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Extending the Storage Life of Foods Using Shungite

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Abstract

Background: Shungite has gained popularity in recent years as a material for water purification and food preservation. The purpose of the study is to develop a fast method of assessing the biological activity of shungite batches and to determine the time of contact between shungite and water to increase or reduce the bioactivity of shungite water in the food industry, specifically in the production of baked goods with extended shelf life.

Methods: The authors study the bioactivity of pre-prepared water using yeasts of Saccharomyces cerevisiae species based on the evaluation of the fermentation rate of sugar solutions in their presence. Infused shungite was used in kneading dough and by applying shungite water after baking. The experiment involved infusing distilled water on shungite for varying periods of time, preparing three versions of 30% aqueous solutions with distilled water and shungite water, adding 2% dry baking yeast to each solution, conducting fermentation processes, and mixing dough for bread with regular and shungite water. The bread samples were evaluated for their organoleptic characteristics and physical and chemical properties.

Results: The study concludes that the use of shungite water in the preparation of bread dough has no negative impact on the quality of the final product. It can even help to prolong the shelf life of baked goods, making it a promising material for the food industry. As a result, the authors propose a process of bread processing to increase its shelf life.

Conclusion: The results suggest that further research is needed to determine the long-term effects of using shungite water and its potential benefits for human health, as well as to explore the impact of different contact times between shungite and water on the biological activity of water and its effect on the quality of the final product.

Introduction

Shungite is a natural material containing non-crystalline carbon. Shungite is composed of mostly carbon, along with other elements such as silicon, aluminum, and iron. It has unique properties such as electrical conductivity, high adsorption capacity, and ability to neutralize harmful substances. Shungite has gained popularity in recent years as a material for water purification. Scientific research demonstrates that shungite has good adsorption properties relative to various organic compounds and heavy metals, and also shows antibacterial properties [1].Unlike technical carbon, which contains harmful toxic substances that alter cells at the genetic level, shungite has bactericidal properties [2].

There are five types of shungite classified by carbon content. Type I shungite contains more than 98% of carbon by weight, type II – 35-80%, type III – 20-35%, type IV – 10-20%, and type V – <10% of carbon by weight [3]. Type III shungite is the most common in use. Its largest deposits are located in Karelia (Russia). In addition to carbon shungite usually contains quartz, aluminosilicates, and carbonates. Various micro-impurities, including Fe, Ni, Cu, and Zn, can also be found in shungite mainly in the form of sulfides, sulfates, and oxides [4]. Shungite eliminates unpleasant taste and odor, organic compounds, heavy metals, and bacteria and enriches water with microelements. Indeed, studies show that shungite has good adsorption properties compared to various organic compounds, as well as antibacterial properties. For example, low carbon shungite (total carbon content of 5.4%) can be used as an alternative adsorbent to remove Zn (II) from water [5].

There are also several methods for assessing the biological activity of shungite without the use of water:

- Tactile or organoleptic method. In this method, the hand is held over a shungite object (a pyramid, cube, ball, or egg) or a hill of rubble, and the heat coming from the shungite object is felt;
- The pain syndrome method. In this method, shungite is applied to a sore spot. When the active form of shungite is used, the pain will subside in 20 minutes [6];
- Evaluation by appearance. Quality high carbon shungite has a blacker color, a homogeneous structure with small inclusions, and significantly greater weight.

Another known method of assessing the biological activity of shungite without the use of water is the chemical method. It is based on determining the chemical composition of shungite [7]. Shungite with a carbon content of 30-40% has been found to have therapeutic properties.

Assessment of activated water containing shungite is conducted by other methods, for example, using various biological features of living organisms: daphnia, frogs, rats, earthworms, preparations of nerve cells, etc. [8]. Shungite's unique properties make it an ideal material for food preservation and storage. Due to its high carbon content, shungite has a high adsorption capacity, which allows it to absorb and remove various impurities, such as bacteria, viruses, and toxins, from food and water. As a result, shungite is often used in the production of water filters, air purifiers, and food storage containers [9]. The present study focuses on increasing the shelf life of freshly baked bread and baked products by using water infused in shungite when kneading dough and by applying it after baking. This goal is met by using shungite containing the nanomaterial of fullerene in the preparation and processing of wheat bread and baked goods to extend their shelf life. The use of shungite in the preparation and processing of wheat bread and baked goods to extend their shelf life is made possible by the presence of the nanomaterial fullerene in shungite. Fullerene is a unique molecule consisting only of carbon atoms arranged in a single spherical structure with alternating single and double bonds. Shungite is known to contain this nanomaterial, which has been found to have various potential applications in medicine, electronics, and even food preservation. By incorporating shungite into the preparation and processing of bread and baked goods, the fullerene molecules in the shungite are thought to inhibit the growth of bacteria and fungi, ultimately extending the shelf life of these products. Fullerene, also called buckminsterfullerene, is a carbon molecule that forms either a closed "buckyball" cell or a cylinder (carbon "nanotubes"). The C60 molecule was named Buckminsterfullerene (or, in simpler language, buckyball) after the American architect R. Buckminster Fuller. Elongated buckyballs, carbon nanotubes, were identified in 1991 by a Japanese researcher, S. Iijima [10]. Fullerenes that contain an allotropic form of carbon with conjugated double bonds are powerful multi-acting antioxidants. There are different types of fullerenes. Fullerene C60 is the most prominent representative of the fullerene family. It consists of 60 carbon atoms. The various structures of fullerene molecules are presented in Figure 1. Water infused with shungite is a molecular colloidal solution of hydrated fullerenes, which now belong to a new generation of nanomaterials [11]. Nanotubes have a wide range of novel mechanical and electronic properties. They are excellent heat and electricity conductors and have high tensile strength [12]. Fullerenes have a wide range of antibacterial properties and can be used to fight viral diseases as well as for many industrial purposes [13].

Thus, the antibacterial properties of fullerenes make them a useful tool in the food industry for fighting bacterial contamination and increasing the shelf life of food products.

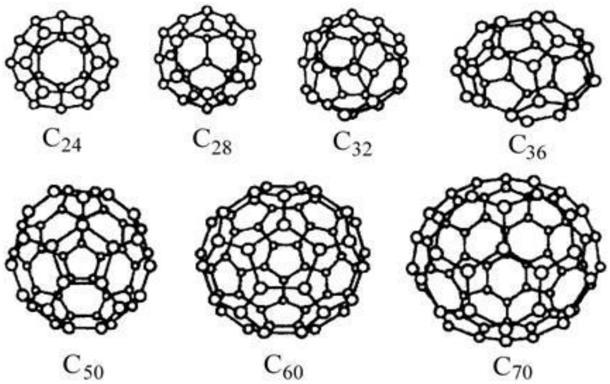

Figure 1: Fullerene molecule structures.

Therefore, the purpose of the purpose of the study is to develop a fast method of assessing the biological activity of shungite batches and to determine the time of contact between shungite and water to increase or reduce the bioactivity of shungite water in the food industry, specifically in the production of baked goods with extended shelf life.

Methods

Research design

The study was conducted in 2022 based on the Kemerovo Institute of Food Science and Technology (Kemerovo, Russia).

Research objects:

- shungite;
- drinking water (SanPiN 2.1.4.1074-01);
- table salt (GOST R 51574-2018);
- yeast – species Saccharomyces cerevisiae;
- high-grade wheat flour (GOST 52189-2003),
- samples of dough prepared with shungite water instead of drinking water;
- ready-made baked goods.

Research methods

In addition to the fermentation processes with the use of a carbon dioxide collection unit; the study also employed organoleptic characteristics of different versions of bakery products were determined according to GOST 27842-88. The physicochemical indicators were defined according to GOST 21094-75, GOST 5669-96, and GOST 5670-96.

Research procedure:

The experiment consisted of the following stages:

1. Infusion of distilled water on shungite for varying periods of time;
2. Preparation of three versions of 30% aqueous solutions – with distilled water and shungite water with different times of contact with shungite;
3. Adding 2% dry baking yeast, Saccharomyces cerevisiae species, to each solution;
4. Conducting fermentation processes with the use of a carbon dioxide collection unit;
5. Mixing dough for bread with regular and shungite water;
   The versions of water for dough were:
   - ordinary drinking water;
   - water infused in the natural material of shungite for 48 hours.
6. Baking bread and determining the quality of the finished product.

Samples of bread were baked according to GOST R 58233-2018, the basis was the recipe for the highest-grade wheat bread. Sample No. 1 (control) had no shungite water added and Sample No. 2 contained water infused with shungite for 48 hours. Dough maturation occurred during storage under 2-4°C for 8-10 hours. The dough was prepared by a non-leavening method. In addition, baked bread was sprayed with shungite water. After cooling, the two variants of bread were put into plastic bags. The quality of bread was daily evaluated organoleptically by smell, taste, color, surface condition, and appearance; its physical and chemical parameters were determined [8]. All experimental procedures were repeated three times.

Results

The results of tests of fermentation processes using the carbon dioxide collection unit are provided in Table 1. Table 1 demonstrates that the biological activity of water depends on the time of its contact with shungite. The maximum exposure time of water to shungite was 48 hours. The results of experiments on kneading bread dough on regular and shungite water are given in Table 2. The experimental data indicate that bread samples No. 1 and 2 in terms of their organoleptic characteristics meet the regulatory requirements, and the physical and chemical properties of bread sample No.1 are above the recommended values.Bread sample No. 2 prepared from the dough using water infused with the natural material shungite has a shelf life of 60 days and is not prone to the development of potato blight. In contrast, the shelf life of bread sample No. 1 made of dough prepared with ordinary drinking water is only 6 days.

No.	Type of water	Contact time of water with shungite, h	Time to reach stationary phase, h	Volume of CO_2, ml/h	Effect of shungite
1	Initial water sample	0	2	50	-
2	Shungite water	24	1.2	70	Activated water
3	Shungite water	48	1	90	Activated water

Table 1: Study of the fermentation process.

Indicator	Norms per GOST 31805-2012 [10]	Sample 1	Sample 2
Appearance: shape and surface - color	Consistent with the mold in which the bread was baked, with a slightly convex top crust, no lateral bulges; without major cracks or undercuts, with or without incisions or notches in accordance with the instructions; smooth or rough; color ranging from light yellow to dark brown	Consistent with the bread form, without lateral populations; without major cracks and undercuts, with punctures; the shape is rough; color – light yellow	Consistent with the bread form, without lateral populations; without major cracks and undercuts, with punctures; the shape is rough; color – light yellow
Taste	Characteristic of this type of product, with no extraneous taste	Characteristic of this type of product, with no extraneous taste	Characteristic of this type of product, with no extraneous taste
Smell	Characteristic of this type of product, with no extraneous smell	Characteristic of this type of product, with no extraneous smell	Characteristic of this type of product, with no extraneous smell
Crumb moisture, %	43.0	45.0	43.0
Crumb porosity, %, no less than	70.0	71.0	68.0
Acidity, deg.	2.5	2.3	2.2

Table 2: Quality indicators of finished products.

Discussion

The results presented in Table 2 indicate that the use of shungite water in the preparation of bread dough had no significant effect on the organoleptic characteristics of the final product. Both samples of bread showed consistent shape and surface color, with no major cracks or undercuts, and characteristic taste and smell. However, there was a slight difference in the crumb porosity, with Sample 1 showing slightly higher porosity than Sample 2.

The acidity of the bread samples was also measured, and it was found that both samples were within the acceptable range according to GOST 31805-2012. The moisture content of the bread samples was slightly higher in Sample 1, which could be attributed to the use of shungite water. The results suggest that the use of shungite water in the preparation of bread dough has no negative impact on the quality of the final product.

The findings of this study are consistent with previous research on the use of shungite in the food industry [14]. For example, a study by Mashanov et al. [15] investigated the use of shungite water in the production of sourdough bread and found that it led to an increase in the lactic acid bacteria count and improved the bread's texture and taste. Similarly, a study by Joshi et al. [16] explored the use of shungite in the production of wheat bread and found that it helped to prolong the shelf life of the bread.

Several studies have explored the potential benefits of shungite in food production, such as extending the shelf life of bakery products. For instance, a study conducted by Viejo et al. [17] investigated the effect of shungite powder on the quality of sourdough bread. The results showed that the addition of shungite powder improved the physical and sensory characteristics of bread, including increased volume, porosity, and crust color.

It is important to note that while our study focused specifically on the use of shungite water in the preparation of baked goods, the potential applications of shungite extend beyond the food industry [18]. For example, shungite has been found to exhibit antibacterial and antiviral properties, making it a promising material for use in medical and industrial applications [19, 20]. The results of this study have implications for the food industry, particularly for the production of baked goods with extended shelf life. The use of shungite water in the preparation of bread dough can improve the quality of the final product, including its texture, taste, and moisture content.

In conclusion, our study found that the use of shungite water in the preparation of bread dough did not significantly affect the organoleptic characteristics of the final product. Both bread samples met regulatory requirements, with consistent shape and surface color, characteristic taste and smell, and acceptable acidity levels. Although there was a slight difference in crumb porosity and moisture content, these findings suggest that the use of shungite water in bread production has no negative impact on the quality of the final product. The findings of our study highlight the potential benefits of using shungite water in the food industry, particularly for the production of baked goods with extended shelf life. Further research is needed to determine the long-term effects of using shungite water and its potential benefits for human health, as well as to explore the impact of different contact times between shungite and water on the biological activity of water and its effect on the quality of the final product.

Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

All authors of the article contributed equally.

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