Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XV, Issue 1 - 2016, pag. 71 - 75

MATHEMATICAL MODELING OF PREPARING "OIL / WATER" EMULSIONS

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Received March 6th 2016, accepted March 29th 2016

Abstract: *Past studies on the effect of the number of emulsifiers in emulsion characteristics obtained showed that the change in the fate of particle distribution depended on the particle size emulsion close to Gaussian distribution. Therefore, the designed factor model depends on the particle size emulsion of their number.*

Keywords: *emulsion, phase, starch, Arabic gum, mathematical modeling*

1. Introduction

Nowadays, the emulsion is widely used in different sectors of the food industry. Getting a stable emulsion system is an important and promising issue.
As the stabilizing and emulsifying ingredient in the manufacture of scented oil emulsions using gum Arabic (E 414) and starch (E 1450). Starch - is one of the most widely used thickeners and emulsifier. Gum Arabic provides better emulsion stability [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 it 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.
For each emulsifier has its own optimal concentration for the stability of 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 [7]. To determine the most effective parameters of technological processes of production EMULSIONS to build a mathematical model of conduct and its optimization of defined parameters.
Model - a conventional image of the object which displays its most significant characteristics required for the study.
• Any model performs predictive function without which it would build inappropriate for theory and practical use.
• Experimental models based only on the laws of probab
ility theory.
• In constructing these models studied processes conventionally regarded as deterministic, but the model is introduced elements of evaluating the probability of obtaining a certain result.

Determined factor analysis -it analysis of factors resulting indicator can be presented as a product, part or the algebraic sum of factors [8].

Past studies on the effect of the number of emulsifiers in emulsion characteristics obtained showed that changing the fate of particle distribution depending on the particle size emulsion close to Gaussian distribution - probability distribution, which is set in one-dimensional case, the probability density function.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

where μ - expectation (average), median and mode of distribution, and the parameter

σ - standard deviation (σ ² - variance) distribution.

If the variable has a normal distribution, then it there (end) points for all values such that in different parts of the domain, it can be given different analytical expressions or piecewise given function.

Piecewise given function is a function that is defined on the set of real numbers given on each of the intervals, the domain of the components, a separate formula. In general terms:

$$y = \begin{cases} f(x), if & a_1 \le x \le b_1 \\ \varphi(x), if & a_2 \le x \le b_2 \\ \phi(x), if & a_3 \le x \le b_3 \end{cases}$$

where - function defined on a certain interval - the lower limit of the range - upper limit of the range,

The analysis of the experimental data shows that the value of the particle size can be determined at such intervals (0, 0.1); [0.1, 1) and (1, 10). In the interval (0, 0.1) function is a linear regression on the interval (0.1, 1) and (1, 10) function is polynomial model n- order. If we denote the fate of particle distribution variable y, a particle size emulsion x, then the general model takes the form.

$$y = \begin{cases} c, if \quad 0 < x < 0,1; \\ a_0 + a_1 \cdot x + a_2 \cdot x^2 + a_3 \cdot x^3 + a_4 \cdot x^4 + a_5 \cdot x^5, if \quad 0,1 \le x \le 1; \\ b_0 + b_1 \cdot x + b_2 \cdot x^2 + b_3 \cdot x^3 + b_4 \cdot x^4 + b_5 \cdot x^5, if \quad 1 < x \le 10. \end{cases}$$

Calculation of the model is the method of least squares (MLS). The method is based on minimizing the sum of squared deviations of certain functions of the unknown variables. It is used to "solve" overriding systems of equations (equations when the number exceeds the number of unknowns), to find a solution in the case of conventional systems of nonlinear equations to approximate point values of some function. MLS is a basic regression analysis methods for the estimation of the unknown parameters of regression models for the sample data.Objective Research to conduct mathematical modeling study of the influence quantity of emulsifier gum arabic or starch and the oil phase to final figures emulsions "oil / water"

2. Material and methods

We built a model of distribution of particles emulsions containing emulsifiers equal amount of gum arabic (5%) and different amounts of oil phase.For oil content of 14.0% phase model is:

$$y = \begin{cases} 0, if \quad 0_1 < x < 0,1 \\ -3,974 + 27,381 \cdot x + 97,261 \cdot x^2 - 339,517 \cdot x^3 + \\ + 299,106 \cdot x^4 - 78,381 \cdot x^5, if \quad 0,1 \le x \le 1 \\ 1,867 - 0,308 \cdot x - 0,041 \cdot x^2 + 0,017 \cdot x^3 - \\ - 0,002 \cdot x^4 + 0,0001 \cdot x^5, if \quad 1 < x \le 10 \end{cases}$$

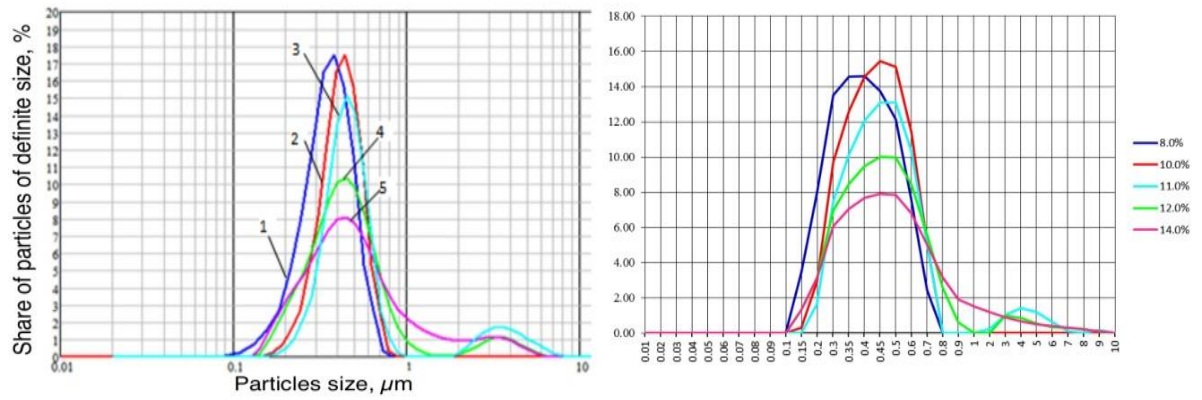
For each oil phase built their system, describing the experimental data for predicting the future of individual particle size

Similarly, processed research data at constant oil phases and changes in the content and formed stabilizer system of mathematical models describing the formation of particles of different size stabilizer.

Similarly, there was a process of modeling the distribution of the fate of particle size emulsion particles at different pressure homogenization.

3. Results and discussion

Figure 1 shows the experimental and calculated curves of particle size distribution with stable emulsions containing emulsifier gum arabic - 5% oil content and a different phase (8.0%; 10.0%; 11.0%; 12.0%; 14 0%).

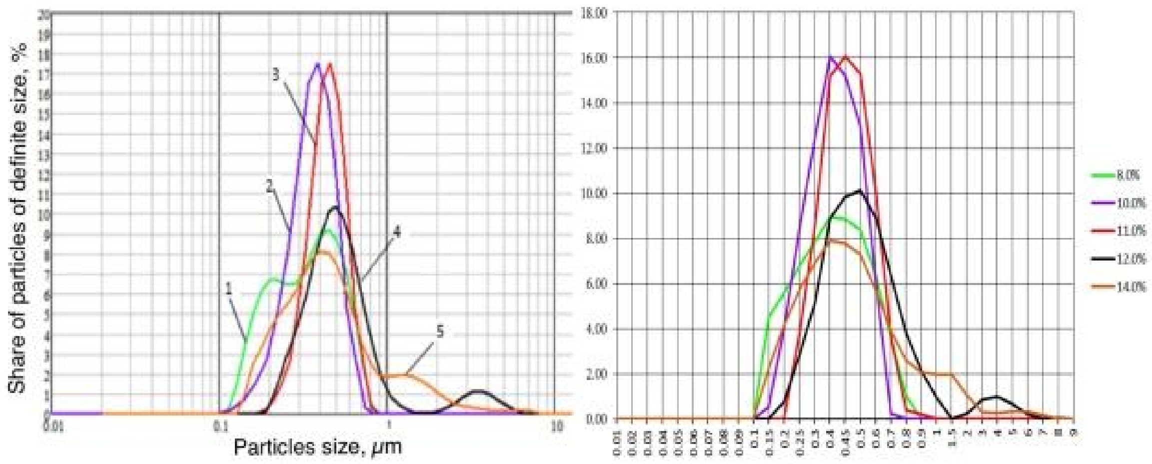


a) **b)**

Fig. 1. Curves size distribution of particles emulsions with constant content of emulsifier gum arabic - 5% and oil content varying phases: 1 - 8.0%; 2 - 10.0%; 3 - 11.0%; 4 - 12.0%; 5 - 14.0%: a) experimental data; b) estimates

Construct models of the size distribution of particles emulsions with constant emulsifier starch content (12%) and different content oil phase.

Figure 2 shows the experimental and calculated curves of size distribution of particles emulsions with constant emulsifier starch content of 12% oil content and a different phase (8.0%; 10.0%; 11.0%; 12.0%; 14 0%.

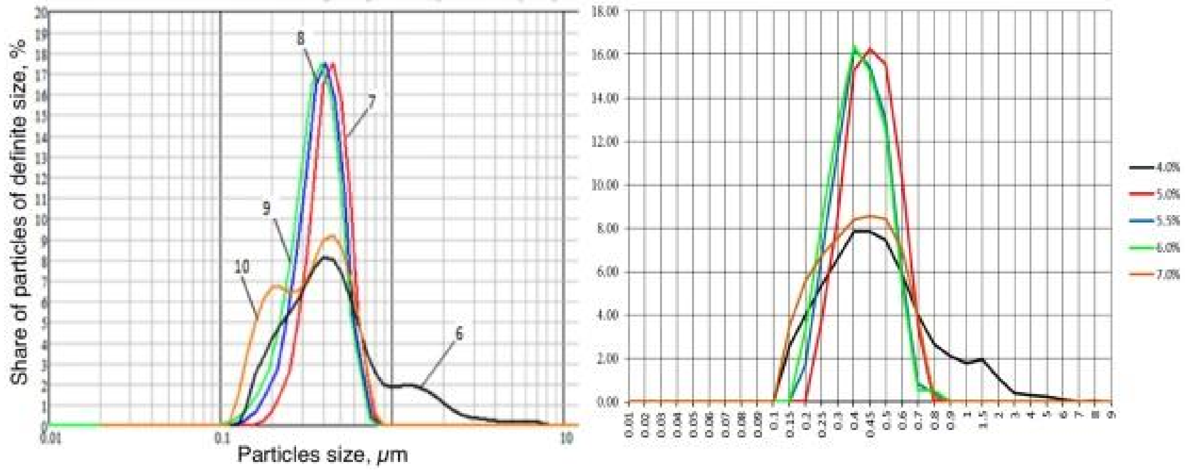


a) **b)**

Fig.2. Curves size distribution of particles emulsions with constant emulsifier starch content of 12.0% and oil content varying phases: 1 - 8.0%; 2 - 10.0%; 3 - 11.0%; 4 - 12.0%; 5 - 14.0%: a) experimental data; b) estimates

Construct models of the size distribution of particles emulsions with a constant number of oil phase - 10.0% and different content emulsifier gum arabic.

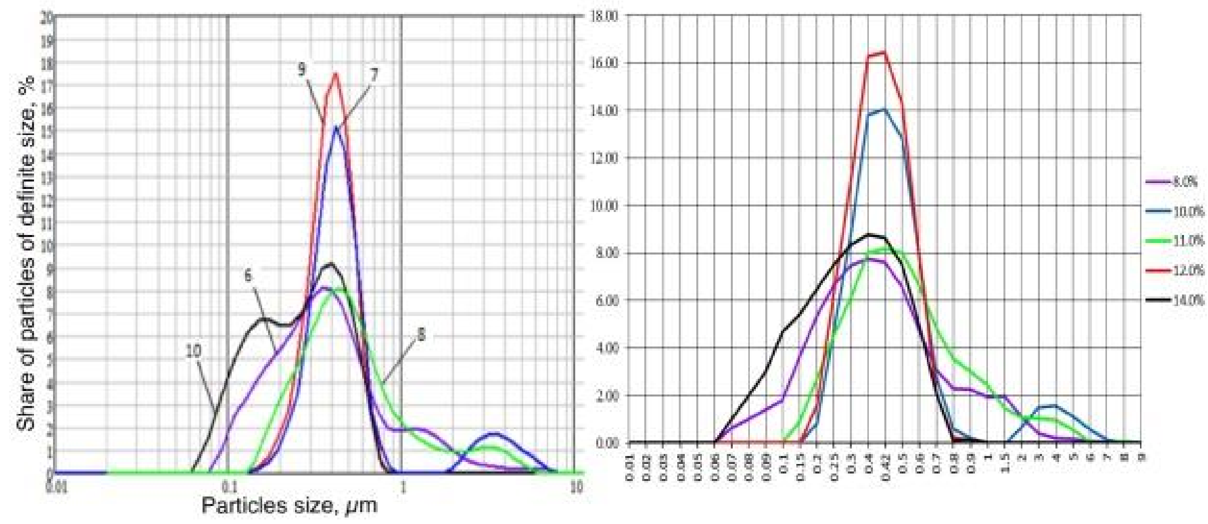
Figure 3 shows the experimental and calculated curves of size distribution of particles emulsions with a constant number of oil phase - 10.0% and different content emulsifier gum arabic (4.0%; 5.0%; 5.5%; 6.0%; 7.0%.



a) b)

Fig. 3. Curves size distribution of particles emulsions with a constant number of oil phase - 10.0% and different content emulsifier gum arabic 6 - 4.0%; 7 - 5.0%; 8 - 5.5%; 9- 6.0%; 10 - 7.0%: a) experimental data; b) estimates

Construct models of the size distribution of particles emulsions with a constant number of oil phase - 11.0% and different content emulsifier starch. For example, the starch content of 8.0% emulsifier model is:



a) b)

Fig. 4. Curves size distribution of particles emulsions with a constant number of oil phase - 11.0% and different content emulsifier starch 6 - 8.0%; 7 - 10.0%; 8 - 11.0%; 9 - 12.0%; 10 - 14.0%: a) experimental data; b) estimates

4. Conclusion

The best result of research in starch emulsion – is to obtain the maximum number of particles of about 1 micron.

In order to determine the most effective process parameters of food production to build a mathematical model of optimization of certain parameters. Analysis of a priori information and experience on current technology and conditions of production of aromatic emulsions allow for process modeling approaches applied regression analysis and choose the regression equation of the second order.

The results of computational experiments show that almost all indicators emulsion stabilizer content is more important.

The relative error of calculations does not exceed 3%. For all models Fisher criterion settlement does not exceed the tabular value that indicates the adequacy of research models and can be used for decision making.

Unlike emulsion stabilizer - acacia, modeling parameters emulsions with starch show that oil phase is more influentual. The relative error of calculations does not exceed 4.5%, and the estimated Fisher criterion is less than the table and all models also adequately describe the study process for all models of criterion Fisher estimated value does not exceed tabular Ftabl. = 4.96/. Therefore all the models adequately describe the study process and can be used for decision-making).

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