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PROCESSING AND DISINFECTION OF BARLEY FEED GRAIN

Abstract

Seeds are biological entities known to release water through respiration. Within a silo, this moisture is distributed upward due to convective air currents. This phenomenon occurs as a result of the temperature differential between the warmer seeds at the silo's center and the cooler walls. If grain is stored at a humidity level below 12% and protected from insect infestation, increases in humidity in the upper layers of the seeds will likely remain minimal.

Conversely, should the grain be stored with humidity exceeding 12%, sufficient moisture can develop on the upper layer, fostering mold growth. Such conditions lead to microbial proliferation, rendering the grain unsuitable for livestock, poultry feed, and other by-products. Consequently, the eradication of harmful microflora during grain processing and storage represents a critical concern for farmers. Deficiencies in the final product may arise from the utilization of low-quality grain, deviations from production protocols, and non-adherence to established storage conditions and requirements.

The primary defects comprise impairments in organic and physicochemical properties, as well as microdefects. To avert contamination of food products, grains, and seeds, it is imperative that food grains undergo sterilization and disinfection above the prescribed standards prior to storage and transportation. The predominant methods of sterilization and disinfection include chemical coatings, thermal treatments, and cold treatments, or a combination of these biological approaches.

A key factor contributing to spoilage is the moisture content of the grains; thus, heating, utilizing the dry heat mechanism, has gained acceptance among major storage and transportation entities. To inhibit microbial activity, ultraviolet radiation (UV radiation) serves as an effective treatment method, utilized to disrupt microbial activity and eliminate grain pests through the interaction with electromagnetic radiation in the spectrum between visible light and X-rays.
Keywords: *barley, spoilage, processing, quality, exposure.*

Introduction. Improving the quality of seeds is one of the most important issues in agricultural production, which allows not only to increase grain yields but also to reduce the specific costs of its processing. The negative impact of microorganisms is an important factor that reduces the quality of grain and causes its deterioration. Microorganisms attach to grain during the growing season.

During harvesting and processing, when seeds come into contact with soil particles, the number and composition of microorganisms on the grain surface increases. The growth, development and formation of fruits occur in conditions of high microbial content, so the surface of grain and seeds of all crops, regardless of age and quality, contains microorganisms. Obviously, there is a need for surface treatment to control plant pests [1, 2, 4].

Analysis of recent research and publications. Grain microflora consists of microorganisms that live on plants. They can be divided into epiphytic microorganisms endemic to each genus and species of plants, parasitic microorganisms that parasitise plants, parasitic microorganisms that accidentally parasitise plants, and microorganisms that enter the grain mass during harvesting or improper storage and handling.

Grain microflora can be divided into three groups according to their life forms and their impact on the grain: rotiferous, phytopathogenic and pathogenic. Rotiferous microbes include bacteria, yeasts, moulds and actinomycetes. Bacteria are commonly found in freshly harvested grain and good grain batches [5, 7, 8].The main representatives of bacteria belong to the genera Ervinea and Pseudomonas; E. herbicola aureum is a motile, small, non-spore-forming, rod-shaped bacterium, 1-3 μm long. It forms colonies of golden colour on solid nutrient media. The second species of bacteria in this genus, E. herbicola rubrum, forms red colonies on dense media. In freshly harvested batches of grain, E. Herbicola accounts for 92-95% of the total bacterial population and indicates good grain quality and freshness, as these bacteria do not spoil the grain.

The spore-forming bacteria in the grain mass are mainly represented by potato (Bacillus mesentericus) and straw (Bacillus subtilis) bacteria. These are typical spore-forming fungi with very resistant spores that can remain in the grain for a long time [6, 8, 10].Their spores are highly heat-resistant and do not die during bread baking, which makes the bread crumb less elastic, sticky and pliable, making it unsuitable for human consumption. The main method of controlling grain microflora is to remove impurities as soon as possible after harvesting and bring the grain to a dry state.

Lowering the temperature also inhibits microbial activity in the grain mass, but at a temperature of 5-10°C, mould growth slows down in grain with a high moisture content.

Therefore, cooled raw grain, especially seed grain, can only be stored satisfactorily for a short time, as it can only be stored successfully in a dry state. Phytopathogenic microorganisms in cereals include bacteria, fungi and viruses. These microorganisms cause various plant diseases - bacterioses (bacteria) and mycoses (fungi). Pathogens enter plants mainly through insects, wind and rain drops [7, 9, 11]. Pathogens develop on the surface of the plant and form mycelium and spores. After being destroyed by enzymes, microorganisms enter the plant through plant openings (stomata) and parts of the epidermis. Plants affected by phytopathogenic microorganisms either die or their quality and yield are reduced. Although phytopathogenic microorganisms are not known to affect the storage of grain in bulk, the presence of signs of grain damage is taken into account in the overall assessment of grain and its use as food, feed and seed. Microorganisms that are pathogenic to humans and animals often enter grain storage facilities by accident. They can directly infect humans and animals. In all products, processed grain is evaluated for its organic and physicochemical properties. The most important indicators of grain quality in all bakery products are colour, smell, condition, appearance, moisture content, impurities, including harmful ones, and pest infestation. In wheat and rye, the actual weight, number of small grains, droplets, nitrites, gluten content and quality are also measured. All these quality indicators are of great importance.

Sensory testing methods measure the colour, appearance, aroma and taste of the grain. The barley seed is called a caryopsis, and its shell consists of seven cell layers that form a layer of seed (or flower), fruit (or pericarp) and embryo (or pulp). Among industrial crops, barley is the only one that has a sexual capsule. The dry matter of barley consists mainly of organic matter and accounts for 85% of the total weight of the grain.

Table 1

Chemical composition of barley, per 100 g of dry matter

Name	Value max	Value min
Water	-	8,0
Starch	70,0	50,0
Cellulose	6,0	4,0
Hemicellulose	5,0	4,0
Pentosans	10,0	5,0
Amino acids	-	-
White	16,0	8,0
Fats (lipids)	5,0	2,0
Mono-, di-, and trisaccharides	2,0	1,0

Gummy substances	1,4	0,6
Mineral substances	3,0	2,0
Tannins (polyphenols)	0,3	0,1

An important indicator is grain moisture, which is measured as a percentage of seed weight. Barley moisture content ranges from 8-20%. In class 1, barley moisture content should not exceed 15% [6, 9, 12, 14]. To maintain seed viability, barley moisture content should be below 10%. A further decrease in moisture content can lead to irreversible coagulation of cytoplasmic protoplasmic proteins, which can negatively affect seed germination [7, 9, 11, 15]. It should be noted that the yield of the concentrate decreases by an average of 0.76% regardless of moisture content.

In addition, dry seeds are much cheaper to transport, store and process than wet seeds. When analysing the biochemical effects that occur during storage, the following components of barley should be considered

- carbohydrates
- nitrogenous preparations
- phenolic compounds
- lipids
- mineral preparations
- vitamins
- inorganic compounds.

The surface of barley has always been home to a large number of different microorganisms, including bacteria, microfungi and actinomycetes. There is a paradox in this diversity. Bacteria have a large share in this infection, while mycorrhizal fungi play an important role in seed decay, but on average account for less than 1% of the total number of microorganisms [6, 9, 16]. According to various authors, gas contamination with bacteria ranges from 1 to 7 million cells/g, but the most common of 98 million cells/g are lactic acid microbes (14,000/g each) - pathogens of the genera Lactobacillus and Pediococcus. The taste of beer is also not affected by gram-negative microorganisms, especially bacteria of the genera Erwinia and Pseudomonas. Gram-positive microorganisms include representatives of the genera Micrococcus and Bacillus.

Contamination of cereal components by microorganisms and their waste products occurs at different times:

- during the growing season
- during harvesting, especially in conditions of high humidity, during threshing or post-harvest grain processing
- during storage due to violations of the grain storage regime and when grain is put into storage. The appearance of unusual odours in the grain indicates the decomposition of organic substances and microbial products in the grain:
- wormwood
- garlic

- mouldy
- musty
- musty smell;
- malt smell;
- putrid smell.

Grain microflora is represented by groups of saprophytic, phytopathogenic pathogenic categories [8, 11, 16]. Ultraviolet radiation as one of the processing methods for terminating the activity of microorganisms and eliminating grain microflora (UV radiation) is an electromagnetic radiation that occupies the spectral range between visible light and X-rays. The wavelength of ultraviolet radiation ranges from 10 to 400 nm (7.5 - 1014 - 3 - 1016 Hz). The term comes from the Latin words ultra - above, beyond and violet.

The term 'ultraviolet' is sometimes used in colloquial speech [1]. Microorganisms are an important cause of poor quality and spoilage of feed. Depending on the type of damage and the degree of development of microorganisms, nutrient degradation in feed, formation and accumulation of harmful metabolites, growth of pathogenic microorganisms and formation of their toxins occur.

At the stage of scientific and technological development of agriculture, the technology of feed disinfection is changing. In addition, quality requirements have increased significantly.

Compound feeds must not only contain all the necessary nutrients and biologically active substances, but also meet veterinary and sanitary requirements. Traditional disinfection methods based on the use of chemical disinfectants and radiation sterilisation methods using various ionising radiations are not considered satisfactory for feed, as they are harmful to the environment and can lead to significant and undesirable contamination.

Despite repeated attempts to develop effective methods of sterilisation of bulk foodstuffs using ultraviolet radiation, no significant progress has been made towards industrial practical application. Scope of research: agricultural enterprises: livestock, poultry, crop production, fodder production, farms.

Ultraviolet lamps are used for disinfection (disinfection) of grain, water, air and various surfaces in all areas of human activity. UV radiation does not affect some bacteria, many types of fungi and prions, so complete disinfection from microorganisms is impossible. In the most common low-pressure lamps, almost the entire radiation spectrum is occupied by the wavelength of 253.7 nm, which corresponds well to the peak of the bactericidal efficiency curve (the efficiency of absorption of UV radiation by DNA molecules). This peak is located at a wavelength of about 265 nm [13] and has the greatest effect on DNA, while natural substances (e.g. water) slow down the transmission of UV light.

The relative spectral bactericidal efficiency of UV radiation is the relative dependence of the bactericidal effect of UV radiation on the wavelength in the spectral range of 205-315 nm. At a wavelength of 265 nm, the maximum value of spectral bactericidal efficiency is 1. VH bactericidal lamps emit peak radiation at 185 nm in addition to radiation at 253.7 nm, creating concentrated ozone in the air. Ozone is a highly reactive oxidant that kills microorganisms and eliminates unpleasant odours. Together with the air, ozone also penetrates places protected from UV radiation. To produce ozone in different concentrations, antimicrobial ozone lamps are available in different sizes.

Advantages of UV disinfection:

- Does not harm the environment, no need for hazardous pesticides, easy to maintain and store.
- Lowest investment and operating costs compared to other cleaning technologies. Easy and simple maintenance, periodic cleaning
- Immediate action (or stop), no need to install special tanks.
- No changes in the pH of the irradiated water, its taste and smell, or conductivity compared to chemical water treatment.
- No need to work with toxic (poisonous) materials and no need for special storage.
- Easy to integrate into technological processes of disinfection.

Goal: determine the time for processing raw materials according to product quality indicators.

Presentation of the main research material. There are many ways to disinfect seeds. One of them is UV treatment, which is considered a harmless and proven method of eliminating pathogens and extending the shelf life of food and beverages. Bactericidal UV radiation of this wavelength causes thymine dimerisation of DNA molecules.

The accumulation of these changes in the DNA of microorganisms leads to slower reproduction and extinction. Germicidal UV lamps are often used in bactericidal irradiation systems and bactericidal recirculation systems.

Thanks to the development and improvement of artificial ultraviolet light (UV II) sources, which coincided with the development of electric light sources for visible light, the scope of UV applications in medicine, preventive medicine, hygiene and agriculture has expanded significantly.

A number of large electric lighting companies and others are developing and producing UV lamps for photobiological plants (PBUs).

Unlike illumination light sources, UV radiation sources usually have a selective spectrum designed to maximise the impact on specific PB processes. The classification of artificial UV II by application is determined by the spectrum of the FB process of interest with a specific spectral range of UV radiation: - Erythema lamps were developed to compensate for the ‘UV deficiency’ of natural radiation and, in particular, to enhance the photochemical process of vitamin D3 synthesis.

UV radiation can be divided into three groups according to wavelength: UV-A has the longest wavelength of 320-400 nm and is considered a precursor to sunburn and is traditionally associated with the skin of the back of the head; UVB has a wavelength of 280-320 nm and, compared to sunburn and UV-A, UV-B has an even shorter wavelength, and the third, UV-C, has an even shorter wavelength and is used for disinfecting surfaces, According to the FDA, 200-280 UV-C belongs to the ‘germicidal spectrum’ and ‘completely inactivates bacteria and germs, completely inactivates bacteria and germs'. This is probably due to the DNA mutations that occur when UV radiation is absorbed by DNA molecules.

During this sterilisation, the grain material was processed in motion with delays of 5 and 10 minutes. Thus, the results of the study of the intensity of the manifestation of the quality characteristics of seeds treated with different exposures of the top coating are presented.

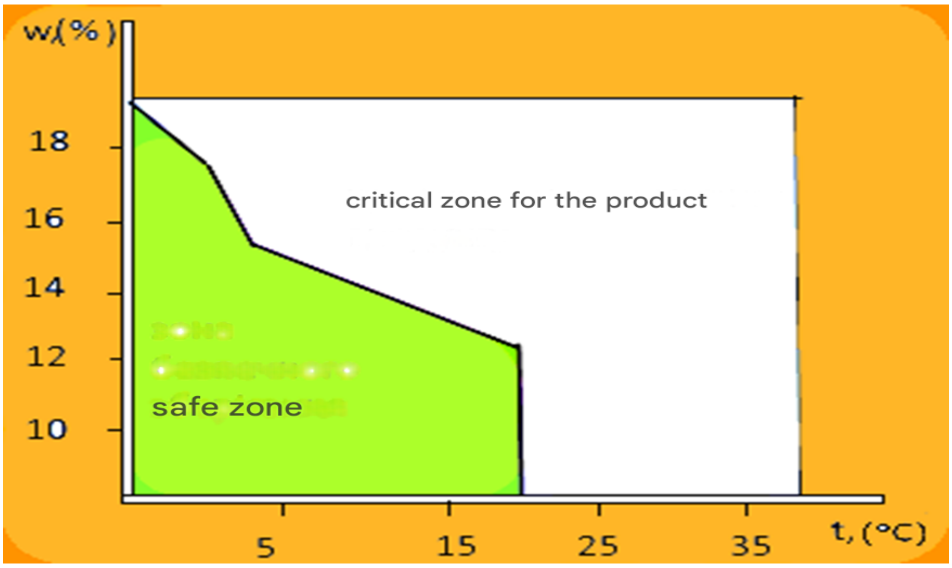

Figure1. Safe storage conditions.

Table 2

Results of research on high-quality seed characteristics processed with different exposures.

Final score with weighting factor, S	Category of intensity of change of qualitative indicator, J	Relative humidity ,φ %	Storage temperature, t, ºC	Number of days of storage, τ, of processed raw materials (exposure duration t, 5 min)	Number of days of storage, τ, of the processed raw material (exposure duration, t, 10 min).	Raw material is not processed
0	0	80	20	21	24	9
5	1	80	20	25	27	11
10	2	80	20	29	33	19
15	3	80	20	32	37	21
20	4	80	20	37	40	23
25	5	80	20	43	46	24
30	6	80	20	49	53	27

Conclusions and prospects for further research. The data obtained show that the fastest processing time for raw materials in accordance with quality indicators is 24 days when processing raw materials for 10 minutes.

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ОБРОБКА ТА ЗНЕЗАРАЖЕННЯ ФУРАЖНОГО ЗЕРНА ЯЧМЕНЮ

Анотація

Насіння - це біологічні організми, і вважається, що вони виділяють воду через дихання. Усередині силосу воно поширюється вгору конвективними потоками повітря. Цей невагомий потік спричинений різницею температур між теплим насінням у центрі силосу та більш холодними стінками силосу і навпаки. Якщо зерно зберігається з вологістю менше 12% і в захищеному від комах місці, підвищення вологості у верхніх шарах насіння не буде суттєво порушено.

Якщо зерно зберігається з вологістю понад 12%, у верхньому шарі утворюється достатньо вологи, щоб на насінні з'явилася пліснява. За таких умов, внаслідок розмноження мікроорганізмів, зерно втрачає свої кондиції і стає непридатним для виробництва кормів для худоби і птиці та інших продуктів, тому усунення шкідливої мікрофлори при переробці та зберіганні зерна є актуальним питанням для аграріїв.

Дефекти в кінцевому продукті виникають через використання неякісного зерна, порушення технології виробництва та недотримання умов і вимог зберігання. Основними дефектами є дефекти органічних і фізико-хімічних властивостей та мікродефекти.

Щоб запобігти зараженню продуктів харчування, зерна та насіння, продовольче зерно перед зберіганням і транспортуванням слід стерилізувати та дезінфікувати понад рекомендовані норми.

Найпоширенішими методами стерилізації та дезінфекції є хімічне покриття, теплова та холодна обробка або комбінація цих біологічних методів. Основна причина пошкоджень пов'язана з вмістом води в зернах, тому нагрів (механізм сухого тепла) став найбільш широко прийнятим великими органами зі зберігання і транспортування.

Для усунення діяльності мікрофлори використовується ультрафіолетове випромінювання (УФ-випромінювання), як один з методів обробки, він застосовується для припинення мікробної активності і видалення шкідників зерна, дією з електромагнітним випромінюванням в спектральному діапазоні між видимим світлом і рентгенівськими променями.

***Ключові слова**: ячмінь, псування, обробка, якість, експозиція.*

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