Particle size distribution of barley Talgan, prepared according to traditional and innovative technologies

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Abstract. The purpose of the research was to analyze the fractional composition of the national Khakass product Talgan, prepared by traditional and innovative methods from barley grain of different varieties (Biom, Krasnoyarsk 91, Omsk Golozerny 1). The distribution of grain particles in Talgan by fractions was studied by the standard method of determination using grain sieves. It was found that in the product manufactured by innovative technology compared to traditional, the relative proportion of particles having a maximum size was lower, and the proportion of particles with smaller sizes was higher. On average, barley Talgan is respectively manufactured using innovative and traditional technology, the fraction of particles with sizes greater than 1 mm was 51.0 and 73.9%, the fraction smaller than 0.25 mm - 21.6 and 11.3%. It was found that for each barley variety the value of the grain grinding module for the innovative technology for Talgan production was lower compared to those for the traditional technology. It has been suggested that the previously recorded result of a higher total antioxidant content in barley Talgan, produced using innovative technology, was due, among other things, to more efficient extraction of antioxidants from smaller grain particles. Using two-factor analysis, it was found that the distribution of particles in Talgan at 80.9% depends on the technology of its preparation.

1. Introduction

An important role in improving public health can be played by the inclusion of functional nutritional components in the daily diet. It is known that products prepared on the basis of barley grain have high nutritional value and are characterized by the presence of a variety of biologically active substances, including proteins, fats, beta-glucans, antioxidants, vitamins and mineral elements [1, 2]. It is scientifically proven that the inclusion of functional foods in the diet can reduce the risk of developing a number of serious diseases, maintain and improve human health [3].

One of the ways to include barley-based products in the diet is to use the national Khakass product of Talgan, which, as you know, can be manufactured using traditional and innovative technologies [4]. As shown in the literature, upon receipt of Talgan by innovative technology, significantly more valuable substances are stored in it, including those with antioxidant activity [5]. A possible reason for this positive effect, according to the authors of [4, 5], may be milder conditions for the heat treatment of barley grain with such technology for manufacturing the product. It is logical to assume that another reason for the increased content of antioxidants in Talgan made by innovative technology may be a more efficient extraction of valuable substances from grain particles when measuring their concentration in the finished product. As you know, the acceleration of the extraction of chemicals from solid particles can occur with a decrease in the size of the latter [6].

To test this hypothesis, a study was carried out, the purpose of which was to analyze the fractional composition of barley grain particles included in the product of Talgan, prepared according to traditional and innovative technologies.
2. Materials and methods

The object of the study was samples of Talgan made from roasted barley grain of three varieties: Biom, Krasnoyarsk 91, OmskGolozerny 1. The samples were grown on the territory of the Bay state variety testing site of the Republic of Khakassia, located in the steppe zone of foothills on ordinary and southern chernozems. The duration of the growing season in the studied varieties was almost the same, and the mass of 1000 grains did not differ much between them.

Talgan product was prepared in two ways. The first is traditional (the prototype is the production of the Khakass national dish - barley and wheat Talgan) where at the first stage barley grain was heat-treated with its subsequent grinding. Preliminarily, the grain with the shell (if it is a film form) was purified from impurities, then it was subjected to heat treatment (fried) for 10 minutes at 150 °C; further cooled and crushed. In the second version of the production of Talgan by innovative technology [4], the order of operations and the processing regime of grain changed: first it was crushed, and then heat treated for 2-3 minutes at a temperature of 110 °C.

The quality of the obtained grain product was judged by the analysis of its fractional composition. To take into account the distribution of grain particles by their size, the samples of Talgan from each grade of barley were separated using a set of sieves with holes: 1.0 mm; 0.5 mm and 0.25 mm [7]. After sieving the samples, the mass of each sample fraction was determined. The repetition of all measurements is fourfold. According to the results of the analysis of grain particle sizes, the grinding module (weighted average particle size) was calculated by the known method [8, 9].

The significance of differences between the variants was evaluated by Student's t-test at p ≤ 0.05. Statistical processing of the results was performed using the Microsoft Excel 2003 data processing program.

3. Discussion of the results

The results of the analysis of the fractional composition of grain particles in Talgan are given in table 1.

| Variety               | Mass fraction of particles by size and technology. % |   |   |   |   |
|-----------------------|-----------------------------------------------------|---|---|---|---|
|                       | More than 1 mm | 0.5-1 mm | 0.25-0.5 mm | Less than 0.25 mm |
|                       | **T**         | **I**    | T   | I   | T   | I   | T   | I   |
| Biom                  | 73.7±0.4*a    | 43.4±0.2*a | 2.8 | 6.7 | 15.0 | 19.4 | 8.4 | 30.5 |
| Krasnoyarsk 91        | 64.1±0.6*b    | 43.2±0.2*a | 4.6 | 13.3 | 15.1 | 21.9 | 16.2 | 21.7 |
| OmskGolozerny 1       | 84.0±1.5*c    | 66.3±0.2*a | 2.1 | 7.9 | 4.5  | 13.0 | 9.4 | 12.7 |
| Average value         | 73.9±3.9*a    | 51.0±5.9*a | 3.2 | 9.3 | 11.5 | 18.1 | 11.3 | 21.6 |

Note: the values in the lines with different letters differ significantly among themselves within each column according to the t-test at p ≤ 0.05; * the values of the fractions of particles within each size differ significantly between different technologies according to the t-test at p ≤ 0.05; ** T - traditional technology, I - innovative technology for manufacturing Talgan.

It can be seen that in a product manufactured by innovative technology compared to traditional, the relative proportion of particles having a maximum size was significantly lower, and the proportion of particles with smaller sizes was correspondingly higher. This effect was recorded in all variants, except for one for the variety Omsk golozerny 1. Note that significant intervarietal differences in the fractional composition of Talgan were found for almost all variants. The maximum decrease in the proportion of particles with sizes greater than 1 mm was observed in the product obtained from barley.
of the Biom cultivar (30.1%), and the minimum - in the one obtained from the variety Omsk golozerny 1 (17.7%).

The results indicating the influence of the technology of manufacturing Talgan on the value of the modulus of its grinding for each grade of barley are given in table 2. It can be seen that the average values of the grain grinding modulus for the innovative technology for the production of Talgan were significantly lower compared to those for the traditional technology. The result obtained may indicate a less heterogeneous fractional composition of the product obtained by the new method, as referred to in the literature [10].

Table 2. Dependence of the magnitude of the modulus of grinding of Talgan on the technology of its manufacture, the stage of separation into fractions by size and the type of barley used

| Variety             | Talgan grinding module for various preparation methods |
|---------------------|------------------------------------------------------|
|                     | Traditional   | Innovative  |
| Biom                | 2.92         | 2.03        |
| Krasnoyarsk 91      | 2.66         | 2.28        |
| OmskGolozerny 1     | 3.11         | 2.78        |
| Average value       | 2.90±0.09*   | 2.36±0.16*  |

Note: * the values in the lines differ significantly among themselves according to the t-test at p ≤0.05.

Previously, we found that in the manufacture of Talgan from barley grain using innovative technology, the level of total antioxidant content in the product had higher values compared to traditional [5]. As is known, the efficiency of extraction of a substance by a liquid, in addition to solubility, depends on the rate of its transition from a solid phase to a liquid one. The last process can be accelerated, for example, by increasing the surface of the solid phase with a larger degree of grinding of the sample [6]. It was established [11] that in dry seeds finer grinding, increasing the dispersion of particles, significantly increases the yield of valuable substances during extraction. Therefore, based on the results obtained in this work, it can be assumed that the reason for the increase in the content of antioxidants in Talgan made using innovative technology is not only a milder heat treatment, but also an increase in the relative fraction of particles in the smaller product and, accordingly, a decrease in the largest fraction.

Figure 1. The dependence of the particle size of barley Talgan on the preparation method and variety

Using two-factor analysis, it was found (Figure 1) that the particle size is more influenced by the method of manufacturing Talgan: traditional or innovative 1)
4. Conclusion

Thus, it was found that in the Talgan made using innovative technology compared to the traditional one, the relative proportion of grain particles having a size of more than 1 mm was significantly lower, and the fraction of fractions with smaller sizes was correspondingly higher. The maximum decrease in the proportion of particles with sizes greater than 1 mm was observed in the product obtained from the Biom cultivar (30.1%), and the minimum - in the one obtained from the Omsk holozerny 1 cultivar (17.7%). Significant intervarietal differences in the fractional composition of Talgan were found regardless of the manufacturing technology of the product, which allows us to optimize this process by selecting a variety of barley. It was found that for each barley variety the value of the grain grinding modulus for the innovative technology for the production of Talgan was lower compared to those for the traditional technology, which indicates a less heterogeneous fractional composition of the product obtained by the new method. Based on a comparison of the results of the fractional composition of the product and the content of antioxidants in it (according to [5]), it can be assumed that the reason for the increase in the content of these biologically active substances in Talgan made using innovative technology is not only milder heat treatment, but also an increase in the final product of the relative fraction of smaller particles.

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