Development of technology of choux pastry semi-finished product enriched with oyster mushroom powder

A N Sapozhnikov¹, A V Kopylova¹,², S A Krainov¹ and I V Kveglis¹

¹ Novosibirsk State Technical University, 20, K. Marksa ave., Novosibirsk, 630073, Russia
² Siberian Research and Technological Institute of Agricultural Production Processing, Siberian Federal Scientific Centre of Agro-Biotechnologies of the Russian Academy of Sciences, P.O. box 267, Krasnoobsk, Novosibirsk region, 630501, Russia

E-mail: a.sapozhnikov@corp.nstu.ru

Abstract. Bakery products are popular food product among Russian population. Despite of their high sensory characteristics, they are high-calorie products. For their enrichment with useful substances, the powder obtained from cultivated oyster mushrooms (Pleurotus ostreatus) can be used as a non-conventional plant raw material. The paper presents the results of development of choux pastry semi-finished product decorated with craquelin dough, which are both enriched with oyster mushroom powder. The technological process of semi-finished products obtaining is developed, where the mushroom powder is introduced into semi-finished product formulations in the amount of 2.5%, 5.0% and 7.5% by weight of high-grade wheat flour. The optimal quantity of the powder introduced into craquelin dough is 2.5% from flour weight. The control and experimental samples were evaluated by sensory and physico-chemical characteristics, and their nutritional value was calculated. The research results showed that with the increase of oyster mushroom powder in choux pastry semi-finished products their sensory characteristics improve. Dry matter content increases by 0.8…4.8%, and ash content increases by 0.24…0.55%. The calculation of samples’ nutritional value shows the increase of proteins, vitamins, and mineral substances content. Herewith, the contents of fats and carbohydrates decrease, which also decreases energy value of semi-finished products. Therefore, the optimal amount of oyster mushroom powder for introducing into semi-finished product formulation is 7.5% from flour weight. The developed semi-finished products are recommended for further practical implementation and technology improvement.

1. Introduction
Bakery products are obtained mostly from wheat flour and are used to be an inherent part of Russian population diet and one of the most essential products. In Russian consumer market they are presented in a wide range. Among various bakery products choux pastry products are of interest. Their formulations can be improved by introduction of different supplements into them or by using different stuffing. Despite of high sensory characteristics of choux pastry products, their main disadvantage is high calorie. With the current sedentary way of life and non-productive labor activities of many people high calorie of bakery products is undesirable factor. This problem can be solved by using unconventional plant raw materials in bakery products formulations. In Siberian region, fresh or
processed cultivated oyster mushrooms (*Pleurotus ostreatus*) can be used as an enriching ingredient from these kinds of plant raw materials.

According to previously carried out researches, powders obtained from various mushrooms can improve the nutritional value of bakery products enriched with them [1–10], structural and mechanical properties of dough and ready production and slow down staling of the products [3, 7, 8, 11, 12–14]. Herewith, the raw material for the powders obtaining can be both fruiting bodies and mycelium [15–17].

Despite of a wide study of bakery products enriching with mushroom powders, their influence on choux pastry production properties decorated with craquelin dough has been not yet studied. Craquelin dough is a kind of shortbread dough, which creates characteristic pattern on the surface of ready bakery products. Introducing of mushroom powders into both choux pastry dough and craquelin dough will reduce their calories, improve their nutritional value, give them new sensory properties, and expand their range.

2. Materials and methods
The formulation and technology of choux pastry product with craquelin dough, which are both enriched with oyster mushroom powder, were developed and carried out at the Technology and Organization of Food Industries Department of Novosibirsk State Technical University. The semi-finished product itself was enriched with mushroom powder in the amount of 2.5%, 5.0% and 7.5% by weight of high-grade wheat flour. After preliminary experiments, it was decided that oyster mushroom powder was used in craquelin dough formulation in amount of 2.5% from flour weight.

2.1. Materials
The main raw materials for the obtaining of choux pastry semi-finished products samples were high-grade wheat flour, which was obtained on “Avangard Flour Mill Plant” in Novosibirsk, Russian Federation, and oyster mushroom powder, which was obtained on “Maslyaninskoe Lukoshko”, LLC manufacturing company in Maslyanino village, Novosibirsk region, Russian Federation. The powder was obtained by freeze-drying, which preserves the quality and nutritional value of fresh mushrooms as much as possible.

The other raw materials (sugar, salt, butter, almond flour, milk, eggs) were purchased from local retail network in Novosibirsk.

2.2. Choux pastry bakery products samples preparing
The samples were prepared according to the formulation № 15 from “The Digest of Flour, Pastry and Bakery Products” (1998). The choux pastry dough preparing process consisted of following technological operations. In the cookware, the softened butter, milk, water, salt and sugar were mixed. Then the mixture was heated to boiling temperature of 100 °C. After that, wheat flour was added gradually into the mixture. The dough was brewed until thickening and transforming into plastic mass.

Further the dough was cooled during 3…4 min and placed into the bowl of the TAUR022-2V spiral dough kneader. At the middle mixing speed, the egg mass and oyster mushroom powder (into experimental samples) were added.

The choux pastry dough was dropped from pastry bag onto the baking tray, then the craquelin dough was placed on the top of the formed choux pastry dough pieces. After that, the pieces were frozen in the Indesit SFR 167 NF freezer at –15…–18 °C. The frozen dough pieces were placed into the Electrolux A0S061EAA1 combi oven (Sweden) at 160…180 °C and prepared during 20…25 min at the convection mode.

The semi-finished products were cooled to 20…25 °C and evaluated on their sensory and physico-chemical characteristics. Their nutritional value was also calculated.

During the research process, the following semi-finished products samples were obtained:

- choux pastry semi-finished product with craquelin – control sample;
• choux pastry semi-finished product with craquelin and oyster mushroom powder (2.5% from flour weight) – experimental sample № 1;
• choux pastry semi-finished product with craquelin and oyster mushroom powder (5.0% from flour weight) – experimental sample № 2;
• choux pastry semi-finished product with craquelin and oyster mushroom powder (7.5% from flour weight) – experimental sample № 3.

2.3. Sensory evaluation
Sensory evaluation of obtained semi-finished product samples was carried out according to Russian national standard GOST 31986-2012 “Public catering service. Method of sensory evaluation of catering products” for the following characteristics: appearance, scent, taste, color, consistency. Every sensory characteristic was evaluated on the 5-point scale (5 indicates the best and 1 implies the worst) by 4 semi-trained panelists. As a result of the evaluation, the average points for each characteristic were obtained and presented in the form of profilogram.

2.4. Physico-chemical characteristics evaluation
Physico-chemical characteristics evaluation of samples were carried out for dry matters and ash content.

2.4.1. Dry matters content. The dry matters content was evaluated according to GOST 5900-2014 “Confectionery. Methods for determination of moisture and solids”. The drying of prepared and weighted samples to constant weight at (130±2) °C was carried out in the ShS-80-01 SPU drying cabinet (Russia). The samples before and after drying were compared by their weights, and dry matters content was determined using the methodic presented in the standard.

2.4.2. Ash content. This characteristic was evaluated according to GOST 27494-87 “Flour and bran. Methods for determination of ash content”. The sample weights were ignited in crucibles at the hotplate at 400...500 °C with following incinerating at the PM-10M 732 muffle furnace (Russia) at 350...400 °C during 1.5...2 days to constant weight. After incineration, the ash content was determined using the methodic presented in the standard.

Nutritional and energy value calculation and evaluation.
The nutritional and energy values of choux pastry semi-finished products samples were calculated and evaluated according to reference data from “Chemical Compositions of Russian Food Products Manual” (2002).

3. Results and discussion

3.1. Sensory characteristics
The results of sensory evaluation of choux pastry semi-finished products are shown in figure 1.

All samples have got high points on all their sensory properties. For the consistency, the experimental samples have got lower points than control sample. It can be explained that oyster mushroom powder contains less moisture than flour, so the consistency of the experimental samples is drier than the consistency of the control sample. For the other sensory characteristics, their value increased. The appearance, color, taste and scent of the samples became more pronounced. These high points show the positive influence of oyster mushroom powder on the sensory characteristics of choux pastry semi-finished products. However, a drier consistency of products can be removed by adding more water into the dough.
3.2. Physico-chemical characteristics

The results of dry matter content evaluation in control and experimental choux pastry semi-finished product samples are presented in figure 2.

![Figure 2](image.png)

**Figure 2.** Dry matters content evaluation of choux pastry semi-finished product samples with craquelin dough and oyster mushroom powder.

With the increase of the oyster mushroom powder quantity, the dry matters content in semi-finished product samples increased because of concentrated oyster mushroom powder. In the experimental sample № 1 dry matters content increased by 0.8% toward the control sample, in the experimental sample № 2 – by 1.4%, in the experimental sample № 3 – by 4.8%.

The results of ash content evaluation in control and experimental choux pastry semi-finished product samples are presented in figure 3.

![Figure 3](image.png)

**Figure 3.** Ash content evaluation of choux pastry semi-finished product samples with craquelin dough and oyster mushroom powder.

With the increase of the quantity of oyster mushroom powder, the ash content in semi-finished product samples increased because of high concentration of minerals in the powder. In the experimental sample № 1 ash content increased by 0.14% toward the control sample, in the experimental sample № 2 – by 0.24%, in the experimental sample № 3 – by 0.55%.
3.3. Nutritional and energy value
The results of calculation of nutritional and energy value of choux pastry semi-finished product samples are shown in table 1.

| Characteristics, by 100 g of product | Control sample | Experimental sample № 1 | Experimental sample № 2 | Experimental sample № 3 |
|-------------------------------------|----------------|--------------------------|--------------------------|--------------------------|
| Proteins, g                         | 13.9           | 14.0                     | 14.1                     | 14.3                     |
| Fats, g                             | 46.3           | 46.1                     | 45.9                     | 45.6                     |
| Carbohydrates, g                    | 41.3           | 41.1                     | 41.0                     | 40.8                     |
| Energy value, kcal                  | 638            | 635                      | 633                      | 631                      |
| Mineral substances                  |                |                          |                          |                          |
| Na, mg                              | 464.42         | 465.98                   | 467.61                   | 469.07                   |
| K, mg                               | 307.67         | 342.6                    | 376.31                   | 407.48                   |
| Ca, mg                              | 116.9          | 115.75                   | 114.61                   | 113.54                   |
| Mg, mg                              | 56.82          | 57.22                    | 57.7                     | 58.07                    |
| P, mg                               | 227.36         | 235.38                   | 243.84                   | 251.28                   |
| Fe, mg                              | 2.43           | 2.51                     | 2.62                     | 2.69                     |
| Vitamins                            |                |                          |                          |                          |
| A, mcg                              | 335.2          | 335.36                   | 335.54                   | 335.68                   |
| E, mg                               | 5.63           | 5.5                      | 5.37                     | 5.26                     |
| B1, mg                              | 0.13           | 0.14                     | 0.15                     | 0.16                     |
| B2, mg                              | 0.4            | 0.44                     | 0.46                     | 0.49                     |
| PP, mg                              | 1.58           | 1.99                     | 2.41                     | 2.8                      |

The results of calculations on the example of control sample and experimental sample № 3 show that with the increase of oyster mushroom powder content the protein content increased by 0.4 g, the fats and carbohydrates content decreased by 0.7 g and 0.5 g accordingly, and energy value decreased by 7 kcal. The minerals and vitamins content also increased, especially potassium – by 100 mg, phosphorus – by 24 mg and vitamin PP – by 1.22 g. The content of calcium and vitamin E are slightly decreased by 3.4 mg and 0.37 mg accordingly.

Thereby, the introduction of oyster mushroom powder into choux pastry semi-finished product allows to increase its nutritional value and at the same time reduce its energy value.

4. Conclusion
The results of carried out researches show that the introduction of dried oyster mushroom powder into choux pastry semi-finished product in the amount of 7.5% from flour weight and its introduction into craquelin dough in the amount of 2.5% from flour weight (experimental sample № 3) are optimal. Dry matters and ashes content in the experimental sample № 3 are 36.4% and 1.95 accordingly, which is higher by 4.8% and 0.55% accordingly than in the control sample. Further, the higher content of the powder in choux pastry semi-finished product can be advisable, because there have been found clear tendencies of nutritional value improvement in the experimental samples. The obtained formulations and technologies can be used accordingly in the formulations of choux pastry products with their practical implementation into production and realization on public catering and retail enterprises.

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