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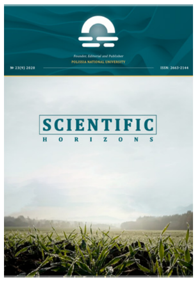

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Effect of an ultra-high frequency electromagnetic field on the physical properties of spelt grain

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Abstract. Since spelt grain is one of the most promising non-conventional types of plant material for healthy food products, it is important to investigate environmentally friendly technologies for post-harvest processing of this crop. The purpose of this study was to determine the physical changes in spelt wheat grain under the influence of microwave electromagnetic radiation. The study presented the results of research on how the electromagnetic field of ultra-high frequencies and the duration of processing

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affect the quality characteristics of spelt grain of the Holikovska wheat variety harvested in Cherkasy region in 2020 and 2021. During the experimental study, physical methods of grain quality research were used following the developed and existing methods and industry standards. The complex structural changes in spelt grains during their treatment with an ultra-high frequency electromagnetic field with an increase in grain size, shape, and volume were investigated. Analysis found that the grain fractional composition changed towards reducing the passage depending on the processing time by 1.5-4.0 times. It was found that the treatment of spelt grain with high-frequency waves for 20-180 s reduces grain moisture content by 2-36% compared to the control, with a significant decrease after the first minute of exposure. Moreover, during the first minute of intensive grain heating, the grain temperature increased, while during the next two minutes, the intensity of grain heating decreased by 1.5-3 times. It was also proved that irradiation with ultra-high frequencies decreased the number of vitreous grains, while the number of floury grains, on the contrary, increased. The analysis also found that the vitreousity of treated spelt wheat grain by electromagnetic waves of ultra-high frequency decreases by 1.3-1.5 times during the last 2-3 minutes of treatment. The developed recommendations for the use of ultra-high frequency electromagnetic waves in the technological processes of storage and processing of spelt grain can be used by enterprises to intensify the production of environmentally friendly products

Keywords: spelt grain processing; ultra-high frequencies; grain heating; quality; vitreousity; fractional composition

INTRODUCTION

The use of high and ultra-high frequency electromagnetic waves opens new opportunities for creating environmentally friendly grain storage and processing. The influence of the electromagnetic field of ultra-high frequency on the technological quality of spelt grain needs to be investigated to understand the nature of its further use. Microwave heating processes are currently used in many areas: from environmental remediation processes (Stanislavov *et al.*, 2018); in the food industry (Demir *et al.*, 2023), to new pharmaceutical technologies (Kumeda & Sukhodub, 2021). According to researchers, spelt wheat grain is a valuable source of protein, fibre, and many useful components, and has a special flavour with nutty notes, making it a valuable raw material for the food industry. L.A. Vecherska *et al.* (2018) emphasise the key problem of the agro-industrial complex – increasing the nutritional value, digestibility, and assimilation of grain as a component of food and feed production. Y. Kretova *et al.* (2018) recommend grain treatment by microwave irradiation to stabilise the product and as an effective alternative to chemical insect deinfestation methods.

In experiments on irradiation of plant seeds with an ultra-high frequency electromagnetic field (UHF EMF) (Zhong *et al.*, 2018), two effects are described: one is stimulation of germinating ability and germination energy of seeds, increase in the biomass of the crop, improvement of its structure (increase in the content of carotene and sugar in roots, protein in grain, starch in potatoes), and the second is lethality to living organisms. The most widespread processing of grain raw materials with UHF waves in the food industry is in the bakery, confectionery, and oil industry (Osadchuk, 2019).

Y. Kovra *et al.* (2022) found the influence of the ultra-low frequency electromagnetic field (ULF EMF), electromagnetic induction (EMI), processing duration, conditions and duration of storage of the treated grain on the quality characteristics of wheat grain. Microwave treatment is widely used to disinfect and improve the value of grain. Thus, M. Sarraf *et al.* (2020) investigated the bactericidal effect of UHF treatment, inhibiting and destroying existing fungi, bacteria, and insects, ensuring this without any chemicals, which is extremely relevant today. V. Liubych *et al.* (2019) argue that intensive and environmentally friendly technologies are increasingly used for grain cultivation. Therewith, the requirements for alternative methods of replacing chemical processing include competitiveness, environmental friendliness, and safety for humans. That is why such a method of exposure as irradiation with UHF waves was recommended. The specific feature of heating bulk material with UHF is its penetration of the electromagnetic field into the grain without an intermediate gas medium, while the amount of heat generated in it and its distribution throughout the grain depended on the humidity. Where the humidity was higher, the temperature was also higher. Since the moisture content in the centre of the kernel is always higher, the temperature and pressure in the centre of the kernel are also consistently higher than in the shell. Due to this effect, moisture from the inside of the kernel is forced to the surface of the kernel, from where it can be easily removed, which is an advantage of this method of hydrothermal treatment.

A. Zykov *et al.* (2019) states that considerable advantages in drying bulk materials are provided by the use of UHF electromagnetic field energy. Thus, since electromagnetic waves penetrate each particle of raw material, heating it from the inside, and the heating is more intense the higher its moisture content, the release of moisture is much more intense due to an increase in internal steam pressure; this is especially true for grains with hard shells. Therewith, energy consumption and material intensity of production lines reduced, while the consumer received a high-quality product. The purpose of this study was to establish the effect of microwave oven electromagnetic radiation at different exposure times on the physical properties of spelt grain.

MATERIALS AND METHODS

The principal research was conducted at the educational and scientific laboratory "Quality Assessment of Grain and its Processed Products" of the Department of Food Technologies of the Faculty of Engineering and Technology of Uman National University of Horticulture in 2020-2022. For UHF treatment, the study used spelt wheat grain of the Holikovska variety. The theoretical research was based on the methods of the theory of heat and mass transfer and drying, mathematical modelling of technological processes, and was carried out using the basic principles of higher mathematics, while experimental studies were carried out following the developed and existing methods and industry standards (DSTU 3355-96, 1996; DSTU 4138-2002, 2003; DSTU ISO 712:2015, 2016) in laboratory conditions on the developed experimental microwave oven unit using the planning of a multivariate experiment and the application of statistical processing methods.

The study was conducted according to the following scheme:

- processing grain in a microwave oven;
- determination of temperature rise under the influence of an electromagnetic field;
- determination of changes in grain size using laboratory sieves;
- investigation of the effect of grain temperature on their vitreousity.

During the experiment, physical research methods were used to treat the grain with UHF waves, determine the temperature of the grain, its fractional composition, and vitreousity. The grains were treated with the electromagnetic field of a kitchen microwave oven (P=1.0 kW). The prototypes were exposed to an electromagnetic field from 20 to 180 s (periods with an interval of 20 s).

An increase in temperature above 40°C in the initial stages inactivates the enzymatic activity of the grain, and above 60°C leads to coagulation and protein denaturation. At 50-60°C grain starts losing its viability. The temperature was measured immediately after grain processing with a compact pyrometer. The moisture content of spelt grain was determined by drying in an electric drying oven (SES-3MC, Ukraine) at 130°C for 40 min.

The total vitreousity of the grain is determined in a 50 g sample of wheat grains, free from debris and grain impurities. The total vitreousity is the sum of the fully vitreous and half of the partially vitreous grains. The analysis is performed using a DSZ-3 diaphanoscope (OLISLAB 1100, Ukraine). The total vitreousity of spelt grain was determined according to the following formula:

$$\text{Vitreousity (\%)} = 0.5\times C - 0.5\times B + 50\%, \qquad (1)$$

where C is the number of fully vitreous grains, pcs; B is the number of fully mealy grains, pcs.

Generally accepted methods for determining grain moisture and vitreous content were used, as described in Methods of determining product quality indicators of crop production (2016), approved by Working instruction No. 04 (NIBULON LLC, 2021). The size of wheat grains was determined using sieves with different diameters, namely ø2.0, ø2.2, ø2.4, ø2.6, ø2.8, and ø3.0. The sieves were placed on a universal laboratory sieving machine RLU-1 (OLISLAB 5100, Ukraine). The sieving time was 2 min. After sieving, grain fractions were selected from each sieve and weighed using a KERN 440-21N laboratory balance (KERN&SOHN, Germany).

RESULTS AND DISCUSSION

Temperature of spelt wheat grain after UHF treatment. When spelt grain was treated with microwave beams, it was heated, which led to the evaporation of moisture and drying of the grain. It is important to establish regularities in the temperature and moisture content of the grain. The dynamics of these indicators was recorded for 180 s (3 min) in increments of 20 s (Table 1).

Table 1. *Temperature of spelt wheat grain after UHF treatment*

Duration of exposure to UHF EMF, s	Temperature, °C			Humidity, %
	minimum	maximum	average	
0	–	–	15.5	11.9
20	29.8	48.6	39.2	11.7
40	45.2	82.5	63.8	11.4
60	56.6	109	82.8	11.0
80	64.8	125.1	94.9	10.5
100	77.5	135.5	106.5	10.1
120	93.6	138.4	116	9.4
140	97.8	146.5	122.1	8.9
160	102.1	144.3	123	8.0
180	112.2	142.8	127.5	7.6
LSD_{05}	*6.1*	*9.7*	*7.7*	*0.7*

Note*: the temperature before grain processing was 15.5°C*
Source*: developed by the authors of this study based on (Qu et al., 2017; Osokina et al., 2020)*

Table 1 shows that after 20 s of heating, the grain temperature increased: at the minimum, from 15.5°C to 29.8°C, and at the maximum, up to 48.6°C, which is on average 2.5 times higher than the initial temperature of the spelt grain. After 40 s of heating, the minimum grain temperature increased by 3 times, and the maximum by 5 times, or 4 times on average. After 60 s of heating, the rate of temperature increase decreased slightly, but the minimum temperature increased 3.7 times, while the maximum temperature increased 7 times, or 5.3 times on average. In other words, after 1.0 min of heating the grain, the temperature increased to 57-109°C or an average of 83°C.

During the second minute of heating for 80-120 s, the minimum temperature of the spelt grain increased 5-6 times and reached 93.6°C, the maximum temperature increased 8-9 times and reached 108.4°C. Therewith, the average temperature crossed the 138°C mark, i.e., it averaged 116°C, a 7.5-fold increase. During the third minute of heating, the intensity of the process slowed down and the minimum temperature increased to 112°C or 6.7 times, the maximum temperature to almost 143°C or slightly more than 9 times. The average temperature reached 127°C, while the increase was 9.3 times higher.

Thus, a sharp increase in grain temperature (min – 60°C, max – 109°C, average – 83°C) occurred during the first minute of heating, which was 4.7 and 5 times higher than the initial temperature, respectively. During the second minute, the heating rate was 1.5 times higher compared to the first minute. Therefore, the grain temperature was min up to 94°C, max up to 134°C, and an average of 116°C, which corresponded to an increase of 6.6-7.5 times. During the third minute, the grain continued to heat, but the intensity decreased by a third compared to the second minute, and therefore the grain temperature was: min – 112°C, max – 144°C, and on average – 127°C, which corresponds to an increase of 7.7, 9.3, and 8.2 times, respectively. At the same time, a decrease in grain moisture content was observed during heating. However, the changes had a slightly different trend.

During the first minute of heating, the moisture content of the grain decreased by almost 1% – from 11.9% to 11%, which was only 10% of the initial moisture content. In the second minute (within 100 s), the humidity decreased and reached 1.8% (only 12%). Over the next 120-140 s, these indicators increased, while the humidity decreased to 8.9%, or a 1.3-fold decrease by 3 relative percent. By the end of the third minute, the grain moisture content had decreased by 4.3%, or 1.5 times, to 7.6%. This trend could be explained by the fact that the grain sample at the beginning of the experiment had a low moisture content of 11.9% (dry grain). There is no free moisture in this grain. During the energy, bound moisture was released from the grain – hygroscopic moisture. The process started with external heating and then moved to the centre of the kernel. Based on the analysis, it can be concluded that microwave rays had a specific effect on the heating intensity of spelt grain and changes in its moisture content. The moisture content of dry grain (11.9%) decreases by only 10% in the first minute, by 12% in the second minute, and by 1.5 times by the end of the third minute. In total, the grain lost 4.6% of its moisture, with a significant deepening by the end of the process.

Fractional composition of spelt wheat grain after UHF EMF treatment. The grain arriving at the elevator often differed substantially in quality. To improve them, it is advisable to fractionate grain and seeds by different properties (geometric dimensions, density, etc.) (Kostetska & Herasymchuk, 2022). Having quantified the distribution of grains by their geometric structure (in %), the fractional composition of the grain was obtained. In this case, the fines and tails of grains from sieves of different diameters. For the study, 200 g of grain was used with different duration of exposure to UHF EMF. The grain fractional composition after UHF treatment is presented in Table 2.

Table 2. *Fractional composition of spelt grain after UHF treatment, %*

Duration of action UHF EMF, s	Sieve fines ø					Sieve tails ø
	2.2 mm	2.4 mm	2.6 mm	2.8 mm	3.0 mm	3.0 mm
0	4.4	9.5	26.7	28.0	21.6	8.5
20	2.6	10.5	25.9	27.5	23.9	8.7
40	2.8	9.2	26.0	28.1	24.0	8.9
60	2.0	8.5	22.8	29.4	26.0	10.3
80	2.4	8.9	23.8	27.0	26.2	10.1
100	2.3	8.8	23.0	25.9	27.0	10.6
120	2.5	8.2	22.1	26.7	26.6	12.2
140	1.4	4.8	12.8	20.3	27.8	29.30
160	1.1	4.3	11.2	16.5	24.9	38.4
180	1.2	4.4	14.1	17.6	28.3	29.6

Source*: developed by the authors of this study based on (Qu et al., 2017; Kostetska & Herasymchuk, 2022)*

During prolonged treatment with UHF EMF, the grain deformed, increased in size, and swelled. The data in Table 2 show that the treatment of spelt wheat with UHF EMF substantially affects the grain size. Since the number of fines decreased when the grain was sieved through a 2.2 mm sieve, it can be assumed that the shape of the grains became more rounded. If the amount of sifted untreated grain was 4.4%, then with the duration of exposure to UHF EMF, this amount decreased by 1.6-3.6 times. Moreover, for the duration of UHF exposure – 20-40 s – the indicator decreased by 1.6-1.8% or 1.6 times, and for the duration of 60-120 s – by 2.0% or almost 2 times compared to untreated grain. With a processing time of 140-180 s, it increases by 3.1-3.3% or 3.6-4.0 times. That is, the most critical moments in the change in grain size are during processing for 40-60 s and after 120 s.

An analogous trend was observed with grain sieved through a 2.4 mm sieve. The critical limit for a sharp decrease in the number of grains after sieving is wheat at a processing time of 140 s. Thus, the figure dropped from 8.2% (120 s duration) to 4.8%, which is almost 2 times lower. When the grain was sieved through a 2.6 mm sieve, an analogous decrease in the number of grains was observed at the critical limit of the treatment time of 140 s. That is, after 120 s, the number of grains decreased by almost 2 times or 9.3%. A less drastic reduction in grain was observed when sieving on a 2.8 mm sieve. However, after a treatment duration of 120 s, the indicator decreased by 6.7%, which is only 5% relative; after 180 s, it decreased by 10.4%, or 1.6 times.

That is, it was found that with an increase in the fraction of sifted grain, the number of fines decreased. This confirms the conclusion that the bulk grain size increased after irradiation. This pattern is also confirmed by the fact that if one combines the largest fractions of the fines through the ø2.6, 2.8, and ø3.0 mm sieves, their sum is 76.3% for untreated grain, and after treatment up to 180 s, the figures are 77% and 75%, i.e., they did not differ significantly. However, during further processing, the amount of sifted grain decreased to 60% and 57.7%, i.e., there was less sifted grain because its size increased and it stayed on the sieve surface. This is especially evident when looking at the passage and descent of grain through a 3.0 mm sieve. The number of fines and tails through the ø3.0 mm sieve increased during processing. However, the trends were different.

The passage through the 3.0 mm sieve increased slightly by 4.4% after 60 s of processing and stayed at 5% after 120 s, while after 180 s the increase was 6.2-6.7%. In other words, the overall increase was 1.2 times, and 1.3 times in 180 s. The tails from a ø3.0 mm sieve increased only to 2-3% in 120 s, and during the third minute of treatment, the excess reached 20-30%, or 1.2-1.4 times and 3.4-4.5 times, respectively. The data obtained confirm that during the irradiation treatment of grain, the fraction of grain with a larger volume and size increased during the grain sieving and the volume of grain increased significantly during its treatment for three minutes. Thus, it can be concluded that complex structural changes in the grains occurred during the treatment of spelt grain with UHF EMF. This led to an increase in their size, shape, and volume. The grain fractional composition during sieving through ø2.2, ø2.4, ø2.6, and ø2.8 mm sieves changed towards reducing the passage by 1.5-2.0 times and even 3.6-4.0 times, respectively. On the other hand, the fines and tails of a ø3.0 mm grain increased by 1.2-1.3 times and 1.4-3.4 times, respectively.

Vitreousity of spelt grain after UHF treatment. Vitreousity affects the structural and mechanical properties of the grain, which determine the modes of preparation for processing. Wheat grain is divided into three groups according to its vitreousity: ⩾40% – floury, 40-60% – semi-glazed, ⩽60% – vitreous. The vitreous spelt grains had a transparent consistency with a horn-shaped structure in the section, and the floury grains had an opaque consistency, loose, white in the section. It is known (Osokina *et al.*, 2020) that vitreous characterises certain technological properties of grain, its intended use, and usually vitreous grain contains more proteins than floury grain. The data are presented in Table 3.

Table 3. *Vitreousity of spelt grain after UHF treatment*

Duration of action UHF EMF, s	Number of grains pieces		Vitreousity, %
	vitreous	mealy	
0	69	2	83.5
20	59	6	76.5
40	53	4	74.5
60	54	4	75.0
80	46	5	70.5
100	33	10	61.5
120	35	11	62.0
140	28	16	56.0
160	17	26	45.5
180	20	30	45.0
LSD_{05}	–	–	*3.25*

Source*: developed by the authors of this study based on (Liubych et al., 2019; Osokina et al., 2020)*

Table 3 shows substantial changes in the vitreous content of spelt grain. With increasing irradiation time, the number of vitreous grains decreased: in the first minute of treatment – by 1.3 times, in the second minute – by 2 times, and in the third minute – by 3.5 times. At the same time, the amount of floury grains increased significantly: in the first minute of processing – by 3 times, in the second minute – by 5.5 times, and in the third minute – by 15 times. These changes have a substantial impact on the grain's vitreousity. As Table 3 shows, unprocessed spelt wheat grain is highly vitreous, with a vitreousity of 83.5%. However, in the first minute of grain processing, the figure dropped substantially – by 8-10% but was still high – up to 75%. After the second minute of processing, the grain vitreousity decreased by 26% to 62%, but the grain stayed in the highly vitreous group. However, during the third minute of grain processing, its vitreousity decreased by 1.3-1.5 times and dropped to 46%. As a result, the grain has moved into the medium-vitreous group.

Changes in the vitreous quality of the grain are natural and are associated with a decrease in protein and starch content and a disruption in the grain structure, which changed the monolithic bond between protein and starch. Thus, the number of vitreous grains decreased within three minutes of processing by 1.3, 2, and 3.5 times, and the number of flour grains increased by 3, 5.5, and 15 times during the same time. This was reflected in the vitreousity of the grain, which decreased from 83.5% to 45%, or by 10%, 26%, 46%, or 1.3-1.5 times in the last 2-3 minutes of treatment. The positive experience in reducing moisture content as a result of the UHF EHF confirmed in this study confirms the possibility of using these technologies for drying spelt grain. However, among other microwave conditions, heating spelt grain shows significant results in terms of increasing the floury grain in these samples already after 20 s.

Research confirms the conclusions of A. Zykov *et al*. (2019) about effective microwave drying of grain, which allows ensuring the supply of powerful energy flows to the drying object and obtaining a significant intensification of moisture evaporation. The use of microwave irradiation in the heat treatment of grain is relevant and of practical importance for modern industrial grain processing. The revealed effects of grain irradiation before processing indicate the prospects of introducing the proposed processing methods into production. The shortcomings of the study include the lack of technical and economic indicators of grain production using UHF irradiation. It is advisable to conduct further research on the energy intensity of the microwave irradiation process and compare it with conventional drying methods for existing enterprises. Furthermore, a detailed investigation of the reduction of investment risks resulting from the integration of microwave irradiation into the design of new grain mills of various capacities is required. It is advisable to further study the effect of UHF irradiation on the yield and quality of grain processing products. The safety indicators of finished products, specifically microbiological changes in spelt grain and the quality of finished products as a result of UHF irradiation before hulling, grinding, grinding, etc., need to be clarified.

The obtained results of the effect of such treatment on reducing the vitreousity of spelt grain necessitate the development of recommendations for the use of UHF EMF treatment for milling or feed grain, where the highly vitreous characteristics of grain are of less technological importance. The study by V. Liubych *et al*. (2019) on the use of alternative methods of hydrothermal treatment to further improve the hulling of cereal grain is for spelt grain, which the authors recommend to be used for flattening. Considering the findings of S.S. Biradar *et al*. (2021) on the value of spelt grain as a source of useful components, it is relevant to use UHF EMF to process raw materials processed into functional foods. Moreover, according to H. Zhong *et al*. (2018), the application of electric field and electromagnetic waves can cause conformational changes in the protein by creating free radicals or larger or smaller molecules that damage the primary, secondary, tertiary, and quaternary structure of the protein and thus affect the functional properties of the product. Therefore, electric fields and electromagnetic waves are useful methods for changing the structure of food products, but the changes in protein structure modification of spelt grain are still understudied. Furthermore, research by A. Arzani (2019) confirm that the sustainable use of natural genetic resources is important for achieving the goals of using biological diversity, ensuring the reproduction of ecological integrity and environmental sustainability. Therefore, reviving the unfulfilled potential of ancestral species such as spelt, which is the domesticated ancestor of modern bread and durum wheat, should include multidimensional measures of genetic resources, food diversity, and ecosystem benefits. This creates the preconditions for growing this crop through organic farming. The recommended regimes can be applied to spelt wheat grain of the Holikovska variety or other wheat varieties with comparable technological characteristics. The processing of spelt grain with other technological properties requires a separate investigation.

CONCLUSIONS

Based on the analysis, it can be concluded that UHF rays have a specific effect on the heating intensity of spelt grain. Within the first minute of heating, the grain temperature increases to an average of 83°C. During the second minute, the grain heating intensity decreases by 1.5 times, while the grain temperature is 6.6-7.5 times higher than the initial one. After the third minute of heating the grain, the temperature decreases by three times, with an average grain temperature of 127°C. It can be concluded that complex structural changes occur in spelt grains during microwave EMF treatment. This leads to an increase in their size, shape, and volume. The grain fractional composition during sieving through ø2.2, ø2.4, ø2.6, and ø2.8 mm sieves changes towards reducing the passage by 1.5-2.0 times and even 3.6-4.0 times, respectively. In contrast, the fines and tails of a ø3.0 mm grain increase by a 1.2-1.3 times and 1.4-3.4 times, respectively.

The UHF irradiation caused considerable changes in the grain vitreousity. Thus, the number of vitreous grains decreases within three minutes of processing by 1.3, 2.0, and 3.5 times, while the number of mealy grains increases by 3.0, 5.5, and 15.0 times during the same time. This had an impact on the grain's vitreousity. It decreased from 83.5% to 45%, or by 10%, 26%, 46% in three minutes of processing, or by 1.3-1.5 times in the last 2-3 minutes.

Thus, studies established a substantial effect of UHF electromagnetic radiation of the exposure duration on the physical properties of spelt wheat grain, namely an increase in grain size, its mealiness and temperature with a significant decrease in grain moisture content after the first minute of exposure. It is recommended to investigate the impact of UHF EMFs on the technological properties of grain, including the nutritional value of the finished product, in greater detail with regard to quality and safety indicators for the further use of such grain for agricultural (sowing) or food (processing) purposes. Having reviewed and investigated the study conducted by scientists on the effects of electromagnetic radiation on food, and having drawn conclusions regarding the current research, the authors of this study recommend that further clinical and biochemical studies be conducted.

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CONFLICT OF INTEREST

The authors of this study declare no conflict of interest.

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Вплив електромагнітного поля надзвичайно високої частоти на фізичні властивості зерна полби

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Анотація. Оскільки зерно полби є одним із найбільш перспективних нетрадиційних видів рослинної сировини для продуктів здорового харчування є актуальним вивчення екологічно чистих технологій післязбирального оброблення зерна цієї культури. Метою роботи було встановлення фізичних змін зерна пшениці полби під дією електромагнітного випромінювання мікрохвильової печі. У статті представлені результати досліджень того, як електромагнітне поле надзвичайно високих частот, а також тривалість обробки впливають на якісні характеристики зерна пшениці полби сорту Голіковська зібраної в Черкаській області у 2020 та 2021 роках. Під час експериментальної роботи були використані фізичні методи дослідження якості зерна згідно розроблених та існуючих методик і галузевих стандартів.Досліджено складні структурні зміни в зернівках полби під час його оброблення електромагнітним полем надзвичайно високої частоти із підвищенням розміру, форми та об'єму зернівки. Було проаналізовано, що фракційний склад зерна змінювався вбік зменшення проходу залежно від тривалості оброблення в 1,5-4,0 рази. Встановлено, що обробка зерна полби високочастотними хвилями впродовж 20-180 с знижує вологість зерна порівняно з контролем на 2-36 % зі суттєвим її зменшенням уже після першої хвилини впливу. При чому, відразу впродовж першої хвилини за інтенсивного нагрівання зерна відбувалося збільшення температури зерна, тоді як протягом двох наступних хвилин встановлено зменшення інтенсивності нагрівання зерна в 1,5-3 рази. Також, доведено, що опромінення надзвичайно високих частот впливало на зменшення кількості склоподібних зерен, а кількість борошнистих зерен, навпаки, збільшувалась. Було проаналізовано, що склоподібність обробленого зерна пшениці полби електромагнітними хвилями надзвичайно високої частоти знижується в 1,3-1,5 рази за останні дві-три хвилини оброблення. Розроблені рекомендації використання електромагнітних хвиль надвисокої частоти у технологічних процесах зберігання і перероблення зерна полби можуть бути використані підприємствами для інтенсифікації виробництва екологічно чистих продуктів

Ключові слова: оброблення зерна полби; вкрай високі частоти; нагрівання зерна; якість, склоподібність; фракційний склад