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THE INFLUENCE OF ANAEROBIC CONDITIONS OF MAIZE GRAIN STORAGE ON THE CHANGES IN THE QUALITY PARAMETER “FALLING NUMBER”

A. Borta, Candidate of technical science, associate professor¹M. Zhelobkova, director²¹Department of grain storage technology

Odessa National Academy of Food Technologies

112, Kanatna str., Odesa, Ukraine, 65039

²LLC MILL BASE

22 Lysenka str., Andrushivka, Zhytomyr region, 13400

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Correspondence:

M. Zhelobkova

E-mail: noria@meta.ua

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Abstract. In recent decades, at Ukrainian farms and grain-processing enterprises, the technology of storing grain in silo bags has become widespread. In this type of storage, anaerobic conditions are created due to the physiological respiration process, which ensures extended shelf life of freshly harvested grain. This, in turn, allows the use of low-power processing equipment for post-harvest grain processing, which is especially important for wet and moist maize as it requires powerful grain dryers. The article presents the results of a study of the effect that the initial moisture content of maize grain, the temperature and the duration of its storage under anaerobic conditions have on the Falling Number, one of the quality parameters depending on the amylase activity of the grain. The object of the study was grain samples of freshly harvested (in 2017) dent maize, the hybrid DKC 3705, with the average moisture contents 14%, 21%, and 28%, stored under anaerobic conditions for 3 months at temperatures of +18°C, +11°C, and +4°C. The Falling Number was determined by the standardized Hagberg-Perten method on a ПЧН-7 instrument (“Falling Number Apparatus”). Based on the results obtained, histograms of the kinetics of Falling Number changes have been constructed, the analysis of which made it possible to establish patterns of the changes in the Falling Number depending on the moisture content of the grain and the duration of its storage at different temperatures. It has been shown that in the maize grain samples with the initial moisture content 14%, regardless of the temperature conditions during storage for 3 months, there is a steady tendency to a gradual decrease in the Falling Number. In the maize grain samples with the initial moisture content over 14%, at the beginning of storage, there is a period of an increase in the Falling Number, the intensity of which depends on the initial moisture content of the grain and the temperature conditions of its anaerobic storage. After the completion of post-harvest maturation processes in freshly harvested maize grain, its further storage leads to a decrease in the Falling Number. To summarize the experimental data, a nonlinear empirical equation is suggested to describe the patterns of changes in the Falling Number depending on the factors studied: the moisture content of maize grain, the temperature conditions and duration of storage. Considering that the value of the Falling Number is determined by the activity of the amylase complex of the grain, it can be used as an express method of monitoring the state of grain stored in silo bags.

Key words: maize grain, storage, silo bags, Falling Number, amylase complex activity

Introduction. Formulation of the problem

In recent decades, the technology of storage of grain under anaerobic conditions, known for several thousand years, has acquired a new meaning and been widely adopted [1]. Its benefit consists in the fact that it allows controlling in the natural way the breeding of insects and the growth of moulds [2]. Nowadays, the volume of products stored in airtight conditions has grown from

small family-owned cellars to large industrial storage facilities, mainly due to the use of flexible polyethylene granaries – silo bags providing a level of airtightness enough for a large grain storage volume [1,3]. Now this technology is used mainly for dry grain. However, as large volumes of grain are delivered to enterprises during harvesting periods, there is a need to delay the technological drying of wet and moist grain at grain-processing enterprises, and later on, bring the grain

quality to the contract requirements. This problem can be solved by using the economical technology of storing grain in silo bags, where anaerobic conditions are created due to the physiological process of respiration, and where grain can be reliably stored for a significantly longer time. This is especially true for a crop with so high a moisture content as maize, which requires powerful technological equipment for its post-harvest processing, primarily drying [4]. When freshly harvested maize grain is stored in sealed silo bags at the initial stages, it allows the physiological and biochemical processes of post-harvest maturation to complete. Then, depending on the moisture and temperature of the grain, undesirable changes in its quality can occur, primarily due to the activation of enzymatic complexes, in particular, amylase. At the same time, starch hydrolysis will intensify in maize grain, the amount of simple sugars will increase, and the grain quality will deteriorate. This obviously makes it necessary to monitor periodically the state of grain in the silo bags, and to have simple and available methods and quality parameters to this end.

Analysis of recent research and publications

Various authors have studied the process of storing grain under anaerobic conditions. These studies have shown that under these conditions, the chemical composition of grain remains almost unchanged. However, there can be a slight increase in the moisture content of grain, because when grain respire, it emits vapourized moisture. There are also certain changes in the organoleptic characteristics of the grain and in some physical and technological quality parameters [5-7]. It is noted that it is the initial moisture content of the grain and the temperature conditions of its storage that determine how its final moisture content changes. This coincides with and is explained by the nature of the processes of oxygen absorption and carbon dioxide emission.

Grain is a living organism, and it is characterized by the natural physiological processes of respiration, on which grain carbohydrates are spent. The biochemical processes of enzymatic hydrolysis of grain polysaccharides lead to the formation of low molecular weight compounds, in particular, mono and disaccharides, in the fractional composition of carbohydrates. The activity of amylolytic enzyme systems of grain, responsible for splitting polysaccharides to low molecular weight carbohydrates, determines the intensity of physiological processes in the grain. These processes depend on the moisture content and the temperature of the grain, that is, on the storage conditions [8-10]. Many authors who study the storage of grain in silo bags consider this type of granary as suitable for storing dry grain, or for storing wet and moist grain with its subsequent use as animal feed [11].

Chemical methods of determining the activity of amylase complexes are time taking, complicated, or

inconvenient for analyzing grain quality in farms and other grain-processing enterprises. At the same time, almost all enterprises have devices for express determination of some parameters of grain quality. One of them is a device for determining the so-called Falling Number (FN). This parameter indirectly characterizes the degree of breaking starch down by the amylase enzymatic complex. This manifests itself in changes in the viscosity of the starch suspension in the device, and is expressed by the duration of the free fall of the stirrer down to the bottom of the device in seconds (which is, in fact, what is called Falling Number). Thus, observing the tendencies in the changes of the Falling Number, we make a conclusion about the stability of the maize grain during storage, or about the activation of the amylase enzymatic complex, which may be one of the reasons for undesirable changes in the quality of, or for damage to grain during storage.

As literary review has shown, there have been no previous studies of changes of the Falling Number for maize grain depending on the moisture content of the grain and the duration of its storage under various temperature conditions. That is why, the results we have obtained make our work scientifically novel.

The purpose of the work was to establish regular patterns in the changes of the quality parameter "Falling Number" determined by the activity of the amylase complex, depending on the moisture content of the maize grain, the temperature conditions, and the duration of its anaerobic storage. This is supposed to allow rapidly controlling the state of maize grain of various moisture content, stored in silo bags.

The research **objectives** were to study the kinetics of changes in the Falling Number depending on the moisture content of maize grain, the temperature conditions and the duration of its storage, to compose an empirical equation describing the identified tendencies in the Falling Number changes during storage under various conditions, and to generalize the results.

Research materials and methods

Materials: a hybrid of maize grain of the dent type DKC 3705, which, according to its botanical and agrotechnical properties and to our research, was found to be the best for the formation of export consignments of maize grain, as well as for its use as food and for other needs [6]. Experimental models of silo bags, 300 mm long, 100 mm wide, made from the material of industrial silo bags, glued with reinforced adhesive tape to provide the highest air tightness, filled with maize grain of the above-mentioned hybrid.

Research methods. The Falling Number (FN) was determined by the Hagberg-Perten method developed in the 1960s to determine the activity of α -amylase in grain and malt [12]. Despite a great many new methods [13-15], it is still a standardized method (ICC 107/1, ISO 3093-2004, AACC 56-81B) used in grain processing industries throughout the world. As

the α -amylase activity is determined indirectly, it is impossible to measure the absolute value of the activity of this enzyme. However, the stable inverse dependence of the Falling Number on the activity of α -amylase [12,16] allows us to analyze the changes in the grain with a degree of accuracy sufficient for the research. Current ICC Standard No. 107/1 *Determination of the Falling Number according to Hagberg - Perten as a Measure of the Degree of Alpha-Amylase Activity in Grain and Flour* allows using this technique for flour and whole-grain meal of wheat, rye, barley, and other cereals. Besides, the method is applicable to products containing starch and malt, that is, to maize, too. Other authors have used it to study the Falling Number of maize flour [17].

The chemical essence of the method is rapid gelatinization of a flour or grain suspension in a test tube immersed in a boiling water bath, followed by liquefaction under the influence of α -amylase. Stirring ensures homogeneous gelatinization of the suspension. In the range of high temperatures, α -amylase begins breaking the starch down, and the viscosity of the suspension decreases. The amount of the destroyed starch correlates with the activity of α -amylase: the higher the α -amylase activity, the lower the viscosity is. When the stirrer freely falls down the suspension, the speed of this fall and, accordingly, the time the stirrer needs to reach the bottom of the tube will depend on the viscosity of the suspension.

The Falling Number was determined on a ПЧП-7 device (with a closed cooling system) by the following method. To prepare a sample, 300 grams of maize grain was ground in a technological laboratory mill JIMT equipped with a sieve with 0.8 mm meshes, which is necessary to minimize a possible sampling error. The ground grain weighing 7.0 ± 0.05 g was placed in a viscometric test tube. The amount of flour was adjusted by its moisture content by measuring the actual moisture content in the sample. 25 ± 0.2 cm³ of distilled water was added to the test tube. The sample and water were mixed by shaking the tubes intensely until a homogeneous suspension was obtained. Next, the test tube with a stirring rod in it was placed into a container with boiling water. Stirring began after 5 seconds. After 60 (5+55) seconds, the stirrer is automatically moved to the upper position, and then it begins falling down due to its own weight. The total time in seconds, from the moment the analysis starts to the moment the stirrer reaches the required level registered by the device, is the Falling Number.

Samples of freshly harvested maize grain with the initial average moisture content 14%, 21%, and 28% were stored under anaerobic conditions at the temperatures 18°C, 11°C, and 4°C. The necessary temperature conditions of storage were provided in an ENIEM refrigerator ($4 \pm 1^\circ\text{C}$), in the basement ($11 \pm 3^\circ\text{C}$), and in the thermostat TC-80M ($18 \pm 0.3^\circ\text{C}$).

In a series of studies aimed at determining the general tendencies in the activity of α -amylase in maize grain during 3-month storage (12 weeks), the Falling Number was determined weekly. The Falling Number (s) was the average of the three parallel experimental values of time that correlates with the α -amylase activity in the maize grain. The correlation is the following: the lower the Falling Number, the higher the α -amylase activity in the test sample. Accordingly, the activity of α -amylase will be less otherwise.

The kinetics of the changes in the Falling Number in the grain samples of different initial moisture content, stored at different temperatures, is presented as bar charts in Fig. 1.

Fig. 1a shows how the Falling Number changed in maize grain with the initial moisture content 14%, 21%, and 28%, stored at 18°C for 3 months (12 weeks).

Fig. 1a makes it evident that during storage of maize grain at 18 °C, in the sample with the moisture content 14%, there was a gradual decrease in the FN, which was 3.8% at the end of the 1st week, 2.9% in the 2nd, 2.4% in the 3rd, and 2.1% in the 4th week. The total Falling Number decrease in the first month was 10.7%. This indicates a possible increase in the α -amylase activity of the maize grain.

During the second month of the experiment, the tendency for a gradual Falling Number decrease in this sample remained. The average Falling Number decrease was 11.7% in the 2nd month. Moreover, unlike the first month of storage, for each subsequent two weeks of the research, the Falling Number was by 5.3% lower from the 4th to the 6th week, and by 6.7% lower from the 6th to the 8th week, compared to the previous values.

The third month of storage, like the previous two months, is accompanied by a further gradual decrease in the Falling Number. Its overall decrease was 16.7%: 7.6% from the 8th to the 10th week, and 9.9% from the 10th to 12th week of storage.

Thus, grain storage under these conditions was accompanied by a gradual Falling Number decrease, which may be caused by a gradual increase in the α -amylase activity due to a slight increase in the storage temperature.

In the grain sample with the initial moisture content 21%, stored under anaerobic conditions at 18°C (Fig. 1), unlike the grain with the initial moisture content 14%, the tendency to a gradual Falling Number increase is observed during the first month of storage. In the first three weeks of the study, the Falling Number increased by a total of 8.4%, and during the 1st week of storage, this increase was 4.2%, during the second, 3.6%, and during the third, 0.4%. Starting from the 4th week, the tendency for a change in the Falling Number becomes the opposite: it begins decreasing, and at the end of the 4th week, is by 2.1% lower, compared to the 3rd week.

During the second and third months of storage, the same tendency for a rather intensive Falling Number decrease is observed in this sample of grain: it decreases,

Results of the research and their discussion

in total, by 21.4% in the 2nd, and by 31.9% in the 3rd month of storage, compared to the previous months. Moreover, starting from the fourth week of the experiment, every subsequent two weeks of the study are accompanied by a Falling Number decrease (compared with the corresponding values of the previous term) by 6.2% from the 4th to the 6th, by 16.2% from the 6th to the 8th, by 12.6% from the 8th to the 10th, and by 22.2% from the 10th to the 12th week of the research.

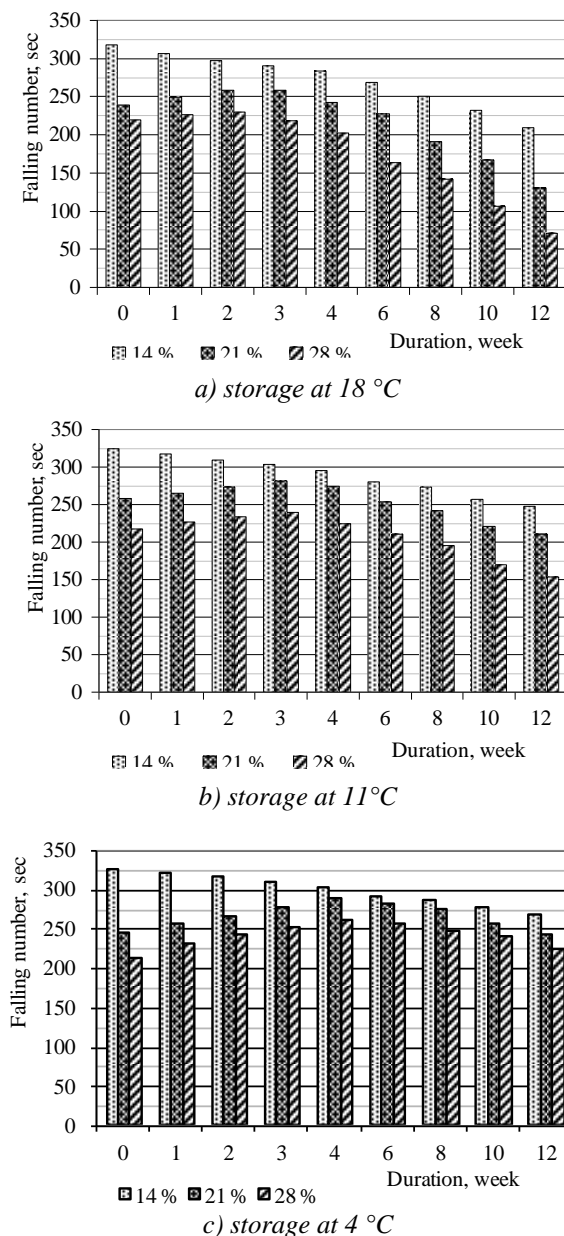


Fig. 1. Kinetics of the Falling number changes in the samples of maize grain with the initial moisture content 14%, 21%, and 28%, stored under anaerobic conditions for three months at various temperatures

Such Falling Number changes can be explained by the fact that in the first period of storage of freshly

harvested grain, the post-harvest maturing processes gradually decrease their intensity till they complete (including the biochemical processes associated with a decrease in the activity of amylase complexes), which leads to a Falling Number increase. Further on, anaerobic respiration processes continue in the silo bags, and heat and moisture are emitted. This probably activates the enzymatic complexes, in particular, amylase, which manifest itself in the gradual Falling Number decrease noted above.

In the maize grain sample with the initial moisture content 28%, stored at +18°C (see Fig. 1a), the tendencies for changes in the Falling Number, depending on the α -amylase activity, are similar to those discussed above. During the first two weeks of storage, the Falling Number increases by an average of 4.5%, and then gradually decreases: during the 3rd week of storage, by 5.2%, and during the 4th week, by 7.3%

Subsequently, during the next second and third month of storage, a very intensive Falling Number decrease in the grain sample with a moisture content of 28°C is continued: Falling Number decreased by 29.7% and 50%, respectively. Starting from the fourth week of the experiment, each subsequent two weeks of storage is accompanied by a Falling Number decrease: by 19.3% from the 4th to 6th week of storage, by 12.9% from the 6th to the 8th, by 25.4% from the 8th to the 10th and 33% from the 10th to the 12th week.

Fig. 1b shows the results of storing the maize grain samples at +11°C. So, in the sample with the moisture content 14%, there is the same tendency for a gradual Falling Number decrease as in the above described results of storing the maize grain at 18°C. It can be seen that during the first month of storage, the Falling Number decreased by 8.9%. At the same time, certain fluctuations are observed in the Falling Number decrease: for the 1st and 2nd weeks, the Falling Number decreases by 2.2% and 2.5%, respectively, in the 3rd week, it decreases only by 1.9%, and by the 4th week, it is still lower by 2.6%, compared with the third week.

Over the next two months of storage of this grain sample, a gradual Falling Number decrease is also observed: the Falling Number decreased by 7.5% in the 2nd month, and by 9.2% in the 3rd month. Every two weeks of the experiment, starting from the 4th, there is a decrease in the Falling Number: by 5.1% from the 4th to the 6th week, by 2.5% from the 6th to the 8th week, by 5.9% from the 8th to the 10th week, and by 3.5% from the 10th to the 12th week of storage.

In the grain sample with the moisture content 21%, stored at +11°C (see Fig. 1b), like it was during storage at +18°C, there is a tendency for a gradual Falling Number increase. On average, the Falling Number increases by 8.9% over this period, and, during the 1st week, it increases by 2.7%, during the second, by 3.0%, and during the 3rd, by 2.9%.

Starting from the fourth week of storage, on the contrary, the Falling Number is reduced by 2.5% in

one week. In the following second and third months of storage, there is a stable tendency for a Falling Number decrease: during the 2nd month, by 3.3%, and during the 3rd month, by 21%. Starting from the 4th week of storage, the Falling Number decreases by 7.7% from the 4th to the 6th week, by 4.3% from the 6th to the 8th week, by 8.7% from the 8th to the 10th week, and by 5.0% from the 10th to the 12th week of storage.

In the sample with the initial moisture content 28%, stored at +11°C (see Fig. 1b), these tendencies remain, but with a more pronounced intensity. So, in the first three weeks of grain storage, the Falling Number gradually increases, on average by 10.0%: during the 1st week, by 4.6 %, during the second, by 3.1%, and during the 3rd, by 2%. In the fourth week of storage, the Falling Number decreases already by 6.0 %, then, over the next 2 months, it decreases by 3.3%, and during the 3rd month, by 23%. As can be seen, starting from the 4th week of the study, the Falling Number decrease gradually goes down and is 6.3% from the 4th to the 6th week, 7.1% from the 6th to the 8th week, 12.8% from the 8th to the 10th week, and 11.8% from the 10th to the 12th week of storage.

The revealed trends in the Falling Number and the associated α -amylase activity of maize depending on grain moisture, which were established during storage of grain at temperatures of 18 and 11°C, are also kept at lower storage temperatures.

From fig. 1-c, it is clear that when storing maize grain at a temperature of 4 °C in a sample with a moisture content of 14%, there is a tendency to a gradual Falling Number decrease, but it is less pronounced. The monthly Falling Number decrease is: 4.9% for the 1st month, 5.3% for the 2nd and 6.6% for the 3rd. Weekly Falling Number decrease are – for the 1st 1.8%, 2nd 1.2%, 3rd 1.9% 4th 2.6%. Subsequently, every next two weeks of storage reduce the Falling Number: it decreases – by 3.6% from the 4th to the 6th week, by 1.7% from the 6th to the 8th week, by 3.1% from the 8th to the 10th week and by 3.6% from the 10th to the 12th week of storage.

In the sample of maize grain with the initial moisture content 21%, stored at +4°C, during the first month of storage, the tendency in the Falling Number is as follows: it increased by 18%, of which 4.9% in the first week, in the 2nd, by 3.9%, in the 3rd, by 4.1%, and in the 4th, by 4.0%. During further storage, the Falling Number decreases by 4.5% during the 2nd month (by 2.1% from the 4th to the 6th week, by 2.5% from the 6th to the 8th week), and by 12% during the 3rd month (by 6.5% from the 8th to the 10th week, by 5.8% from the 10th to the 12th week).

In the sample with the initial moisture content 28%, stored at +4°C, a sharp Falling Number increase was observed during the first month of storage: the Falling Number increased by 23.1% in a month (8.5% in the 1st week, 5.7% in the 2nd week, 3.3% in the 3rd week, and 4.0% in the 4th week). Over the next two

months of storage, the Falling Number decreased by 5.7% in the 2nd month, and by 8.9% in the 3rd month. Taken by weeks, this parameter was changing as follows: by 2.3% from the 4th to the 6th week, by 3.5% from the 6th to the 8th week, by 2.8% from the 8th to the 10th week, and by 6.3% from the 10th to the 12th week.

A comparison of the tendencies in the Falling Number decrease caused by the corresponding changes in the α -amylase activity in the samples with the initial moisture contents 14%, 21%, and 28%, stored under certain identical temperature conditions, indicates that the course of these processes varies depending on the initial moisture content in the grain. At the same time, in the grain samples with the initial moisture content 14%, there is a tendency for a gradual Falling Number decrease throughout the entire storage period. However, in the samples with the initial moisture contents 21% and 28%, at the beginning of the experiment, there is a tendency for a partial Falling Number increase, which, depending on the initial moisture content of the grain, can have different duration and different intensity of the process. After this initial period, which is associated with postharvest maturation of grain, in the samples with the initial moisture content higher than 14%, the Falling Number gradually decreases towards the end of the 3rd month of storage.

This pattern can be explained by the gradual completion of the processes of post-harvest maturation of grain with a high moisture content, which is confirmed by other authors' studies [7]. At the same time, a comparison of the tendencies in the FN changes in the samples with the same initial moisture content stored under different temperature conditions shows that changing the temperature conditions of anaerobic storage of grain has practically no effect on these tendencies, but only changes the intensity of their course

Changing the temperature conditions of storage of maize grain changes the Falling Number in this way.

With a decrease in the temperature from 18°C to 11°C in the grain samples:

- in those with the initial moisture content 14%, the Falling Number is lower by 28.4%;

- in those with the initial moisture content 21% during the first 3-week storage period, the Falling Number increases by 15%, and then, during the next 9 weeks of storage, it decreases by 45%;

- in those with the initial moisture content 28%, the period of Falling Number increase changes from 2 to 3 weeks, while the Falling Number increases by 120%, and then, by the end of the 3rd month, it decreases by 44%.

When the storage temperature is lowered from 11°C to 4°C (i. e. by 7°C), in the grain samples:

– in those with the initial moisture content 14%, the Falling Number gradually decreases by 24.4% by the end of the 3rd month;

– in those with the initial moisture content 21%, the period of the Falling Number increase changes from 3 to 4 weeks, while the Falling Number grows by 191%, and then, over the next 8 weeks, the Falling Number decreases by 35%;

– in those with the initial moisture content 28%, the period Falling Number increase also becomes longer (not 3, but 4 weeks), while the Falling Number increases by 123%, and then, over the next 8 weeks, the Falling Number decreases by 58%.

To summarize the identified patterns of changes in the Falling Number during storage of maize grain with the moisture content $w = 14\text{--}28\%$ at the temperatures

$t = 4\text{--}18^\circ\text{C}$ (which reflect the changes of the amylase activity), an empirical equation describing the Falling Number dependence on the maize grain moisture content, temperature conditions, and storage duration was obtained by the method of least squares. The equation has the form:

$$\text{FN} = 340.49 - 3.55 \cdot w + 4.12 \cdot t + 8.45 \cdot \tau - 0.19 \cdot w \cdot t - 0.65 \cdot t \cdot \tau - 0.63 \cdot \tau^2, \quad (1)$$

where: FN is Falling Number, s; w is moisture content, %; t is storage temperature, $^\circ\text{C}$. τ is storage duration, weeks.

The standard deviation s for the calculated values of the FN is 11.30 %, which indicates satisfactory convergence with the experimental data.

As can be seen from the obtained equation, the Falling Number has a nonlinear dependence on the considered factors w , t , and τ . The statistical significance of the pairwise-interaction coefficients w and t , and t and τ , respectively 0.19 and 0.65, indicates the controversial influence of these factors on the value and patterns of changes in the Falling Number. Due to the parabolic dependence of the Falling Number on the duration of anaerobic storage of maize grain and considering the negative sign of this dependence (coefficient -0.63), when the moisture content of grain is above normal, along the storage duration axis τ , the Falling Number has its maximum position that depends not only on the duration of storage, but also on its temperature conditions (which is indicated by the significant pairwise-interaction coefficient -0.65).

A visual representation of these dependencies is shown in Fig. 2.

We emphasize that all the established tendencies of changes in the Falling Number of maize grain that have been observed in the experiment can probably be explained by the corresponding changes in the amylase activity, which is the base of the method of determining the Falling Number and, as is known from literature [12], has the opposite nonlinear correlation dependence on it.

Testing the research results. The research results obtained can be used in farms and grain-processing enterprises for the express control of the condition of maize grain stored in silo bags.

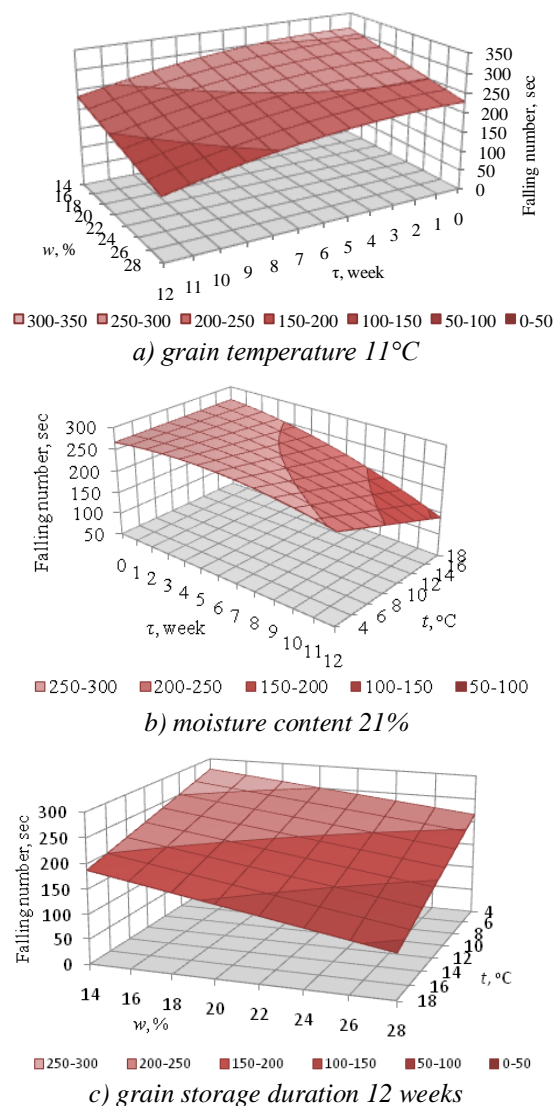


Fig. 2. Dependence of the Falling Number on the moisture content, grain temperature, and duration of storage under anaerobic conditions

Conclusion

The studies have shown that in the maize grain samples with the initial moisture content 14%, regardless of the temperature conditions during storage for 3 months, there is a steady tendency for a gradual Falling Number decrease. In the maize grain samples with the initial moisture content more than 14%, at the beginning of storage, there is a period of the growth of the Falling Number, the intensity of which depends on the initial moisture content of the grain and the temperature conditions of its anaerobic storage. This period of the Falling Number growth, with the moisture content of maize grain ranging 14–28% and the storage temperatures 4–18 $^\circ\text{C}$, is within

2–4 weeks. On completion of post-harvest maturation processes in freshly harvested maize grain, its further storage leads to the Falling Number decrease.

If there are similar studies of other maize varieties and hybrids, they will further allow establishing more accurately the correlation

dependence of the Falling Number on the amylase activity of maize grain. Besides, they will improve the express method for controlling the quality of maize grain stored in silo bags, substantiate the optimum terms of its safe storage, and allow suggesting a nomogram to predict them.

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ДОСЛІДЖЕННЯ ВПЛИВУ АНАЕРОБНИХ УМОВ ЗБЕРІГАННЯ ЗЕРНА КУКУРУДЗИ НА ЗАКОНОМІРНОСТІ ЗМІНИ ПОКАЗНИКА ЯКОСТІ «ЧИСЛО ПАДІННЯ»

А.В. Борта, кандидат технічних наук, доцент¹, E-mail: borta.alla@ukr.net

М.В. Желобкова, директор², E-mail: noria@meta.ua

¹Кафедра технології зберігання зерна

Одеська національна академія харчових технологій, вул. Канатна, 112, м. Одеса, Україна, 65039

²ТОВ «Млин база», вул. Лисенка, 22, Андрушівка, Житомирська область, 13400

Анотація. Останніми десятиліттями в Україні на фермерських господарствах та зернозаготівельних підприємствах набула поширення технологія зберігання зерна в герметичних полімерних зернових рукавах, у яких за рахунок фізіологічного процесу дихання створюються анаеробні умови, що забезпечує подовження термінів надійного зберігання свіжозібраного зерна. Це, у свою чергу, дозволяє використовувати для післязбирального оброблення зерна малопотужне технологічне обладнання, що особливо важливо для сирової та вологої кукурудзи, яка потребує для цього наявності потужних зерносушарок. У статті наведено результати дослідження впливу початкової вологості зерна кукурудзи, температурних умов та тривалості зберігання зерна в анаеробних умовах на число падіння – один з показників якості, що залежить від амілазної активності зерна. Предметом дослідження були зразки зерна свіжозібраної кукурудзи зубоподібного типу, гібриду ДКС 3705 2017 року врожаю, з усередненою вологістю 14%, 21% та 28%, які зберігали в анаеробних умовах протягом 3 місяців за температур 18°C, 11°C та 4°C. Показник число падіння визначали стандартизованим методом Хагберга-Пертена на приладі «ПЧП-7». На підставі отриманих результатів побудовано гістограми кінетики зміни числа падіння, аналіз яких дозволив встановити закономірності зміни числа падіння залежно від вологості зерна та тривалості його зберігання за різних температур. Показано, що у зразках зерна кукурудзи з початковою вологістю 14% незалежно від температурних умов протягом зберігання впродовж 3 місяців спостерігається стійка тенденція до поступового зниження числа падіння. У зразках зерна кукурудзи з початковою вологістю понад 14%, на початку зберігання спостерігається період зростання числа падіння, інтенсивність якого залежить від початкової вологості зерна і температурних умов його анаеробного зберігання. Після

завершення процесів післязбирального дозрівання у свіжозібраному зерні кукурудзи, подальше його зберігання призводить до поступового зменшення числа падіння. Для узагальнення експериментальних даних запропоноване нелінійне емпіричне рівняння, що описує закономірності зміни числа падіння залежно від досліджених факторів – вологості зерна кукурудзи, температурних умов та тривалості зберігання. Зважаючи на те, значення показника числа падіння обумовлюється активністю амілазного комплексу зерна, його можна використовувати як експрес-метод для контролю стану зерна, що зберігається у полімерних зернових рукавах.

Ключові слова: зерно кукурудзи, зберігання, полімерні зернові рукави, число падіння, активність амілазного комплексу.

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