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New technologies for the storage of agricultural products

A V Diachkova, S L Tikhonov and N V Tikhonova

Ural State University of Economics, 62/45, 8 Marta/Narodnaya Volya street, Ekaterinburg, 620144, Russia

E-mail: tihonov75@bk.ru

Abstract. The paper presents a study of microencapsulated ascorbic acid stability on an experimental apparatus with a spouting layer in enriched sausages processed by ultrahigh pressure (600 MPa for 3 minutes using experimental hydrostat). A maltodextrin dispersion in a fluidized bed was used as a protective layer for C vitamin. As a result of research, it was established that the processing of boiled sausages by ultrahigh pressure did not adversely affect the stability of C vitamin in the product. The amount of ascorbic acid in the test samples decreased slightly after 7 days of storage. The research describes the ways of increasing the vitality of vitamins during manufacturing processes, especially during heat treatment. Creating a system of microencapsulation, which acts as an "insulating material" for vitamins, is one of the most possible ways that can be widely used in the agro-industrial complex.

1. Introduction

One of the priorities identified in the Strategy for the Improvement of the Quality of Food Products of the Russian Federation until 2030 is the preservation of food nutrients and the enrichment of food with essential micronutrients, in particular, vitamins. Enterprises of the agro-industrial complex pay considerable attention to increasing the content of macro- and micronutrients in food products, preserving them throughout the entire shelf life, and strive to increase the storage capacity of the products produced. There are several basic technologies for food production with the necessary properties and given nutritional value (in vivo and in vitro). Thus, the technology based on in vitro, involves the introduction of a product of new biologically active substances, their preservation, as well as the inactivation of other unsafe components into the formulation. The inclusion of vitamins in food matrices is one of the complex areas of research in the field of food technology. Vitamins are quite sensitive to environmental conditions, such as temperature. Therefore, special attention should be paid to the enrichment of food products as a replacement for irreplaceable micronutrients lost as a result of technological temperature processing. As far as agricultural technologies are concerned, the term "bio-enrichment" should be considered i.e. an increase in the nutritional value of food raw materials during its production, for example, in growing crops, or in vivo enrichment of farm animal meat with biologically active substances, by introducing them into a diet, i.e. "Lifetime formation" of the chemical composition and technological properties of agricultural raw materials. When developing the technology of enrichment of food products with irreplaceable micronutrients, their safety during production and storage should be considered. It is known that many biologically active substances as a result of heat treatment lose their activity or are destroyed. In this regard, it is necessary to apply various gentle technological regimes and protective coatings for micronutrients, the so-called "microencapsulation".

When microencapsulated, the biologically active substance is placed in a thin shell of polymer or other material. The size of microcapsules is 1 to 2000 microns. In the food industry, as a rule, enzymes, pharmacologically active substances, in particular vitamins, fatty oils, and others that are used to enrich food products, encapsulate insecticides in agronomy, in the pharmaceutical industry - medicinal substances for the purpose of prolongation and directional action in certain organs. and tissues of the human body. With the help of microencapsulation, the shelf life of biologically active substances is increased, by applying an inert coating on them, for example, antibiotics with active principle; cephalexin is placed in a food additive - gum, ampicillin - in sodium carboxymethylcellulose, an antifungal drug kanamycin - in sodium alginate. It is known that some medicinal substances are placed in micro-shells from plant extracts with a similar pharmacological orientation, which makes it possible to impart a synergistic effect to the drug [1, 2].

At the same time, encapsulated forms of substances must meet certain requirements. In particular, in order to achieve the biologically active substance of the small intestine, it is necessary that the capsule not be destroyed in the acidic environment of the gastric juice; the active substance should be released from the capsule slowly, which will prolong the resulting effect [2].

Micronutrient microencapsulation technologies in the food industry are different. Coating in the flowing layer is becoming widely used. The gushing layer is used today for drying granulated polymers and grains, suspensions and solutions on inert particles; granulating melts or solutions; mixing solid granules of various materials. The main advantage of the spouting layer in the technological processes associated with drying, heating and cooling during granulation of solid particles consists in the intensive mixing of solid particles, providing effective contacting of gas and solid material. When granulating and coating (encapsulating), the regular cyclic movement of solid particles contributes to the uniform sedimentation of granular droplets (capsuler) on the surface of the fountain particles [3,4].

One of the important directions of the food industry is the development and introduction of fortified food products, in particular, sausages into the production.

Sausages are perishable food products; and to increase their shelf life various food additives, as well as some physical methods are used. One of the most promising is the processing of meat products by ultrahigh pressure, which allows inhibiting the development of microbiological damage.

High hydrostatic pressure treatment effectively inactivates most pathogens, including yeast, mold, and gram-positive and gram-negative bacteria, such as B. cereus, C. perfringens, E. coli and S aureus. At the same time, pressure treatment has a slight effect on the taste, flavour, texture, appearance and nutritional value of food products [5]. The pressure range commonly used ranges from 300 to 600 MPa, while the efficiency of inactivation of microorganisms depends on pressure, exposure time and temperature, as well as on the stability of microorganisms [6].

It is worth noting that there is a lot of modern researches concerning microencapsulation technologies [7-12]. In our opinion, a number of technologies encapsulating biologically active substances in research [10,12,15] are economically inexpedient due to their high cost or low efficiency, and therefore they are unlikely to be able to find wide application in the food industry.

At the same time, questions concerning the effect of ultrahigh pressure on the persistence of microencapsulated labile micronutrients in fortified foods are not studied enough in domestic and foreign literature.

In this regard, the purpose of our work is to study the stability of microencapsulated ascorbic acid on the apparatus with a spouting layer in enriched sausages processed by ultrahigh pressure.

2. Research methods

For the experiment, two groups of cooked sausages were formed (in a natural casing with a shelf life of not more than 5 days) “Doctor's sausage” of category A ”with the following composition: pork, beef, drinking water, food eggs, drinking milk, table salt, edible additive E 452 (stabilizer - sodium polyphosphate soluble), food additive E 250 (colour fixer - sodium nitrite), sugar, nutmeg, enriching additive (microencapsulated ascorbic acid) was introduced into the stuffing at the rate of 10 mg per 100 g. Samples of boiled sausages first group (control) was not treated with high pressure; Samples of boiled sausages of the second group (experiment) were treated with a pressure of 600 MPa for 3 minutes using an experimental hydrostat (figure 1).

Figure 1. Experimental hydrostat for processing food products by ultrahigh pressure.

A maltodextrin dispersion in a fluidized bed was used as a protective layer for C vitamin. The choice of maltodexrin is due to its high degree of water solubility and low viscosity; maltodextrin solutions are colorless, inexpensive, and are widely used in food production [11,14,15]. The advantage of this technology is the diffusion of gas into solid particles of the active substance (ascorbic acid), which ensures uniform deposition of a protective substance in the form of a gas on the surface of the fountain particles. Microencapsulation was performed in the apparatus (figure 2) by applying ascorbic acid maltodextrin (10% -. Aqueous maltodextrin obtained by acid from corn starch as a result of its partial hydrolysis and weight dextrose equivalent) to the surface of the fluidized bed. Maltodextrin is a polysaccharide unsweetened nutrient, consisting of bound D-glucose. At a temperature of 100 ° C and a pH of 4.0–5.0, corn starch is destroyed, and as a result, maltodextrin and corn syrup are obtained.

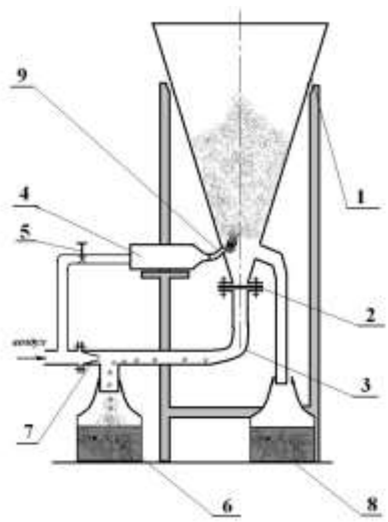

Figure 2. A device for the microencapsulation of ascorbic acid.

The developed device for ascorbic acid microencapsulation consists of a body (1) of conical shape and has replaceable washers (2) on nozzle (3), for introducing a stream of particles dispersed by means of nozzle (7) with air. Reducing the diameters of the openings of the washers (2), as well as the conical shape of the apparatus, allow processing in the spouting layer particles of biologically active substances of various sizes (from 10 μm to 0.5 mm in the example). Jet dispersing device (4) provides input of maltodextrin of the required size to the device drops through the pipe (9); it works from the same air from the compressor (not shown in figure 2) with flow controlled valve (5). The containers (6) and (8) serve for portions of the original particles and product accordingly.

The ratio of the solid substance to the liquid one (S/L) was kept in the range of 10/1 ÷ 11.5 / 1. The fluidizing agent, including in the drying mode, was of room-temperature air pumped through the apparatus. The process of microencapsulation using maltodextrin provided sufficient hardness of the walls of the capsule; the thickness of the protective layer of maltodextrin was 4 μm.

The content of ascorbic acid in sausages was determined by iodometric method.

3. Research results

As a result of the research, it was established that the processing of boiled sausages by ultrahigh pressure did not affect the stability of C vitamin in the product adversely (table 1).

Table 1. Dynamics of C vitamin content in boiled sausages.

	Amount of C vitamin, mg/100 g of product	
	Control samples	Prototypes
After production	8.6	8.7
After pressure treatment	8.6 (without pressure processing)	8.7
1 day storage	8.2	8.3
3 days storage	8.2	8.3
7 days of storage	8.1	8.2

As a result of the technological process of production of boiled sausages, the amount of injected ascorbic acid is reduced by 14 and 13% in the control and experimental groups in comparison with the initial amount of micronutrient in the minced meat. Thus, the amount of ascorbic acid in the control and experimental samples of sausages after production was 8.6 and 8.7 mg/100 g of the product, which is 88 and 87% of the initial level of application. After pressure treatment (test), the content of ascorbic acid did not change and amounted to 8.7 mg/100 g of product. It should be noted that during storage there is a decrease in ascorbic acid in both the control and experimental samples of boiled sausages. In samples of sausages treated with high pressure, after 1 and 7 days of storage, a decrease in ascorbic acid by 4 and 5%, respectively, was observed, compared with the initial level after production. Similar results were obtained in the study of control samples of boiled sausages. After 7 days of storage, the content of C vitamin in the control and experimental samples of boiled sausages was 8.1 mg/100 g of the product in the first group, 8.2 mg/100 g of the product in the second group.

4. Conclusion

Thus, high-pressure processing of sausages enriched with microencapsulated ascorbic acid does not adversely affect theur shelf life.

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