Digitalization of the process of traceability of grain processing products

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Abstract
The work is devoted to organizing the process of traceability of the quality of oatmeal using digital technologies and the economic costs of implementation. One of the most important factors influencing a person's health and life expectancy is nutrition. The use of modern technologies makes it possible to organize a transparent traceability system, allowing the buyer to be confident in the quality of the product.

1 Introduction

One of the most important factors influencing the state of health and life expectancy of a person is nutrition. However, the diet of a modern person does not always meet the standards of a balanced diet. This is due to the consumption of fast foods, fast food products that are high in sugar and fat, as well as a sedentary lifestyle, all of which lead to the emergence of various chronic diseases.

In this regard, one of the priority areas of the State policy of the Russian Federation is to ensure food security, promote a healthy lifestyle and form a system of good nutrition [1].

At the heart of the food pyramid developed by the World Health Organization are products from cereals. The Russian cereal market has long been a stable segment in which there have been no significant changes. However, as the popularity and promotion of a healthy lifestyle grew, the demand for healthy products began to increase. Therefore, at present, cereal producers began to expand the range, develop new products, paying attention to consumers on their nutritional value.

In the consumer market of the country, a wide range of multi-component instant flakes obtained from several types of cereals are presented, but the predominant component that is found in almost all flakes is oat flakes. If we consider the Russian market for the consumption of cereals, then oatmeal is in the top three, after rice and buckwheat, due to its high nutritional value.

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Fig. 1. Share of various types of cereals in total consumption, 2017-2022, %

Why has there been recent interest in oatmeal, and why has the consumption of oatmeal porridge increased greatly? First of all, oats have a very favorable chemical composition; the healing properties of oats were known at the dawn of the development of medicine. Hippocrates recommended drinking oatmeal broth for general health. And in the modern world, consumers do not eat whole grain cereals, but oatmeal, which cooks quickly and at the same time retains all its beneficial properties.

Oat flakes are oat groats that have gone through several stages of industrial processing: cleaning, grinding, steaming. In appearance, they resemble petals of different sizes, smooth or grooved. Depending on the degree of processing, the main types of oat flakes are distinguished: smooth large flakes of flattened grain, steamed. Hercules. Petal flakes are thinner, rolled out with special rollers to obtain a corrugated surface.

Instant flakes, polished, steamed, crushed, thin due to careful rolling, do not require cooking. "Extra" type of cereal, made from whole grains, minimally processed without heat, retains the properties of the grain, and contains the maximum amount of fiber.

Oatmeal is a source of polysaccharides. Carbohydrates help a person maintain energy for a long time and improve mood. Regular consumption of cereal prevents the formation of cholesterol plaques, improves heart function, and stabilizes weight. Due to the high fiber content, flakes remove waste and toxins from the body and normalize intestinal metabolism. As a result, the walls are cleaned, patency is improved, and peristalsis is stabilized.

Oatmeal contains B vitamins, which have a positive effect on brain activity and the nervous system. Pyridoxine (B6) helps brain cells absorb amino acids and nutrients. Pantothenic acid (B5) improves mental abilities. Choline (B4) protects the membrane of gray matter cells. In addition, the iodine contained in the flakes increases concentration, and iron and zinc normalize cognitive function.

Flakes slow down the aging process and the formation of wrinkles, maintain water balance, relieve inflammation, and nourish hair roots.

The nutritional characteristics of oatmeal make it a universal product for many well-known diets, including overweight. Including water porridge in the menu will speed up protein metabolism, increase muscle mass, and reduce the amount of excess fat tissue.
2 Research materials and methods

Cereals are food products with a long shelf life, and some types of cereals can be stored for up to a year. But due to the distribution of fat in the grain and the content of fatty acids, oat flakes have a short shelf life [2]. Particular attention is paid to the integrity of the package during storage—it must be airtight, because oatmeal absorbs moisture very well, as well as the relative humidity of the air in the premises, not more than 70% and the air temperature should not be higher than 25 °C, without sudden changes. Also, two dates must be indicated on the packaging—the date of production and the date of packaging of the product. The recommended shelf life of oatmeal is set by the manufacturer depending on the raw materials, production technology, and packaging used. The shelf life of oatmeal is 4-6 months from the date of production, and instant oatmeal is 6 to 12 months. The shelf life of oatmeal is calculated from the date of production, and not from the day of packaging. Quite often, manufacturers put only the packaging date, and then the expiration date, thereby increasing the selling time, which affects the quality of oatmeal. If storage conditions are not observed, a variety of lipid oxidation products, including toxic ones, accumulate in cereals. Products of lipid oxidation, interacting with other substances of cereals, form complexes and compounds of different strength and reduce the biological and nutritional value of not only fats, but proteins, carbohydrates and other compounds [3]. At the same time, the groats become rancid, and its stability decreases sharply during further storage. The acid number of fat increases during storage. The occurrence of defects will affect the quality indicators of cereals and consumer properties of the finished product [4].

During storage of cereals, changes in organoleptic characteristics occur (weakening of taste and aroma, change in color); rancidity and souring of cereals, as well as a decrease in nutritional value. In cereals, the main focus of physical and biochemical processes is the same as in the corresponding raw materials. But their intensity under similar conditions is significantly higher, which is associated with a violation of the integrity of the grain. Technological processes during the processing of grain into flour and cereals have a certain influence on the rate and ratio of biochemical changes. Heat exchange plays an important role in storing cereals. Cereals are characterized by significantly less porosity than grain, which significantly reduces heat transfer by convection. Therefore, the thermal conductivity of these products is even lower than that of raw materials. They retain the same temperature for a long time as they were when the stack was laid, especially in its middle rows. If products are stored for storage in the winter and they are cold, they can be stored for a long time. It is advisable to cool warm bags before stacking.

The sorption properties of cereals are closer to the original grain than flour. The equilibrium moisture content of millet is slightly higher than that of millet, and for other types of cereals it is slightly lower than for raw materials. The equilibrium moisture content of rice,
millet, pea and buckwheat groats from unsteamed grains under the same storage conditions is always higher than that of oatmeal and quick-cooking groats. During long-term storage, the equilibrium moisture content of all types of cereals decreases. The rate of mass transfer in cereals is slightly higher than in flour, therefore, under unfavorable storage conditions, it gradually becomes moistened not only in the peripheral parts of the bag, but also in its middle.

Gas exchange—the absorption of oxygen and the release of carbon dioxide in freshly processed products occurs very intensively. According to N.I. Sosedov, this is the overall consequence of increased respiration in damaged grain tissues and the activity of aerobic microorganisms, as well as sharply accelerated oxidative processes. Gradually, the intensity of breathing and the amount of carbon dioxide released decrease.

Defects in oatmeal are shown in the figure 2.

**Fig. 2. Defects in oatmeal**

Grain includes impurities that have some nutritional and feed value and, to a lesser extent, affect the quality of grain products obtained from it. Let's consider the composition of impurities in Table 1.

<table>
<thead>
<tr>
<th>Impurities</th>
<th>Composition of impurities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weed impurity</td>
<td>Mineral impurity—earth, sand, pebbles, particles of earth, emery and slag.</td>
</tr>
<tr>
<td>Organic impurity</td>
<td>Seeds of all wild and cultivated plants. Flower films, stems, and their parts.</td>
</tr>
<tr>
<td>Harmful impurities</td>
<td>Cockle, smut, ergot, mustard, knitted elm. Seeds of all weeds and cultivated plants.</td>
</tr>
<tr>
<td>Spoiled kernels</td>
<td>Moldy, rot, discolored kernel from light brown to black.</td>
</tr>
<tr>
<td>Unhulled grains</td>
<td>Oat grains not freed from flower films.</td>
</tr>
<tr>
<td>Broken kernels</td>
<td>Oat grains passing through a sieve with holes 0.2 mm and not passing through metal woven</td>
</tr>
<tr>
<td></td>
<td>sieve No. 063, if present in the range of up to 0.5% inclusive for the highest grade and</td>
</tr>
<tr>
<td></td>
<td>1.0% inclusive for the first grade are classified as a good quality kernel.</td>
</tr>
<tr>
<td>Bran</td>
<td>All passage through metal woven sieve No. 063.</td>
</tr>
</tbody>
</table>

The flour content in premium grade cereals is allowed to be no more than 0.3% and for first grade cereals to be no more than 0.5%.

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</tr>
</thead>
<tbody>
<tr>
<td>Weed seeds</td>
<td>Earth, sand, pebbles, etc.</td>
</tr>
<tr>
<td>Organic impurity</td>
<td>Seeds of all wild and cultivated plants. Flower films, stems, and their parts.</td>
</tr>
<tr>
<td>Rolled hulled barley grains</td>
<td>Over 1%</td>
</tr>
<tr>
<td>Contents of benign grain</td>
<td>In accordance with the requirements of the standard, impurities are divided into two main groups - weeds and grains.</td>
</tr>
</tbody>
</table>
When choosing a product in a store, first of all pay attention to organoleptic properties, such as color (creamy white with a beige tint) and the integrity of the flakes. Tightness and packaging material - oatmeal is stored longer in a plastic bag than in a cardboard container; the expiration date, remember, is counted not from the date of packaging, but from the date of production. When stored for a long time, the flakes often acquire a bitter taste, so you should not stock up on oatmeal.

The most important component influencing the level of quality of manufactured products at food enterprises is the implementation of constant incoming control of raw materials, control at all technological stages and quality control of finished products. The main task is to assess the conformity of a process or product and detect non-conformities with the standards, as well as their further elimination. This function is especially well implemented at enterprises for the production of meat and dairy products, but when processing vegetable raw materials, the elements of the HACCP system are practically not implemented. This gives rise to risks and losses, and, according to the classification of quality costs, it is the external costs that grow, which turn into a loss of the consumer.

Phased quality control is not included in the stages of the life cycle of oatmeal (Fig. 3), and at retailers such control is carried out only in the presence of negative reviews and one has to rely entirely on the honesty of the supplier. Most logistics companies also do not strictly monitor storage and transportation conditions when working with plant-based food products, believing that the risks are negligible.

3 Results

![Fig. 3. Life cycle stages of oat flakes. I- production, II- delivery, III- implementation. ● - product quality control is carried out, ○ - quality control is not always carried out, ● - quality control is carried out in the presence of negative reviews.](image)
In addition to the quality indicators of oatmeal, the date of production and packaging, the manufacturer can also indicate from which raw materials the products were made, information about the region of dispatch, and information about the intermediary to whom the batch was shipped.

Also, the information on the resource can be supplemented with data from logistics companies, since many of them are already constantly monitoring the conditions of storage and movement, while they are contacted only in cases of serious claims from the consumer. Based on this data, you can track changes in temperature and humidity, loading time and transportation route.

Making the most of the data already collected, it is possible to reduce the economic costs of implementation, so the costs of the manufacturer can be 300 thousand rubles, the logistics company - 150 thousand rubles, the retailer up to 50 thousand rubles. The cost of the NFC tag printed on the package is up to 5 rubles, when using a QR code up to 2 rubles.

4 Conclusion

The use of a QR code instead of an NFC tag also reduces the cost of implementation and increases the availability of information to the consumer (any smartphone can read the code), but reduces the reliability of the system, since in order to read information, it is necessary to have visual contact of the reader with an intact QR code.

A QR code can be used to duplicate information contained in an NFC tag (a QR code can be applied to an NFC tag), this will increase the reliability of the system, while the cost of implementation will increase by 10%, the cost of one -time components will not exceed 7 rubles.

Now marking using radio-frequency tags is used for fur products, alcoholic beverages, and on medicines. The spread of such labeling will inevitably reduce the cost of both implementation and labeling.

References


