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Physical property of food	Automation of food processes
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Influence ratio of water and oil phases of emulsions with starch on viscosity, density, particle size and muddy turbidity of system

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Abstract

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Introduction. It is necessary to selection of optimal ratios of water and oil phases, mode selection mixing of the two phases, the selection of parameters homogenization in which a stable emulsion system.

Materials and methods. To study prepared 5 samples of food emulsions with a variable number of the oil phase and a constant amount of stabilizer (starch) and 5 samples of food emulsions using different amounts of starch at a constant amount of the oil phase. The viscosity of emulsion was determined at Brookfield viscometer, the particle size – at microscope Eastcolight 92012-ES (100x, 250x, 550x, 750h), the muddy turbidity – at muddy turbidity meter 2100b, the density – at laboratoru aerometer.

Results and discussion. Analysis of emulsion with a variable number of the oil phase and a constant amount of starch shows that the greater rate of oil phase, the higher the viscosity, turbidity, density, pH and particle size of the emulsion, but the particle size must not exceed 1 mm. Analysis of emulsion using different amounts of starch at a constant amount of the oil phase shows that the more starch in the composition of the product, the smaller the particle size of emulsion turbidity, which improves the stability of the emulsion. Increasing the number of stabilizer improves the stability of the emulsion, as the particle size decreases, but has little effect on turbidity. If insufficient quantities of stabilizer formed particles are larger than 1 micron, which may lead to a "fat ring" in the system storage. The best result of a study of emulsions with starch - is to get the maximum number of particles about 1 micron.

Conclusions. The results can be the basis for the technology of production of emulsions as a class of foods. Creating a stable emulsion system is a pressing issue in the food industry, so these studies are useful and important for the development of new food products.

Introduction

Despite the large number of studies on the use of starch in different sectors of the food industry, little attention was paid to the study of the stabilizer in food emulsions. To date, the emulsion is widely used in different sectors of the food industry. Getting a stable emulsion system is important and promising issue.

Literature review

As the stabilizing and emulsifying ingredient in the manufacture of scented oil emulsions using starch (E 1450). Starch - is one of the most widely used thickeners and emulsifier [1].

Found that a stable, emulsions are closely associated with the mechanism of dispersion and depends on many factors, such as oil content, type and concentration of emulsifier, the route of administration phases, time and intensity and degree of dispersion and temperature. Study of factors that ensure stability of emulsion, led to the conclusion that the critical degree of dispersion [2–3].

Experiments found that for each type of emulsifier has its own optimum concentration that provides the highest resistance obtained emulsions [4]. For an introduction to emulsify oils (for each concentration of emulsifier) is also optimum in which the most stable emulsion is obtained, that are determining the optimal ratio between the aqueous and oil phases. Introduction of excess oil causing stratification. Thus for each emulsifier is its optimum concentration, the corresponding amount of oil in the emulsion [5-6].

The optimum concentrations of emulsifiers for certain ratios of the phases in obtaining stable emulsions are not fixed and depend on the degree of dispersion. The use of high-speed mixing, and especially increasing pressure homogenizer leads to increased dispersion, viscosity and the formation of more stable emulsions [7].

The process of emulsification controlled in several ways, but most commonly used viscometer Brabendera or express-methods of analysis of viscosity. Thus the dependence of viscosity starches obtained by time, temperature and shear rate. State of the starch granules can be controlled also under the microscope [8].

Starch – is one of the primary emulsifier for soft drinks, all their components are compatible with starch, including:

- citrus oils , synthetic flavors, oils when neutral vegetable oils, triglycerides, etc.;
- artificial colors, including yellow “sunset” and tartrazin and natural dyes , including carotene and maslosmoly .

The concentrated emulsion with 10–20 % fat phase in the production of non-alcoholic beverages or diluted to a concentration of 10–20 g/l in concentrated syrup with a high density of BRICS), or to a concentration of 1–2 g/l soda water. Such stabilized emulsions can be used in obtaining flavored alcoholic beverages strength to 20 %, which starch flocculation occurs.

It is important to be able to predict the stability of the emulsion. In most cases, this is done on the basis of data on the size distribution of particles obtained by laser granulometry microscopy or emulsions at high and room temperature, and the results of observations (both visually and methods of analysis of light transmission and backscattering) per bundle emulsion and sediment. Naturally, these accelerated methods must be accompanied by long-term observation of the behavior of drinks during storage [7–8].

In emulsions such as “oil in water” starch E 1450 plays the role of an emulsifier and a stabilizer.

There are several factors that hinder the wide industrial application of native starches. One of the main factors is that native starches cannot be emulsifiers because it does not contain lipophilic balance oktenilsuktsynat, which is introduced in addition to modified starches to ensure their emulsifying properties.

Native starches have only hydrophilic residues, so as Thickeners are used in products with a short shelf life.

Modified starch emulsifier is in own way as part containing lipophilic and hydrophilic residues.

Lipophilic remains of oktenilsuktsynat provide electrostatic stability of the product, by reducing the value of the surface tension, hydrophilic residues provide mechanical stability of the product, interact with water make thicker product [9].

The process of destruction of the emulsion described rate of destabilization (V) by Stokes law:

$$V = \frac{2 \cdot r^2 (d_1 - d_2) \cdot g}{9 \cdot q}$$

where: V – speed destabilization of the emulsion;

d_1 and d_2 – density of the dispersed phase and the dispersion, respectively;

q – the viscosity of the medium;

r – radius of the globule of fat;

g – acceleration due to gravity.

To reduce the V, you must use oil with a high density (about 1.0) or increase the density of light oil (such as citrus, which $d \sim 0,80$) by making authorized for use in foodstuffs agents such as sucrose atsetatizobutirat.

To reduce the fat globules range 0.4–1.0 microns are used to mixing with a high shear stress and homogenisation of emulsions pressure 100–300 kg/cm². With this amount of fat globule coalescence is minimized, and the dissolution is a strong turbidity.

Efficient dispersion and homogenization of the emulsion in syrup achieved with the dispersion medium viscosity 30-100 mPa s.

When homogenization pressure of 300 kg/cm² commonly used twohod and two stages system.

Materials and method

For studies prepared 5 sample emulsions of varying oil phase and a constant number of starch (Table 1) and 5 samples of food emulsions using different amounts of starch as stabilizer (at constant oil phase) (Table 2)

Preparation of emulsion with starch

Preparation of oil phase. Weigh the required amount of flavor; add Esther scales in stirrer at room temperature until Esther scales completely dissolved.

Preparation of the aqueous phase (starch solution).

1. Weigh the required amount of water into a glass and heated to 20-50 ° C.
2. Attach the required amount of sodium benzoate and completely dissolve. Add citric acid and dissolve completely.
3. Attach the required amount of starch and dye solution in warm water (20-50 ° C).
4. Starch mix and dissolve at a moderate speed mixer until it is completely dissolved. Subject the immediate hydration; leave for a few minutes for aeration.

Preparation of the pre- emulsion. For the pre- emulsion using a high-speed mixer UltraTurrax.

Cooking pre-emulsion, slowly adding the oil phase to the aqueous phase, and then stirred at maximum speed using a high-speed blender.

Preparation of the emulsion.

1. Homogenized according to by following the parameters.
2. Measure turbidity, viscosity and average particle size of the emulsion.

Parameters of the fat phase. Temperature [° C] room temperature.

Parameters of the aqueous phase (starch solution).

Starch solution temperature [° C] room temperature

Mechanical mixing (Anchor mixer) (rpm) 40

Parameters of the pre- emulsion

Starch solution temperature [° C] room temperature

Temperature of oil phase [° C] room temperature

mechanical stirring (UltraTurrax) 20 min / 3000rpm

Parameters of the homogenization

Number of moves 2

Pressure is the first step / second step [bar] 200 /50

Table 1
Formulations of stable emulsion stabilizer of hydrogen and a variable number of fat phase

The ingredients of the emulsion	Content ingredient, g/kg				
	Number of emulsion				
	1	2	3	4	5
Citrus oil	40	50	55	60	70
Rezynogum (E 445)	40	50	55	60	70
Starch (E 1450)	120	120	120	120	120
Citric acid (E 330)	5	5	5	5	5
Sodium benzoate (E211)	2,5	2,5	2,5	2,5	2,5
Water	792,5	772,5	762,5	752,5	732,5
Total	1000	1000	1000	1000	1000

Table 2
Formulations emulsions with constant number of fat phase and a variable number of water stabilizer

The ingredients of the emulsion	Content ingredient, g/kg				
	Number of emulsion				
	6	7	8	9	10
Citrus oil	55	55	55	55	55
Rezynogum (E 445)	55	55	55	55	55
Starch (E 1450)	80	100	110	120	140
Citric acid (E 330)	5	5	5	5	5
Sodium benzoate (E211)	2,5	2,5	2,5	2,5	2,5
Water	802,5	782,5	772,5	762,5	742,5
Total	1000	1000	1000	1000	1000

Results and discussion

The results of measurement of each emulsion: Brookfield viscometer - viscosity microscope EASTCOLIGHT 92012-ES (100x, 250x, 550x, 750h) – particle size, muddy turbidity meter 2100P, lab aerometer - density, lab pH-meter - pH displayed in Table 3.

Table 3

The results of measurement of the finished product

Number of emulsion	Viscosity Brookfield, cP	Turbidity dilution 0.025 %, NTU	The average diameter of the particles of oil D, μm	Density, g/cm^3	pH
1	20	143	0,67	1,03	2,6
2	22	156	0,73	1,05	3,0
3	23	170	0,75	1,07	3,3
4	24	182	0,84	1,09	3,7
5	26	196	0,97	1,10	4,0
6	19	210	0,98	1,04	2,7
7	21	196	0,91	1,06	3,1
8	22	184	0,83	1,07	3,2
9	23	170	0,75	1,07	3,3
10	25	157	0,68	1,10	3,8

Analyzing the figures 1, 2, 3, 4, 5 emulsion bigger the figure the better the oil phase viscosity, turbidity, density, pH and particle size of the emulsion, but the particle size must not exceed 1 micron, and therefore the stabilizer should be enough.

Analyzing the figures 6, 7, 8, 9, 10 emulsions, characterized by an increase in the number of starch as a part of the product shows that slightly increasing viscosity, density, pH and decreasing particle size emulsion, turbidity. By continuing other components of the emulsion, the smaller the particle size, the lower the turbidity of the emulsion (but higher storage stability). If the particle size less than 1 micron, the emulsion is highly robust stability and gives some turbidity but less than 1 micron particle size, the less turbidity, if the particle size is not greater than 0.3 micron, the turbidity almost any clear solution.

For emulsion using starch as an emulsifier, selected modes and modes of stirring pre-emulsion homogenizing emulsions that provide stability during storage system.

Conclusion

1. The best result of research in starch emulsion – is to obtain the maximum number of particles of about 1 micron.
2. If the amount of water stabilizer increased by 0.5 %, the changes of the studied parameters viscosity, turbidity and particle size of the emulsion is not significant.
3. By increasing the amount of oil phase composition of the product increases viscosity, turbidity, density, pH and particle size of the emulsion.

4. Number stabilizer may affect the stability of the emulsion, but has little effect on turbidity, with insufficient quantity of stabilizer may form a small number of particles larger than 1 micron, which can lead to the formation of «oil ring» during prolonged storage.
5. For emulsion using starch as an emulsifier, selected modes and modes of stirring pre-emulsion homogenizing emulsions that provide stability during storage system.
6. The results can be the basis for the technology of emulsions production as a class of foods. Creating a stable emulsion system is a pressing issue in the food industry, so these studies are useful and important for the development of new food products.

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Anomalous properties in aqueous solutions of polysaccharides

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Abstract

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Introduction. The study of physicochemical properties of suspensions of polysaccharides in a wide range of mechanical stress and temperature are important in justifying the technological conditions of production of quality food.

Materials and methods. For experiments prepared 0.5% suspension of guar gum, xanthan gum and carob gum, 1.5% suspension of pectin and 10% suspension of native potato starch in distilled water. These suspensions kept in an incubator for 30 minutes at different temperatures in the range 20-90°C.

Results. The existence in diffractograms studied polysaccharides broad band indicates that the dissolution of these substances in water are formed or associates polymer molecules and water. Analysis micrographs of samples polysaccharides confirm this statement. However crystallinity associates gum appears rather weak, which may be associated with features of the structure of the molecules gum with branched side chains. With increasing temperature aqueous solutions of polysaccharides above 400 C is destroyed quasicrystalline structure complex molecules, increases mobility solution, resulting in a disordered structure. This should increase the density of the solution, causing its viscosity to a temperature of 400 C, above which the viscosity begins to decrease. This anomalous behavior solutions can be explained polymorphic transformations polysaccharide molecules in the temperature range 35-55⁰ C with increasing freedom of movement, as evidenced by the existence of exothermic peak in differential scanning calorimetry curves.

Conclusion. As a result of polymorphic transformations increases the activity of polysaccharide molecules in intermolecular interactions.

Introduction

In the newest food technologies used natural polysaccharides, which perform the functions: thickening and gelling aqueous solutions, stabilizing foams, emulsions and suspensions, slow crystallization of ice and sugar, regulate taste of food, stability of solutions during heating, transparency, control syneresis, regulation astringents properties, stability, pH and others. Easy to use polysaccharides in different manufacturing processes to create a wide range of quality food products: mayonnaises, sauces, pastes, dairy products, dairy desserts, juices, jellies, jams, salad dressings, meat products, baby foods and dietary foods, bakery products [1, 3, 6, 8, 12, 17, 18, 22, 26, 27]. Permit for the use of natural polysaccharides in the food industry has been provided by the European Commission in 1995 in the framework of Miscellaneous Additives Directive 95/2/EC.

Polysaccharides - water soluble compounds are widespread in nature. By sources of origin and their preparation can be divided into 4 groups: botanical (cellulose, starch, pectin, guar gum, carob gum, et al.), from seaweeds (agar, carrageenan, alginate), microbiological (xanthan gum, dextran, kurdlan et al.), animal (gelatin, casein, chitosan) [4, 12, 28].

Consider especially the preparation and use of certain polysaccharides that are widely used in the production of various food products.

Pectin separated from citrus and apple marc, sugar beet pulp and sunflower baskets. Important biological properties of pectin caused the presence of free carboxyl groups and hidrocarboxyl galacturonic acids. These groups are able to bind heavy metals, including radionuclides to form insoluble complexes that removed from the body.

Pectin also regulates cholesterol, improves intracellular reactions of respiration and metabolism, increases resistance to allergic factors, stimulate wound healing, speeds up the treatment of burns.

Starch - the main reserve polysaccharide of plants that accumulates in the form of granules in the cells of seeds, bulbs, tubers and in leaves and stems. Starch molecules are composed of two polysaccharides: amylose and amylopectin, and their ratio varies widely for different botanical origin of starches. As a result of physical, chemical, biological or combined effects changing the structure and properties of starch, making this polysaccharide is universal in application in the food industry.

Carob and guar gums isolated from the seeds of leguminous plants. Polysaccharide chains have a similar irregular chemical structure with alternate linear and branched zones. The use of these gums in food technology due to the following properties: the ability to form viscous aqueous solutions, synergistic interactions with other polysaccharides, leading to the formation gels of different structure, the ability to regulate the process of syneresis. These gums are not degraded in the gastrointestinal tract of humans and can be used for making baby food.

Xanthan gum is produced during fermentation by bacteria *Xanthomonas Campestris* with a molecular weight from one to several million. Xanthan is marked by three important properties that provide indispensability of this product: the ability to maintain long dispersed particles in suspension, unique pseudo ductility and resistance to intense mechanical and thermal actions. Use of xanthan gum can provide all the qualities that are necessary foods for success in today's market: stability, desired structure, presentation and natural.

According to modern research [7, 10, 19, 29, 30], polysaccharide molecules have a complex structure and exhibit the ability to form helical chains, where a special role in stabilizing this structure plays water. The behavior of colloidal polysaccharides suspensions