The use of water-honey extract of hypericum herb to prevent bakery products from "potato disease"

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Abstract. Unwanted microflora in bread causes a disease called "potato disease", as a result of which bakery products mold prematurely. The causative agents of this process are the spore-forming bacteria Bac.mesentericus and Bac.subtilis. A method for preventing “potato disease” is proposed due to the use of hypericum, honey, sour cream of 10% fat in the recipe. Water-honey extract fermented with Str.lactis and Str.cremoris was obtained. The introduction of 6% of the studied LAB fermented Str.lactis and Str.cremoris water-honey extract of hypericum, when mixing wheat dough, prevents the development of "potato disease" and mildew, intensifies the process of dough preparation. Dough fermentation is reduced by 60 min, gas-forming ability and fermentation activity of the dough are improved. This allows to obtain finished products with improved organoleptic (color, aroma, taste) and physico-chemical quality indicators (porosity, specific volume).

1. Introduction

The production of bread is based on microbiological processes, on which the quality of the finished product largely depends. However, along with the vital types of microorganisms in semi-finished products and bread, harmful ones can be found that can drastically worsen the quality of products and cause its microbiological damage.

Diseases of bread are caused by unwanted microflora developing in it. The most common ones are potato disease and mold. Molding most often occurs during long-term storage and is caused by the ingress and development of spores of micromycetes of the genus Aspergillus, Mucor, Penicillium from the environment onto the surface of products and into cracks. The causative agents of the “potato disease” of bread are the spore-forming bacteria Bac.mesentericus and Bac.subtilis. These bacteria are widespread in nature (air, soil, plants) and are found in varying amounts on grain and flour. During baking, spores are not inhibited and retain their viability (they die only when instantly heated to 130 °C or at 100 °C after 6 hours). The most favorable conditions for their germination: significant product moisture, a neutral reaction of the environment and a temperature of 37 °C. Bacillus subtilis has a complex of active amylolytic (including α-amylase) and proteolytic (proteinase, polypeptidase,
dipeptidase) enzymes, the action of which causes specific changes in the crumb of bakery products from wheat flour in the summer, making the products unsuitable for human consumption [1].

The affected bread first loses its natural taste and aroma, then a peculiar sweetish smell appears in it. This is due to the process of deep proteolysis of protein substances, as a result of which the diacetyl content in the crumb increases.

The crumb turns into sticky, yellow-brown, pinkish-dirty spots form. The formation of dark-colored compounds cause oxidative processes. During a break, mucous stretching threads are observed. Pores lose their structure as a result of the ability of Bacillus mesentericus bacteria to hydrolyze starch to soluble carbohydrates: sugars and dextrins.

As a result, the products become unsuitable for consumption as they cause severe body diseases - pneumonia, meningitis, endocarditis, endophthalmitis, arthritis, osteomyelitis and others with a fatal outcome [2].

Ensuring the safety of products, taking into account the norms of their storage by preventing the development of pathogenic microorganisms in it, is an important task for the baking industry.

2. Materials and methods

To solve this problem, we must use integrated technologies, as well as products with antibacterial or antibiotic properties. Fermented LAB Str.lactis and Str.cremoris water-honey extract from hypericum has such properties.

Hypericum belongs to the family of St. John's wort (Figure 1). It is distributed in forest and forest-steppe zones. Hypericum grass contains essential oil, tarry and tannins, vitamins C, PP, carotene, choline, nicotinic acid, flavonoids. The complex chemical composition determines the diversity of the plant. Hypericum preparations have an antiseptic, pronounced astringent and diuretic effect, stimulate tissue regeneration.

Figure 1. Hypericum inflorescence

The infusion of the plant is recommended as a sedative and anticonvulsant. It is used externally for lotions, compresses and therapeutic baths for skin diseases and diathesis. It is beneficial for female diseases, used for diseases of the mouth and throat, hepatitis, gastritis and for the treatment of urolithiasis [3].

Bee honey is one of the most complex natural products, in the composition of which more than four hundred different components were found. Honey as a natural product in the number of ash elements is unparalleled. About 40 macro- and microelements were found in it: potassium, phosphorus, calcium, chlorine, sulfur, magnesium, copper, manganese, iodine, zinc, aluminum, cobalt, nickel, etc. Some trace elements are found in honey in the same concentration and the same correlation with each other, as in human blood. The similarity of the mineral composition of blood and honey determines the rapid absorption of honey, its nutritional, dietary and medicinal properties. The bactericidal effect of honey is due to the content of phytoncides and enzymes involved in oxidative reactions with the
release of active oxygen. It is involved in the oxidation of unsaturated fatty acids present in flour and introduced with new raw materials to peroxides. They, in turn, oxidizing SH-groups in protein globules, strengthen protein and gluten, which increases the volume of finished products.

On the basis of hypericum, honey, sour cream of 10% fat content, Str.lactis and Str.cremoris water-honey extract was fermented with lactic acid bacteria (LAB).

According to the chemical composition (table 1), fermented hypericum herb extract is characterized by a high content of tannins, carbohydrates, antioxidants (flavonoids and vitamins C, beta-carotene).

**Table 1. The chemical composition of the extract**

| Component name | Value display |
|----------------|---------------|
| Tannins, %     | 10,0          |
| Proteins, %    | 2,6           |
| Fats, %        | 3,6           |
| Carbohydrates, %| 15,2         |
| Vitamin A, %   | 30,0          |
| Vitamin C, %   | 45,0          |
| Vitamin P, %   | 32,0          |
| Vitamin PP, %  | 20,0          |

Tannins have an antimicrobial effect, they inhibit the development of microbiological damage. Antioxidants are substances that increase the shelf life of products, reduce the proportion of free radicals in the body. Organoleptic and physico-chemical characteristics of the extract are presented in table 2.

**Table 2. Organoleptic and physico-chemical characteristics of the extract**

| Name of indicator | Characteristics |
|-------------------|-----------------|
| **Organoleptic characteristics** | |
| Appearance        | Opaque liquid  |
| Colour            | Light brown to dark brown |
| Taste             | Sour-sweet, without pronounced bitterness |
| Solubility in water | Opalescence is allowed due to the characteristics of the raw materials used, and the precipitation of single particles |
| **Physico-chemical characteristics** | |
| Acidity, degrees  | 23,8           |
| Mass fraction of solids, % | 6,7           |
| Antioxidant activity, mg/dm³ | 10784,2       |

3. The discussion of the results

Given there are unique antimicrobial properties of hypericum and honey, studies were carried out on the effect of the fermented microbial Str. Lactis and Str.cremoris fermented water-honey extract of hypericum on microorganisms that cause mold and potato disease of wheat flour products.

As control, white bread made from premium wheat flour (GOST 26987-86) and rifled loaf (GOST 27844-88) was selected.
To determine the rational dosage of the extract, laboratory test baking of bread and loaf was carried out from flour artificially infected with Bac.subtilis spore bacteria, based on the calculation of the content of 104 spores / g of flour, which corresponds to the content of spores in the flour unsuitable for production. An extract in the amount of 0 ... 6.0% by weight of flour in the dough was added to the experimental samples. The baked bread and loaf were wrapped in moist paper and incubated under provocative conditions (temperature – 37 °C, relative humidity – 85-90%) for 48 hours, after which the manifestation of “potato disease” was organoleptically determined in them [4-6]. The results of the analysis are presented in table 3.

| Sample                  | The manifestation of "potato disease" |
|-------------------------|---------------------------------------|
|                         | Bread                                  | Loaf                                  |
| Control                 | the aroma characteristic of premium wheat flour bread; crumb without signs of disease; | the flavor characteristic of a rifled loaf; crumb without signs of disease; |
| Sample 1 with 0% extract| fruit aroma; with sticky crumb;         |                                       |
| Sample 2 with 3% extract| light fruity aroma, no crumb changes;   |                                       |
| Sample 3 with 6% extract| the aroma characteristic of premium wheat flour bread; crumb without signs of disease | |

As can be seen from table 3, the introduction of the extract at a dosage of 6% by weight of flour in the dough, bread and loaf was not infected with "potato disease".

**Figure 2.** The content of Bac.subtilis in the studied samples (dilution 10^-3):
1 – control;
2 – sample 1, containing 0% fermented extract;
3 – sample 4, containing 6% fermented extract.
To determine the inhibitory effect of the extract, the content of Bac.subtilis was determined by the bacteriological method by plating the crumb on meat-peptone agar. Then we counted the characteristic colonies grown on Petri dishes. To confirm that the grown colonies belong to Bac.subtilis, at least five colonies were selected for microscopy. At the same time, control and samples with a dosage of extract of 0 and 6% by weight of flour were investigated. The results of the analysis, using bread and loaf as an example, are presented in Figure 2 and in Table 4.

**Table 4. The number of colonies of Bac.subtilis in the studied samples**

| Dilution | Control | Sample 1 with 0 % extract | Sample 3 with 6 % extract |
|----------|---------|---------------------------|---------------------------|
|          | Bread   | Loaf                      | Bread                     | Loaf                      |
| 10-1     | continuous growth | continuous growth | 8                        | 7                         |
| 10-2     | 35      | 30                        | 150                       | 130                       | 2                        | 0                         |
| 10-3     | 10      | 10                        | 60                        | 50                        | -                        | -                         |

As can be seen from Figure 2 and Table 4, the introduction of a 6% extract when baking bakery products has an inhibitory effect on the causative agent of "potato disease" Bac.subtilis more than 100 times. The microbiological state of bread and loaf during storage in various conditions is presented in table 5.

**Table 5. The microbiological state of bread during storage in various conditions**

| Indoor storage: (indoor air temperature – 21 ± 1 °C) | Storage under provoking conditions: (temperature – 38 °C, wet wrap) |
|---------------------------------------------------|-------------------------------------------------------------------|
| **Inspect Ion of products after baking, in … hours** | **Bread characteristic** |
| | Control | Sample 3 with 6 % extract | Inspection of products after baking, in … hours | **Bread characteristic** |
| | Bread | Loaf | Bread | Loaf | Bread | Loaf | Bread | Loaf |
| 24 | - | - | - | - | 24 | - | - | - |
| 48 | - | - | - | - | 48 | - | - | - |
| 72 | - | - | - | - | 72 | +Δ | +Δ | - |
| 96 | Δ | Δ | - | - | 96 | ++ΔΔ | ++ΔΔ | - |
| 120 | ΔΔ | ΔΔ | - | - | 120 | ++ΔΔΔ | ++ΔΔΔ | Δ | Δ |

**Designations:** + - weak damage to bread by potato disease; ++ - severe damage to bread by potato disease; Δ – molding; ΔΔ – severe molding.

Quality indicators of bread with extract, in comparison with white bread made from premium wheat flour, are presented in table 6.
Table 6. Quality indicators of finished products

| Quality indicators | White bread made from premium wheat flour (GOST 26987-86) | Bread "Luchisty" Project TU 9114-144-02068108-2008 |
|--------------------|----------------------------------------------------------|-------------------------------------------------|
| Organoleptic indicators | | |
| Appearance: | | |
| form; | - corresponding to the bread form in which the baking was made, without lateral outflows; | |
| surface; | - without large cracks and blasts; | |
| colour; | - light yellow; | |
| Crumb condition: | | |
| bakedness; | - baked, not wet to the touch, elastic, after light pressure with your fingers the crumb takes its original shape; | |
| knead; | - without lumps and traces of poor knead; | |
| porousness; | - developed, without voids and seals; | |
| Taste | - characteristic of this type of product, sweet, without extraneous taste | |
| Smell | - characteristic of this type of product, no odor | |
| physical and chemical indicators | | |
| Crumb moisture, % | 42,0 | 43,5 |
| Crumb acidity, degrees | 3,0 | 3,0 |
| Crumb porosity, % | 74,0 | 80,0 |
| Specific volume of bread, cm³/100 g | 290,0 | 345,0 |
| (non-GOST indicator) | | |
| Antioxidant activity, mg / g | 6050,27 | 7739,06 |

Analyzing the data obtained during the research, we can conclude that the addition of 6% of the studied LAB fermented Str. Lactis and Str. Cremoris water-honey extract of hypericum when mixing wheat dough, prevents the development of "potato disease" and mold, intensifies the process dough preparations (dough fermentation is reduced by 60 min). This allows one to improve the gas-forming ability and fermentation activity of the dough, to obtain finished products with improved organoleptic (color, aroma, taste) and physico-chemical parameters and quality (porosity, specific volume) [7, 8].

4. Conclusion
A method of preventing bakery products from "potato disease" is proposed. The signs of “potato disease” in the samples were identified; the number of Bac.subtilis colonies in the samples was examined. The microbiological state of the bread during storage under various conditions was studied, and quality indicators of the finished products were presented. After conducting all the studies and analyzing the results, the optimal dosage of the test solution was selected, which helps to prevent "potato disease".
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