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FORMATION OF EMULSION PROPERTIES WITH CELERY ROOT POWDER

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Abstract

Celery root powder obtained by drying with mixed heat supply, which is a promising raw material of plant origin as a source of biologically active substances for use in the composition of culinary products of polyphasic type due to functional and technological properties contributes to the formation of appropriate emulsion properties, prescription ingredients of this plant material. The work aims to study the effect of celery root powder obtained by drying with mixed heat supply on sedimentation resistance, structure and rheological properties of emulsions for a wide range of culinary products.

The material for the study was celery root variety "Diamant", from which obtained a powder form after pre-drying with mixed heat supply, based on the active hydrodynamic and thermal interaction of the drying agent with the object inside a special heat and mass transfer module, with particle sizes of 10 - 25 μm and model systems - emulsions obtained at different dosages of celery root powder: 10, 15 and 20% by weight of the composition containing wheat flour. The microstructure of emulsions with a powder content of celery root with 10, 15 and 20% by weight of the composition was determined by microscopy, the dispersion of celery powder - by calculating the particle size with an eyepiece micrometer and an optical microscope at a magnification of 600 times. Sedimentation stability was determined by a method based on the dependence of the deposition rate of homogeneous particles in a liquid medium. Rheological properties of model systems were performed using the device "Reotest-2".

When adding 10 and 15% of celery root powder to the model system, the formation of a homogeneous system is observed, the components of the dispersed phase of which are in the form of tightly packed formations of regular shape up to 10 μm. The introduction of 20% powder from the root of celery leads to the formation of heterogeneous structures with a size of 15 - 25 μm, which prevents the uniform distribution of particles in the emulsion. In model systems there is no unauthorized aggregation of solid particles of celery root powder, and the system is in a state with higher potential energy and aggregative stability. By the nature of the rheological curves of viscosity and fluidity, the emulsion with celery root powder belongs to the coagulation system. When using a mass fraction of celery root powder 15% by weight of the prescription composition, the viscosity increases 4 times compared to the control.

Therefore, according to the study of structure, sedimentation stability and rheological properties of model systems, it is rational to dose celery root powder

15% by weight of the prescription composition of culinary products of polyphasic type and makes it when mixed with wheat flour.

Key words: *Celery root powder, Microstructure, Sedimentation stability, Rheological properties, Emulsion.*

1. Introduction

Promising in the direction of reducing the energy value while increasing the nutritional value of a wide range of culinary products of the polyphasic type is the inclusion of dried food products - vegetables in the form of fine powders [1 - 3].

An innovative method of drying, which can be used to obtain dried food products with high rehydration properties, includes drying with mixed heat, based on the active hydrodynamic and thermal interaction of the drying agent with the object, which is inside a special heat and mass transfer module [4].

Celery root powder obtained by the method of drying with mixed heat transfer is a promising raw material of plant origin as a source of biologically active substances, polysaccharides (fibre, pectin, etc.) [5 - 7]. The use of celery root powder promotes the formation of the appropriate properties of emulsions, which will obtain high-quality food masses when replacing the recipe ingredients with this plant material.

The work aims to study the effect of celery root powder obtained by drying with mixed heat supply on sedimentation resistance, structure and rheological properties of emulsions for a wide range of culinary products.

2. Materials and Methods

The material for the study was celery root variety "Diamant", from which obtained a powder form after pre-drying with mixed heat supply, based on the active hydrodynamic and thermal interaction of the drying agent with the object inside a special heat and mass transfer module, with particle sizes of 10 - 25 μm and model systems - emulsions obtained at different dosages of celery root powder - 10, 15, and 20% by weight of the composition containing wheat flour.

The microstructure of emulsions containing celery root powder 10, 15, and 20% by weight of the composition was determined by microscopy [8].

The dispersion of celery powder was determined by calculating the particle size using an ocular micrometre and an optical microscope at a magnification of 600 times [8].

Sedimentation stability was determined by a method based on the dependence of the deposition rate of homogeneous particles in a liquid medium [9].

Rheological properties of model systems were performed using the device «Reotest-2» [9].

3. Results and Discussion

At the first stage of research the influence of fine fraction of celery root powder (10 - 25 μm) on the structure and rheological properties of model systems - emulsions was determined, which was obtained at different dosages of this plant ingredient - 10, 15 and 20% by weight of the composition.

Model samples were prepared in compliance with the prescription ratio of ingredients, as shown in the Table 1.

Table 1. Prescription ratio of ingredients in model systems

Raw	Control - without additives	With the addition of celery root powder, % by weight of the prescription composition		
		10	15	20
Margarine	52.4	48.5	48.5	45.1
White sugar	34.9	32.3	31.3	30.1
Chicken eggs	12.2	18.1	11.3	10.5
Celery root powder	–	7.5	10.9	14
Food salt	0.3	0.3	0.3	0.3
Sodium bicarbonate	0.1	0.1	0.1	0.1
Total, %	100	100	100	100

The micrographs (Figure 1) show the microstructure of the studied model systems. In Figure 1 (a) shows the microstructure of the model system according to the traditional recipe.

As can be seen, when adding to the model system 10 and 15% powder from celery root (Figure 1, b, c) the formation of a more homogeneous system is observed, the components of the dispersed phase of which are in the form of tightly packed formations of regular shape - spheres and ovals. the highest degree of dispersion within 10 microns. These particles of celery root powder helps to organize the structure.

The addition of 20% powder from celery root (Figure 1, d) leads to the formation of disparate structures of irregular shape, this concentration prevents the uniform distribution of particles in the emulsion, the components are located separately, ie the system stratifies. The components of the dispersed phase acquire a dispersion of 15 - 25 μm.

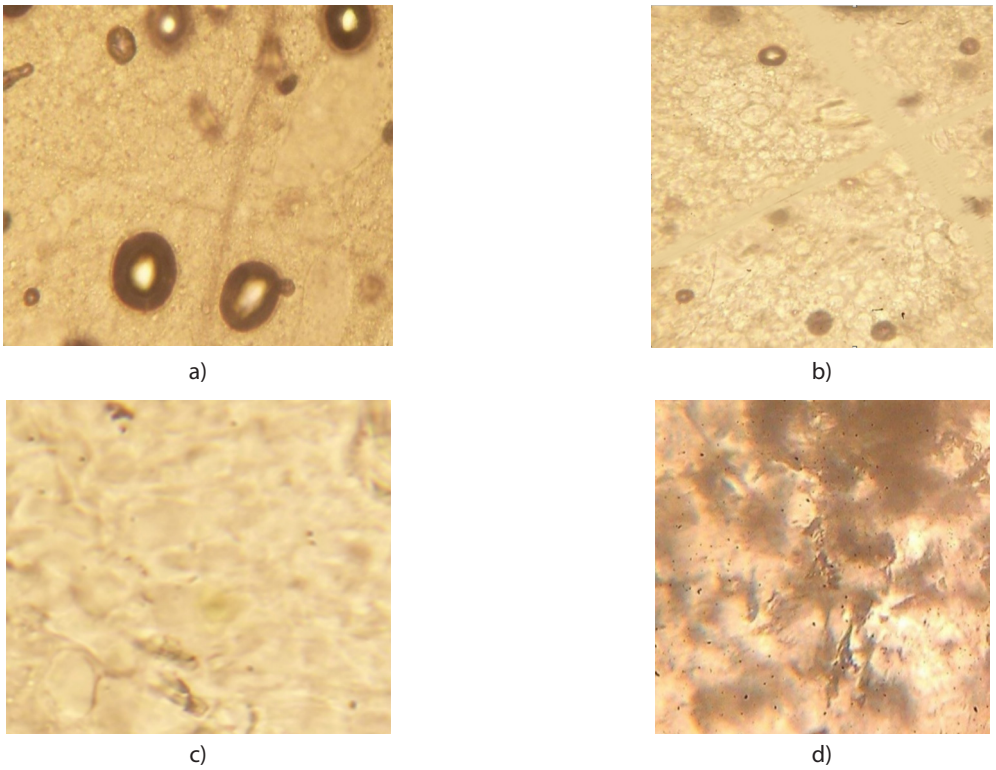

Figure 1. Microstructure of model systems at a magnification of 600 times: a - control; b - 10% powder of celery root; c - 15% of celery root powder; d - 20% powder of celery root

The results of microstructural studies are also confirmed by the data on the formation of a stable emulsion using celery root powder in the study of sedimentation stability of model systems - Figure 2.

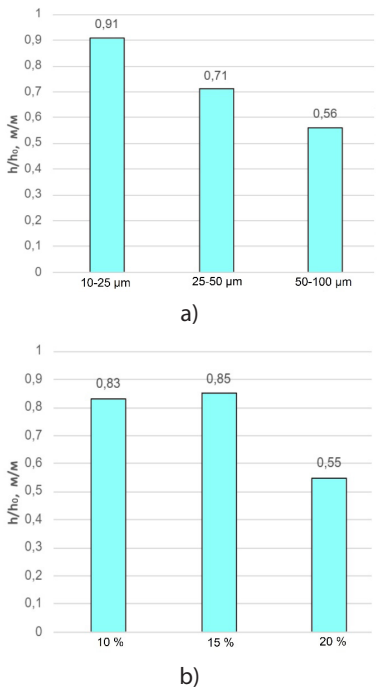

Figure 2. Sedimentation of celery root powder particles in the emulsion depending on: a - dispersion; b - concentrations in model systems

As can be seen, despite the low emulsifying ability of celery root powders, in all model systems there is no spontaneous aggregation (coagulation) of solid particles of the plant additive, deposition in the gravitational field, ie the system is in a state with higher potential energy. This is due to the increased moisture-retaining and fat-retaining abilities of vegetable powder with a dispersion of 10 - 25 μm.

The technological purpose of the obtained data is to form a high-quality stable emulsion, and, consequently, finished products based on it.

Thus, it was found that the addition of celery root powder in a mass fraction of 10 - 15% does not adversely affect the properties of emulsions. When adding 20% of celery root powder, aggregation of particles and, accordingly, stratification of the structure is observed.

The next stage of research was to study the effect of celery root powder dosing on the rheological properties of model systems. The research results are shown in Figures 3 and 4.

From Figure 3 determined the parameters that characterize the change in the viscosity of the solid.

By the nature of the rheological curves of viscosity and fluidity, the emulsion with celery root powder belongs to the coagulation system (Figures 3 and 4,

respectively). This system is formed when the particles of the dispersed phase interact directly or through thin layers of liquid dispersed medium.

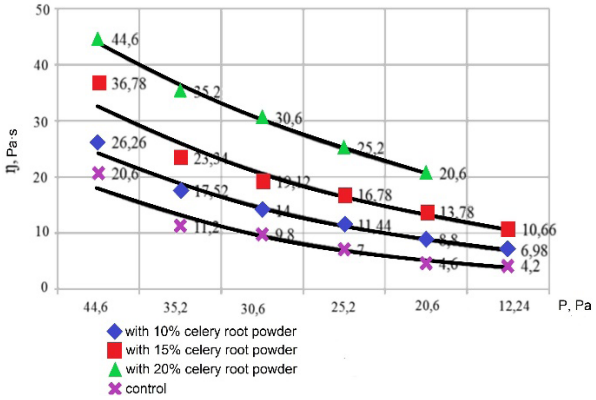

Figure 3. Rheological viscosity curves of emulsions

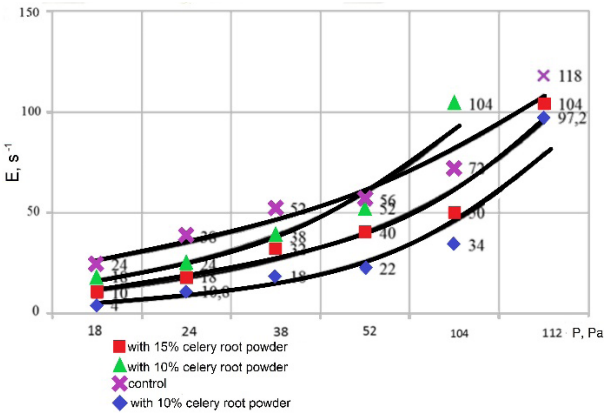

Figure 4. Rheological curves of emulsion fluidity

Due to the action of intermolecular forces of attraction, coagulation contacts usually appear on the lyophilic and lipophilic parts of the mosaic surface of the dispersed phase particles, which makes it possible to use surfactants of celery root powder to weaken and strengthen such components.

The coagulation system, which includes an emulsion with the addition of celery root powder, is characterized by not too high strength, high fluidity, pronounced thixotropy.

As can be seen from Figures 3 and 4, emulsions using celery root powder are significantly different from viscosity control. That is, the use of celery root powder leads to an increase in the viscosity of the emulsions, especially when using a mass fraction of 15% by weight of the prescription mixture, the value of the indicator increases 4 times the value of the control sample.

The obtained data allow not only to determine the rational dosage of celery root powder in prescription compositions of culinary products of a polyphasic type but also to choose a rational technological method of its addition - pre-mixing with flour and not with emulsion, because very high moisture-binding and fat-holding capacity of powder. celery root will not allow wheat flour to absorb water and fat to some extent.

Thus, based on a set of studies, it is shown that the structure and sedimentation stability of emulsions at selected doses of powder 10 and 15% of celery root does not deteriorate. However, according to the study of the rheological properties of model systems, it is rational to choose the dosage of powder in the amount of 15% by weight of the formulation and its introduction when mixed with wheat flour.

4. Conclusions

- The sedimentation stability of emulsions using celery root powder depending on its dispersion and concentration in the model system was studied. It is shown that the powder with a dispersion of 10...25 μm helps to obtain an emulsion more resistant to sedimentation. Samples with mass fractions of powder 10 and 15% contribute to a stable structure compared to 20% powder.
- The research results were confirmed by studying the microstructure of emulsions with celery root powder. The formation of a more homogeneous system with the addition of celery root powder in the amount of 15% is shown.
- According to the results of sedimentation, microstructural and rheological studies of model systems of emulsions using celery root powder, the choice of rational dispersion and mass fraction of celery root powder, which is 10 - 25 μm, and 15% by weight of the prescription mixture, respectively, is substantiated. The uniformity of the distribution of powder particles at a given concentration and, accordingly, the stability of the structure is shown.

5. References

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