structural and mechanical properties can be obtained. Therefore, the next study was to determine the viscosity of starch paste at a temperature of 85±5 °C, depending on the concentration of starches (Fig. 1).

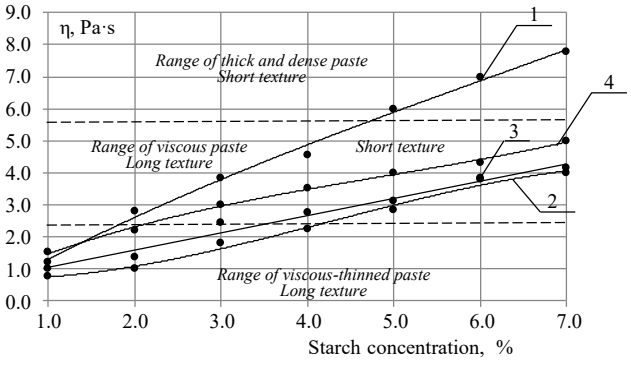

Fig. 1. Dependence of the effective viscosity of starch paste (t=80±5 °C) on the starch concentration: 1 – native potato starch; 2 – «Gelamil 120» starch; 3 – «Gelamil 140 SAV» starch; 4 – «Gelamil 3501» starch ($\gamma = 50^{s-1}$)

So, the pastes of starches of the «Gelamil» series at a concentration of 1.0 % to 3.0 % have a pronounced fluidity and fluidity. As the concentration for the G 140 SAV and G 3501 starches increases from 3.5 % to 4.0 %, the starch paste acquires a viscous-flowing consistency and a long texture. Dispersions with a starch content of G 3501, G 140 SAV, G 120 from 5.0 to 7.0 % form a paste with a short texture.

The viscosity of native potato starch differs significantly from the viscosity of Gelamil starches. So, with an increase in concentration from 2.0 % to 4.0 %, the paste quickly acquires a viscous-flowing consistency. With an increase in concentration to 7.0 %, the paste acquires a dense and thick consistency.

For the production of puree soups, it is necessary to observe the homogeneity of the structure, i. e. there should be no delamination of the system, which can occur due to synergistic changes in starches. In particular, if the system contains starch in a native state (native potato starch or wheat flour) [8].

Analyzing the experimental data, it was determined that the stability of starch paste based on potato starch during storage significantly deteriorates. So, the amount of water exfoliated at 10 % of potato paste after an hour of storage was 50.0 %. This is due to the fact that native potato starch contains up to 25 % amylose, and food products with their use as thickeners and gelling agents are characterized by low technological stability and show a pronounced tendency to syneresis [8].

Regarding starches of the «Gelamil» series, they demonstrate fairly stable indicators during storage, only 2 hours later, moisture peeling began in the paste, but not significantly.

Puree soups contain vegetables and legumes, most of them are potatoes, cabbage, carrots and legumes (peas, beans). Analyzing the recipe composition, it was determined that vegetables such as potatoes, mushrooms and legumes contain starch (2.0–16.8 %), fiber (1.2–5.7 %), hemicellulose (1.7–4.4 %), which are able to influence the structural and mechanical properties of soups-puree [9, 10].

At the level of multicomponent model systems (MMS), the content of starches of the «Gelamil» series was substantiated in order to determine their optimal concentration. As mentioned earlier, the consistency of the puree soup should have a uniform viscous consistency, so the following concentrations were taken for the study: 2.0; 3.0; 4.0. These concentrations in the composition of the model systems «water – starch» have shown themselves in the state of a viscous-rarefied mixture, therefore, to combine with vegetable and legume raw materials, they can change the structure.

According to research, it has been established that with an increase in the starch content in MMS, the viscosity grows dynamically. This is accompanied, firstly, by the gelatinization of starch grains, and secondly, by the chemical composition of vegetable and legume purees, which include starch, fiber, hemicellulose and pectin. Thus, the polysaccharides of vegetable and legume purees affect the structural and mechanical characteristics of puree soups. For complete visualization of the MMS structure, a texture characteristic has been developed (Table 2).

In the course of experimental studies, it was found that starches of the «Gelamil» series manifest themselves as liquid-boiling starches, which do not increase their viscosity depending on the temperature increase, and also show their stabilizing properties during storage.

To expand the range of puree soups, a technology project and their assortment have been developed, these are:

– diet puree soup, the main raw materials of which are potatoes, cabbage, zucchini, carrots, onions, greens. Drinking milk is used as an emulsifying base. Gelamil 140 SAV starch will be used as a thickener and stabilizer for the consistency of the soup at a content of 2.0 %;

– cream-spinach soup, the main raw material of which is spinach, champignons, asparagus, greens. Instead of milk, let's use milk cream 15.0 % fat, dry egg white. A thickener and stabilizer of the consistency of the soup will be used Gelamil 3501 starch at a content of 2.0 %;

– assorted bean puree soup, the main raw materials of which are lentils, green and onions, parsley root. Let's use drinking milk as an emulsifying base. Gelamil 120 starch will be used as a thickener and stabilizer for the consistency of the soup at a content of 2.0 %.

Table 2

Characterization of the texture of multicomponent model systems

Composition of a multicomponent model system (t=65±5 °C)	«Gelamil» starch content, % in a multicomponent system		
	2.0	3.0	4.0
No. 1 «Mashed potatoes – starch suspension of starch G 120»	Viscous flowing, homogeneous with a long texture	Viscous-flowing, homogeneous, with a short texture	Thick, homogeneous consistency, with a short texture
No. 2 «Mashed potatoes – starch suspension with starch G 140 SAV»	Viscous, homogeneous, with a short texture	Sufficiently thick, homogeneous, with a short texture	Gelatinous, homogeneous, with a short texture
No. 3 «Mashed potatoes – starch suspension with starch content G 3501»	Viscous-flowing, homogeneous, with a short texture	Thick, homogeneous consistency, with a short texture	Gel-like, homogeneous
No. 4 «Spinach puree – starch suspension with starch content G 3501 with starch content G 120»	Viscous-flowing, homogeneous with a long texture	Viscous flowing, homogeneous with a long texture	Viscous-flowing, homogeneous, with a short texture
No. 5 «Spinach puree – starch suspension with starch G 140 SAV»	Viscous, homogeneous, with a short texture	Viscous, homogeneous, with a short texture	Viscous, homogeneous, with a short texture
No. 6 «Spinach puree – starch suspension with starch content G 3501»	Viscous, homogeneous, with a short texture	Thick, homogeneous consistency, with a short texture	Thick, homogeneous consistency, with a short texture
No. 7 «Pea puree – starch suspension with starch content G 120»	Viscous, homogeneous, with a short texture	Gel-like, homogeneous consistency	Gel-like, homogeneous consistency
No. 8 «Pea puree – starch suspension with starch G 140 SAV»	Gel-like, homogeneous consistency	Sufficiently dense, gel-like consistency	Sufficiently dense, gel-like consistency
No. 9 «Pea puree – starch suspension with starch content G 3501»	Sufficiently dense, gel-like consistency	Sufficiently dense, gel-like consistency	Sufficiently dense, gel-like consistency

Note: SP – G 120 – Gelamil 120; G 140 SAV – Gelamil 140 SAV; G 3501 – Gelamil 3501

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The technological process for the production of soups-puree using starches of the «Gelamil» series consists in the production of vegetable puree with a homogeneous puree-like consistency, which is emulsified with the help of milk-containing products (drinking milk, milk cream, milk sauces). The vegetable-milk emulsion is heated to a temperature of 98±2 °C, a starch suspension is introduced and cooked with constant stirring until the starch is completely gelatinized.

Today, one of the limitations in the technology of puree soups is the lack of functional and technological ingredients with a «clean» label. In this case, starches of the «Gelamil» series are chemically modified, which in the future, their use and application may be limited in children's, elderly nutrition and the like.

For the prospect of obtaining rational parameters of the technology of soups-puree, it is necessary to carry out structural and mechanical studies of starches of the «Gelamil» series. One of the main objectives of research is to determine the influence of technological factors on the functional and technological properties of starch paste based on starches of the «Gelamil» series. The main technological factors are:

– pH of the environment;
– mechanical effect in the technology of soups-puree;
– presence of surfactants;
– content of polysaccharides (starch, pectin, fiber, etc.) contained in vegetable or legumes.

The generalization of the research results became the basis for the development of recommendations for the use of starches of the «Gelamil» series in the composition of culinary products. Due to the functional and technological properties of starches of the Gelamil series (high temperature, resistance to syneresis), it is possible to correct any food system, it has a viscous consistency. So, for example, starches of the «Gelamil» series can be used in the production of: drinks (viscous like jelly), sauces, have a viscous consistency (syrups, dressings, toppings) and can be used for heat treatment.

4. Conclusions

In the course of experimental studies, practical substantiation of the expediency of using starches of the «Gelamil» series (c=2.0 %), which showed the best stabilizing effects in the manufacture of soups-puree. To develop the recipe composition, multicomponent model systems were investigated that form the recipe composition of puree soups for the process of thickening and stabilizing the consistency using research starches.

According to experimental studies, the following types and concentrations of starches are accepted:

– for mashed soups with a combination of mashed potatoes – G 140 SAV starch at a content of 2.0 %;
– for puree soups with a combination of spinach puree – G 3501 starch, content 2.0 %;
– for puree soups with a combination of pea puree – G 120 starch, content 2.0 %.

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