Development criteria for gluten-free foods

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Abstract. The paper presents marketing research of the gluten-free food market in the Saratov region. As a result of the data obtained, it has been established that gluten-free foods are mainly supplied by foreign brands such as “Dr. Korner” (Germany) and Dr. Schar” (Italy), supplying the market with a wide range of flour confectionery, pasta and bakery products. The market of domestic producers is mainly represented by LLC “Garnets” (RF) and LLC “Dietika” (RF). The work investigated the quantitative content of gluten in several developed dietary cereal culinary and flour confectionery products, namely: a casserole made from rice groats with almond milk and corn flour, a casserole made from rice groats with almond milk and flax flour, buckwheat pudding with goat milk and rice flour, cookies made from a mixture of flax and corn flour, gluten-free cake with added flax and rice flour, gluten-free cake with added corn and pumpkin flour, and gluten-free cake with added corn and rice flour. The fractional composition of the types of flour and its mixtures used in the developed products was calculated and the gluten level therein as experimentally confirmed (less than 20 mg/kg).

1. Introduction
Celiac disease is a chronic hereditary disease characterized by persistent intolerance to proteins of cereals with the development of atrophy of the mucous membrane of the small intestine and the associated malabsorption syndrome. It is characterized not only by intestinal damage, being a reaction of the whole organism to gluten. As a result of the disease, almost all human organs or systems are damaged [1]. It is impossible to recover from this disease; one needs a certain diet excluding irritant foods (containing gluten) to improve his/her life quality.

The main components of gluten are prolamins (wheat gliadin, rye sekalin, barley hordein and oat avenin), which constitute from 5 to 50% of the total amount of protein and are soluble in 60–80% ethanol solution, and glutelins, soluble in 0.1–0.2% alkali solutions. It has been proven by now that glutelins have toxic amino acid sequences identical to the peptides of prolamins; therefore, usually only one common name for toxic cereal proteins is used – gluten [2] (table 1).

As can be seen from table 1, such cereals as wheat and barley have the maximum amount of alcohol-soluble (prolamins) and alkali-soluble (glutelins) protein fractions, while rye has lower ones, and the alkali-soluble fraction predominates in oats. These crops are widely used in the production of flour confectionery and bakery products; however, they are not acceptable in the production of gluten-free products.

Nowadays, in most developed countries, the development and production of gluten-free products is at a high level and is widely developed. At the same time, this market in the Russian Federation is at
an early stage, therefore, the issue of creating a wide range of products from gluten-free raw materials, ensuring the production of high-quality, competitive products, is urgent for domestic specialists.

Table 1. Contents of protein fractions in cereal grain.

| Contents of protein fractions, % | Wheat | Barley | Rye | Oats |
|--------------------------------|-------|--------|-----|------|
| Albumins                       | 1.2   | 12.5   | 25.3| 12.5 |
| Globulins                      | 2.8   | 12.7   | 19.2| 17.3 |
| Prolamins                      | 43.5  | 34.4   | 25.4| 23.1 |
| Glutelins                      | 36.0  | 29.6   | 16.5| 29.3 |

During our study, it was necessary to solve the following tasks:

- Conduct marketing research of the gluten-free products market;
- Analyze the gluten level in our developed foods.

The aim of the study was to estimate the level of gluten in our developed cereal and flour confectionery products for their introduction into the food industry.

2. Materials and methods
Marketing research was carried out in accordance with GOST R ISO 20252 - 2014 "Research of the market, public opinion and social problems", determination of the quantitative content of gluten in developed products was carried out using the immunoassay test, the RIDASCREEN Gliadin competitive system [9].

3. Results and Discussion
We carried out marketing research of the gluten-free food market. The following distribution networks of Saratov and the Saratov region were surveyed: LLC "O'key group", LLC "Lenta", the network of health food stores "Spinat", JSC "Trading house Perekrestok", LLC "Metro Cash and Carry".

As a result of our research, it was revealed that the manufacturers of gluten-free products were mainly foreign trademarks: “Dr. Korner” (Germany), "Dr. Schar” (Italy), and such domestic ones as LLC “Garnets” (RF), LLC “Dietika” (RF). As can be seen from figure 2, the leaders in the sale of gluten-free products were Spinat (28%), followed by LLC “Lenta” (25%), LLC Metro Cash and Carry (22%), LLC O’key Group (14%) and the last place was occupied by JSC "Trading house Perekrestok” (11%) (figure 1).

At present, both in Russia and in the Saratov region, the list of gluten-free products consists mainly of ready-made mixtures for bread or specialized types of flour (rice, buckwheat, oatmeal, flax, chickpea, LLC "Garnets", RF), confectionery ("Dr. Schar”, Italy), pasta ("Mac Master", RF), as well as gluten-free bread ("Dr. Korner", Germany), ("Zdorovey", RF) (figure 2).

As a result of our studies, a narrow range of specialized products in the regional distribution network and a high specific volume of foreign manufacturing companies are noted.

Previously, we have developed recipes and technologies for several gluten-free products, namely: a casserole made from rice groats with almond milk and corn flour, a casserole made from rice groats with almond milk and flax flour, buckwheat groats with goat milk and rice flour, cookies from a mixture of flax and corn flour, gluten-free cake with flax and rice flour, gluten-free cake with corn and pumpkin flour, and gluten-free cake with corn and rice flour [4-6]. In order for these products to be labeled as "gluten-free", it is necessary to analyze the level of gluten in accordance with TR CU 027/2012 "On the safety of certain types of specialized food products, including dietary therapeutic and preventive dietary nutrition." In accordance with this regulation, gluten-free food products must be made from one or more ingredients that do not contain wheat, rye, barley, oats or their crossbred
variants and/or must consist or be made in a special way (to reduce gluten level) from one or more components obtained from wheat, rye, barley, oats or their crossbred variants, while the level of gluten in the ready-to-eat product is not more than 20 mg/kg [7].

Figure 1. Major distribution companies for gluten-free products in Saratov and the Saratov region.

In the course of further research, we preliminarily analyzed the fractional composition of several types of flour and its mixtures used in our developed products using the calculation method. Table 2 shows the results obtained.

Based on the data in Table 2, it can be seen that the gliadin content in the types of flour we uses is less than 20 mg/kg, while gliadin is known to play the major role in the onset of the disease, since it intensively reacts with antigliadin antibodies IgA and IgG that appear in blood of patients with celiac disease [8].

Then we experimentally analyzed the gluten content in our developed food products using the RIDASCREEN Gliadin competitive enzyme immunoassay system with the optical density at 450 nm [9-10] (figures 3-5).
Table 2. Mass percentage of protein fractions of various types of flour and their mixtures.

| Type of flour                      | Albumins | Globulins | Glutelins | Insoluble proteins | Prolamins (gliadin) | Zein |
|-----------------------------------|----------|-----------|-----------|-------------------|--------------------|------|
| Wheat                             | 1.20     | 2.80      | 36.00     | 8.70              | 43.50              | –    |
| Pumpkin                           | 25.20    | 42.80     | 21.80     | 10.20             | –                  | –    |
| Corn                              | 8.10     | 5.90      | 80.00     | –                 | –                  | 5.90 |
| Rice                              | 5.84     | 9.17      | 70.90     | –                 | 14.17              | –    |
| Linen                             | 0.92     | 1.48      | 2.20      | –                 | 0.92               | –    |
| Composite pumpkin and corn mix    | 16.65    | 24.35     | 50.90     | 5.10              | –                  | 2.95 |
| Composite flax and rice mix       | 4.36     | 6.85      | 50.29     | –                 | 10.18              | –    |
| Composite corn and rice mix       | 6.97     | 7.53      | 75.45     | –                 | 7.10               | 2.95 |

Figure 3. Gluten contents in our developed dietary cakes.

Figure 4. Gluten contents in our developed dietary cereal culinary products.

Figure 5. Gluten contents in our developed dietary cookies.

As can be seen in figures 3–5, the use of gluten-free raw materials in the development of dietary products has reduced the gluten level in cakes by an average of 124 times, in cereal culinary products by an average of 143 times and in cookies by 130 times.

4. Conclusion

Thus, on the basis of our marketing research, a shortage of gluten-free food products of domestic production was revealed, therefore, the cereals and flour confectionery products we have developed will be in demand on the market. In addition, the gluten content in these products complies with the gluten-free labeling requirements, since it does not exceed the standard value of 20 mg/kg and is recommended by us for people with celiac disease.
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