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The technology of butters' enriching with carrots' powder

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Abstract

The article shows the necessity of the development the technology of butter's enrichment with carrot powder. Technological operations are given and modes of enriched butter production are established. It is suggested to use a carrot powder additives produced by convective and cold spray drying for enrichment. The images of microstructure of aqueous solutions of selected powders are given in the article. It is established that only the suspension of the powder of cold spray drying contains particles of 20-80 microns large and particles of 1-5 microns. It is also indicated that they participate in the formation of structure between powder parts. The structure between the additive's particles (convective drying) is formed slightly. Butter enriched with carrot powder was investigated. It was established that introduction of additives improves the organoleptic properties of enriched butter and simultaneously improves the performance of the structure and consistency. It was suggested that due to the introduction of powder in butter the extra space is formed between additive and butter particles. This increases the hardness of the butter and improves its heat resistance and plasticity. This assumption is consistent and is supported by studies of additives' microstructure. It is set that the powders obtained by different drying technologies influence differently the structures' formation of enriched butter. A products' fat phase was studied by differential scanning calorimetry. By diffraction pattern it was found that introducing carrots powder impedes recrystallization of glycerides during the enriched butter storage. It is set, that additive's introduction and the way of their obtainment differently influence the crystallization process in enriched butter.

Keywords: Technology of butter's enrichment, carrot powder, fat phase

1. Introduction

The main scientists of the world consider that the situation of bad health and appearing some chronic diseases in many cases is associated with bad nutrition. Because of this situation one of the main

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problems nowadays is new products producing that are rich for biological active substances. It should be a harmoniums combination of traditional food with natural additions. Today, the powders from plant material are often used as these additives. The prospect of their use is in their naturalness, and safety in a natural combination of complex biologically active substances.

Butter - is virtually the only fat animal products consumed in kind. It does not accumulate heavy metal ions. The need for its daily consumption has been proved by doctors: butter's components are involved in the synthesis of substances that regulate the immune system, directly affecting the normal operation for adrenal glands, the synthesis of sex hormones, the normal functioning of the nervous system. Doctors found that butter includes substances which impede the development of malignant tumors. Therefore, a technology of manufacturing functional kind of butter with plant powders based on traditional dairy lines was developed. During investigations it was found [1] that the introduction of herbal supplements to the butter changes its nanostructure, promotes improvement of the organoleptic and physical-chemical characteristics of the product, and improves its capacity for storage. According to the results of clinical trials and concluding MOH Ukraine the developed butter kinds are recommended in health care and wellness nutrition [2]. Based on the positive results of previous developments we have created a way to enrich butter - the introduction of additives to the finished butter during its machining. The essence of the method is in introducing a specially prepared suspension of powder from herbal material during its machining - homogenization. To prepare the suspension the herbal powder should be mixed with milk and kept at a temperature above 45 ° C during 10-15 min for swelling of the powder. Using low-temperature preparation of powders allows to save the valuable properties of the components. Then the suspension is cooled to a temperature of 14-16 ° C and brought in butter during its homogenization. This ensures the even distribution of the additives in the structure of the product. The interest is in the ability to manufacture functional product on the existing equipment of dairy enterprises, as well as in catering with health and medical purposes. We think that the production and consumption of quickly made products will significantly increase its functional effects on human organism.

The criteria for powders selection was their functional properties and harmonious combination with butter taste. Immunomodulatory, oncology and radioprotective properties of carrots' components are well known and widely used around the world. Therefore, multifunctional additive powder of carrots produced by different methods of drying was selected for further research as an additive.

In our opinion, to understand better the enriched butter's structure formation, scientists should investigate the microstructure of carrots' powder and examine their impact on the structure and texture of enriched butter. There should be mentioned that first we carried out studying the microstructure of the carrot powders obtained by cryogenic, convection and cold spray drying [3]. Our results revealed differences in the microstructure of powders obtained by different methods of drying and there was the structure between the particles of carrots' powder.

The purpose of this research is continuing to study the microstructure of aqueous solutions of carrot powders obtained by different methods of drying; the influence of selected additives on the consistency of enriched butter; the changes occurring in the fatty phase of enriched butter during storage at +5 ° C due to imposed supplements.

2. Materials & Methods

The subject of research for the microstructure's study were water suspensions of carrot powders, obtained by thermal, convection and cold spray drying (powder Karotte-100 made by "OBIPEKTIN AG, CH-9220 BISCHOFSZELL", Switzerland). For making carrot's microscopic suspensions' preparation the powder was restored in water at 30 ... 35 ° C. From the received suspensions a preparation was made for viewing on an optical microscope MIN-8 with light "on passing" by the standard procedure. The study was performed at 20 ° C. Were investigated the samples of butter with carrot powder of convective and cold spray drying. The test samples were made by the described technology of enriched butter producing.

We studied the consistency of butter indicators: hardness and heat resistance (CT) of butter. The hardness of butter was determined by penetrometer AP 4\2 on the depth of ebonite cone with angle of 45 ° immersion at a temperature of butter - 15 ° C. The powder influence on the phase transformation in butter's fat has been studied by differential scanning calorimetry methods.

3. Results & Discussion

Figure 1 shows photographs of microstructure of carrot powders obtained by methods of thermal, convection and cold spray drying. Microstructure of powder (obtained by heat drying) suspension (see Fig. 1, a) is represented by particles that are unexpressed structure and after repairing stick together and form a pasty mass. It is noted that there is no structure between the particles of powder. This is because the thermal drying of plant material goes at high temperatures (around 100 º C). This causes irreversible processes in the powder composition: protein denaturation, decomposition of fats, the destruction of the structure of the feedstock. Fig. 1, b represents in the microstructure of powder carrot (obtained by convective drying) suspension. It contains recovered particles of carrot's intact tissues A that are similar structurally to the structure of fresh carrot tissue [2]. Structure between the particles of this suspension is not formed. Fig. 1, c. shows the microstructure of powder (cold spray drying - CSD) carrot suspension. It shows the internal structure of recovered particles (A), that is similar to the structure of tissues of fresh vegetables. Between the renewed particles of powder the microstructure formed by water-soluble powder constituents is observed (B). It is noted that only in aqueous solution of powder (CSD) there are particles not only with the size of 20-80 micrometers, but also with the size of 1.5 micrometers. We believe their appearance is connected with the features of powder manufacturing technology that is used by additives' manufacturer.

So, it can be concluded that drying method determines the microstructures of powder suspension. It is noted that the manufacture of powders by convective methods and by cold spray drying helps preserve the structure of carrot tissues. The microstructure between the powder (CSD) particles suggests about saving initial properties of carrots' constituents. Also this method contributes to the formation of small particles of powder with size 1.5 micrometers. In the manufacture of additives by convective drying the particles of that size are almost absent, and the structure between the particles is formed slightly. The studies have shown that thermal drying powder is worse restored and has no structure, so it was not used in further researches.

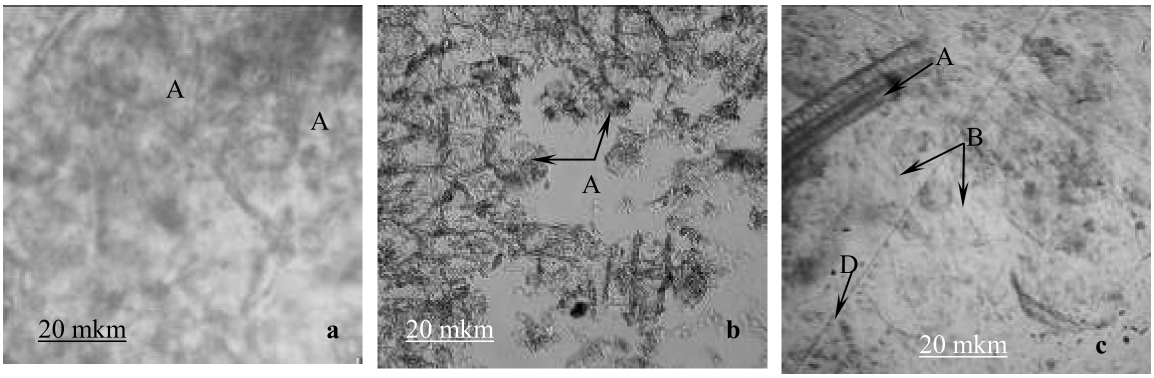

Fig. 1. The microstructure of aqueous solutions of powdered carrots

a - thermal drying; b - convective drying; c-cold spray drying.
A - the powder; B - microstructure, formed by water-soluble components of powder;
D – small powder particles.

For studying the effect of carrot powders obtained by different methods of drying it was conducted producing kinds of enriched butter. During butter's homogenization we added a specially prepared suspension of carrot powder. Preparation of the suspension was performed with the above described technology. The amount of powder in the final product was 1,2%. The control sample was butter with the same machining. In all kinds of butter produced the moisture content was 25%. The organoleptic studies of butter with carrot powders showed that insertion the powder of cold spray drying improves the taste of butter and gives it a pleasant, slightly sweetish and has a light yellow color. Its consistency is homogeneous. Even after storage at low temperatures (-18 ° C), the product has good pasting and plasticity. Dry and glossy surface on the cut of butter shows a high dispersion of liquid phase in product. Insertion the carrot powder of convective drying in the butter contributes to feed and thermal taste caused by the additives.

To study the effect of powders on the formation of enriched butter's consistency we have determined the parameters of hardness and heat resistance. It is known that butter with high quality should not flow and exude a liquid fraction of fat – should be resistant. Such properties in the butter are resulted because of the interaction forces between the constituents of milk fat and van Van der Waals bonds. They form the inner product space mesh and give it plasticity. During the experiment, it was noted that butter enriched with carrot powder has good heat resistance after the first day of storage at a temperature of 5 º C, while in the control sample the heat resistance was satisfactory (PR = 0,80).

Upon further storage at +5 ° C the enriched types of butter have PR about 0.9 and good thermal stability, while the control sample ~ 0.8 and has a satisfactory rating. While studying the hardness of products it was revealed that butter enriched with carrot powder has a higher hardness and better plasticity compared to the control sample. Also it was noted that increasing the hardness of butter with powder during storage goes differently. The hardness of butter with carrot powder of cold spray drying has a rate close to the hardness of control sample after the first period of storage. With the lapse of time, hardness of butter with powder of CSD approximate to the indicators of the butter with the powder of convective drying powder (3-day storage) and during future storage outgoes its rates. Obviously, slower formation of butter's structure with CSD powder at the beginning of storage is associated with a big amount of powder particles with the size 1.2 micrometers. It is known that the introducing of superfine additives causes the structure's oddness - the additives' particles act as mechanical supplements and prevent the formation of internal bonds between the system components.

With the lapse of time, while the formation of secondary spatial grid with powder particles that are larger, small additive particles (size ~ 2.1 micrometers) are also included in the spatial grid and take part in its construction, and therefore the formation of internal ties is faster in an enriched butter with powder of convective drying. Also, the hardness index of butter is rising faster and the product is characterized by better plasticity. So, enrichment butter with carrot powders, according to on their drying processes, leads to increasing heat resistance, hardness and better plasticity.

To understand the influence of selected additives and their role in forming quality consumer parameters of finished product, we conducted a study of butter's fat phase samples. The study of phase transformations in milk fat of butter samples was performed by using the thermal differential scanning calorimeter (DSC). DSC curves showed the melting peaks of group's of high-melting (HMG), medium-melting glycerides (MMG) and a peak of compatible liquid phase and low-melt glycerides (LMG). The curves showed their melting temperature (Figure 2). In Figure 2 the DSC curves of just prepared samples of butter. In curve (Figure 2 I, a) the control sample we clearly see the interval with a peak melting - 32,4 ° C, which corresponds to the group HMG. Melting peak at 13,2 ° C is in the temperature interval of 8 ° C to 25 ° C and corresponds to a compatible melting compatible of MMG and LMG. The largest peak temperature of 3,8 ° C was formed by melting of LMG and liquid phase of product. In the curve the jump of devitrifycation at -31 ° C is marked. The process of devitrifycation passes without change of phase, and therefore it is not a phase transition. During this process the process of "unfreezing" of mobility glycerides of milk fat is going on.

When comparing the DSC curves of fresh made butter with the carrot powder of convective drying and the control sample, we can see that the introduction of additives leads to the appearance of distinct melting peaks diffuse of MMG and HMG. Their melting temperatures in butter with powder of convective drying are 1,4 and 0,23 ° C lower than melting temperature of the peaks in control sample. The peak temperature of LMG and liquid phase of product decreases for 3,6 ° C. On the DSC curves of butter with powders two peaks of LMG and liquid phase of product are present. The melting temperature of peaks in comparison with control sample reduced to 2,8 ° C after adding the powder of CSD. So, there are two peaks of MMG and LMG with melting temperatures of 25,9 and 14,5 ° C. The melting temperature peak of HMG of 35 ° C. It is 2,6 °C more to conformable peak melting from control. The general trend for both types of butter with the powder compared to the control is reducing the melting temperature peaks compatible LMG and liquid phase of product. This gives evidence shows that the powder presence in the system promotes differentiated edging of LMG that are unable to crystallize during the formation of crystalline phases of butter in the area of lower temperatures. We believe this is due to the additives' presence that and their ties in a fatty phase of the product that is not typical for butter components.

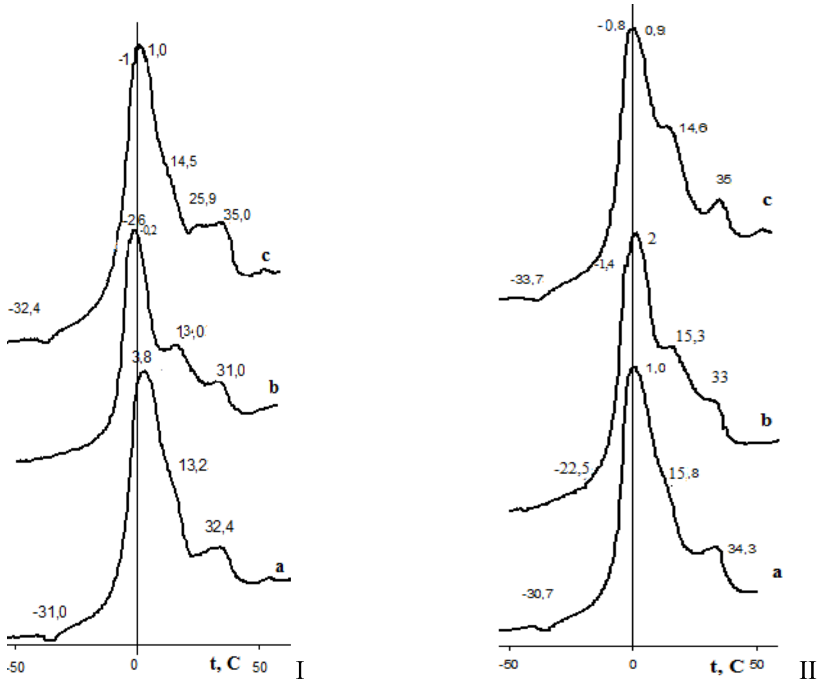

Fig. 2. Curves of butter's specific heat

I – fresh-made butter; II – after storage (+5 °C): a- control sample; b – butter with carrot powder of convective drying; c – butter with carrot powder of cold spray drying.

During control sample storage the temperature of the melting peaks of MMG and HMG grow on 2,6 and 1,9 ° C. This is due to glyceride's recrystallization processes. A decline of melting temperature of LMG and liquid phase of product of butter for 2,8 ° C also shows that. The processes of recrystallization of glycerides' separate groups undergo during the storage of butter with carrot powder of convective drying. This is evidenced by the growth of the temperature of the melting peaks of HMG, NMG and LMG with liquid phase of product. In the butter with powder of CSD the melting temperature peaks of glycerides individual groups vary slightly after storage. One melting peak of MMG disappears. That's why manifested peaks of melting of LNG and HSV temperatures 14.6 and 35°C are shown more clearly on the curve.

4. Conclusion

According to the microstructural studies it was revealed that production of carrot powder by cold spray drying contributes to the formation of particles with a size 1-5 micrometers and saves the powder component properties. It was found that butter with carrot powder is more heat resistible, has a better hardness and plasticity. The melting curves of butter showed that the introduction of carrot powder leads to displacement of fusible glycerides of the solidification front into the zone of lower temperatures. Insertion of additives of cold spray drying leads to reducing the temperature melting peaks of compatible LMG and liquid phase product to 2,8 ° C and to increasing the melting temperature peak of HMG to 2,6 ° C in the fresh butter. During further storage of butter with carrot powder of cold spray drying the temperature melting peaks of glycerides vary slightly. Adding the powder of convective drying reduces the melting temperature of compatible LMG and liquid phase product at 4 ° C. During further storage the temperature melting peaks of glycerides groups gradually increase and are close to the melting temperature of the control sample.

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