

## INCREASING OF MICROBIOLOGICAL STABILITY OF BREAD WITH USING SECONDARY RAW MATERIALS FROM CEREAL PROCESSING

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Bread and bakery products are one of the main food products, and their quality does not always meet the requirements of modern nutrition science. One of the directions of solving this problem is the creation of new safe varieties of bakery products of functional purpose to correct the nutrition of the population. The article considers the causes of microbial spoilage, the negative influence of mold fungi and spore-forming bacteria of the genus *Bacillus* on the safety of bread with the use of secondary raw materials of grain crops processing. The main objects of research were bakery products with the use of rice and buckwheat brans, prepared by the traditional method and on complex sourdough starter. Studies on the influence of the method of rice and buckwheat brans application on resistance to mold and potato disease infection were conducted.

**Keywords:** Microbiological safety, bread, secondary raw materials, rice bran, buckwheat bran, fermented brew, mold, potato disease.

## ДӘНДІ ДАҚЫЛДАРДЫ ҚАЙТА ӨНДЕУДІҢ ЕКІНШІЛІК ШИКІЗАТЫН ҚОЛДАНА ОТЫРЫП НАННЫҢ МИКРОБИОЛОГИЯЛЫҚ ТҰРАҚТЫЛЫҒЫН АРТТЫРУ

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Нан және нан өнімдері негізгі тағамдардың бірі болып табылады және олардың сапасы қазіргі заманғы тамақтану ғылымының талаптарына әрдайым сәйкес келе бермейді. Бұл мәселені шешудің бір бағыты – халықтың тамақтануын түзету үшін функционалды мақсаттағы нан өнімдерінің жаңа қауіпсіз сорттарын әзірлеу. Мақалада дәнді дақылдарды қайта өңдеудің екіншілік шикізатын қолдана отырып нанның қауіпсіздігіне микробтардың бүліну себептері, зен саңырауқұлақтары мен *Bacillus* тектес спора түзетін бактериялардың кері әсері қарастырылады. Негізгі зерттеу нысандары дәстүрлі әдіспен және кешенді ашытқымен дайындалған күріш және қарақұмық ұншығынан жасалған нан өнімдері болды. Күріш және қарақұмық ұншығын енгізу әдісінің көгеруге және картоп ауруына төзімділігіне әсері бойынша зерттеулер жүргізілді.

**Түйін сөздер:** Микробиологиялық қауіпсіздік, нан, екіншілік шикізат, күріш ұншығы, қарақұмық ұншығы, ашытылған қайнатпа, көгеру, картоп ауруы.

## ПОВЫШЕНИЕ МИКРОБИОЛОГИЧЕСКОЙ УСТОЙЧИВОСТИ ХЛЕБА С ПРИМЕНЕНИЕМ ВТОРИЧНОГО СЫРЬЯ ПЕРЕРАБОТКИ ЗЕРНОВЫХ КУЛЬТУР

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Хлеб и хлебобулочные изделия являются одним из основных продуктов питания, а их качество далеко не всегда соответствует предъявляемым требованиям современной науки о питании. Одним из направлений решения данной проблемы является создание новых безопасных сортов хлебобулочных изделий функционального назначения для коррекции питания населения. В статье рассмотрены причины микробной порчи, отрицательное влияние плесневых грибов и спорообразующих бактерий рода *Bacillus* на безопасность хлеба с применением вторичного сырья переработки зерновых культур. Основными объектами исследований выступали хлебобулочные изделия с использованием рисовой и гречневой мучек, приготовленные традиционным способом и на комплексной закваске. Проведены исследования по влиянию способа внесения рисовой и гречневой мучек на устойчивость к плесневению и заражению картофельной болезнью.

**Ключевые слова:** Микробиологическая безопасность, хлеб, вторичное сырье, рисовая мука, гречневая мука, заквашенная заварка, плесневение, картофельная болезнь.

**Introduction.** In the modern world food production is put on a stream, a stable process of production of high-quality bakery products is impossible without the purposeful use of food additives, improvers, various types of raw materials. They have a wide functional range, have the properties to affect the components of raw materials, give a certain quality to finished products, increase nutritional value, and also give the opportunity to form certain properties of dough from flour with unstable baking characteristics.

Ingredients, with the help of which it is possible to increase the nutritional value of wheat bread, are currently very diverse. The most appropriate is the use of non-traditional ingredients of plant origin, containing a high amount of proteins, micro and macronutrients. When they are used, the therapeutic and preventive value of wheat bread increases [1, 2]. One of such ingredients is rice and buckwheat bran [3]. These raw materials contain a wide range of biologically active substances, which, when added to food, have a beneficial effect on the human body.

Analysis of scientific and industrial developments indicate that there are numerous studies on the use of secondary raw materials of cereal crops for enrichment of bakery products. However, currently a serious problem of bakery products is their vulnerability to microbial spoilage under the action of bacteria and mold fungi, as it not only leads to deterioration of the appearance of bakery products, but also negatively affects their quality and safety.

The most dangerous and widespread disease of bread is considered to be potato disease, which is often observed in regions with hot climate and in summer time. In recent years, due to the widespread use of packaging in polymeric materials, which is a provoking

factor for the development of microbial spoilage, the spread of cases of potato disease is noted not only in the southern regions, but also in the northern regions of Kazakhstan and in the spring-summer period, and in winter [4, 5]. The causative agents of this disease are spore-forming bacteria of the genus *Bacillus*. Spores of potato bread disease pathogens, unlike mold fungi, are able to persist in the finished product after baking.

Affected bread first loses its natural taste and aroma, then a peculiar sweetish odor appears in it, which as the disease develops intensifies and the smell of bread acquires a rotten tinge. Under the influence of active enzymes of the causative agent of potato bread disease, there are significant changes in the structure of the bread crumb: dark smearing and pulling threads appear inside.

The second common type of microbial spoilage of bakery products is mold, which occurs as a result of the development of mold fungi of the genera *Aspergillus* (*A. flavus*, *A. fumigatus*, *A. glaucus*, *A. nidulans*, *A. niger*, *A. ochraceus*), *Mucor* (*M. mucedo*, *M. pusillus*, *M. spinosus*), *Penicillium* (*P. crustosum*, *P. expansum*), *Rhizopusnigricans*, *Geotrichumcandidum*. The surface of bread affected by mold is covered with fluffy plaque of various colors: gray, white, green, yellow, bluish, black [6]. The bread comes out of the oven sterile, i.e. mold is a secondary contamination.

Mould fungi adversely affect the quality of raw materials and finished bread. They cause profound changes in bread by breaking down proteins, carbohydrates and fats with the help of their enzymes. Bread that is affected by mold fungi has an unpleasant taste and musty odor. About 80 species of mold fungi produce mycotoxins. Mycotoxins can cause health problems in people who consume bread affected by

mold fungi [7].

A promising step in combating microbial spoilage of bread using secondary raw materials of cereal crop processing is the use of substances of natural origin that have a preserving effect, such as metabolites of lactic acid bacteria, such as organic acids and bacteriocins. The use of sourdough starters to inhibit microbial spoilage of bread has been the subject of much research in recent years. It is proved that bread prepared on sourdough starter with directed cultivation is characterized by improved porosity structure and crumb properties, taste and odor, microbiological purity, ability to preserve freshness for a long time. The use of sourdough starter bred on pure cultures of starter microorganisms allows to increase microbiological safety and quality of bread.

In this regard, the research on the development of bread assortment with the use of secondary raw materials of grain crops processing of improved quality, increased nutritional value and microbiological stability is relevant.

The purpose of the present research was to study the influence of the method of rice and buckwheat brans application on the resistance of bakery products to mold and potato disease development.

**Materials and methods.** The research was carried out on the basis of the “Laboratory of innovative technologies and assortment of bakery products” of the St. Petersburg branch of the Federal State Autonomous Scientific Institution “Research Institute of Baking Industry”. The objects of research were bakery products with the use of rice and buckwheat brans, prepared by traditional method and on complex sourdough starter. The control sample of bread was prepared without the addition of rice and buckwheat brans by the method of trial laboratory baking.

In the traditional method, 5% rice bran and 10% buckwheat bran in dry form and 85% first grade wheat flour, salt and pressed baking yeast, sugar according to the recipe and water in the amount providing dough moisture 48.0% were added to the dough.

When preparing dough on complex sourdough starter, the sourdough starter was prepared in accordance with the “Collection of technological instructions for the production of bakery products” [8,9], bred on pure cultures of microorganisms in liquid form.

The peculiarity of the preparation of dough on complex sourdough starter is the use of complex sourdough starter, by fermenting of sugared brew at

a temperature of 32-34°C. Also using a composition of pure cultures of starter microorganisms. These compositions have probiotic properties and antibiotic action against spore microflora. At the same time, traditional biological starters (thick, liquid without brewing, liquid with brewing) are excluded from the technological process, the amount of flour introduced in brewed form (25-35%) is increased.

Preparation of complex sourdough starter includes dilution and production cycles.

For preparation of complex sourdough starter were used pure cultures of lactic acid bacteria *L.plantarum* 1, *L. brevis* E120, (1.5 ml each) and yeast *S.cerevisiae* st. L-1 (1 ml of aqueous suspension).

The dilution cycle was used with a small mass of sourdough starter (500 g in the first phase). Microbial cultures were fused together, added to the saccharified brew of rice and buckwheat brans with the addition of unfermented barley malt (2% to the weight of brans) and water, and left to ferment for 20 hours.

The complex sourdough starter bred by breeding cycle using pure cultures of lactic acid bacteria and starter yeast in liquid form in the production cycle was maintained by refreshing with sugared brew in the ratio of 1:1 - 1:9, i.e. complex sourdough starter - nutrition (sugared brew) depending on the duration of sourdough starter fermentation.

80% of the complex sourdough starter obtained was used for bread production and the remaining part (20%) was used for its refreshing.

To establish the influence of bread preparation technology on the rate of mold development, we conducted model experiments with the infection of its sterile slices with pure culture of mold fungi *Penicillium chrysogenum* [10,11].

To determine the possibility of suppressing the potato disease of bread, the method of putting finished products infected with spore bacteria into conditions provoking the development of *B. subtilis* was used. To create provoking conditions, dry bread crumbs infected with *B. subtilis* spore-forming bacteria and containing 10<sup>8</sup> KOE/g of spores were introduced during dough kneading. To determine the content of *B. subtilis* spores in the infected crumb, the method described in the book “Microbiology of Baking Production” (Afanasyeva O.V., 2003) was used [12]. Bread was stored according to the Instruction for the prevention of potato bread disease [13], for which immediately after baking the bread was wrapped in damp paper and placed in a thermostat at 37°C. After 24 hours, the

bread was cut with a knife and the presence of signs of disease (specific unpleasant odor, sticky crumb) was determined visually. In the absence of the disease, the bread was further incubated under the same conditions.

**Results and discussion.** In the preparation of bread using rice and buckwheat brans by the traditional method, it was found that the use of secondary raw materials in dry form provokes the growth of mold fungi during the storage of bread compared to products prepared on complex sourdough starter and without the addition of secondary raw materials.

At infection of sterile bread slices with rice and

buckwheat brans on complex sourdough starter, pure culture of mold *Penicillium chrysogenum*, mold spores did not appear, which proves that the use of secondary raw materials in the form of fermented brew during dough kneading provides its microbiological purity, especially resistance of bread to mold. At the same time on the surface of bread slices prepared with rice and buckwheat brans in dry form, mold growth was observed after 26 hours. While on a slice of control bread, prepared from first-grade wheat flour without the addition of secondary raw materials, mold spores appeared after 28 hours (Fig. 1).

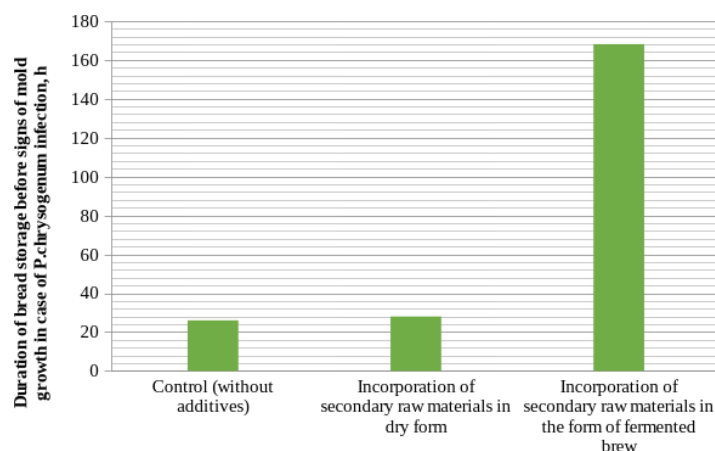


Figure 1 - Effect of rice and buckwheat brans application method on bread resistance to moldiness

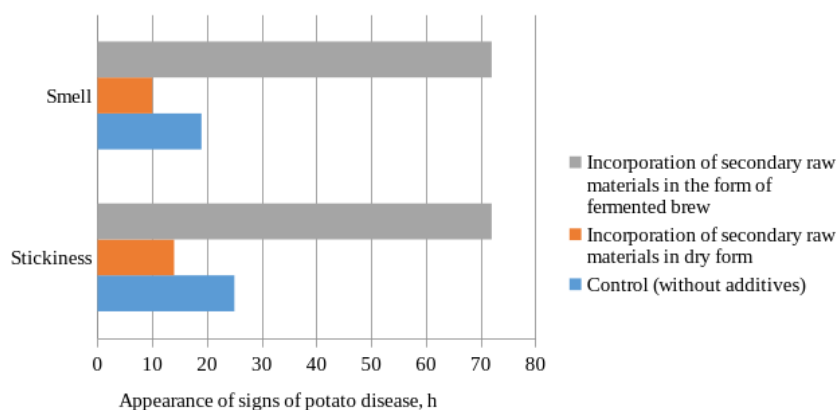


Figure 2 - Effect of rice and buckwheat brans application method on resistance to potato bread disease

Considering that the biological method involving the use of acidifying components is one of the most effective ways to protect bread from potato blight, the effect of rice and buckwheat brans on the suppression of potato bacillus spores was investigated.

As a result of trial baking it was found that the appearance of signs of potato disease after 10 hours in the form of unpleasant odor and after 14 hours - stickiness of the crumb, was observed in the sample of bread prepared with the addition of rice and buckwheat

brans in dry form. In the control sample of bread prepared from first grade wheat flour without the addition of secondary raw materials, unpleasant odor and stickiness of the crumb appeared after 19 and 25 hours, respectively. The bread sample with the addition of rice and buckwheat brans in the form of fermented brew did not get potato disease (Fig. 2).

As a result of the conducted research it was found that the introduction of rice and buckwheat brans in the form of fermented brew increases antagonistic activity to *Bacillus subtilis* and completely suppresses the development of spores of potato bacillus.

**Conclusions.** According to the results of studies of microbiological indicators of bread quality it was

found that the application of secondary products of cereal crops: rice and buckwheat brans in the form of fermented brew increases the resistance of bread to mold and completely suppresses the development of potato disease. This indicates that the introduction of secondary products of cereal crops in the form of fermented brew has a significant effect on microbial spoilage of bread, compared to traditional methods of bread preparation. The results of the research can be recommended for use in the development of multicomponent products based on secondary raw materials, namely rice and buckwheat bran. This will improve the range of products and diversify the nutrition of consumers seeking a healthy lifestyle.

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