Organization of the wheat flour quality traceability

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Abstract. Currently, the problems of quality and safety of food products are the most important for the processing enterprises of the agro-industrial complex. Increasingly important are activities aimed at improving the quality of the life cycle processes of food products. One of the basic foods in the diet of most consumers is bread and bakery products, and the main raw material for their production is flour. Therefore, the topic under consideration of our paper is relevant.

Bakery industry belongs to the leading food industries of the agro-industrial complex. One of the priorities facing the agro-industrial complex today is improving the quality and safety of products. In addition, the relevance of product quality concern is predetermined not only by the conditions of a market economy, but also by social importance, and this, above all, is the satisfaction of the population with high-quality food products of daily demand.

One of the main food products in the diet of most people in our country is bread and bakery products. Bread consumes all segments of the population, regardless of age, gender and social status. That is why great attention is paid to the stable development and functioning of the bread baking industry. The total number of bakery enterprises in Russia is about 13 thousand, of which the major share is occupied by small and medium-sized businesses, large retail chains, and even small convenience stores also have their own mini-bakeries over the last years. According to the monitoring of Russian Guild of Bakers and Confectioners (RosPik), there is a tendency to increase the share of small and medium-sized enterprises, both by value and volume.

As shown in figure 1, the volume of bakery production in industrial enterprises is decreasing, and in small enterprises is increasing.

However, lately complaints of consumers about poor quality of flour and bread have become more frequent. One of the reasons for the deterioration is the lack of a unified system for monitoring the quality of grain processing products. Especially it is necessary to enhance monitoring, as noted by the Russian Union of Flour Mills and Cereal Plants, of small and medium-sized businesses, as well as at all stages of grain products production “from field to market”. Therefore, the subject of our research is relevant.
As you know, one of the main factors affecting the final product quality is raw materials. Flour is the main component of most grain products, and the establishment and prevention of it from possible causes of non-compliance with the quality level is a guarantee of quality and safety of the final product.

The main raw material for the wheat flour production is wheat. However, in connection with the deterioration of grain quality in recent years, there is a problem of stabilizing the grinding batches quality. Many mills do not form the necessary grinding batches; as a result, bakery enterprises use flour with reduced technological properties, with low or unsatisfactory quality of gluten, increased or decreased activity of enzymes [1].

Many unscrupulous manufacturers are deliberately trying to fake one or more characteristics of the product.

One of the most common falsifications is the information one. When receiving a batch of flour, special attention should be paid to the marking; the following data is often inaccurate: item name, grade of flour, the amount of flour.

In the accompanying documents, the delivery notes or the certificate is most often counterfeited. In the consignment note you should pay special attention to the item name, the manufacturer and the quantity; in the certificate: the use of a genuine form with the introduction of all the details of the falsified product; forgery of a genuine copy of the certificate by removing some information, substitution of certificates.

Assortment adulteration of flour occurs due to the substitution of one type of flour for others. The most common assortment adulteration of wheat flour is the supply of the first grade flour under the guise of highest grade flour [2]. At the enterprises that do not have a laboratory such a forgery is often determined according to color. However, the color of flour is not a reliable identifying feature. For more precise identification, when establishing a grade, we determine the mass fraction of ash and fiber contained in the grain bran. In the case of falsification, some suppliers carry out flour bleaching. Oxidizing agent is added to flour of lower grades; the flour is bleached and becomes identical in color to the highest grade flour.

Qualitative flour falsification can be achieved by adding other, cheaper types of flour, such as corn, which might be found out at the expense of gluten content while wheat flour must contain at least 28% gluten. Recently, various food additives have been used to "improve the quality" of flour: increasing the amount of gluten, increasing the gas-forming ability of flour, by adding various chemical leavening agents.

During storage and transportation, flour quality changes also occur, depending on the initial properties of the products, duration, storage and transportation conditions. Therefore, the shelf life
(including transportation), packaging significantly affects both the quality and the technological properties of flour put into commerce or processing [3].

Flour refers to food products with a long shelf life, since it has low water content. Obligatory storage conditions are: relative humidity of the storage environment is no more than 70%, temperature is no higher than 25 °C without rapid temperature change, adherence to the commodity neighborhood.

The movement of moisture in flour is especially dangerous when there is a temperature drop, as it creates the prerequisites for the moisture of condensation formation in certain areas and the emergence of microbiological foci [4].

If the storage conditions are not observed, free water accumulates, the activity of enzymes is activated, which contributes to the rapid development of micro flora, that sharply reduces the storage capacity and often leads to the spoilage of flour. In addition, increased moisture content of flour significantly affects the properties of proteins and starch, reduces its ability to swell and deterioration baking properties; increasing humidity by 1% reduces the yield of bread by about 1.5%.

The acidity of flour characterizes its freshness. When flour is stored under the influence of the biochemical processes occurring in it, the acidity raises that in adverse storage conditions can lead to the appearance of foreign taste in flour. Storage of flour at elevated temperature and humidity leads to an acceleration of these processes due to the growth of activity of flour enzymes. Thus, flour with high acidity was either stored for a long time, or stored under unfavorable conditions Bread from flour with high acidity is more sour, with less developed crumb grain and reduced specific volume. The close crumb is at the bottom of the product. The appearance of the crust deteriorates: the crust becomes uneven; the color of the crust is brown.

The most important component affecting the quality of products level at food enterprises is the implementation of constant input control of raw materials, control at all technological stages and quality control of final products [5]. The main task is to assess the conformity of the process or products and to detect inconsistencies in the norms, as well as their further elimination [6].

At mini bakeries, and especially at retail outlets, it is not always possible to assess the quality of flour and they have to rely entirely on the integrity of the supplier. At the same time, as it was said above, the quality of raw materials can be influenced not only by the technological stages of production.

To neutralize negative consequences on the reputation of the manufacturer of non-compliance with storage and transportation conditions of the flour, radio-frequency tags, for example, passive tags of NFC (figure 2) can be used without the possibility of rewriting or NFC-PASS tags with the information about the Internet resource on which one can find the information about this particular lot. In addition to the quality indicators for a particular batch of flour and the date of its production, the producer can also specify the kind of the grain the product was manufactured from, information about the region of dispatch, and data of the intermediary to whom the batch was shipped.

![Figure 2. NFC tag of Mikron manufacturer.](image)
Also, if agreed with the intermediaries, the information at the resource can be supplemented with data on movements of flour and the delivery chain, as even moving to short distance (to the neighboring region) but with a large number of resellers can lead to the deterioration in quality.

At the same time, even a long transportation and an intricate route of delivery not always mean an inevitable deterioration in the quality of flour. If the intermediary observes all the terms of transportation and storage, then the indicators do not decrease.

Modern logistic companies constantly monitor storage and transportation conditions, but these data rarely go outside the company, settling in the quality management departments, and at the same time they can be used as a competitive advantage if they are listed on the portal in a specific lot card.

The main problem during transportation and storage is not observance of the conditions and as a consequence, the increase in humidity, the increase in the acidity of flour, which will naturally affect the quality of bread. To quantify the relative humidity within the package, one can use paper cobalt-free maximum humidity indicator cards with six levels-10, 20, 30, 40, 50, and 60% (figure 3), despite the fact that the error of this express method does not exceed 5%.

![Figure 3. Paper cobalt-free maximum humidity indicator cards with six levels.](image)

To exclude the substitution of humidity indicator data and NFC tags, they should be placed inside the package containing the elements of protection against opening. In order to prevent direct contact of the flour with the humidity indicator and NFC tag, they can be packed inside moisture-sensitive bags.

It may seem that the economic costs of introducing this system will be extremely high, but according to the calculations made at the implementation stage, the manufacturer's costs can be 500 thousand rubles, the supplier-250 thousand rubles, the bakeries up to 100 thousand rubles. The cost of disposable components (NFC tag and humidity indicator packed in a bag) will not exceed 30 rubles [7].

The use of QR-code instead of NFC tags allow to reduce the cost of implementation, but also reduces the reliability of the system as in order to read the information it is necessary to have a visual contact of the reader with the QR code. The QR code can be used to duplicate the information in NFC tag (the QR code can be applied to NFC tag), this will increase the reliability of the system while the cost of implementation will increase by 20% and costs for disposable components will not increase.

The most expensive disposable element of control is the humidity indicator. Its cost can reach 20 rubles per piece, but with large wholesale purchases, the price of one piece can decrease to 5 rubles.

Now labels using NFC tags are used for fur products, but in the near future such practices are being extended to shoes, children's items and pharmaceuticals. The spread of such markings will inevitably reduce the cost of both the implementation and the disposable components used.

The use of reliable and modern means of identification and control of goods storage conditions such as radio frequency tags and maximum humidity indicators will allow "honest" flour producers to create additional competitive advantage and optimize supply channels, and mini bakeries will improve the quality of the product without significantly increasing its cost to the ultimate consumer.
References

[1] Arvanitoyannis I and Traikou A A 2007 Comprehensive Review of the Implementation of Hazard Analysis Critical Control Point (HACCP) to the Production of Flour and Flour-Based Products. Critical Reviews in Food Science and Nutrition 45 327-70

[2] Martínez-Monzo J et al. 2013 Trends and Innovations in Bread, Bakery, and Pastry. Journal of Culinary Science & Technology 11 55-65

[3] Barling D et al. 2009 Traceability and ethical concerns in the UK wheat—bread chain: from food safety to provenance to transparency International Journal of Agricultural Sustainability 7 261–278

[4] Karen N et al. 2018 Biocontrol as an Efficient Tool for Food Control and Biosecurity Food Safety and Preservation 167-93

[5] Siddh M S et al. 2018 Structural model of perishable food supply chain quality (PFSCQ) to improve sustainable organizational performance Benchmarking: An International Journal 25 2272-2317

[6] Gava O et al. 2018 Linking Sustainability with Geographical Proximity in Food Supply Chains An Indicator Selection Framework: Agriculture 8 130

[7] Pereira L L et al. 2021 Processing modes influence on the sensory profile of various types of coffee IOP Conference Series: Earth and Environmental Science 677(5) 052036