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## Alternative raw materials for food industry

**O I Kohlman, G V Ivanova, T N Yamskikh, A N Ivanova and E O Nikulina**

Siberian Federal University, Svobodny prospect, 79, Krasnoyarsk, 660041, Russia

E-mail: kolmanolya@mail.ru

**Abstract.** The paper is devoted to searching for alternative raw materials for the food industry. The purpose of this study is to develop a recipe and technology to prepare cheese curds coated with dried apricots. Conventional methods are used to study structural and mechanical parameters. The results obtained when investigating structural and mechanical indicators of fruit coating for cheese curds with the software package STATISTICA 6.0 are presented. The research involves regression and correlation analysis of experimental data. Based on the results we could determine the exact amount of each ingredient in the recipe for multicomponent fruit coating of cheese curds. A recipe and the stages of manufacturing process for the production of sweet cheese curds coated with dried fruit have been developed. The manufacturing process proposed for the production of cheese curds coated with dried fruit has a number of advantages in comparison with the traditional technologies for the production of glazed cheese curds. Replacing the chocolate glaze with dried apricots resulted in decreasing the cost of the cheese curds coated with dried apricots per 5 kg batch. Moreover, cheese curds with the fruit coating are a good source of complete proteins, fiber, vitamin C, and minerals.

### 1. Introduction

In Russia, the number of territories where a real ecological catastrophe is provoked increases from year to year. Environmental problems threaten health of the residents. Chemical pollution is the potential for toxic effects in humans living in large industrial cities, which causes spread of ecology-dependent diseases. Toxic compounds in the ambient air cause impairments concerning various organs and systems.

Enriching food with necessary nutrients and biologically active additives it is possible to provide the body with the substances it needs and increase its resistance to adverse environmental factors [1]. In recent years, there has been a tendency to create products on the basis of milk-protein combination with various additives of plant origin [2]. This ensures a high level of balance and functional properties of the food product [3].

In this regard, one of the priority tasks is the development of new food products that contribute to the improvement of the human organism, since nutrition is one of the most important factors determining human health. Proper nutrition contributes to the prevention of disease, prolongs life, increases efficiency and creates conditions for adequate adaptation of the human body to the environment. At the same time, the food patterns of modern humans revealed nutritional deficiencies, primarily vitamins, macro- and micronutrients, complete proteins, dietary fibers, and polyunsaturated fatty acids, which increase the resistance against negative effects of the adverse environmental factors [1].

Food enrichment with vitamins, missing macro- and microelements is a serious intervention in the traditionally established structure of human nutrition. The need for such intervention is dictated by objective changes in lifestyle, recruitment and nutritional value of the food consumed. [1]



Foods enriched with vitamins and minerals are included in the vast group of functional food products, i.e., enriched with functional physiologically beneficial food ingredients that improve human health. These ingredients, along with vitamins and minerals, include dietary fiber, lipids containing polyunsaturated fatty acids, live lactic acid bacteria, in particular bifidobacteria, and oligosaccharides necessary for their nutrition [1], [2], [3].

The purpose of this study is to develop a recipe and technology to prepare cheese curds coated with dried apricots.

Materials and methods of research. The object of the research is sweet cheese curds. Currently, only chocolate glaze is used as a coating in the production of cheese curds. It has a number of negative properties (allergic reactions, increased caloric content, low biological value, etc.). Alternatively, we have proposed the option of replacing the chocolate glaze in the production of glazed cheese curds with the fruit coating.

Cottage cheese belongs to the class of natural, unripened, soft cheeses, which are the most complete food source. It contains from 14 (fat) to 18% (fat-free) complete protein (mainly casein) and from 0.6 (fat-free) to 18% (fat) fat. Its protein is complete, and fats are rich in biologically active unsaturated acids. It contains lipotropic compounds (methionine, choline, lecithin, etc.), which contribute to the prevention of atherosclerosis and liver obesity. It plays a significant role as a source of minerals and vitamins: A and E (fat curd), B6, B12, biotin, riboflavin, folacin, etc., but it is poor in vitamin C content [4].

As it is well known, cottage cheese does not contain easily digestible carbohydrates, organic acids, some vitamins, microelements, which can be found, for example, in vegetables or berries. The combination of animal and plant food ensures supplementing the products with missing biologically active substances and can be the basis for providing functional nutrition support. The use of plant additives and their mixtures in the curd mass will improve the nutritional quality of curd products; increase their nutritional and culinary value.

Dried apricots contain almost 7–20% sugar, 2–10 mg% carotene (provitamin A), organic acids, pectin and aromatic substances, and mineral salts (potassium, calcium, phosphorus) [4].

Sea buckthorn puree contains organic acids (malic, oxalic, citric, tartaric) - 1–4.2%, sugar - 1.6–7%, carotene, essential oils, tannins, trace elements (magnesium, manganese, silicon and others) [4], [5], [6], [7], [8].

The structural and mechanical properties of coating for sweet cheese curds from dried apricots were studied using the well-known techniques: a paste-like mass of dried apricots and olive oil with a number of stabilizing ingredients. We carried out correlation and regression analysis of structural and mechanical indicators of coatings prepared from fruit and thus determined the proper ratio of the ingredients.

## 2. Results

The following indicators were selected as response functions:  $y_1$  – elasticity, %;  $y_2$  – firmness, %. Concentration of dried apricots-  $x_1$ , %; and concentration of olive oil -  $x_2$ , % were considered as independent or variable factors.

The obtained experimental data were processed using the software package Statistica 6.0.

The results of linear regression analysis are presented in table 1.

**Table 1.** Results of linear regression analysis.

| Indicator  | Coefficient     |                                 | Fisher Criterion (F) |
|------------|-----------------|---------------------------------|----------------------|
|            | correlation (R) | determination (R <sup>2</sup> ) |                      |
| Elasticity | 0,96            | 0,93                            | 87,57*               |
| Firmness   | 0,94            | 0,88                            | 48,1*                |

\* The critical value of  $F_{\text{tabl.}}$  is found using the table (F - distribution: critical values of F with degrees of freedom  $\nu_1$  and  $\nu_2$ ; significance level of 5%):  $F_{\text{tabl.}} = 3.89$  [9].

Since the research has shown that  $F_{\text{fact.}} > F_{\text{tabl.}}$ , the equations which are presented below adequately describe the experimental data:

$$y_1 = 19,96 - 0,17 \cdot x_1 + 0,73 \cdot x_2. \quad (1)$$

$$y_2 = 1,85 + 1,75 \cdot x_1 + 2,32 \cdot x_2. \quad (2)$$

Table 2 presents a correlation analysis showing the closeness of relationships between factors and response functions.

**Table 2.** Correlation analysis of factors affect on the response function.

| Indicator  | Pearson correlation coefficient |                  |
|------------|---------------------------------|------------------|
|            | Dried apricots, $x_1$           | Olive oil, $x_2$ |
| Elasticity | -0,964                          | 0,965            |
| Firmness   | -0,93                           | 0,934            |

A representative set of data obtained from calculations show that the required functions  $y_1$ ,  $y_2$  adequately describe changes in structural-mechanical properties; they are approximated by linear lines and their analysis allows us to identify the following patterns:

- elasticity decreases with an increase in the mass fraction of dried apricots ( $r_1 = -0,964$ ) and increases with an increase in the mass fraction of olive oil ( $r_1 = 0,965$ );
- firmness decreases with an increase in the mass fraction of dried apricots ( $r_1 = -0,93$ ) and increases with an increase in the mass fraction of olive oil ( $r_1 = 0,934$ ).

Thus, the proper ratio of dried apricots and olive oil is 1: 0,25.

Taking into account the current trends in the creation of functional dairy products, we have developed the stages of manufacturing process for the production of sweet cheese curds in fruit coating. The main ingredient is sweet curd mixture. Jams and jellies from fresh fruits and berries or prepared on the basis of natural juices are mainly used in production of flavored cheese. The main distinctive features of curds proposed in our recipe are the use of dried apricots instead of chocolate glaze, as well as dried apricots prepared with the addition of sea-buckthorn berries puree.

### 3. The manufacturing process for cooking curd mass

Cottage cheese is crushed and rubbed to a paste-like homogeneous consistency. This operation is performed with standard choppers (or cutters).

Butter (for curd mass) is purified and ground in special grinders before adding to the mixture. Sugar is sifted; dried apricots are washed, scalded, poured with water for 15 minutes, and then crushed to a paste-like mass. Sea-buckthorn berries puree is pasteurized and cooled to a temperature of 16–20 °C.

All ingredients are measured in the prescribed amount. Curd and sugar are placed into a special mixing machine (usually a 150 -335 liters meat mixer) and thoroughly mixed. Then dried apricots, butter and sea buckthorn puree are added. The whole mass is mixed again to homogeneous consistency. The average mixing time is 5–10 min.

### 4. The manufacturing process for cooking fruit coating

The ingredients required for fruit coating include the following: dried apricots, olive oil, stabilizers. Dried apricots are washed, scalded, poured with water for 15 minutes and then ground to a paste-like consistency, adding olive oil and stabilizing ingredients. Then the whole mass is placed in the dosing dispenser, from which it passes between the rollers, heated to a predetermined temperature. In the process of heating, thin strips of dried apricots are obtained, which are then fed to the conveyor.

## 5. The manufacturing process for cooking cheese curds in fruit coating

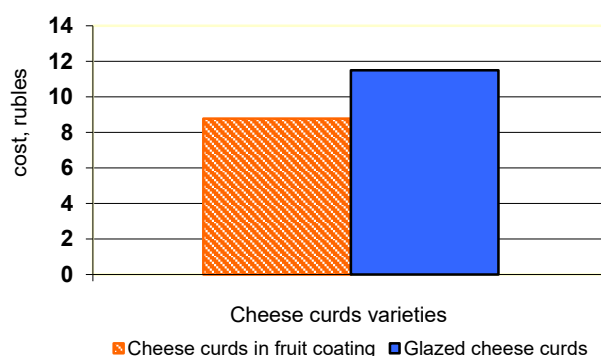
Cavities are made with the beaters on the strips of dried apricots passing through a conveyor. The shaper extrudes the curd mixture cooled to a temperature of 5–9 °C into these cavities. The first layer prepared in this way is covered with the second strip of dried apricots and then cut into chunks by the rollers of the cutting mechanism. The layer of dried apricots should be at least 5 mm thick and cover the whole cheese curd. The standard amount of cheese in the proposed coating is 50-100 g.

The cheese curd is a bright orange hemisphere with homogeneous fruit filling of sweet chopped apricots, having a delicate aroma of sea buckthorn and pleasant sourness.

The finished cheese curds are delivered to the wrapping machine, which is mostly a horizontal type packaging machine. The wrapped and packed in boxes products are stored at a temperature not exceeding 8 °C.

The study of chemical composition has shown that the proposed recipe and technology to prepare cheese curds in fruit coating provides higher content of such valuable for the human substances as vitamins – C, E,  $\beta$ -carotene, PP, minerals (K, Ca, Mn, Na Mg), organic acids as compared to traditional recipes. These products can satisfy 52% of the daily need for potassium, 24% - for calcium, 16% -for phosphorus, 20% of protein requirements, 5% of fat, 40% of  $\beta$ -carotene, 15% of vitamin C, 11% of vitamin E.

As a part of this research cost estimation was carried out to prove the **cost efficiency of the** developed recipe for cheese curds in fruit coating. The economic effect achieved as a result of changes in cooking technology is reflected in cost decrease per unit of product. The cost calculation for cheese in fruit coating is presented in figure 1.



**Figure 1.** The relative cost of cheese curds.

The manufacturing process for the production of cheese curds in fruit coating thus developed has a number of advantages as compared to the traditional technologies for the production of glazed cheese curds. Cheese curds in fruit coating are not only a good source of complete proteins, dietary fiber, vitamins and minerals, but also cheaper than the glazed ones. The cost of 50 g cheese curd in fruit coating is 8.87 RUB, while the glazed one - 11.5 RUB. The relative savings make 2.73 RUB. (22.8%) per unit of product, or 17.74 RUB per 100 units (5 kg) (22.8%).

## 6. Discussion

The experimental results showed the possibility of creating an alternative functional product with optimal structural-mechanical properties and organoleptic characteristics, nutritional and energy value for people living in conditions of environmental pressure and thereby solve the problem of the negative impact on the human, considered by V. A. Tutelyan [1].

The issues related to the development of new recipes for cheese curds balanced in terms of basic food substances were discussed in the works of Burmagina, T. Yu., Parmenova N.M., Gnezdilova A.I. [2], Prisyazhnaya S.P., Uvarova L.M., Gartovannaya E. A. Uvarov S.A. [3]. Cheese curds in the fruit coating satisfy 52% of the daily need for potassium, 24% - for calcium, 16% -for phosphorus, 20% of protein

requirements, 5% of fat, 40% of  $\beta$ -carotene, 15% of vitamin C, 11% of vitamin E. This is achieved due to the fact that ingredients constituting cheese curds are characterized by high nutritional value, as evidenced in the cookbooks [4] and research works of the following authors: Zheng, J., Yang, B., Trépanier, M., and Kallio, H. [5], Kaushal M., Sharma P. C. [6], Gao X., Ohlander M., Jeppsson N., Bjork L., Trajkovski V. [7], Zeb A. [8].

Thus, replacing the chocolate glaze with dried apricots resulted in decreasing the cost of the cheese curds coated with dried apricots per 5 kg batch as compared to traditional glazed cheese curds. Moreover, cheese curds in fruit coating are a good source of complete proteins, fiber, vitamin C, and minerals.

## 7. Conclusion

- Cheese curds in fruit coating are a good source of complete proteins, fiber, vitamin C, minerals.
- Replacing the chocolate glaze with dried apricots resulted in decreasing the cost of the cheese curds coated with dried apricots per 5 kg batch as compared to traditional glazed cheese curds.

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