Production of vitaminized food products as a new development vector for the agro-industrial complex

A V Diachkova, S I Tikhonov, N V Tikhonova and V O Tolmachev
Ural State University of Economics, 62/45, 8 Marta/Narodnoy voli str., Ekaterinburg, 620144, Russia

E-mail: tihonov75@bk.ru

Abstract. The paper presents the development of the formulation for a non-carbonated soft drink “With raspberry and cranberry flavour” enriched with microencapsulated vitamin premix. Beverages samples of the first group (control) were produced with the usual non-encapsulated vitamin premix 963/7; in the formulation of beverages of the second test group the microencapsulated vitamin premix maltodextrin was used. Encapsulation was carried out in a pseudo-boiling layer. The study made it possible to conclude that the microencapsulation of the vitamin premix had a positive effect on the persistence of vitamins in a drink. The amount of vitamin PP, vitamin B6, pantothenic acid, folic acid and vitamin C in the test drink samples was higher than in the control sample by 33, 50, 50 and 95 %. On the basis of the conducted studies, the warranty period and storage mode were identified: 4 months at a temperature ranging from 0°C to +25°C and a relative humidity of not more than 75%. After opening, open packaging should be stored at a temperature ranging from 0°C to +5°C for no more than 1 day.

1. Introduction
Nowadays, the sustainable development of the agro-industrial complex in the Russian Federation determines the level of food security, consisting of a consumption system that depends on the economic availability of food, the saturation of the consumer food market, and the ratio of domestic and imported food products. In this case, the most important factor determining the health and performance of the population is the nutritional value of the diet. A special role in this is played by food products of mass consumption, including non-alcoholic drinks, enriched with essential nutrients, in particular, with vitamins. When developing such beverages, the integrity of the micronutrients added to the basic formulation during production and storage should be taken into account.

To ensure the integrity of the added biologically active substances, they are often covered with a protective layer, i.e. microcapsulated.

Microcapsules can have up to several protective layers from micrometers to millimeters [1]. Microcapsules of two types are identified. In the first type, the active substance is in a homogeneous space and enclosed in a capsule, in the other type the active substance is dispersed into the matrix of the protective substance [2].

Today, the food industry uses various methods: gas-phase polymerization, spray drying, freezing, jet cooling, applying a fluidized layer, extrusion, coacervation, cocrystallization [3-5].

Based on the above, the goal of the work is to develop a non-carbonated soft drink “With raspberry and cranberry flavour”, enriched with a microencapsulated vitamin premix.
2. Material and methods
The vitamin premix 963/7 was used to enrich drinks. The study of the quality of the drink was carried out according to generally accepted methods. The content of vitamins and vitamin C in the drink was determined by the chromatographic and iodometric methods, respectively. Samples of beverages of the first group (control) were produced with the usual non-encapsulated vitamin premix; in the formulation for beverages of the second test group the microencapsulated vitamin premix maltodextrin was used. The encapsulation was carried out in a pseudo-boiling layer.

3. Research results
The formulation of soft drinks has been developed; the main parameters are presented in table 1.

| Name of raw materials       | Unit of measurement | Quantity | Mass fraction, % | Solid matter content in raw materials |
|-----------------------------|---------------------|----------|------------------|---------------------------------------|
| Sugar                       | kg                  | 70,00    | 99,85            | 69,90                                 |
| Concentrated cranberry juice| kg                  | 28,00    | 65,00            | 18,20                                 |
| Concentrated raspberry juice| kg                  | 7,00     | 64,00            | 4,48                                  |
| Potato starch               | kg                  | 12,00    | 81,70            | 9,80                                  |
| Complex functional food additive | kg              | 1,00     | 88,00            | 0,88                                  |
| Vitamin premix 963/7        | kg                  | 0,15     | 99,90            | 0,15                                  |
| Stevioside                  | kg                  | 0,067    | 95,00            | 0,064                                 |
| Water                       | dm³                 | up to 1000,00 |               |                                       |

For the drink production, raw materials were used that meet the requirements of the Technical Regulations of the Customs Union TR CU 021/2011 “On food products safety”, TR CU 029/2012 “Safety requirements for food additives, flavors and technological aids” approved for food production by Rospotrebnadzor and accompanied by documents, confirming its quality:

- sugar GOST 21-94;
- cranberry juice concentrated clarified according to the GOST standard 32102-2013 and manufacturer’s specifications;
- raspberry juice concentrated according to the GOST standard 32102-2013 and manufacturer’s specifications;
- stevioside – according to the manufacturer’s specification;
- complex functional food additive – according to the manufacturer’s specification;
- potato starch - according to the GOST standard 53876-2010 and manufacturer’s specifications;
- vitamin premix 963/7 - according to the manufacturer’s specification.

Table 2 presents the organoleptic properties of drinks.

| Parameter                  | Group                           |
|----------------------------|---------------------------------|


Group 1 (control) w/o microcapsulation of vitamin premix
Group 2 (test) w. microencapsulated vitamin premix

| Parameter          | Group 1 | Group 2 |
|--------------------|---------|---------|
| Appearance         | Opaque liquid | Opaque liquid |
| Color              | Characteristic of the color of the raw materials used | Characteristic of the color of the raw materials used |
| Taste              | Sour-sweet, characteristic of raspberry, cranberry | Sour-sweet, characteristic of raspberry, cranberry |
| Aroma              | Characteristic of raspberry, cranberry | Characteristic of raspberry, cranberry |

Table 2 indicates that the microcapsulation of the premix did not adversely affect the organoleptic properties of the drink.

Table 3 presents the physical-chemical properties of drinks.

Table 3. Physical - chemical properties of drinks.

| Parameter | Group 1 (control) w/o microcapsulation of vitamin premix | Group 2 (test) w. microencapsulated vitamin premix |
|-----------|---------------------------------------------------------|---------------------------------------------------|
| Dry solids weight ratio, % in a freshly made drink | 10,0±0,2 | 10,0±0,1 |
| Acidity, cc of sodium hydroxide solution with a concentration of 1.0 mole / dm³ per 100 cc | 6,1±0,3 | 6,1±0,5 |

Table 3 indicates that the physical-chemical characteristics of beverages with microencapsulated vitamin premix do not differ significantly from a beverage using a premix without encapsulation.

When examining the microbiological characteristics, it was found out that the developed drinks met the requirements of the Technical Regulations of the Customs Union TR CU 21/2011 “On food safety” (Annex 1, Annex 2, Section 1.7). On the content of toxic elements, the drinks complied with the requirements of the Technical Regulations of the Customs Union TR CU 021/2011 “On food safety” (Annex 3, Section 8).

Products are labeled according to the GOST standard R 51074, TR CU 022/2011 "Food products in part of its labeling".

Table 4 presents the nutritional values in the developed drinks after 60 days of storage.

Table 4. Nutritional value of drinks after 60 days of storage.

| Parameter                | Group 1 (control) w/o microcapsulation of vitamin premix | Group 2 (test) w. microencapsulated vitamin premix | Consumption rate, mg/day |
|--------------------------|---------------------------------------------------------|---------------------------------------------------|-------------------------|
| Nutritional value (total carbohydrate), g/100 cc | 10,0 | 10,0 | - |
| Energy value (calories), kJ | 170,0 | 170,0 | - |
| kcal/100 cc              | 40,0 | 40,0 | - |
Vitamin PP, mg/100 cc  2,1  2,8  20,0
Vitamin B6, mg/100 cc  0,2  0,3  2,0
Pantothenic acid, mg/100 cc  1,1  1,65  5,0
Folic acid, mg/100 cc  0,02  0,04  0,4
Vitamin C, mg/100 cc  4,8  9,4  70,0

Table 4 indicates that the microencapsulation of the vitamin premix had a positive effect on the presence of vitamins in the drink. Thus, the amount of vitamin PP, vitamin B6, pantothenic acid, folic acid and vitamin C in the test samples of the drink was 2.8; 0.3; 1.65; 0.004 and 9.4 mg/100cc, which is higher than the control by 33% 50; 50 and 95%.

Based on the conducted studies, regulated quality indicators (table 5), warranty period and storage mode were identified: 4 months at a temperature ranging from 0°C to + 25°C and relative air humidity not more than 75%. After opening, open packaging should be stored at a temperature ranging from 0°C to +5°C for no more than 1 day.

**Table 5. Regulated quality indicators of the vitaminized drink.**

| Parameter                  | Characteristics/content                                      |
|----------------------------|-------------------------------------------------------------|
| Appearance                 | Opaque liquid                                               |
| Color                      | Characteristic of the color of the raw materials used       |
| Taste                      | Sour-sweet, characteristic of raspberry, cranberry          |
| Aroma                      | Characteristic of raspberry, cranberry                       |
|                            | Foreign flavor and smell are not allowed.                   |
| Acidity, cc of sodium hydroxide solution with a concentration of 1.0 mole / dm³ per 100cc | 9                                                          |
| Vitamin PP, mg/100cc       | 2,5-2,9                                                     |
| Vitamin B6, mg/100cc       | 0,26-0,29                                                   |
| Pantothenic acid, mg/100cc | 1,5-1,8                                                     |
| Folic acid, mg/100cc       | 0,03-0,005                                                  |
| Vitamin C, mg/100cc        | 8,0-12,0                                                    |

Drinks for sale can be packaged in the following containers:

- glass bottles of not more than 0.5 dm³ capacity, sealed with crown caps according to the GOST standard R 53921, the GOST standard 32131 and regulatory documentation;
- bottles made of polymeric materials according to the GOST standard R 51760, the standard GOST R 52789 and the regulatory document;
- consumer packaging of not more than 1.5 dm³ capacity made of combined and polymeric materials authorized by the State Sanitary and Epidemiological Surveillance Department for contact with food products, with a capacity of;
- kegs authorized by the State Sanitary and Epidemiological Surveillance Department.

Consumer packaging should be hermetically sealed. Polymer bottles with beverages must be hermetically sealed with screw caps with a control ring made of polymeric materials according to the
GOST standard R 51958. Beverage glass containers are packaged in boxes of corrugated cardboard made of polymeric materials according to the GOST standard R 54463 and regulatory documentation, and also in containers - equipment according to the GOST standard 24831. PET bottles are packaged in polyethylene heat-shrink film according to the GOST standard 25951 and other documentation.

References
[1] Jeyakumari A, Zynudheen A A and Parvathy U 2016 Microencapsulation of bioactive food ingredients and controlled release - a review ICAR-Mumbai research of centre of Central Institute of Fisheries Technology 2(6-7) 1-9
[2] De Vos et al. 2010 Encapsulation for preservation of functionality and targeted delivery of bioactive food components International dairy Journal 20 292-302
[3] Champagne C P and Fustier P 2007 Microencapsulation for the improved delivery of bioactive compounds into foods Current Opinion Biotechnology 18(2) 184-90
[4] KOÇ M, SAKİN M and KAYMAK-ERTEKİN ve F (2010) Mikroenkapsülasyon ve Gıda Teknolojisinde Kullanımı (Turkey: Pamukkale University) Journal of Engineering Sciences 16(1) 77-86
[5] Betz M and Kulozik U 2011 Microencapsulation of bioactive bilberry anthocyanins by means of whey protein gels Procedia food science 1 2047-56