



INFLUENCE OF STARCH AND OIL PHASE RATIO ON THE QUALITY OF EMULSIONS

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Received November 25th 2014, accepted.....

Abstract: *The paper provides basic information on improvements in the production of emulsions. We consider the theory of a stable emulsion system, namely the particular use of raw materials and their properties in order to analyze the conditions required by the process of homogenization. Therefore, due to the great number of existing theories, our aim is to determine the most efficient one to be used in the production of emulsions. Great attention is being paid as well to the use of stabilizer receipt of test data required by the calculation formulas of finished products and technological design process of emulsions. To assign these methods of using stabilizer such as modified starch, different yield results were obtained regarding the storage stability of emulsions.*

The particle size is of great importance for the stability of these products. The diameter of emulsion depends on the process of manufacturing technology. In this sense, further details on the process of homogenization of emulsions are provided. Moreover the features of this process are analyzed by means of the results on emulsion stability during storage.

Keywords: *emulsion, particle size, phase, stability, starch*

1. Introduction

Despite the large number of studies on the use of starch in different sectors of food industry, little attention was paid to the study of 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.

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 Brabenderaor 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 foods, 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.

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.

If you delve starch at the molecular level, it appears that the starch granules are composed of two types of natural polymer molecules - polysaccharides. Line polysaccharide called amylose (fig 1) and branched – amylopectin (fig 2).

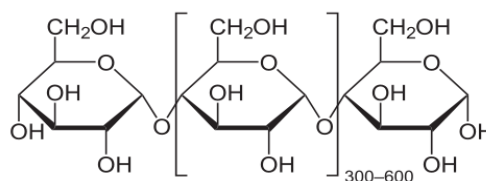


Fig. 1. Amylose formula

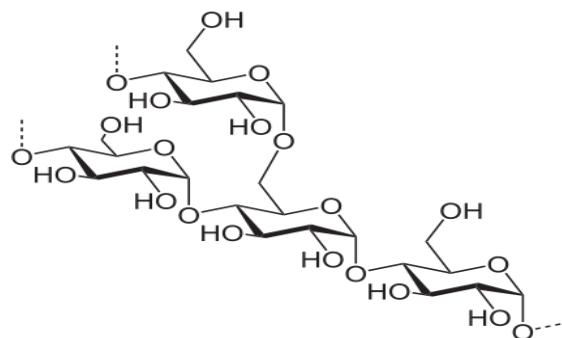


Fig. 2. Amylopectine formula

In most cases, the linear amylose content of about 20% and amylopectin - 80%. However, there are exceptions, such as waxy maize and highamylose maize. In the first case, the content of amylose minimal (less than 1%) and the second case - the maximum (90%). Because of the lack of amylose starch from waxy corn gives blue color iodine - starch reaction, and texture brewed starch solution is pasty (sour cream) and does not turn into a gel during storage. In contrast, a high percentage of amylose leads to the fact that during cooling and storage starch paste turns into a gel.

Modified starch emulsifier is in own way as part containing lipophilic and hydrophilic residues (Fig. 3).

Lipophilic remains 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 makethicker product [9].

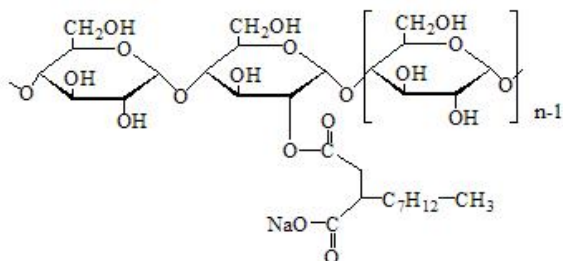


Fig. 3. Emulsifying starch formula

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

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

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 200/50 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 cP.

When homogenization pressure of 200/50 kg/cm² commonly used two stages system.

2. Material and methods

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).

The aim of the study particle size effects on the stability of emulsions during storage and use in the manufacture of beverages and their stability during 180 days.

Table 1

Formulations of emulsion of varying oil phase and a constant number of starches

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) 211211)	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 of emulsion of constant number of oil phase and varying of starch

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

Preparation of emulsions

1. Preparation of oil phase.

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

2. Preparation of the aqueous phase.

a. Weigh the required amount of water into a glass and heated to 20-30 ° C.

b. Attach the required amount of sodium benzoate and completely dissolve. Add citric acid and dissolve completely.

c. Attach the required amount of stabilizer and dye solution in warm water (20-30°C).

d. *Stabilizer* mix and dissolve at a moderate speed mixer until it is completely dissolved. Subject the immediate hydration; leave for a few minutes for aeration.

3. Preparation of the pre- emulsion

For the *preparation of the* pre-emulsion use a high-speed mixer. Slowly adding the oil phase to the aqueous phase, and then stirred at maximum speed.

4. Preparation of the emulsion by homogenization.

Pressure is the first step / second step 200 /50 bar, two numbers of moves for emulsion with starch.

5. Measure turbidity, viscosity and average particle size of the emulsion.

Investigation of the stability of emulsions was carried out by determining the size of the diameter of the particles by laser granulometry and placement on the stability of soft drink, which was used emulsion for 180 days. In the production of

emulsions initially prepared aqueous and lipid phases, mixed them turbomixer and received pre-emulsion with particle size of about 3.0 microns. In the next step, by homogenizing the emulsion obtained with particle size from 0.1 to 1.0 microns. During the preparation of the aqueous phase in water soluble all items that are parts of this phase: modified starch, acid dyes, water soluble, preservatives, antioxidants (ascorbic acid). In practice, the most important stabilizer in the manufacture of emulsions for soft drinks is modified starch. To protect the product from microbial spoilage used preservative sodium benzoate. Acidification lemon emulsion or malic acid to pH 4.0 bolsters preservative as well as a positive effect on the effective viscosity of the emulsion.

3. 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.

Analyzing the figures emulsions with stabilizer characterized by an increase in the number of oil as a part of the product shows that increasing viscosity, density, particle size of emulsion and turbidity.

Example diagram Brabendera modified starch is shown in figure 4. It can be

clearly seen no peak viscosity or viscosity drop during heating.

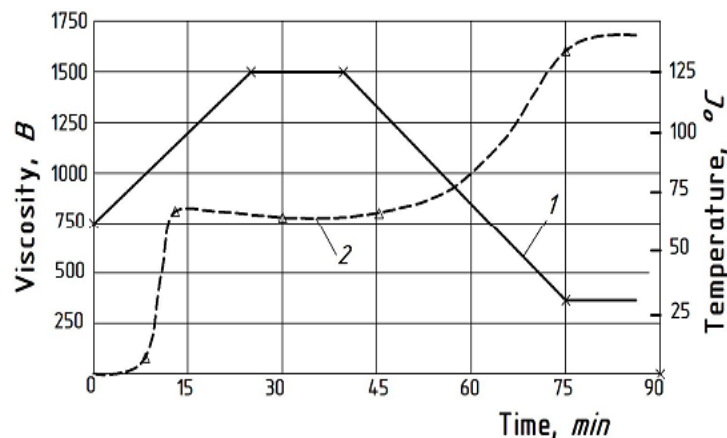


Fig. 4. The dynamics of the viscosity of modified starch (1 - pH=7, 2 - pH<7)

As a result, studies of viscosity versus time, temperature and pH of food emulsions proved that in an acidic medium at pH 6.5 viscosity emulsion with modified starch is stored and then increases over a

longer time compared with the emulsion of native starch where the viscosity at the beginning of the storage period increases and then decreases.

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
3	23	170	0.75	1.07	3.3
4	24	182	0.84	1.09	3.65
5	26	196	0.97	1.1	4
6	19	210	0.98	1.04	2.7
7	21	196	0.91	1.06	3.1
8	22	184	0.83	1.065	3.2
9	23	170	0.75	1.07	3.3
10	25	157	0.68	1.1	3.8

Analyzing 1, 2, 3, 4, 5 samples of emulsions bigger number of the oil phase the better 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 6, 7, 8, 9, 10 samples of 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. Under the microscope image of a stable emulsion (Fig. 5) with a particle size of system to $1\mu\text{m}$ and an unstable emulsion (Fig. 6) with a particle size of $2-10\mu\text{m}$.



Fig. 5. Stable emulsion with particle size $<1\mu\text{m}$

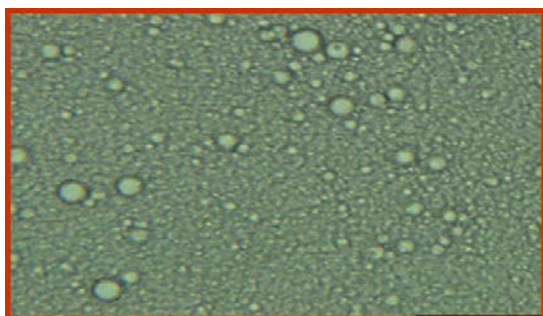


Fig. 6. Unstable emulsion with particle size $2-10\mu\text{m}$

For emulsion using starch as an emulsifier, selected modes and modes of stirring pre-emulsion homogenizing emulsions that provide stability during storage system. To prevent foaming using starch as an emulsifier need stirring slowly to avoid vortex flow in the device, starch solution temperature to $30\text{ }^{\circ}\text{C}$, are additional mixers and fuses vortex flows. Analyzing the results of studies can establish ways to reduce foaming in the application in starch production (Figure 7).

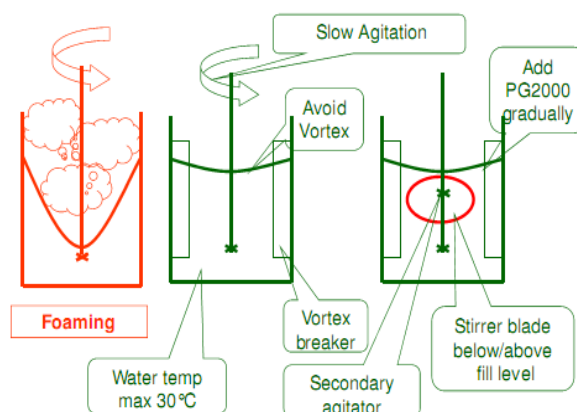


Fig. 7. Ways to reduce foaming of starch in manufacturing

4. Conclusion

The best result of research in starch emulsion – is to obtain the maximum number of particles of about 1 micron. 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. By increasing the amount of oil phase composition of the product increases viscosity, turbidity, density, pH and particle size of the emulsion. 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. For emulsion using starch as an emulsifier, selected modes and modes of stirring pre-emulsion homogenizing emulsions that provide stability during storage system. 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.

5. References

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