The cupcakes with new functional ingredients for personalised school feeding

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Abstract. The production of new types of confectionary with increased nutritional value for the healthy diet of different categories of the population is a perspective trend in the confectionary production. Vegetative resources, particularly farro flour and fruit and vegetable puree, are perspective sources of raw materials. The choice of recipe components has been explained and their nutritional and energetic values have been demonstrated. The research object is wheat flour of premium quality (GOST 26574-2017); farro flour (TU 9293-002-94319966-2010); applesauce (GOST 32742-2014); apple-pumpkin-apricot puree. The appearance, taste, colour, smell, shape, surface, the appearance of fracture were measured organoleptically (GOST 5900-2014), the weight fraction of solid matter (SM) in raw materials, intermediate products and items through dehydrating at 103 °C in the oven during 40 minutes (GOST 5900-2014); alkalinity according to GOST 5898-87, density according to GOST 15810-2014. The calculation of nutritional and energetic value was carried out. The recipe of the cupcake «Apple cupcake» was chosen as controlling. Applesauce was substituted with apple-pumpkin-apricot puree during recalculation for dry substances. Wheat flour was substituted with farro flour according to proportions: 90:10; 70:30; 60:40; 50:50. The 70:30 dosage was chosen to be rational. According to organoleptic indicators, elaborated items differ by a pleasant golden colour of the sourdough and a taste which is common to the fruit and vegetable additive.

1. Introduction
The personalised nutrition is a new scientific approach to the individual health of every person. Personalised food is expected to appear [1]. Full and regular supply of vital macro- and micronutrients is one of the essential factors to provide health, working efficiency, and longevity of a person [2].

In order to adapt school ration to pupil’s needs, it is necessary to constantly collect and process a lot of information about their body, condition, habits and needs. A proper diet is one of the most important conditions to ensure normal growth and development of a child’s body [3-5]. A child should obtain protein, fats, carbohydrates, vitamins, and minerals in food. It means that calorific value of a daily ration must replenish the energy consumption of a growing body [6].

The pastry: biscuits, gingerbread, cupcakes are popular among this category of the population [7]. In pastry there is an excessive amount of fats and easily digestible carbohydrates, insignificant number of vitamins and minerals [6]. Therefore it is important to use animal and vegetable source enrichers to increase a quality, nutrition value and expand the range of general-purpose and diet
products. The introduction of unconventional vegetable flour types and fruit and vegetable fillings to pastry recipes will decrease their energetic value, enrich them with functional ingredients [2-6]. The issues of increasing pastry quality have been widely discussed in the papers of L.P. Paschenko, T.B. Tsyganova, A.Ya. Oleinikova, N.M. Derkanosova, S. Ya. Koryachkin and others. Vaskina V.A. and Bobrova V.A. have elaborated the method of baking cupcakes with decreased calorific value, which implies substitution of sugar with a mixture of sorbitol, erythritol, isomalt. The scientists of the East Siberia State University of Technology and Management have suggested to add blueberry grist, which was beforehand soaked in sugar syrup in order to increase a nutritional value of cupcakes [1-4].

The scientists of Voronezh State University of Engineering Technologies named after Magomedov G.O., Oleinikova A. Ya., Lukina S. I., and others have elaborated a method of baking cupcakes with chickpea intermediate products. As a result, the quality indicators and nutritional value have increased. There is a method to improve cupcake nutritional value, which was elaborated in Mogilev State Food University, the Republic of Belarus. The recipe includes vegetable puree made of carrot and pumpkin [5].

The purpose of the study is to elaborate a technology of baking cupcakes with the addition of fruit and vegetable raw material for school feeding.

2. Materials and methods
The research objects are: wheat flour of premium quality (GOST 26574-2017); farro flour (TU 9293-002-94319966-2010); apple sauce (GOST 32742-2014); apple-pumpkin-apricot puree; the appearance, taste, colour, shape, surface, the appearance of fracture were measured organoleptically (GOST 5900-2014), the weight fraction of solid matter (SM) in raw materials, intermediate products and items through dehydrating at 103 °C in the oven during 40 minutes (GOST 5900-2014); alkalinity according to GOST 5898-87, density according to GOST 15810-2014. The calculation of nutritional and energetic value was carried out.

3. Development of technology of muffins with flour and pumpkin and apple-apricot puree
The recipe of cupcakes baked according to a traditional technology includes wheat flour of premium quality, white sugar, melange, butter or margarine. The recipe of the cupcake «Apple cupcake» was chosen to be a controlling one. Applesauce (SM=10 %) was substituted with a compacted apple-pumpkin-apricot puree (SM=17 %) carried out per solid matters.

Wheat flour was substituted with farro flour according to proportions: 90:10; 70:30; 60:40; 50:50. To cook an apple-pumpkin-apricot puree, fruits were washed, inspected, peeled, shred and mixed according to a proportion of 50:25:25, then they were boiled to SM=17 %.

Applesauce was fully substituted with an apple-pumpkin-apricot puree, and also according to proportions of 30:70; 50:50, 70:30.

The chemical composition of the enrichers is demonstrated in tables 1 and 2.

Farro flour was used in the research due to its valuable nutrition and technological qualities. Farro is a low-calorie cereal crop. Compared to wheat, it is characterised with a significantly higher content of full-value protein (18-37 %), which contains 18 essential amino acids [5, 6]. The content of essential amino acids in farro and farro flour is 70.3 %, essential – 29.7 %. The content of such essential amino acids as leucine, isoleucine, valine, methionine + cysteine is close to the content of these elements in the «perfect» protein. Moreover, scores of these amino acids exceed 90 %. Farro also significantly surpasses wheat in the content of fiber, iron, group B vitamins, and polyunsaturated fat acids.
Table 1. Chemical composition of flour (per 100 gr of a product)

| Basic nutrients       | Content in 100 gr |
|-----------------------|-------------------|
|                       | wheat flour of premium quality | farro flour |
| proteins, gr          | 10.3              | 20.2        |
| fats, gr              | 1.1               | 1.5         |
| carbohydrates, gr     | 68.5              | 60.4        |
| food fibres, gr       | 3.5               | 3.7         |

| Macroelements, mg     |
|-----------------------|
| potassium             | 122.0             | 179.0       |
| calcium               | 11.0              | 18.0        |
| magnesium             | 16.0              | 44.0        |
| sodium                | 2.0               | 3.1         |

| Microelements, mg %:
|-----------------------|
| iron                  | 1.2               | 1.9         |
| phosphorus            | 86.0              | 92.3        |

| Vitamins, mg %:       |
|-----------------------|
| B1                    | 0.17              | 0.15        |
| B2                    | 0.04              | 0.08        |
| PP                    | 2.9               | 3.18        |

| Energetic value, kcal (kJ) | 334 (1396.0) | 339 (1413.6) |

Farro flour is characterised with a low water-absorbing capability and a high ratio of the module of body elasticity to its elongation. Due to this fact farro belongs to «mild» according to the strength indicator. It makes sensible to apply farro flour to the pastry technology [5].

Regular consumption of items made of farro improves the work of cardiovascular, nervous, endocrine, digestive, and reproductive systems, reduces the risk of the development of anaemia, inflectional and oncological diseases, contributes to the immunity strengthening, blood sugar level normalisation. The high content of vitamin B6 is vital for normal assimilation of fats to withdraw excessive cholesterol of a body, which makes farro products valuable for overweight people.

Apple-pumpkin-apricot puree surpasses applesauce in the content of macro elements and vitamins, its energetic value is 2 times lower [8, 10].
The dough for cupcakes was prepared the following way: butter softened at 40 °C was beaten in a mixer machine for 7-10 minutes, then dosed sugar and continued to beat the mixture for 5-7 minutes, then melange and fruit and vegetable puree were added gradually, and beating continued for 8-12 minutes more. In the resulting mixture we added baking powder and dietary table salt, it was mixed thoroughly, then the recipe amount of wheat and farro flour was dosed. The dough was kneaded for 5-10 minutes to a condition of a cream colour homogenous mass. The moisture of the finished dough is 23-25 %. The dough that weighed 50 g was put in disposable paper forms for bakery. Baking time – 25-30 minutes at 190 °C.

**Table 2. Nutritional and energetic value of puree**

| Basic nutrients      | Content in 100 gr |  |  |
|----------------------|-------------------|--|--|
|                      | applesauce puree  | apple-pumpkin-apricot puree (50:25:25) |  |
| Proteins, %          | 0.65              | 0.82 |
| Fats, %              | 0.29              | 0.25 |
| Carbohydrates, %     | 13.48             | 10.1 |
| Food fibres, %       | 5.55              | 5.60 |
| **Macroelements, mg %:** |                  |  |  |
| potassium            | 5.0               | 5.5 |
| calcium              | 1.2               | 2.0 |
| magnesium            | 1.8               | 2.1 |
| sodium               | 0.1               | 0.3 |
| **Microelements, mg %:** |                  |  |  |
| Iron                 | 7.2               | 7.0 |
| **Vitamins, mg %:**  |                   |  |  |
| B1                   | 0.7               | 0.8 |
| B2                   | 1.1               | 1.3 |
| PP                   | 2.5               | 2.5 |
| C                    | 1.8               | 2.2 |
| E                    | 1.3               | 1.5 |
| **Energetic value, kcal (kJ)** | 77 (322)          | 49 (205) |

The impact of different farro flour dosages on the item quality was measured (table 3).
Table 3. The impact of the farro flour dosage on the physics-chemical quality indicators of cupcakes

| Indicator’s name                      | The control with wheat flour of premium quality | Wheat flour and farro flour ratio |
|--------------------------------------|-----------------------------------------------|----------------------------------|
|                                      |                                              | 80:20  | 70:30  | 60:40  | 50:50  |
| Mass part of moisture, %             | 24.0                                          | 24.0   | 24.2   | 24.8   | 25.0   |
| Alkalinity, %                        | 1.8                                           | 1.7    | 1.7    | 1.7    | 1.7    |
| Density, %                           | 0.40                                          | 0.40   | 0.45   | 0.50   | 0.59   |
| Unit volume, cm³/g                   | 2.49                                          | 2.45   | 2.41   | 2.34   | 2.30   |
| Unit swelling ability of sourdough, cm³ | 265.5                                         | 265.1  | 252.2  | 240.2  | 233.6  |
| Friability of sourdough, %           | 4.60                                          | 4.63   | 4.68   | 4.71   | 4.75   |

The indicators of the items quality were measured 24 hours after they were baked. Cupcakes become denser when farro flour dosage increases, which is caused by the deterioration of sourdough looseness, sourdough colour is darker because farro flour was added, taste and smell, obtained distinct nut shade when flour-additive dosage increases. The item shape is right, surface is smooth, upper crust has tears, porosity is uniform, colour is light yellow.

The best quality indicators belong to cupcakes with a wheat and farro flour ratio of 70:30. Substitution of applesauce with an apple-pumpkin-apricot puree improves organoleptic and physics-chemical quality indicators. Sourdough acquires pleasant golden colour and taste which is common to fruit and vegetable additives. Sourdough is properly baked, porosity is uniform, small-scale.

Figure 1 demonstrates the scheme of getting cupcakes.

The packets of technical documentation (TU, TI, RC) for the cupcake «Summer scent» have been elaborated.
4. The conclusion
As a result, the implementation of a new type of vegetable raw material in cupcake recipes will expand the pastry range, enrich them with healthy functional ingredients and will bring a functional focus [8, 9].

The items will be in demand since they have good taste characteristics and increased nutritional value. The innovative production can be recommended for school feeding.

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