The hop sourdough use to improve bread microbiological safety

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Abstract. Marketing research in recent years has shown a steady increase in consumer interest in yeast-free baked goods. The so-called “monastery”, “village” sourdough causes undoubted interest in this regard. Technology of obtaining sourdough on hop cones has recently occupied a special place in the baking development. An important social task of the baking industry is to provide the population with safe products of high quality. Hops contain a large number of macro and microelements, vitamins, nitrogenous substances. The resins, polyphenols, essential oils contained in hops have no substitutes in composition and properties and affect the microflora activity of bakery semi-finished products. Research on introduction of various dosages of hop sourdough and the influence on the wheat bread quality is carried out. The technology of bread production from the 2nd sort wheat flour on hop sourdough is developed. The structural and mechanical properties of bread with the introduction of hop sourdough are determined. Comparative analysis of bread samples indicates to the fact that bread cooked on sourdough has the same organoleptic and physical and chemical parameters with bread cooked on compressed yeast. Studies on the influence of hop sourdough on the resistance of finished products to the development of pathogenic microflora: the causative agent of “potato disease” and mould caused by Aspergillus and Penicillium fungi are conducted. Signs of bread disease in the control sample were found in 16 hours, in bread on the basis of hop sourdough in 24 hours of storage. The analysis of microbiological stability of samples confirmed expediency of the hop sourdough use in order to increase bread microbiological safety.

1. Introduction
One of the main directions in the Russian state policy in the social sphere is to ensure the population’s health. Reducing the spread of non-infectious diseases caused by the adverse environmental conditions, the use of substandard products in the people’s diet is a global issue in all developed countries, including Russia [1].

Bread is a product of mass consumption, in this regard, its quality and safety are especially important from the microbiological point of view. The quality and safety of the finished product are most influenced by the raw materials used and production technology. The most common diseases that pose a danger to people include “potato disease”, the causative agents of which are spore-forming Bacillus subtilis bacteria remaining viable in the crumb of baked goods, as well as mould caused by Aspergillus flavus, Aspergillus niger, Penicillium crustaceum fungi [2].
The decrease in the population’s consumer activity leads to the search for the possibility of using more economical types of raw materials, including bread production; raw materials with reduced quality characteristics are increasingly common. Deterioration of quality and safety of raw materials and finished products, leads to the necessity to search for new technologies and the revival of old recipes, adapting them to modern production. The current situation contributes to a return to the previously used technologies in bread production with the use of hop sourdough, but taking into account new studies of the hop chemical and physiological properties [3, 4].

The research on the possibility of using hop sourdough to prevent bread diseases is of great importance in the field of healthy nutrition. The use of various technological methods allows to regulate the work of microorganisms and to effectively affect the microbiological safety of finished products [5].

Hop is a valuable raw material in the production of bakery products due to its antiseptic effect on most groups of bacteria that cause the product spoilage, while not affecting the viability of yeast cells. It should be noted that the excessive hop content in the sourdough leads to a perceptible bitter taste in the finished product and limits its use [6, 7, 8].

In this regard, the improvement of production technology using hop sourdough and expanding the range of bakery products is an urgent and topical task of the baking industry.

The purpose of the research is the development of wheat bread recipe based on hop sourdough and evaluation of its influence on the development of bread pathogenic microflora.

2. Objects and methodology of research

The research object was bread baked with hop sourdough.

Hop sourdough was prepared on the hop decoction, for which 25 g of dry hop cones were boiled in 0.5 liters of tap water for 25 minutes. The obtained decoction was infused for 8 hours, filtered through a gauze filter, then squeezed, and 5 grams of sucrose were added and used to prepare the sourdough.

To obtain the sourdough the 2nd sort wheat flour and water or hop decoction in the proportion 1:1 were mixed (for the control version) and kept at a temperature of 28-30°C for 48 hours until the appearance of small bubbles on the surface, carrying out the rejuvenation of the sourdough every 24 hours by adding flour and water or the hop decoction in equal quantities. The sourdough moisture content was 57%.

Studies on quality and safety indicators were conducted in the laboratories of the Krasnoyarsk state agrarian university. Determination of indicators was carried out according to standard methods for determining quality indicators used in the baking industry.

Humidity was determined on the moisture analyzer MF-50, bread acidity according to State Standard 5670-96, bread porosity according to State Standard 5669-96, the thermostat, titration unit, penetrometer AP - 4/2 were also used in the research.

Assessment of the mould fungi development was carried out visually in the finished product, produced from the 2nd sort wheat flour. The cooled bread was packed into plastic bags and stored at a temperature of 24 °C assessing the appearance of odour and the presence of fungi colonies on the surface and in the bread crumb, fixing the time of visible mycelium appearance.

3. Results discussion

As part of the tasks, hop sourdoughs were made and bread samples with their different dosages were baked. The formed bread from the 2nd sort flour weighing 400 g was baked according to the recipe given in table 1.

In order to determine the influence of hop sourdough on the finished bread quality, products baked according to traditional technologies with different dosage of hop sourdough were studied, followed by their comparison in organoleptic, physical, chemical and microbiological parameters. Hop sourdough for the dough kneading was added in the amount of 40, 50, 60, 70 and 80 % of the flour weight according to the recipe, that is, 20, 25, 30, 35 and 40% of the flour used, respectively, were leavened. Wheat bread from the 2nd sort flour cooked on pressed yeast was used as a control sample. The dough humidity of all samples was 46 %. The dough acidity in all samples was brought to the required baking standard. In
accordance with State standard 27842-88, the dough was leavened to achieve an acidity of 5.5 degrees in all variants.

Table 1. Production recipe and mode of dough preparation for 100 kg of flour.

| Raw materials, kg | Control | Variant 1 | Variant 2 | Variant 3 | Variant 4 | Variant 5 |
|-------------------|---------|-----------|-----------|-----------|-----------|-----------|
| Sourdough dough   | 25      | 75        | 20        | 80        | 25        | 75        |
| 2nd sort wheat flour | 50      |           |           |           |           |           |
| Pressed yeast     | 50      |           |           |           |           |           |
| Hop sourdough     | 40      | 50        | 60        | 70        | 80        |           |
| Salt              | 1.5     | 1.5       | 1.5       | 1.5       | 1.5       | 1.5       |
| Hop decoction     | 20      | 25        | 30        | 35        | 40        | 20        |
| Water             | 25      | 35        | 40        | 35        | 25        | 20        |

The sourdough dosage increase in the bread recipe allows to reduce the processes of dough preparation, the necessary dough acidity with the introduction of 40% hop sourdough was achieved almost by 35.2% faster than in the control sample (figure 1).

Figure 1. Dependence of fermentation time (t, min) on sourdough dosage (C, %).

To determine the optimal amount of hop sourdough in the formulation, studies were conducted to determine the organoleptic and physical-chemical indicators of the finished products quality (table 2, figure 2).

Table 2. Sensory evaluation of finished bread samples.

| Bread quality indicators | Products samples by variants |
|--------------------------|-----------------------------|
|                          | Control | 1 | 2 | 3 | 4 | 5 |
| Surface condition        | Without major cracks and torn surface | Proper |
| Form                     | Light brown | Brown | Dark brown |
| Bread crust colour       | Thin-walled, fine, uniform | Fine, uniform | Fine, thick-walled |
| Porosity condition       | Light grey | Elastic, well-baked | Jammed |
| Crumb colour             | Peculiar to bread | Poorly identified hop smell | Hop smell |
| Crumb condition          | Peculiar to bread | Taste of hop bitterness |
| Smell                    |                |              |              |
| Taste                    |                |              |              |

The introduction of hop sourdough in the amount of more than 25% led to the bread crumb darkening and the dough stickiness increase, which is associated with the dough rheological characteristics. In all
studied samples the improvement of crumb deformation characteristics in comparison with control is noted, except the sample baked with introduction of 40% of sourdough, it had the compacted structure of bread porosity, dark crumb color and hop taste. It is established that the best dosage of hop sourdough is 20-25% by flour weight in the dough.

Figure 2. The profile of bread quality indicators depending on the sourdough dosage (%): a – specific volume (cm³/g), b – porosity (%), C – acidity (deg.), d – humidity (%).

It is established that bread baked with the introduction of hop sourdough in the amount of 20% and 25% of flour weight, has better results in quality compared to the control product in terms of porosity, specific volume. In this regard, for further research of the hop sourdough use influence on processes of staling and microflora development, bread baked with hop sourdough in quantity of 25% was used.

When storing bread, moisture loss and the development of retrogradation processes in starch grains are inevitable. There are changes in the structure of proteins and starch of finished products in the process of bread storing.

The influence of hop sourdough on staling processes was determined by changing of the bread crumb structural and mechanical properties according to the penetrometer AP-4/2 readouts. Baked bread products were cooled and stored for 48 hours in a laboratory box at a temperature of 18-20°C.

Changes in structural and mechanical properties of finished products were determined after 3, 16, 24, 48 hours (figure 3).

Bread baked with the use of hop sourdough has higher quality indicators, preserves the crumb elasticity longer, and reduces crumbiness. Bread crumb based on hop sourdough has higher compressibility during the storage period compared to the control sample.

Figure 3. The influence of hop sourdough on the processes of bread staling: a – humidity (%), b – crumb compressibility (penetrometer AP-4/2 unit).

Detection of the “potato disease” development was carried out in the finished product produced from 2nd sort wheat flour infected with Bacillus subtilis bacteria. The cooled bread was packed in plastic bags
and stored at a temperature of 24 °C assessing the crumb smell and condition in 12, 16, 20, 24, 28 and 32 hours after baking (figure 4).

![pressed yeast bread](image)

**Figure 4.** Terms of signs detection of bread infection with potato disease.

The first signs of disease in the bread baked according to traditional technology were found in 16 hours and in the bread with hop sourdough in 24 hours of storage.

Visual assessment of the mould fungi presence on the surface of the finished product produced from the 2nd sort wheat flour showed that the first signs of mould were manifested on bread produced using compressed yeast earlier by 26 hours than on bread using hop sourdough (table 3).

**Table 3.** The mould infection duration of the 2nd sort wheat bread on hop sourdough compared with the control sample.

| Sample name                      | Time of formation of fungi mycelium, hours |
|----------------------------------|-------------------------------------------|
| 2nd sort wheat bread on pressed yeast | 97                                        |
| 2nd sort wheat bread on hop sourdough | 123                                       |

The microbiological stability analysis of samples confirmed the expediency of hop sourdough use in order to increase the bread microbiological safety.

**4. Conclusions**

Studies of the hop sourdough influence on the quality of manufactured bread have shown the expediency of using this technology in baking.

As a result of the conducted research it was established that hop sourdough positively influences bread quality, considerably reduces risk of pathogenic microflora development in the finished products, and accelerate the dough preparation processes. The introduction of 20-25% of hop sourdough into the dough suppresses the development of “Potato bacillus” (Bacillus subtilis) and mould fungi.

It was proved that the use of hop sourdough prolongs the bread freshness by 20-25%. The obtained results demonstrate the feasibility of recommending the natural hop sourdough use for mass bread production. Application of the studied technology of hop sourdough allows to expand the range of environmentally friendly bakery products safe for human health.
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