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IMPROVING TECHNOLOGY FOR DISINFECTING GRAIN FROM PESTS OF BREAD STOCK USING ULTRA-HIGH RADIATION FREQUENCIES

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Abstract: This study examines the potential of microwave electromagnetic fields (EMF) for pest control in grain storage facilities. Traditional methods of grain disinsection often require halting production and using harmful chemicals, which can affect grain quality and the environment. By contrast, EMF technology allows for continuous, chemical-free pest control, preserving grain quality and reducing environmental impact. The research investigates optimal EMF settings, focusing on power level and exposure time to maximize pest elimination without compromising grain characteristics. Results indicate that, at 180 W/m² for 120–160 seconds, microwave treatment effectively eradicates pests, enhances germination rates, and maintains grain physicochemical properties. Additionally, microwave-treated flour displays increased water absorption, which improves bread texture and quality. These findings suggest that EMF technology not only serves as an efficient pest management solution but also improves product quality, offering a sustainable alternative to conventional methods and aligning with food industry trends in safety and sustainability. This study thus provides valuable insights into integrating innovative, eco-friendly techniques in grain processing.

Keywords: microwave, pests, power, wheat, humidity, gluten.

Introduction

The Development Strategy of the new Uzbekistan sets the tasks of - "... conducting scientific research and developing specific proposals within the framework of the implementation of the food industry development program, in order to expand the base of food raw materials and gradually increase the volume of organic products, expand the range of food products, attract foreign experts within the framework of the republic's accession to the World Trade Organization" [1].

Disinsection in grain storage and processing facilities is a challenging and costly procedure that necessitates halting production entirely [2]. However, an innovative approach involves using microwave electromagnetic field treatment, which enables disinsection to occur continuously without interrupting operations. This advancement not only cuts costs but also enhances overall efficiency. It is crucial to pursue scientific studies in this field to ensure the effective preservation of grain from insect infestations while maintaining its quality and technological viability.

In addition to the economic benefits, this method presents a sustainable alternative to traditional pest control, which often relies on chemical treatments that can harm the environment and

affect grain quality. The application of microwave technology targets pests without damaging the grain itself, thus preserving its nutritional value and extending shelf life. Research in this area could lead to improved protocols that integrate seamlessly into existing production systems, allowing for real-time pest management [3].

Moreover, as the demand for high-quality grain products rises, implementing such innovative disinsection methods could provide a competitive edge in the market [4]. This shift towards modern pest control techniques aligns with the broader trends in food safety and sustainability, promoting a healthier food supply chain. Overall, advancing the scientific understanding and practical application of microwave treatments in grain facilities is essential for safeguarding food resources and enhancing productivity.

Methods

Preserving grain supplies is critical to ensuring food security and maintaining a stable agricultural economy. While various methods are used to protect these valuable resources, insect pests are a constant threat, which can significantly damage both the quantity and quality of stored grain.
Pests such as granary and rice weevils are particularly notorious for their destructive capabilities. In regions with warm climates and basic storage conditions, these pests, along with other species such as small mealworms, thrive and reproduce rapidly. Their presence poses a serious threat to grain supplies for several reasons:

These insects consume and destroy a significant proportion of stored grain, resulting in significant losses. They contaminate the grain with their remains, exoskeletons and excretions, reducing its quality and making it unfit for consumption or processing.

Self-heating is contamination can promote self-heating within the grain, leading to further spoilage and a potential fire hazard. Damaged and contaminated grain often exhibits compromised processing properties, which affects its suitability for various applications such as milling or brewing. Traditional grain disinfection methods often involve the use of chemicals that can have negative environmental impacts. Therefore, researchers are exploring alternative, eco-friendly approaches such as physical methods such as microwave processing.
Microwave processing has several potential advantages:

1. Environmentally friendly: eliminates the need for harmful chemicals, minimizing environmental impact.
2. Continuous operation: can be applied continuously, reducing the need for production stops that are often costly and disruptive.
3. Minimal volume reduction: microwave processing effectively controls pests without significantly reducing grain volume.

To optimize the effectiveness of microwave processing, researchers have focused on identifying the most suitable parameters for the application of this technology. The studies are examining the effects of different microwave power levels and exposure times on insect mortality, grain quality, and seed germination potential.

The results of these studies are of critical importance for the development of effective and environmentally friendly grain protection methods that ensure the safe and sustainable conservation of valuable food resources.

Results and Discussion

The infestation of grain stocks by pests poses a significant challenge that necessitates effective management solutions. One promising approach to pest control involves the use of ultra-high frequency (UHF) electromagnetic field (EMF) disinfection. The success of this method largely hinges on selecting the appropriate processing parameters, especially the optimal duration of UHF EMF exposure at various power levels.

This study aims to identify the ideal conditions for using UHF EMF to disinfect grain effectively, focusing on pest control efficiency while minimizing any adverse effects on grain quality. Researchers are dedicated to determining processing parameters that can maximize pest eradication rates and maintain the integrity of the grain.

The results from this research are expected to yield practical recommendations for optimizing the microwave disinfection process. Such advancements will help reduce grain stock losses and enhance both the quality and safety of the grain.

In particular, the study examines the physicochemical and baking characteristics of wheat grain. It investigates how disinfection influences these physicochemical properties, revealing no significant deterioration in grain quality when exposed to microwave radiation. Table 1 illustrates the quality metrics for control samples of grain and the processed products derived from a single batch of milling, providing a comprehensive overview of the effects of the disinfection process.

Through these investigations, the research seeks to contribute valuable insights into microwave disinfection methods, paving the way for more effective and sustainable pest control in grain storage and processing. By ensuring that pest management strategies do not compromise grain quality, this work aims to bolster food security and support the grain industry's economic viability.

Furthermore, the integration of UHF EMF disinfection into standard practices can align with contemporary trends in food safety and sustainability, emphasizing the need for innovative pest control solutions that are both effective and environmentally friendly. Overall, this study holds the potential to transform current pest management practices in the grain sector, ensuring a healthier, safer food supply while protecting valuable agricultural resources.

Table 1. Physicochemical parameters of flour and bread (obtained from disinfected wheat grain using EMF microwave radiation at a power of -180 W/m^2).

No	Name of the object	Flour from wheat grain of the milling batch	Wheat grain flour after EMF microwave radiation
	Flour obtained from disinfected wheat grain using EMF microwave radiation at a power of -180 W/m^2		
1	Humidity, %	10,5	10,5
2	Gluten content, %	28	27
3	Indicator, units IDK	85	84
	Bread baked from disinfected wheat grain using EMF microwave radiation at a power of -180 W/m^2		
1	Crumb acidity, deg.	3	3
2	Crumb porosity, %	69	68
3	Crumb moisture, %	45	43

From table 1 it follows that flour and bread obtained from wheat grain disinfected using EMF

microwave radiation comply with the standards established by regulatory documents. The experiments were carried out in laboratory conditions at the State Unitary Enterprise "Agroinspection" of the Andijan branch in 2021, with an emphasis on the Asr variety of winter soft wheat, approved for cultivation in the region [5].

In addition to studying the effect of microwave EMF radiation on the inactivation of insect pests, the scientists also studied its effect on the germination of wheat seeds. Of particular interest was determining the viability of seeds for sowing, especially under short-term storage and post-harvest ripening conditions.

The obtained results of seed germination were systematized and presented in table 2. Data analysis allowed us to establish the effect of microwave EMF radiation on the percentage of seed germination, the rate of germination, and the general condition of the seedlings.

It was found that certain parameters of microwave EMF radiation can stimulate the germination of wheat seeds and improve the quality of seedlings. These results are important for the practical application of microwave EMF radiation in agricultural practice. The correct selection of processing parameters allows not only to protect grain reserves from pests, but also to increase the viability of seeds for subsequent crop cultivation.

The analysis of table 2 shows that at a power of 180 W/m^2 and a duration of 120 seconds, the growth energy and germination of the product are within 92-95%. Experimental data confirm that the proposed parameters do not have a negative effect on the biochemical composition of the grain [6], [7], [8]. The experimental samples showed that the seed germination complies with the regulatory and technical requirements. In the disinfection processes using a power of 180 W/m^2 for 120 and 160 seconds, the growth energy and germination of seeds complied with the regulatory standards.

Throughout the study, the data obtained were consistent with the regulatory quality standards for winter wheat seeds after disinfection using microwave EMF [9,10]. Therefore, using a power of 180 W/m^2 for 160 s is considered appropriate, since it leads to optimal germination (95%) while maintaining the viability of seeds of disinfected wheat grain using microwave EMF [11], [12]. The most effective exposure modes for microwave disinfection are from 120 to 280 seconds at a power of 180 W/m^2. The results of the studies indicate that the use of microwave EMF significantly enhances the destruction of stored pests from grain masses [13], [14].

Table 2. The influence of EMF microwave radiation of wheat grain on the sowing qualities of seeds.

No	Name of indicators	The meaning of the indicators		
		According to regulatory documents	In fact	Regulatory documents on testing methods
1	2	3	4	5
The value of the power of the EMF microwave radiation W-180 W/^{m2},processing time τ-120 s				
1	Energy of growth , %	95	95	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".
2	Grain germination , %	92	95	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".

The value of the power of the EMF microwave radiation W-180 W/m^2, processing time τ-160 s				
3	Growth energy, %	95	93	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".
4	Grain germination, %	92	95	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".
		Control		
5	Growth energy, %	95	95	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".
6	Grain germination, %	92	92	GOST 12038-84 "Seeds of agricultural crops. Methods for determining germination".

Analysis of the effect of microwave EMF on moisture, gluten and temperature of grain shows that the effect of electromagnetic fields with a power of 180 W and a duration of 120-160 seconds meets the regulatory requirements for the physicochemical properties of grain [15], [16]. According to organoleptic assessments, under optimal conditions (180 W/m^2 at 120-160 s), the color, smell and taste of grain remain unchanged during microwave treatment [17], [18].

Conclusion

The use of microwave electromagnetic fields (EMF) for grain disinfection opens up new possibilities in the production of flour with improved technological characteristics. Research has shown that exposure to microwaves can change the properties of the protein-gluten complex of grain, affecting the quality of gluten. Experiments have shown that under certain microwave treatment parameters, flour acquires increased water absorption capacity. This leads to a change in the properties of dough and bread, making it more porous.

It is important to note that the microwave treatment mode directly affects the result. At low radiation intensity (100 W/m²), the disinfestation effect may be absent, but the baking properties of flour are preserved. Thus, microwave grain treatment is a unique tool that allows you to solve several problems simultaneously: (1) Disinfection: Destruction of insect pests without the use of chemicals, (2) Adjustment of flour quality: Improvement of water absorption capacity and porosity of bread, (3) Creation of flour with special properties: The possibility of obtaining flour with improved baking characteristics or special properties for the production of various types of bakery products.

Scientists continue to study the optimal modes of microwave processing of grain in order to maximize its efficiency and ensure the production of high-quality flour with improved properties.

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