Визначено еталонні показники консистенції соусів солодких в залежності від вмісту крохмалів, що стало передумовою розробки рецептурного складу соусів солодких із використанням крохмалів фізичної модифікації.

Досліджено вплив рецептурних компонентів (вид та вміст крохмалів фізичної модифікації, плодово-ягідної сировини, вміст цукру) на фізико-хімічні та структурно-механічні властивості модельних плодово-ягідних систем, що обумовлює можливість регулювання реологічних характеристик солодких соусів. Визначено, що зі збільшення концентрації крохмалів фізичної модифікації серії "Prime", "Endura" ефективна в'язкість підвищується. Згідно з реологічних досліджень плодово-ягідних модельних систем, визначено раціональні діапазони вмісту крохмалів фізичної модифікації для дресінгів, топінгів, діпів та начинок. Так, для одержання дресінгів на основі плодово-ягідного пюре або соку концентрованого, вміст крохмалю "Prime" повинен становити від 0,5 % до 1,5 %, крохмаль "Endura" – 1,5…3,0 %. Для одержання топінгів раціональний діапазон вмісту крохмалю "Prime" в системі повинен становити від 3,0 % до 5,5 %.

Для начинок, дипів, що мають більш густу консистенцію з "короткою" текстурою, вміст крохмалю повинен становити близько 7,0 %.

Під час експериментальних досліджень визначено раціональний діапазон концентрації цукру білого для соусів солодких. Так, за концентрації цурку білого більше 15 % утворюються в'язко-текучі пружні системи, що підходять для топінгів. Установлено, що за концентрації 20 %, консистенція є в'язко-густою, що характеризується консистенцією соусів дип. Досліджено, що подальше збільшення концентрації цукру з 25 до 30 % призводить до утворення гелеподібної пружної консистенції.

Досліджено реологічні показники модельних плодово-ягідних систем за різним вмістом крохмалю під час тривалого зберігання (90 діб). Визначено терміни зберігання соусів солодких.

Проведено дослідження для визначення сталих показників соусів солодких під час циклу "заморожування-розморожування"

Ключові слова: соуси солодкі, крохмалі фізичної модифікації, плодово-ягідна сировина, модельні системи, в'язкість

UDC 664.871:664.2
DOI: 10.15587/1729-4061.2019.180782

STUDYING THE EFFECT OF FORMULATION COMPONENTS ON THE PHYSICAL-CHEMICAL PROPERTIES OF SWEET SAUCES THAT CONTAIN PHYSICALLY-MODIFIED STARCHES

S. Andreeva
PhD, Associate Professor*
E-mail: svetana783@ukr.net
M. Kolesnikova
PhD, Associate Professor*
E-mail: marynakolesnikova@gmail.com
Y. Pyvovarov
Doctor of Technical Sciences, Professor*
E-mail: pcub@ukr.net
T. Khaustova
PhD, Senior Lecturer*
E-mail: haustenok@ukr.net
A. Dikhtyar
PhD, Senior Lecturer*
E-mail: alenadikhtyar@ukr.net
*Department of Food Technology
Kharkiv State University of
Food Technology and Trade
Klochkivska str., 333, Kharkiv, Ukraine, 61051

Received date 30.08.2019
Accepted date 07.10.2019
Published date 24.10.2019

1. Introduction

The current state of food production testifies to the existence of a clear-cut trend to an increase in the demand for finished products. This tendency is essential for restaurant enterprises (REs) and reveals a wide range of problematic issues related to the improvement of quality, extending assortment, provision, variation of shelf life. However, one of the most pressing tasks is ensuring stable technological properties of culinary products in the process of production, storage, and consumption.

In the total amount of production from restaurant enterprises, significant share belongs to meals whose cooking and selling involves sauces, self-made and produced industrially.

In the technological process of sauces production, wide spread are the functional-technological ingredients, which include starches (native, modified). However, native starches have a series of limitations to use: low thermal and acid-stability, tendency to syneresis, short shelf life, etc.

Currently, there is a lot of information about the assortment and properties of starches. These characteristics typically include general recommendations for their use in specific technologies. However, the use of starches implies not only the application of "ready" recommendations, but also understanding patterns in the changes of the functional-technological properties of starches in the implementation of the cycle "production – use as part of products – storage ".

Substantiating the use of the physically-modified starches (PMS) in the technology of sweet sauces is an important scientific and practical task that would have industrial implications; resolving it could form a scientific basis for the technology of sweet sauces.

2. Literature review and problem statement

The technologies of sweet sauces with additives that adjust indicators of nutritional value imply reducing the consumption of thickeners, sugar, making dietary products, enrichment with proteins, vitamins, mineral substances, and dietary fibers. At present, most technologies that employ thickeners are aimed at improving the technologies of heat-resistant fillings based on fruit and vegetable raw materials. However, it has become popular to devise technologies for modern types of sauces (toppings, dressings, dips).

As one can see, a significant proportion of innovations [1–5] aims to ensure stability of consistency that is achieved by adding modifiers: starches of chemical and enzymatic modification, gums, compositions of starches of chemical modification combined with gum, carrageenan, or a combination of gum arabic with low-esterified pectin. In this case, these compositions provide sauces not only with stable consistency, but also the resistance to mechanical stress, the lack of syneresis. Our analysis of these innovations has revealed the main disadvantages of using modifiers in the technology of sweet sauces. Thus, using carrageenan, methylcellulose may decrease the stability of consistency when freezing sauces, or system stratification [1, 2]. Applying xanthan gum, gelan gum, gum arabic in the technology of sauces forms transparent gels, but, after cooling, the gels are prone to syneresis and are not resistant to mechanical stress [3]. One of the promising thickeners for sweet sauces are pectins, but thickening the system with highly esterified pectin can only occur in the presence of sugar and acid. Low-esterified pectin may thicken the system or form stable gels provided the system has free calcium ions [4, 5]. Therefore, these nutritional supplements are combined with others, which further increase the cost of the product and limit their consumption by certain consumer groups.

Food ingredients of a polysaccharide nature are represented by a wide assortment, but the results of systematization of information and the experience of food enterprises have demonstrated that starches are mostly applied in practice.

Given this, those scientific studies are relevant that are aimed to develop fundamental and applied aspects in the field of forming and using non-toxic materials, specifically extruded flour [6].

Important is the research into effect of extruded flour on the physical-chemical characteristics of the model systems of sauces. It has been shown that the pre-gelatinized extruded flour could be used in technology of sauces without thermal treatment. However, the reported results related to a greater degree to studying the impact of particle size and the type of flour on the physical-chemical characteristics of model systems of sauces, while the impact of formulation components in a sauce (heat treatment temperature, pH, sugar content, etc.) was not considered at all.

The above has become a prerequisite to search for functional ingredients, which, during application in technological systems, would provide the implementation of functional-technological properties for obtaining sweet sauces with the predefined consumer properties. In this direction, those scientific studies are relevant that are aimed to develop fundamental and applied aspects in the field of forming and using non-toxic materials, specifically starches. Underlying their properties are the innovative approaches to using chemical modification.

Physical modification is applied to obtain swollen (pre-gelatinized) starch and is carried out by the moisture-thermomechanical treatment of starch in the rolling, spraying dryers or in extrusion installations, which enable quick gelatinization of starch and subsequent drying of the starch gel. Such a treatment results in breaking down the natural structure of starch grains, which is not accompanied by their destruction, and starch acquires the ability to swell and dissolve in cold water.

Authors of [7] investigated the physical-chemical characteristics of starches from wax maize that underwent physical modification. By using the hydrothermal treatment, a starch suspension was heated to a certain temperature (the temperature of gelatinization) whose values are in a wide range from 65 °C to 80 °C. The main drawback of physically-modified starches, obtained by extrusion drying, is the damage to starch grains in the process of fine grinding, which leads to the uneven progress of gelatinization.

Physical modification of polymers properties can be achieved both at the stage of obtaining the ingredients and during the technological process. As regards starch, physical modification is applied in the technology of cold-swelling starches, porous starches, obtained via cryolite (freezing, defrosting) or extrusion, as well as the cleaved starches, obtained in the process of intensive mechanical treatment – mechanolysis [8].

A group of companies "Ingredion" [9, 10] produces a series of innovative starches "Novation" without index E, which are characterized by the highest technological resistance and maximum stability. Within the technological spectrum of products intended for different purposes (sauces, soups, fillers) under conditions of technological influence, the starches "Novation" are claimed to be the ingredients that can form and maintain structure. These types of starch correspond to the EU Resolution 834/2007 and can be labeled as "organic" [11].

When developing modern technologies for modified starches, an important aspect is to study the morphological structure as the size, shape, nature of the surface, and the distribution of grains by size can largely determine the quality of starch and affect the progress of their physical modification.

Physical modification of the Novation starches is predetermined by the specificity of the microstructural characteristics of starch grains, namely their shape, size, which are monodispersed [12, 13]. The monodispersity of physically-modified starches is due to the almost identical size of starch grains. The mono-dispersed system of starch grains has the shape of an acute peak with a rather narrow system [14], which may be the end states of the substance, grain granules of different sizes and phase state, and the dynamic structures, coherent flows of grains, ordered in space and time.

Investigating the physical-chemical foundations of dispersion thickening, as well as studying modern technologies for obtaining physically-modified starches, allows the prediction of prospects of their use in the technology of sweet sauces.

3. The aim and objectives of the study

The aim of research whose results are generalized in the current paper is to prove the expediency of using physically-modified starches in the technology of sweet sauces based on fruit and berry raw materials.

To accomplish the aim, the following tasks have been set:

– to justify the choice and content of fruit and berry raw materials, physically-modified starches, white sugar, in the model systems that imitate the formulation composition of sweet sauces;

– to examine the rheological studies into fruit-and-berry model systems depending on the content of physically-modified starches, white sugar, in order to define a rational range of thickeners concentration, which model the predefined consistency of sauces;

– to establish basic parameters and conditions for storing fruit and berry model systems depending on the content of starch;

– to carry out an experimental study of the cycle "freezing – defrosting" of fruit and berry model systems depending on the content of starch.

4. Materials and methods to study the impact of formulation components on the properties of sauces

In the experimental study, we used concentrated juices, fruit and berry purees (fruit and berry raw materials), which, in terms of quality and safety indicators, complied to the norms of the manufacturer.

To prepare fruit and berry purees, the frozen fruit and berry raw materials were thawed at a temperature of 19±2 °C, the fresh fruit and berry raw materials were washed, skin and seeds were peeled off, then we cut them into slices of $(10...15)\times10^{-3}$ kg. The prepared fruit and berry raw materials were blanched at a temperature of 98±2 °C for (7...8)·60 s and squeezed until obtaining a puree.

We determined active acidity of fruit and berry raw materials according to GOST 26188-84 [15] at a laboratory pH meter, the type of "OR-205/1" with an error of ±0.005 [16]. Mass fraction of dry substances in the fruit and berry raw materials was determined according to GOST 5900-73 [17].

Effective viscosity of the gelatinized starch dispersions (GSD), model systems (MSs), semi-finished and finished products was determined at a rotary viscosimeter, the type of VPN-0.2 [18].

To compare the viscosity of two or more objects, we compared viscosity at the same shear rate, which was chosen in the region of maximum viscosity of the extremely non-destroyed structure or minimum viscosity of the destroyed structure.

The volume of the liquid phase isolated from GSD during storage and a freezing-thawing cycle was determined in line with [18].

We froze model systems at the temperature of −18±2 °C for 7 days. The samples were stored in a glass container with metallic lids.

Statistical processing of results from the study employed the software STATISTICA 13.3 (a Process Optimization build), the graphs were constructed using the tabular processor MS Excel 2010.

5. Investigation of the influence of formulation components on the physical-chemical and structural-mechanical properties of model fruit-berry systems

The interaction between polymers of starch and water largely determines the structure and texture of food products. The swelling of starch is caused by the plasticizing of the amorphous regions and by the melting of starch crystallites, which form a system of transverse bonds [19].

To substantiate the type and content of starch for thickening and stabilization of sweet sauces, we determined changes in the effective viscosity of model systems "starch–water" (Fig. 1). Since GSD are the non-Newtonian liquids, we first determined the viscosity of solutions at different concentrations (2...8 %) depending on the shear rate at a constant temperature of 70±2 °C.

It was established experimentally (Fig. 1) that control of starch content makes it possible to form GSD with the properties of liquid dispersions (from 2.0 % to 3.0 %), dispersions of medium density (from 3.5 to 8.0 %), thick dispersions (from 7.0 to 8.0 %), which were adopted as parameters for the formulation composition of sauces with a variable consistency.

Based on studies into the properties of starches of various brands [20–23], the appropriateness of using the PMS "Prima", "Endura" was established. The rational conditions for obtaining GSD were defined, specifically the content of starch for the respective kinds of sauces consistency, the system's pH, and the content of white sugar (Table 1).

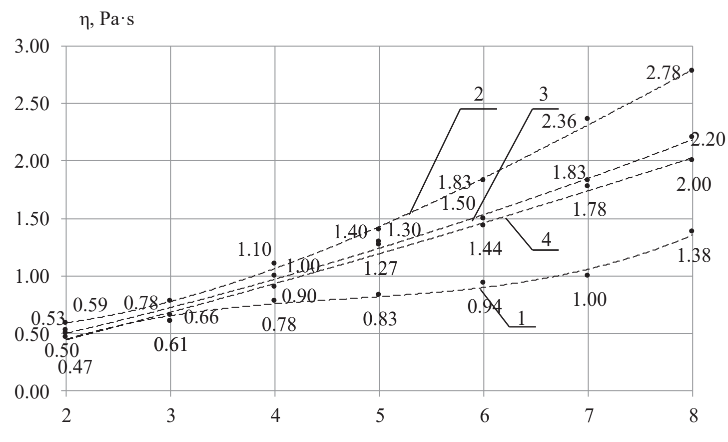

Fig. 1. Dependence of GSD effective viscosity on starch content: 1 — corn amylopectin; 2 — wax corn "Prima"; 3 — tapioca "Endura"; 4 — tapioca "Indulge" (at γ=50 s-1)

The technology of obtaining sweet sauces with the use of PMS is determined by the specificity of functionally-technological properties, associated with the viscosity of the product, effect of fluidity, as well as colloidal stability under storage conditions, changes in temperature.

The substantiation of the formulation composition was preceded by the study of the prototype products, made industrially, which were ranked by the purpose (dressings, toppings, dips and fillings) and based on determining reference characteristics (Table 2). Table 2 gives analysis of the physical-chemical indicators of sauces available in the market [20–23]. The analysis was carried out in order to further compare the physical-chemical indicators of sweet sauces that contain physically-modified starches.

Table 1

Rational parameters for obtaining GSD based on PMS

Parameter title	Measuring unit	Rational parameters		
		dressings	toppings	fillings, dips
Type and content of starch				
Made from wax corn «Prima»	%	2.0...3.0	3.5...7.0	7.5...9.0
Tapioca «Endura»		2.0...3.5	4.0...7.5	8.0...9.0
Heat treatment temperature				
Made from wax corn «Prima»	°C	69 °C≤*t*≤99 °C		
Tapioca «Endura»		68 °C≤*t*≤99 °C		
pH of the system for starch-based GSD				
Made from wax corn «Prima»	device unit	pH≥3.0		
Tapioca «Endura»		pH≥3.0		pH≥4.0
White sugar content for starch-based GSD				
Made from wax corn «Prima»	%	5...10	15...20	25...40
Tapioca «Endura»			15...30	35...40

Table 2

Characteristic of reference indicators for sweet sauces of industrial production

Indicator	Characteristic of indicators for sauces				
Groups of sweet sauces	dressings	toppings		dips	fillings
Consistency	rare	medium density		dense	
Sauce homogeneity	homogeneous	homogeneous	heterogeneous	homogeneous	heterogeneous
Effective viscosity (Pa·s) (γ=50 s^{-1})	0.30±0.01	1.50±0.04	2.07±0.1	3.07±0.1	3.50±0.1
Texture indicators at rest	viscous-rare	viscous-fluid	viscous-fluid, elastic	viscous-elastic	gel-like, elastic
Characteristic of fluidity	texture is fluid «long»			texture is retained at a horizontal surface, «short»	

The ideology of the product implies, first of all, the use of natural raw materials of plant origin (fruits, berries) and concentrates on their base; the justification of the choice of fruit and berry raw materials was based primarily on the consumer preferences research.

Concentrates of juices and fruit and berry purees were used during the research. To justify the content of fruit and berry raw materials in the model system's composition, their physical and chemical characteristics (solids content and active acidity) were investigated.

It was determined that juice concentrates have more solids (62.0–67.0 %) than fruit and berry purees (8.5–24.2 %). Active acidity of fruit and berry raw materials (2.86–3.55), the content of organic acids, the presence of pectins, can affect the structural-mechanical characteristics of a sauce.

The impact of fruit and berry raw materials on the properties of GSD were investigated at the level of model systems. The effect of fruit and berry raw materials and white sugar on the properties of model systems was determined at the constant shear rate of 50 s-1 with constructing the effective viscosity curve. Since the viscosity for GSD at this rate is a constant magnitude, any change in it will be determined by the influence of technological factors.

Data from studying the viscosity of MS "puree – water–starch" (Fig. 2, 3) confirm the behavior of starches in the MS – an increase in starch content increases the effective viscosity.

The rational concentrations of the PMS "Prima" are 1.5–2.0 % for dressings; for toppings – from 2.0 to 6.0 %, respectively, for all the types of purees studied. The content of starch in the range of 6.3–7.5% in the presence of a puree ensures forming a thick dense consistency that is inherent to dips and fillings.

Similar tendencies are demonstrated by model systems based on starch "Endura", but at some other concentrations. The MS based on starch "Endura" have different textural characteristics, which makes it possible to adjust the structure of sauces:

– for dressings (they have liquid consistency, quickly spread at a horizontal surface), it is advisable to use MS based on cranberry and blackcurrant purees at starch content of 1.5...3.0 %, MS based on raspberry and banana – 1.5...2.5 %;

– for toppings, the necessary content of starch is from 3.0 to 5.5 % (for MS based on raspberry puree, banana);

– for fillings, dips, which have a denser consistency with a "short" texture, the content of starch is about 7.0 % for MS based on all types of purees (except banana, which forms a system in the form of a gel).

The technologies of sauces also involve the use of concentrated juices (CJs): cherry, strawberry, peach, which have a series of advantages both for consumer and manufacturer. Therefore, we next investigated the MS "CJ–water–starch" (Fig. 3, 4).

Fig. 3, 4 show that all model systems are characterized by the general nature of an increase in viscosity, under condition that the starch content is increased. Our analysis of curves makes it possible to assert that the use of starch "Prima" in the amount of 0.5...1.5 % is the most rational to form the viscous characteristics of dressings.

Our research into MS viscosity at the "Prima" starch content of 1.5...6.0 %, except for MS based on peach CJ (up to 7.5 %), has substantiated the rational range to form toppings. It was established that the content of starch of 6.0...7.5 % is rational for obtaining dip sauces or fillings.

Model systems with the "Endura" starch content are recommended only for dressings and toppings. Thus, the consistency of MS at the content of starch of 1.5...2.5 % is liquid and rather fluid; an increase in its concentration to 7.5 % transforms it into viscous-fluid.

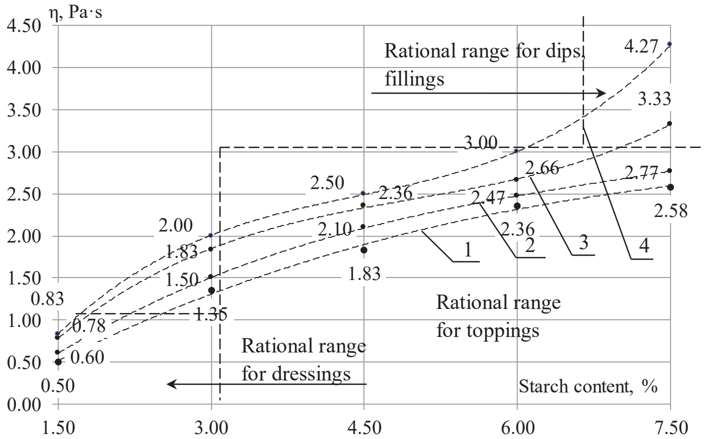

Fig. 2. Dependence of effective viscosity of MS ("puree – water –PMS "Prima") on starch content based on puree: 1 – cranberry; 2 – black currant; 3 – raspberries; 4 – banana (γ=50 s^{-1})

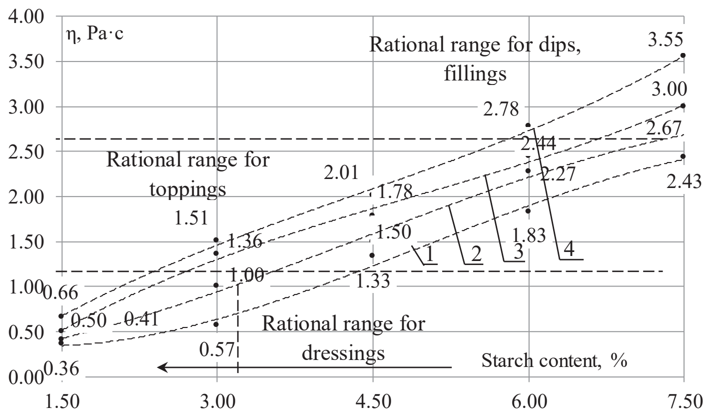

Fig. 3. Dependence of effective viscosity of MS ("puree – water –PMS "Endura") on starch content based on puree: 1 – cranberry; 2 – black currant; 3 – raspberries; 4 – banana (γ=50 s^{-1})

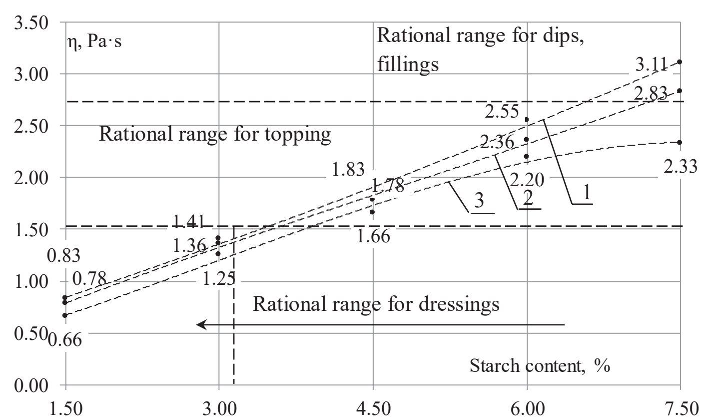

Fig. 4. Dependence of effective viscosity of model systems "Juice –water – PMS "Prima" on starch content based on CJ: 1 – cherry; 2 – raspberry; 3 – peach (50 s^{-1})

The obtained experimental data (Fig. 2–5) confirm resistance to the effect of organic acids by PMS "Prima", "Endura", which in the process of hydrolysis exhibit stability, probably due to the monodispersity of grains.

It was determined [22] that during cooling of GSD based on the starch "Prima" to the temperature of 1...6 °C the viscosity grows due to the formation of hydrogen bonds, while the "Endura" starch-based GSD is characterized by a slight increase in viscosity indicators during cooling. Therefore, we propose using the starch "Endura" for more liquid systems that have a homogeneous texture (for example, dressings, homogeneous toppings, without introduction of fillers).

It is known that the consistency of sauces can be created according to two mechanisms: the concentration of solids (for example, boiling) or the introduction of a structure-forming agent. Since in the technological process the duration parameter is variable it is selected depending on the amount of mixture that is processed, and the type of equipment.

The next level of research implies maximum approximation of the MS composition to the formulation composition of sweet sauces. Therefore, based on previous studies, we developed a composition of MS with different sugar content and investigated the effective viscosity of MS (Fig. 6). In addition to forming a sweet taste, sugar significantly affects the consistency by enhancing the content of dry matter.

It was established that the introduction of sugar in concentrations up to 10.0 % does not significantly affect the viscosity of model systems. The optimum sugar content for MS (1) is 15.0 %. The sugar concentration for MS (2) varies in the range of 15...20 %.

Increasing sugar content increases the viscosity of systems due to starch gelatinization. According to organoleptic parameters for toppings with a homogenic structure, increasing the concentration of sugar changes color and taste.

The MS (3) with the concentration of sugar exceeding 15 % forms viscous-fluid elastic systems. When sugar concentration increases to 20.0 %, the viscosity is 2.47±0.07 Pa·s: these indicators are rational to form toppings with fillers.

The rational range of sugar concentrations for dips and fillings was determined. It was established that at the concentration of 20 % for MS (4) the consistency is viscous-dense, which is characteristic of the consistency for dip sauces. It is investigated that a further increase in sugar concentration from 25 to 30 % leads to the formation of a gel-like elastic consistency, whose viscosity varies from 3.78±0.1 to 4.12±0.1 Pa·s.

The formulation composition and the technological process of production should provide for the formation of the predefined consumer properties and their stability during shelf life. The phenomenon of starch "aging" is a significant drawback and is accompanied by stratification, and a loss of feeling of juiciness.

Model systems were investigated at different concentrations of starches, according to their types – dressings, toppings.

Model systems with the content of starch corn of 2.0 % demonstrate in 3 days the stratification of moisture, to 8.0 %, and at concentration of 7.5 % – the stratification of moisture occurs on day 27, by 18.0 %.

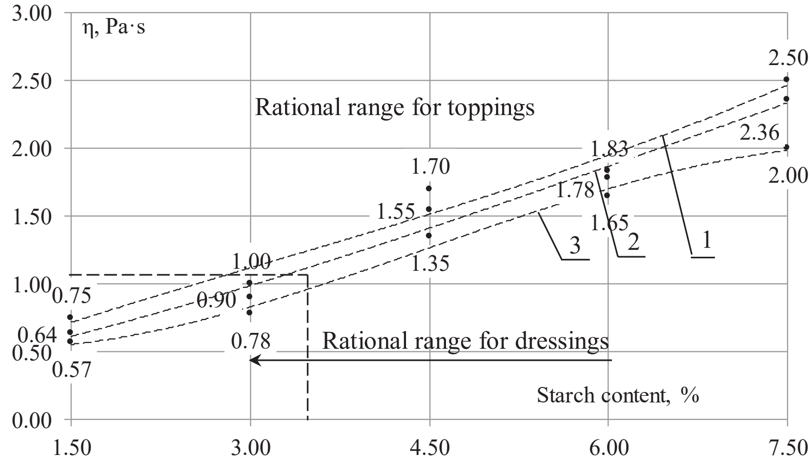

Fig. 5. Dependence of effective viscosity of model systems "Juice – water – PMS "Endura" on starch content based on CJ: 1 – cherry; 2 – raspberry; 3 – peach (γ=50 s^{-1})

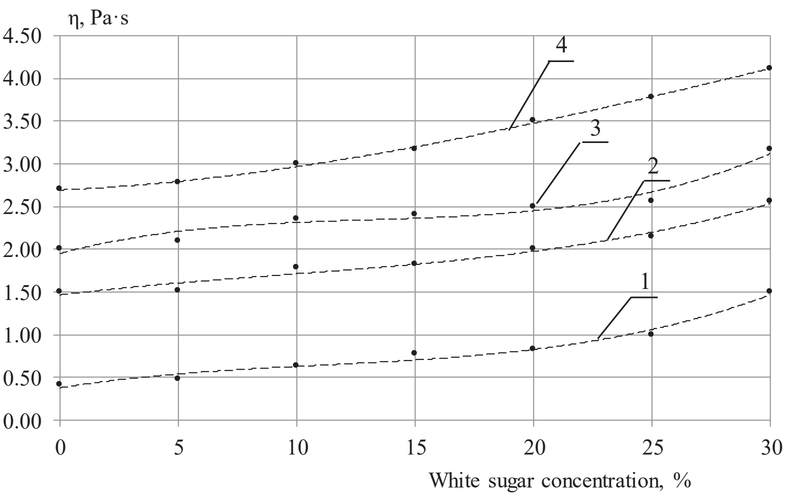

Fig. 6. Dependence of effective viscosity on MS composition based on: 1 – peach CJ; 2 – cherry CJ; 3 – raspberry puree; 4 – blackcurrant puree (γ=50 s^{-1})

The data reported have confirmed the high functionality of "Prima", "Endura" starches, including the processes of storing finished products, which are 90 days at a temperature of 1...6 °C and an air relative humidity of 75.0...85.0 %.

"Loading" a formulation composition of MS with food ingredients (fruit and berry raw materials, sugar) requires their testing in the cycle "freezing–defrosting". The control adopted is a MC based on corn starch.

The research results show the instability of the MS based on corn starch over the cycle "freezing–defrosting". The MSs based on the "Endura", "Prima" starches proved resistant to low temperature, as evidenced by the indicators for effective viscosity before and after defrosting, which remained almost unchanged.

Thus, the set of our studies has scientifically grounded and proven the expediency of using the "Prima", "Endura" starches for sweet sauces, which make it possible to create variable consistencies that are stable over time and resistant to the action of destabilizing factors.

6. Discussing the results of the impact of formulation components on the properties of sweet sauces

Based on the examined properties of starches by various brands, the expediency of using the "Endura", "Prima" PMSs has been established. We have proven the possibility of using, in the composition of sweet sauces, different types of fruit and berry raw materials and semi-finished products: puree (from cherries, strawberries, raspberries, currants, cranberries, banana), concentrated juices (peach, cherry, raspberry).

By following the trend on ranking sauces based on three groups of consistencies, one can define the following patterns. In addition to starch content, the amount and type of a puree would significantly affect the consistency.

Sour taste (a pH level) of fruit and berry sauces can be formed both by using acid-containing raw materials (cranberry, cherry, currant) and by additional introduction of acids (for example, lemon).

Starch contains a share of impurities that reduce the concentration of acid in the solution. When the temperature rises, the hydrolysis rate increases and the temperature affects the chemical reaction rate, characterized by the magnitude of a temperature coefficient of reaction rate. Thus, according to the graphs shown in Fig. 1–4, it was established that the most resistant to the effect of acid-containing raw materials are the starches "Prima", "Endura". In the process of hydrolysis, PMSs exhibit stability, probably due to the monodispersity of grains, which was proven in other studies [20–23].

The effect of white sugar on gelatinization and properties of starch dispersions has practical significance in the manufacture of sauces of different textures. It is known that sucrose delays the swelling of starch grains in water due to high solids content. Therefore, to comprehensively substantiate the use of starches in the technology of sweet sauces, we performed an experimental study (Fig. 5) into the influence of white sugar on the effective viscosity of fruit and berry model systems. The analysis of general tendencies has revealed that an increase in the sugar concentration to 30 % leads to a gradual increase in viscosity indicators for all model systems.

The data obtained on the impact of formulation components on the physical-chemical properties of sweet sauces that include physically-modified starches make it possible to assert the following:

– we have established patterns in the influence of fruit and berry raw materials, white sugar, on the functional-technological properties of food systems that include PMSs;

– we have experimentally determined the kind and rational content of PMSs, confirmed the technological parameters for making sweet sauces that include them, whose implementation ensures constant quality indicators throughout the technological workflow.

Such conclusions could be considered expedient from the practical point of view, because they make it possible to reasonably approach the production of sweet sauces. From a theoretical point of view, they make it possible to argue on using PMSs and on the stability of structural and mechanical parameters of fruit and berry model systems depending on the technological factors, which from certain advantages of the current research.

However, one should note the effects of electrolytes that are present in sauces, which significantly affect the structure, texture, and organoleptic characteristics of the product.

Salts include cations of calcium, sodium, potassium, and anions, such as chlorine, carbonates and phosphates. Salts also include substances that form chelate complexes, for example, ethylenediaminetetraacetic acid, which contributes to slowing down the oxidative damage to a product. The preservatives used also include epy salts of sorbic and benzoic acids. The electrolytes ions interact with starch, facilitating interaction between different molecules to form the spatial mesh structure. Salts reduce the freezing temperature of solutions and increase the temperature of boiling, as well as alter the taste of a product in general. Therefore, in the future it is necessary to experimentally investigate the influence of salts on the structural-mechanical indicators of GSD.

7. Conclusions

1. We have substantiated the types of fruit and berry raw materials and the sequence of their introduction to the formulation of sweet sauces. Our research into the chemical composition and physical-chemical properties of fruit and berry raw materials has established their rational content in the composition of a formulation of sweet sauces.

2. The reference indicators for sauce consistency have been defined (effective viscosity): for dressings – 0.78±0.03 Pa·s at starch content of 2.0...2.5 %; for toppings with a homogeneous structure – 1.60±0.04 Pa·s at starch content of 3.0...4.0 %; for toppings with a heterogeneous structure – 2.70±0.08 Pa·s at starch content of 4.5...6.5 %; for dips – 3.25±0.09 Pa·s at starch content of 7.0; for fillings – 3.50...3.83 Pa·s at starch content of 7.5...8.0 %.

3. It was investigated that at the concentration of sugar from 15.0 to 20 % the viscosity of MS increases from 1.80±0.05 Pa·s to 2.10±0.06 Pa·s; the specified indicators were defined as rational for homogeneous toppings and for those that include fillers. The rational concentration of sugar for dips and fillings was determined. It has been found that increasing the concentration of sugar from 25. 0% to 30.0 % leads to the formation of a gel-like consistency whose viscosity varies from 3.78±0.1 Pa·s to 4.12±0.1 Pa·s.

4. It was determined when storing MS over 90 days that MS based on the starches “Prima”, “Endura” are durable and stable for 90 days of storage under a temperature of 1...6 °C and an air relative humidity of 75.0...85.0 %.

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