PROSPECTS FOR THE USE OF PHYSICAL MODIFICATION STARCH IN FOOD PRODUCT TECHNOLOGY WITH COLLOID STRUCTURE

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Abstract: The aim of research is studying the rheological properties of gelatinized starch dispersions based on physical modification starches, depending on technological factors.
Realization of the research aim will allow to obtain products (sauces, filler creams for confectionery products, etc.) using physical modification starches that are capable of selling products with specified structural and mechanical indicators, quality and safety indicators. And also ensure the rational use of raw materials, reduce the complexity of the technological process of production of culinary products.
The current trends in the development of starch technology for physical modification and their use in food technology are analyzed. A review of literature data has become the background for the use of these starches in food technology, which primarily draws attention to the colloidal stability of food systems.
A decrease in viscosity (the tendency ηmax=>ηmin) indicates the destruction degree of structural elements under the influence of mechanical stress and thermolysis. Tapioca starches "Endura", "Indulge" and waxy maize starch "Prima" have practically the same values η (min) and η (max), which indicates the stability of the structure of gelatinized starch dispersions. This is probably due to the fact that grains with a monodisperse fraction (≈83 %) swell and gelatinize equivalently.
A study of the effect of acids on the formation and stability of gelatinized starch dispersions shows that the most pronounced stability is characterized by dispersions based on Prima waxy starch and Endura tapioca.
The gelatinized starch dispersions based on corn starch amylopectin exhibit low stability during the maximum peak gelatinization depending on the effect of sugar and acid.
A thermodynamic study of physical modification starches wi carried out, which confirms the amount of energy expended on unpacking the starch grain, which confirms the initial gelatinization of starches.
Keywords: physical modification starches, initial and maximum gelatinization, gelatinized starch dispersions.

1. Introduction

An important condition for obtaining finished products with targets is predicting the behavior and effectiveness of the interaction of the individual components of the recipe in the process stream.

Food products (culinary products) as dispersed systems can be homogeneous or heterogeneous. Sauces, mashed soups, creams, fillers for confectionery products are multicomponent systems that undergo significant changes under the influence of technological factors. An important indicator of the quality of this culinary product is consistency – a complex multifactorial indicator, the formation of which depends on the colloidal state and dispersion degree [1, 2].

The difficulty of ensuring colloidal stability is determined both by the peculiarity of the recipe composition (acidic environment, the presence of slices of crushed fruit and berry raw materials, etc.), and by changes in the recipe mixture during processing, storage, use.

The study of factors in which the destruction of consistency occurs is very important for the justification and control of the technological process of production of culinary products. These include: mechanical or temperature effects, the amount of solids, the presence and effectiveness of the use of consistency regulators, pH, the effect of electrolytes.

The solution to the problem of ensuring the stability of disperse systems is facilitated by the introduction of thickeners that bind the liquid and increase the viscosity of the system. For example, starches, which can be native or modified [3, 4].

Today, modified starches are actively used, which, depending on the type of modification (chemical, physical, enzymatic), acquire new technological properties. But the use of chemical reagents, which belong to the group of food additives, limits the use in baby and diet food, the creation of organic products and determines the feasibility of searching for alternative types of starches.

Thanks to innovations in the production of starch and starch products, along with the classic types of native starches, new types with optimized characteristics have been created.

The Ingredion group of companies produces a series of innovative Novation starches without the E index, which are characterized by high technological stability and maximum stability. In a wide technological range of products for various purposes (sauces, soups, fruit fillers, dairy products) under intense mechanical and thermal effects, Novation starches are declared as ingredients that are able to form and provide a certain structure. These types of starch comply with EU Regulation 834/2007 and therefore can be labeled as "organizational" [5].

The introduction of physical modification starches in the technology of culinary products requires the study of effective viscosity from the influence of technological factors.

The aim of research is determination of the rheological properties of gelatinized starch dispersions depending on technological factors (temperature, the effect of citric acid, sugar). This will allow to establish the influence of the parameters of the gelatinization process on the structural and mechanical parameters of gelatinized starch dispersions (GSD). This will make it possible to create products (sauces, creams, etc.) with new consumer properties, reduce the complexity and mechanization of the process.

2. Methods

Subjects of research:

– amylopectin corn starch (control) according to the regulatory documentation in force in Ukraine [6];

– waxy maize starch "Prima" 600, tapioca starch "Endura" 0100, tapioca starch "Indulge" 3920 of the Novation series [7].

The rheological characteristics of starch suspensions upon heating are determined on a Brabender amylograph [8, 9]. The initial temperature of the dispersions is 25 °C, the increase in heating temperature –1.5 °C per minute. The viscosity of the dispersions is expressed in arbitrary units of the amylograph (Brabender units) from 0 to 1000.

Energy changes in starch suspensions are determined by differential scanning calorimetry. DSC is performed for 1 % starch suspensions in the temperature range of 20...100 °C, at an overpressure of 0.25 MPa and a scan speed of 2 K/min.

3. Results

The technological parameters of the gelatinization of starches that were used during the experiments are taken from previously scientifically based materials (**Table 1**) [10].

Table 1
Study of the rheological characteristics of physical modification starches

Type of starch	Rheological studies of starches during gelatinization for gelatinized starch dispersions								
	GSD			GSD when interacting with citric acid			GSD when interacting with sugar		
	Temperature, °C		Resistance coefficient	Temperature, °C		Resistance coefficient	Temperature, °C		Resistance coefficient
	initial gelatinization	maximum gelatinization		initial gelatinization	maximum gelatinization		initial gelatinization	maximum gelatinization	
Amylopectin corn (control)	72±2	78±2	0,15	72±2	74±2	–	74±2	75±2	–
From waxy corn «Prima»	60±1	69±2	1,0	60±1	69±2	0,9	60±1	69±2	1.0
Tapioca «Endura»	58±1	68±2	1,0	58±1	78±2	0,8	60±1	70±2	1.0
Tapioca "Indulge»	62±2	72±2	1,0	62±2	90±2	–	64±2	74±2	1.0

Thermodynamic research methods, for example, differential scanning calorimetry (DSC), are the most normative and accurate when determining specific heat [10]. This experiment confirms the amount of energy expended on the unpacking of starch grains. The results of calorimetric studies are shown in **Fig. 1.**

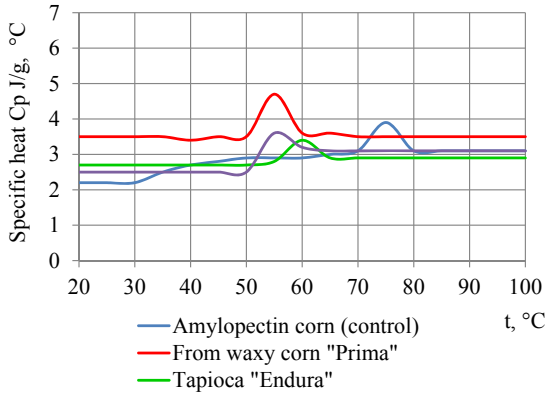

Fig. 1. DSC curves for starch suspensions

4. Discussion and conclusions

It should be noted that GSDs are visco-plastic thixotropic fluids for which the viscosity is a function of shear stress. The thixotropy of the studied systems is manifested in the presence of local values of the maximum and minimum viscosity, the ratio of the values of which determines the coefficient of stability of the system (k = ηmin/ηmax) to external influences – temperature, acid, sugar.

Tapioca starches "Endura", "Indulge" and waxy maize starch "Prima" have a low gelatinization start temperature (58...62 °C). The maximum gelatinization temperature is 68...72 °C, the dispersion is characterized by viscosity values with a maximum stability coefficient of 1.0. This is probably due to the fact that the grains of the monodisperse fraction (≈83 %) [13], which in the grain distribution area swell and gelatinize equivalently.

For amylopectin corn starch, initial gelatinization occurs at a temperature of 72±2 °C, maximum gelatinization occurs at a temperature of 78±2 °C and lasts 3...4 minutes, after which it decreases. This is probably due to the fact that starches have a polydisperse fraction.

From the rheological studies of starches, it is determined that amylopectin corn starch does not meet the technological requirements for the production of food products with a colloidal structure. According to the influence of technological factors (citric acid, sugar), GSD based on amylopectin corn starch is not able to maintain sTable viscosity indicators. This is explained by the fact that, according to their morphology and chemical composition, these starches have different grain rankings.

The studies provide an opportunity to study the features of the process of gelatinization, to identify patterns of GSD behavior in the presence of acid and sugar in the process of gelatinization.

Thermodynamic studies of starch suspensions, which describe the initial gelatinization processes, have shown that the unpacking of starch grains is characterized by endothermic peaks, which spend the energy of activation of moisture binding. As can be seen, the peak values of specific heat clearly correlate with the values of the initial gelatinization temperature. So for amylopectin corn starch they make up 72 °C, "Prima" waxy maize starch – 60 °C, for tapioca starches "Endura" and "Indulge" – 62 °C. The above research results are the main to justify the minimum temperature at which gelatinization of starches will be ensured during the production of food products of colloidal structure.

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