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INVESTIGATION OF THE EFFECT OF VEGETABLE POWDERS ON AQUEOUS AND OIL PHASE IN BUTTER PASTE

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Abstract: *The paper presents a method of enriching oil salt complex natural mixture of micronutrients by a slurry of white sesame seeds and powders from carrot and tomatoes obtained by cold spray drying, in amounts of 2%, 8% and 4% respectively. The control sample used to regulate the skimmed milk solids content moisture content in the test samples was 48%.*
The feasibility of introducing selected herbal ingredients is confirmed by numerous positive results reported in the literature: medical valuable micronutrients selected plant raw materials have a positive effect on the immune, nervous, cardiovascular and respiratory systems, improve liver, promote regeneration of skin cells and the like. The slurry of white sesame seeds produced immediately before introducing it into the oil mixture by grinding seeds in special conditions.
On the basis of microstructure analysis, we studied the structural elements that formed plant components with the fat and aqueous phases salt butter paste, as well as we determined the size and distribution of droplets characterized by plasma product.
The paper studied the effect of carrot and tomato powders and especially of designed suspension of sesame-rich plasma in the dispersion of oil mixture. It is found that the introduction of plant ingredients in the specified amounts increases the number of droplets with sizes of up to 5 microns by 1.8 times.
The method of microstructure analysis of the interacting components of vegetable raw materials with fatty and aqueous phases and oil mixture revealed the formation of sinter mesh structure.
The investigation of crystallization of fat phase was determined by differential scanning calorimetry. These results indicate that there are components of plant raw materials which alter crystallization of the fat phase of the product. When storing the product of the fat phase, greatest changes occur up to three days. It is found that the fat phase recrystallization is fusible and medium melting triglyceride.

Keywords: *glycerides, agglomerate, cellular structure, crystalline linear structure, dispersion, plasma, differentiation, crystalline phase, recrystallization*

1. Introduction

Analysis of the results of recent statistical research indicate a direct connection to reduce the content of natural micronutrients in the diet of the population and distribution, and a significant the rejuvenation of chronic no communicable diseases (NCD) [1-3]. According to WHO, 80 % of the adult working age population mortality in European countries due to the NCD, among them about 50 % of cases due to cardiovascular diseases and 20 % of cancers. Leading experts from the WHO identified six groups of major risk factors that have the greatest impact on the emergence and development of NCD, and the two of them are directly related to the daily food intake of the population [1]. For the purpose of a positive decision, "hidden hunger" and harmonization of nutrition in most European countries and in Ukraine they implemented a range of activities related to the enrichment of traditional foods with micronutrients and natural setting strict state control over the quality and safety of feedstock, semi-finished and finished products [2, 3].

The daily diet of the population consists of dairy products which are perceived as traditional products with pleasant taste properties. However, in recent years there has been a general trend of increasing consumption of dairy products with reduced fat content. This is often due to the existence of views on the harmful effects of one of the components in milk fat - cholesterol on the cardiovascular system of the human body. It must be said that the results of long-term research conducted in academic centres leading countries, indicate that cholesterol is involved in the synthesis of bile acids and some hormones used in the construction of the myelin sheaths of nerve cells and cell membranes. Dutch doctors and scientists from Boston University, based on long medical research found that people with low cholesterol diet have a reduced ability to remember and logical thinking, often in bad moods, tendency to depression and mental disorders [4, 5]. Also, leading scientific journals reported the presence in milk fat and fat globules, a number of medical components capable of, even in small concentrations, acting as inhibitors in carcinogenesis of some cardiovascular and gastrointestinal diseases [4, 5].

Given the above, there is a need to create new types of products based on butter with a high content of natural micronutrients. These include oil mixture. In Ukraine such products are not produced in industrial conditions. At the same time in many European countries a mixture of oil and oil paste are popular enough foodstuff, as evidenced by the presence of existing documentation for these products and the significant volumes of industrial production.

Taking into account modern trends in the development of food science, a method of enriching complex salt-oil mixture of natural micronutrients was developed. According to the proposed technology of making specially slurry of white sesame seeds and powders from carrot and tomatoes obtained by cold spray drying consists in machining the basic oily mixture ingredients. It is pointed out that the enrichment of white sesame seeds is used in the form of slurry which is produced directly before making it into an oil mixture by grinding seeds under special conditions. The feasibility of introducing selected herbal ingredients is confirmed by numerous positive results presented in the literature: medical valuable micronutrients, selected plant raw materials have a positive effect on the immune, nervous, cardiovascular and respiratory systems, improve liver function, contribute to the regeneration of skin cells, etc. [6-8].

According to the results of experimental research and based on the high sensory properties of the finished product, rational concentration of herbal supplements was established. During the production of carrot powder an amount of 2% tomato powder - 8% and sesame paste - 4% respectively were used. The paste is white sesame seed produced on own technology. The setting of the number of herbal supplements was performed at the best structure and taste of the product. It was revealed that the introduction of selected additives in specific amounts reduces the hardness of the finished product and reduces the liquid fat excretion of the product. Also, butter paste has a high ability to retain its shape at high temperatures (30°C). The experimental results indicate the internal interaction and the formation of additional bonds between the components of vegetable raw materials and water and fat phase rich oil mixture. To confirm this hypothesis and for better understanding of the effect of additives on the formation of plant properties of the oil-enriched mixture, we studied its microstructure and its changes occurring in the aqueous and fatty phases of the finished product.

2. Materials and methods

We investigated the butter paste made with carrot powder in an amount of 2% tomato powder - 8% and sesame paste - 4% respectively. Salt was added to enhance the taste of the product. A sample control was used to monitor the changes occurring under the influence of herbal supplements. It was manufactured using the same technology as the research oily paste, but instead of herbal supplements, milk powder was used. Moisture content in the test samples was of 48%.

Micro-structural methods of studying the structural elements are formed by plant components with fatty and aqueous phases of the product. The microstructure characterizing droplet sizes of plasma products and their placement in the structure of the product were analyzed. These microstructures were prepared by „crushed drops." View preparations were carried out at a temperature of 18 ± 1°C; using optical polarizing microscope MBI-15 with lighting "the passage" and in polarized light. Individual fields were photographed with the scale of ocular micrometer.

The research on phase glycoside changes of milk fat in samples was performed by thermodynamic differential scanning calorimeter in the temperature range between -50°C and 50°C. The analysis of crystallization was carried out by obtaining curves, focusing on the values of their highs and substrate temperature melting peak groups of triglyceride fat phase in finished products.

3. Results and discussion

Pictures of the microstructure of salt butter paste in the light "on transmission" and polarized light are shown in the Figure 1. Plasma drops of control sample (Fig. 1, d) are distributed in non-uniform structure and the product is of different magnitudes. The average size is in the range 2.5...7.5 m (Fig. 2). It is pointed out that 30% of the plasma droplets of the control structure have dimensions of 5 ... 6 mm. When microscopically viewed, individual plasma drops of a diameter bigger than 10 microns were identified in the oil mixture without additives. In the literature there is a study which indicates a direct correlation between plasma dispersion of droplets of butter and microbial spoilage [9]. The authors found that with increasing the number of plasma drops with dimensions greater than 5 microns, the microbial spoilage rate increases. The total number of diameters drops in the control sample is about 48 %. The results of research make it possible to predict a low microbiological stability of the oil mixture without herbal supplements during storage.

The microstructure of the sample butter pasta with herbal supplements has many fine droplets of plasma. The structure of the product is placed evenly. The vast majority (70.5%) of plasma droplets have a size of up to 2,5 mm (Fig. 2). Enriched butter paste with droplets greater than 5,0 mm is not more than 5%. This indicates high resistance to microbial spoilage of the finished products during storage.

We should mention that while watching the preparations of enriched butter paste we also found particles of tissue made from herbal ingredients, and the structural elements that are not specific to a control example. Figure 1 *a* and *b* show the picture of the microstructure of butter paste enriched with vegetable powder particles. One can see in the picture traces of the leading C and D in stored tissues. Tissue particles have a size of about 5...10 mm and 60...80 mm respectively.

When viewing the preparations in polarized light (Fig. 1, b and d) at 18°C the surface of powder particles has a bright pale yellow and light orange color. That indicates the interaction of the components of powders with a fat phase in butter paste. As a result of the interaction between particles the surface of tissue is easily crystallized (HMT) and medium melting (MMT) triglycerides.

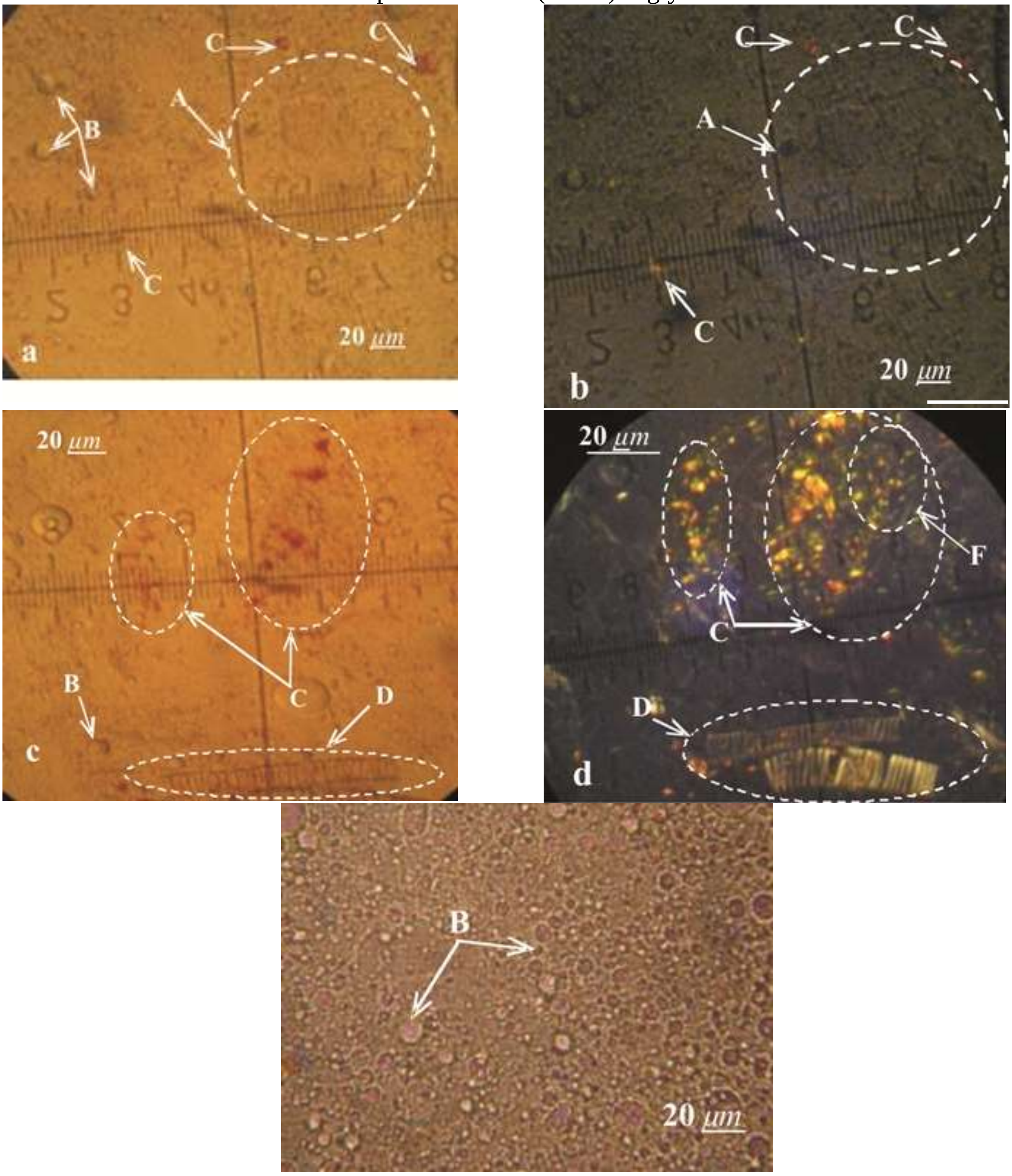

Fig. 1. Microstructure of oil mixtures:
a, b – an enriched butter paste microstructure when viewed in light of "the passage";
c, d - microstructure enriched oil mixture when viewing the preparations in polarized light;
A, F – interparticle cellular structure; B – Oil droplet plasma mixture;
C – store and particle D – conducting tissues vegetable powders

The Fig. 1 shows agglomerate F which has a honeycomb structure. On the sides of the agglomerate linear crystals are placed. They are well visible in polarized light.

Also, agglomerates can be seen (Fig. 1a), which consist of polygons of irregular shapes. The size of the faces of its cells varies between 5...15 mm. A characteristic feature of agglomerate is that they have strongly bound moisture on the surface of its faces, as indicated by viewing the respective portions in the light microscope slide "on transmission", and in polarized light.

These results confirmed the previous research and well-known results obtained by leading scientists in the study of such structures [10, 11].

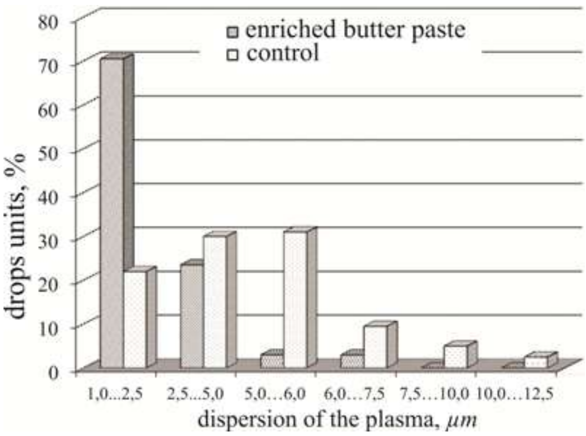

Fig. 2. The fineness of plasma drops

So, microstructural investigations of salt enriched butter paste indicate the interaction between the components of vegetable raw materials with water and fat phase of the final product, creating new structural elements - a honeycomb structure of the agglomerates. At the edges of cells sinter layers, firmly bound aqueous phase and crystalline linear structure are formed from groups LMT and HMT. Changes in the fatty phase of butter paste which were kept 3 days at 6±1°C were studied by differential scanning calorimetry.

The determination of group composition of the crystalline quality of the fat phase of prototypes was carried out according to the method proposed by Professor Tamara Rashevsky. It was obtained by endoderm melting of the crystalline phase of the product laid out on a simple (Gaussian) by least squares method using the program “Peak.Fi”. The laws of normal distribution curves Gauss were used.

The peaks of outlined characterized the change of crystallization processes in the butter paste. Melting endothermic curve prototypes mathematically processed of oil mixtures are presented in Figure 3.

The nature of specific heat control (Fig. 3.a) indicates the gradual melting of the crystalline phase of the product. When carrying out the mathematical processing of the melting curve, low Gaussian temperatures with maximum of –21,3°C and –12,1°C were registered. According to the literature it is known that these peaks characterize the transition from the amorphous phase to the liquid triglyceride fat amorphous phase control. The highest maximum peak was registered at -2,6°C which was formed by melting water and the partial melting of low-melting triglycerides (LPH) fat phase of the product. The presence of diffuse peak in the total heat capacity curve and Gaussian one at 7,8°C indicates the completion of melting triglyceride fraction in the crystalmelting fat phase of the product. The peak with a maximum at 20°C is the result of co-melting fuse light and medium-melting triglycerides (MMT). The diffuse peak at 31.2°C characterizes the melting of high melting triglycerides (HMT) crystalline phase of milk fat.

We observed that the groups of fungal microflora present initially were also identified at the end of the drying process but with different level of contamination depending on the surface drying and the origin of beans (Figures 2 and 3).

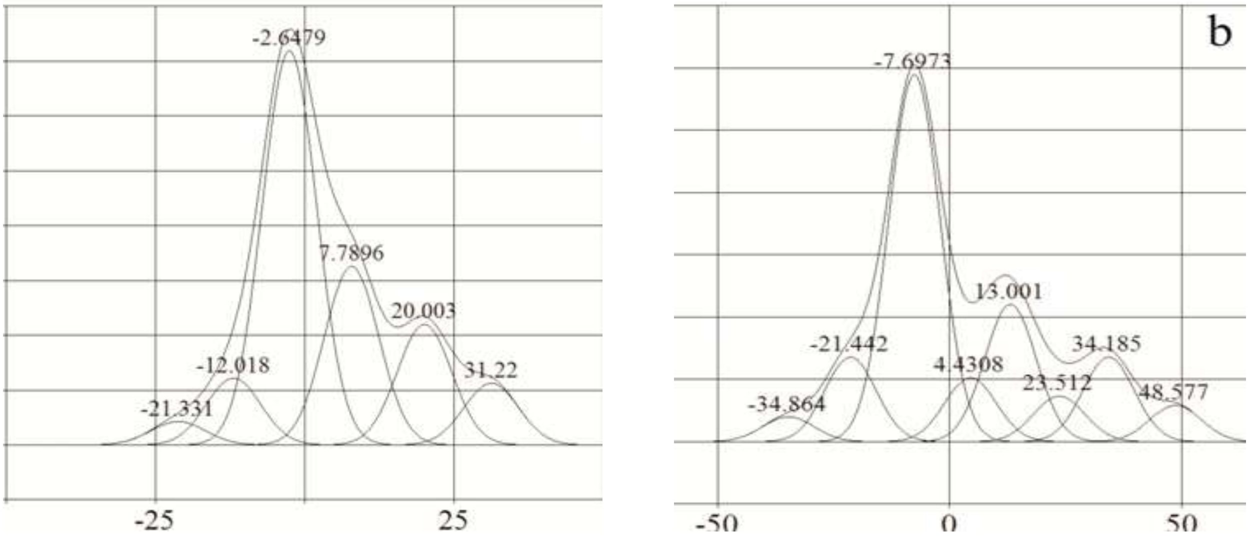

Fig. 3. **Mathematically treated curves melting endothermic crystalline phases of oil mixtures:**
a – control; b – enriched butter paste.

From the beginning to the end of drying, several factors in combination may contribute to impact differently the microbial growth in contaminated cherries. This is strongly supported by the fact that the ANOVA was performed before and at the end of drying, showing a distribution of contamination levels of cherries initially uniform in samples from different areas, but this distribution is no longer uniform at the end of drying. Moreover, an interaction of different factors has been evidenced.

By comparing control endothermic and enriched butter paste it is evident that the final melting of the crystalline phase occurs over a wide range and is described by a large Gaussian number and peaks melting triglycerides individual groups are more pronounced. This nature of the curve indicates discrete crystallizing of triglyceride fat in a crystalline phase, an enriched butter paste during its storage.

The components in butter paste with vegetable should also be mentioned: structural transformations in amorphous milk fat - 14°C and 9°C; the maximum co-melting of water and fat phases LPH product ≈ 5°C. Clearly, such processes are due to the content in sesame oil linoleic acid with a low melting point. The Gaussian number also increased in the finished butter paste, changing the temperature of highs, having in view that the peak melting LPH in enriched butter paste was 4.4°C. The maximum co-melting LPH and LNG (Fig. 3.b.) compared to the control sample is reduced to 13°C. This explains the processes of recrystallization of triglycerides. The melting group MMT occurs at higher temperatures than in the control sample, with a peak at 23.5°C. Melting processes described two Gaussian fractions HMT with peaks at 34.2°C and 48.8°C. It should be noticed that the first peak melting temperature as compared to control was registered at above 3°C. An additional melting peak HSV was obtained at 48.6°C, its area being negligible, whereas for the control sample it was not specific. It was obviously created by melting stearic acid and palmitic sesame oil.

By analyzing the data obtained, it was found that the introduction of the mixture of powders in the oil from carrots and tomatoes, and specially prepared sesame seeds leads to discrete crystallization and recrystallization of individual triglyceride groups in products during storage. These data confirm the results of microstructural investigations.

4. Conclusion

1. The effect of powders of carrot and tomato paste and sesame on the dispersion of the enriched butter paste plasma mixture was analyzed. It is found that the introduction of plant ingredients in the specified amounts increases the number of droplets with sizes of up to 5 microns by 1,8 times.
2. The method of microstructural analysis revealed the interaction between the components of vegetable raw materials with fatty and aqueous phases and butter paste revealed the formation of sinter mesh structure.
3. It was found that the plant components accelerate the process of recrystallization group small LMT and MMT in a crystalline fat phase rich in oil mixture. These processes take place the most intensively during the first 3 days of storage.

5. References

[1]. Course on safely. *Report on health in Europe 2012*, 196, (2013)

[2]. The concept of the national program «Health - 2020: Ukrainian Dimension», *Approved by Cabinet of Ministers of Ukraine*, № 1164-r., (2011)

[3]. S. LINNIK, The directions of realization in Ukraine WHO European strategy for prevention and control of non-communicable diseases, *Scientific work. Governance*, 196, 208: 106-111, (2012)

[4]. M. ANCELIN, I. CARRIERE, J. BOULENGER, Gender and Genotype Modulation of the Association between Lipid Levels and Depressive Symptomatology in Community-Dwelling Elderly (The ESPRIT Study), *Biological Psychiatry*. 68, 2: 125-132, (2010) http://www.biologicalpsychiatryjournal.com/article/S0006-3223(10)00393-8

[5]. V. SPITSBERG, Invited Review: Bovine Milk Fat Globule Membrane as a Potential Nutraceutical, *Journal of Dairy Science*, 88, 7: 2289-2294, (2005)

[6]. M. SIMONOVA, Carotenoids: structure, properties and biological *Biologichni studiyi. Studia Biologica*. 4, 2: 159-170, (2010)

[7]. A. RAJORIA, J. KUMAR, A. CHAUHAN, Anti-oxidative and anti-carcinogenic role of lycopene in human health - a review, *Journal of Dairying, Foods and Home Sciences*, 29, 3: 157-165, (2010)

[8]. V. ISAEV, Polyunsaturated fatty acids and their role in cerebral blood flow, http://www.trinita.ru/articles/pnzhk_mozg.html

[9]. E. KANEVA, F. VYSHEMIRSKY, The fineness of the plasma and ability to persist for butter, *Contribution of science to the development of Butter and Cheese: scientific and engineering. Conf.*, Uglich, 116, 3-4 October, (1994)

[10]. A. KARPENKO, J. VASHEK, O. NEMIRICH, Microstructural investigation of an aqueous suspension sesame seeds, *Scientific papers of young scientists and students*, Odesa: 167-169, (2014)

[11]. M. MAHONINA, T. RASHEKSKA, The fatty phase microstructure slurry additives flax seed, *Food science and technology*, 2(15): 50-53, (2011).