Influence of gum arabic and starch as hydrocolloids on the quality of emulsion type oil-water in food

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Abstract. *The paper systematically describes the basic theoretical information about the 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 analyzed the conditions necessary for the process of homogenization. And based on this, a large number of existing theories determined the most effective, which is used for the production of emulsions. Much attention is paid to the use of different stabilizers receipt of test data required for the calculation formulas finished products, and technological design process of emulsions. To assign these methods are used two stabilizers: gum arabic and modified starch, which when used for stability during storage of emulsions yield different results.*
Of great importance for the stability of these products is the size of the particles. The diameter of the emulsion depends on a process of manufacturing technology. More detail the process of homogenization of emulsions. For the features of this process are a few examples that will visually see the results emulsion stability during storage. Based on the processed foreign sources give modern technology and types of equipment for the homogenization process, with reference to the drawings, which will assimilate the information produced. We consider the design features of these devices, their advantages and disadvantages.

Key Words: emulsion, particle size, phase, stability, stabilizer

I. Introduction

The article is devoted to the important issue of improving production technology emulsions, which are widely used in various sectors of the food industry.

The issue of improving the production technology of aromatic emulsions closely related to features using hydro colloids. Constant attention to the researchers hydrocolloids due to their importance for food technology. Despite the large number of studies on the physicochemical properties of hydrocolloids, there is no scientifically based data on their use in food emulsions [1].

Therefore, current and future issues is the definition of certain laws (based on the recommendations of the manufacturers of) on the influence of the main factors in the production of emulsions: selection of hydrocolloids; the ratio of oil and water phases; (sequence making components, mixing time and temperature parameters of each ingredient in order to ensure their complete solubility); selection of process parameters homogenization. This will facilitate the development of new formulations and optimization processes.

There is a theory about the mechanism of emulsification [1]. The first stage of this process lies in the tension drops of liquid dispersion in a field environment. Pulling drops in thread accompanied by an increase of the surface and flow of work to overcome the molecular forces of surface tension. This extended liquid drop becomes so unstable that spontaneously breaks into small spherical droplets. This is the second stage of the formation of emulsions, which is accompanied by a decrease in surface and spontaneous process. Then comes the next, third stage, when formed droplets on one hand, coagulated in collisions, and on the other - again stretching into smaller parts to equilibrium. The basis of increasing dispersion emulsion is spontaneous decay drops learned to unstable size [2–4].

Found that 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 [5–9].

Experiments found that each type of emulsifier has its own optimum concentration that provides the highest resistance obtained emulsions [7]. For an introduction to emulsify oils (for each concentration of emulsifier) there 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 is causing separation. Thus for each emulsifier is its optimum concentration, the corresponding amount of oil in the emulsion [8].

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 , for which d ~ 0,80 g/см^3) by making authorized for use in foodstuffs agents such as sucrose acetate isobutyrate (SAIB).

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/cm^2. With this amount of fat globule coalescence is minimized, and the dissolution is a strong turbidity.

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. Using of high-speed mixing, and especially increasing pressure homogenizer leads to increased dispersion, viscosity and the formation of more stable emulsions [9].

The process of manufacturing emulsions involves creating optimal conditions that allow for uniform, homogeneous and stable system with virtually insoluble in each other components (oil - water) by adding emulsifiers (stabilizers), the relative density of the equalizer.

II. Materials and methods

The aim is to study particle size effects on the stability of emulsions during storage and use in the manufacture of beverages and their stability during 180 days. As materials for research are prepared samples of emulsions with various stabilizers (gum arabic, modified starch). Stability of emulsions depends of viscosity, particle size, muddy turbidity depends on the ratio of water and oil phases.

For studies prepared sample emulsions of varying oil phase and a constant amount of stabilizer:

-gum arabic (table 1)

-starch (table 3);

and samples of emulsions (at constant oil phase) different amount of stabilizer:

-gum arabic (table 2)

-starch (table 4)

Formulations of emulsion of varying oil phase and a constant quantity of gum arabic

Table 1

The ingredients of the emulsion	Content ingredient, g/kg				
	Number of emulsion				
	1	2	3	4	5
Citrus oil	60	60	60	60	70
Rezynogum (E 445)	20	40	50	60	70
Gum arabic (E 414)	50	50	50	50	50
Citric acid (E 330)	5	5	5	5	5
Sodium benzoate (E211)	2,5	2,5	2,5	2,5	2,5
Colorant (E124)	1,5	1,5	1,5	1,5	1,5
Colorant (E110)	14	14	14	14	14
Antioxidant (E320, E321)	0,025	0,025	0,025	0,025	0,025
Water	846,975	826,975	816,975	806,975	786,975
Total	1000	1000	1000	1000	1000

Formulations of emulsions with constant quantity of fat phase and a variable quantity of gum arabic

Table 2

The ingredients of the emulsion	Content ingredient, g/kg				
	Number of emulsion				
	6	7	8	9	10
Citrus oil	60	60	60	60	60
Rezynogum (E 445)	40	40	40	40	40
Gum arabic (E 414)	40	50	55	60	70
Citric acid (E 330)	5	5	5	5	5
Sodium benzoate (E211) 211211)	2,5	2,5	2,5	2,5	2,5
Colorant (E124)	1,5	1,5	1,5	1,5	1,5
Colorant (E110)	14	14	14	14	14
Antioxidant (E320, E321)	0,025	0,025	0,025	0,025	0,025
Water	836,975	826,975	821,975	816,975	806,975
Total	1000	1000	1000	1000	1000

Formulations of emulsion of varying oil phase and a constant quantity of starch

Table 3

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
Colorant (E124)	1,5	1,5	1,5	1,5	1,5
Colorant (E110)	14	14	14	14	14
Antioxidant (E320, E321)	0,025	0,025	0,025	0,025	0,025
Water	776,975	756,975	746,975	736,975	716,975
Total	1000	1000	1000	1000	1000

Formulations of emulsions with constant quantity of fat phase and a variable quantity of starch

Table 4

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
Colorant (E124)	1,5	1,5	1,5	1,5	1,5
Colorant (E110)	14	14	14	14	14
Antioxidant (E320,	0,025	0,025	0,025	0,025	0,025
Water	786,9	766,975	756,975	746,9	726,975
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 20-50 ° 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 (20-50°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.*

Homogenization undergoing the parameters

a. Pressure is: the first step / second step 200 /50 bar, two numbers of moves for emulsion with starch.
b. Pressure is the first step / second step 280 /40 bar, two numbers of moves for emulsion with gum arabic.

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

III. 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, density- lab density meter, pH- lab pHmeter - displayed in Table 5,6

The results of measurement of the finished product (with gum arabic)

Table 5

Number of emulsion	Visco-sity Brookfield, cP	Turbidity dilution 0.025 %, NTU	The average diameter of the particles of oil D, µm	Density, g/ cm^3	pH
1	14	168	0,505	1,03	2,7
2	15	180	0,659	1,06	3,2
3	16	192	0,705	1,07	3,3
4	17	216	0,903	1,09	3,7
5	18	240	1,101	1,1	3,9
6	14	192	0,75	1,04	2,6
7	15	180	0,659	1,06	3,2
8	15,5	174	0,602	1,07	3,3
9	16	168	0,559	1,085	3,4
10	17	154	0,499	1,1	3,8

The results of measurement of the finished product (with starch)

Table 6

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

By continuing other components of the emulsion, the smaller is the particle size, the lower is the turbidity of the emulsion (but higher storage stability).

If the particle size is 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 principle of leverage ratio of water and oil phase of emulsions with different stabilizers is the same. In the obtained parameters also affects the nature of emulsions stabilizer.

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. During storage of beverages prepared from emulsions studied, there was no formation of oil ring or "creaming" bottled, indicating the stability of emulsion systems.

IV. Conclusions

1. The best result of research in emulsions - is to obtain the maximum number of particles of about 1 micron.
2. Technology of preparation of emulsions with gum arabic is different from the technology of emulsifying starch.
3. Dissolve gum arabic is faster and easier than with the dissolution of starch as emulsion obtained using gum arabic, stable in quality and more expensive in value compared with emulsions prepared by using starch.
4. For studies prepared sample emulsions of varying oil phase and a constant amount of stabilizers and samples of emulsions (at constant oil phase) different amount of stabilizers.
5. The results of measurement of each emulsion: viscosity, particle size, muddy turbidity, density depends on the ratio of water and oil phases.
6. 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.

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