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EFFECT OF EXTRUSION ON PROBIOTIC FEED ADDITIVE

Abstract

Today, in Ukraine, the issue of producing high-quality and safe livestock products is solved by the introduction of intensive technologies that involve the use of various feed additives, including vitamins, probiotics, prebiotics, macro- and microelements. In recent years, the development of feed additives using live cultures of microorganisms, so-called probiotic products, has attracted much attention of scientists. The strategy in the creation of these products is aimed, first of all, at ensuring the physiological needs of the animal body in biologically active substances. The addition of probiotic supplements to feed increases the bioavailability of nutrients, health, immunity, performance and conservation of animals. Probiotic feed additive EnzActive is a special product on the market of feed additives, the addition of which to feed is aimed at reducing, and in the future, the complete elimination of the use of antibiotics in animal feeding. The article examines the mechanism of action of active fodder yeast on the body of farm animals and proves that the use of active fodder yeast in animal feeding helps reduce the cost of feed due to better assimilation by the animal's body and reduction of morbidity among animals. Methods of introduction of active fodder yeast into the technological process of compound feed production are analyzed. On the basis of theoretical and experimental data, a structural scheme for the extrusion of grain raw materials with active fodder yeast is proposed, which involves preliminary mixing with crushed grain raw materials to obtain a highly homogeneous and stable composition. The physical properties of the feed additive, which includes corn grain and active feed yeast EnzActive, were experimentally determined, which indicate that, compared to the loose, extruded feed additive, it has the following advantages: the mass fraction of moisture decreases by 24.4%, the natural slope angle increases by 11, 6%, the flowability decreases by 48.2%, and the volumetric weight decreases by 24%. When extruding corn grain with active fodder yeast, the degree of starch dextrinization is 59%, and the extrudate expansion index is 2.3. Microbiological indicators were determined, which indicate that the number of yeast cells in extruded grain with active feed yeast EnzActive was only 6% compared to the number of yeast cells in untreated corn grain with active feed yeast.

Key words: probiotic feed additive, extrusion, nutrients, farm animals, quality, physical properties, yeast cells.

Introduction

The use of modern technologies for feeding agricultural animals and poultry is impossible without high-quality feed. The use of compound feed in animal husbandry makes it possible to:

- to increase the average daily increase in live weight of animals during fattening by 1.5-2.0 times;
- reduce feed costs for the production of livestock products by 20-30%;
- reduce the duration of poultry and animal fattening by 30-35%;
- to mechanize the process of feeding agricultural animals and poultry.

Thanks to the widespread use of compound feed, it became possible to create large livestock complexes and poultry farms. It was the use of compound feed that made it possible to transfer livestock and poultry farming to an industrial basis, which significantly increased labor productivity in these branches of the agro-industrial complex. Long-term stay of animals and poultry in closed rooms in conditions of limited movement in stable, cage keeping, limiting contacts with the external environment can lead to weakening of immunity, metabolic disorders, reduction of productive and reproductive qualities, emergence of diseases. It should be noted that keeping animals in closed rooms requires an increased content of vitamins, macro- and microelements and other biologically active substances in compound feed.

Recently, numerous feed additives have been used in the diet of farm animals, the use of which does not always have a positive effect on the quality of products. Among feed additives of natural origin, probiotic supplements have become widespread. [1,2]

Enzym Company, the largest producer of yeast in Ukraine, presents its new animal feed product on the domestic market - EnzActive active feed yeast is a probiotic live active feed additive that improves the efficiency of fattening and the nutritional value of livestock products. The live active probiotic feed supplement is ISO 22000, FSSC 22000, GMP+, HACCP, Kosher and Halal certified.

The purpose of the study

The purpose of the work is to study the effect of heat treatment on the quality of feed products using biologically active substances, namely active feed yeast EnzActive.

To achieve the set goal, the following research tasks must be solved:

- to analyze the state and prospects of using active fodder yeast in feeding agricultural animals;
- consider the mechanism of action of active fodder yeast on the animal body;
- to analyze the ways of introducing active fodder yeast into the technological process of compound feed production;
– study the influence of the extrusion process on the nutrients of grain raw materials and analyze the efficiency of using extruded grain in feed;
- to determine the physical properties of extruded grain raw materials with active fodder yeast;
- to investigate the effect of heat treatment on active fodder yeast.

Results and its discussion

Active fodder yeast is a widely distributed probiotic today, the use of which has many advantages of an economic, zootechnical and veterinary nature. Active fodder yeast can be used in farms, agrarian firms, enterprises that produce fodder for farm animals or have feed mills.

The unique production technology and mechanism of action of active fodder yeast (Fig. 1) when feeding farm animals contribute to:

- reduction of the total cost of feed due to its better assimilation by the animal's body;
- ensure stability of the body's internal environment;
- prevent the development of many diseases and pathological conditions. [2-4]

There are various methods of introducing biologically active substances into the compound feed. Practice shows that the introduction of individual vitamins, microelements and other components directly into the compound feed is a less effective method than the use of these substances in the form of vitamin, mineral mixtures or premixes (preliminary mixtures) [5, 6].

Many compound feed factories consider the possibility of independent enrichment of compound feed products with both individual biologically active substances and preliminary mixtures. The variety of recipes of enrichment mixtures and their concentrations on the feed raw materials markets of many countries sometimes puts specialists in a difficult position when solving the "price - quality" problem. The choice of the construction option for the scheme of the technological process of compound feed enrichment depends on the concentration of drugs or preliminary mixtures. [6]

The Enzym Company specialists recommend using EnzActive in the feeding of farm animals - adding it to a balanced basic diet throughout the growing period in the amount of: 100-150g/t of feed for broilers, 50-100g/t of feed for laying hens, 200-500 g/t feed for pigs, 500 g/t feed for cattle or 4-10g/cow/day in two doses (morning and evening). It should be noted that research on the use of EnzActive yeast in feeding farm animals was carried out by adding it to feed in loose form or individually to each animal separately. [3]

The introduction of the EnzActive feed additive in a very small amount into the composition of compound feed, technological methods should be used that ensure high accuracy of dosage and the uniformity of the distribution of biologically active substances in the composition of compound feed. The uniformity of the distribution of EnzActive feed additive depends on the type of mixer, duration of mixing, physical and technological properties of raw materials (flowability, degree of grinding, ability to mix, etc.). [6]

One of the ways to solve the problem of introduction of feed additive EnzActive into the compound feed is a slight modernization of the scheme of the technological process of the production of compound feed products, namely the installation of an additional mixer of small capacity for the preparation of a preliminary mixture with one of the components of the compound feed. Pre-mixing is a guarantee of the formation of not only a highly homogeneous, but also a stable composition.

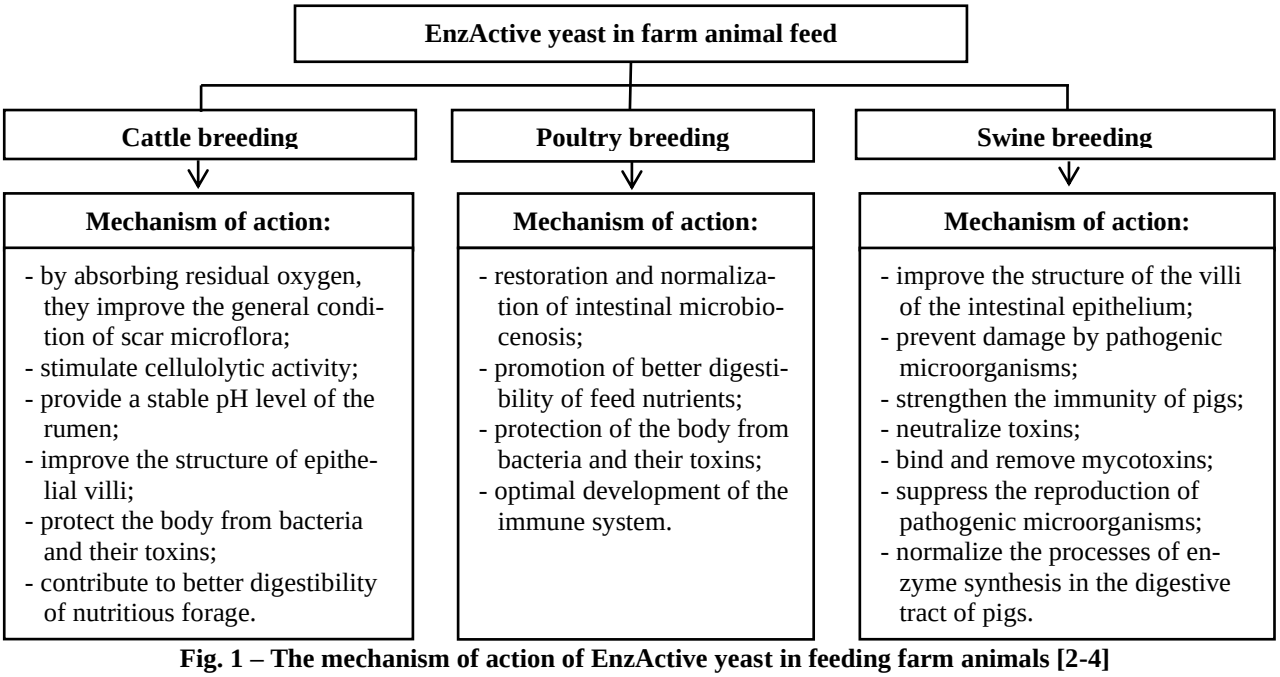

Fig. 1 – The mechanism of action of EnzActive yeast in feeding farm animals [2-4]

The manufactured compound feed product must meet the physiological characteristics and needs of the farm animals for which it is intended as fully as possible. In this regard, compound feed products must have appropriate organoleptic properties, must ensure high productivity of animals, be safe for them and retain their properties during the guaranteed shelf life. [5, 6]

In the production of compound feed for farm animals, the basis of the diet is made up of grain components. The grain of cereal crops, along with other types of nutrients, contains a significant amount of starch, the assimilation of which occurs slowly when feeding poultry, and at the same time, only certain forms are used productively in small quantities. According to a number of studies, the digestibility of the nutritional potential of starch in its natural form does not exceed 20...25%, depending on the type of crops. Therefore, the task of new grain processing technologies is to implement such methods of processing raw materials that would allow converting starch into a form convenient for assimilation by the animal body. This is possible when the granular structure of starch is destroyed at the cellular level, which contributes to its dextrinization and conversion into low-molecular carbohydrates. [7]

Heat treatment contributes to the breakdown of complex nutrients contained in feed into the simplest ones, thereby reducing the energy consumption for their digestion in the animal's body [5,8].

Currently, there are quite a lot of technologies that allow heat treatment of fodder, but for most of them it is necessary to use external heat sources, which requires additional capital investments. Extrusion is one of the most effective and widespread methods of grain processing in the world compound feed industry, which is used both in combination with granulation and independently. When processing grain fodder in this way, two continuous processes occur:

1) thermomechanical deformation and biochemical transformations;

2) the process of adiabatic expansion ("explosion") of the product, which acquires a porous structure. [8,9]

The raw material to be extruded is brought to a moisture content of 16...18%, crushed and fed into the extruder, where under the action of high pressure (2.8...3.9 MPa) and friction, the grain mass is heated to a temperature of 120...150 °C and acquires a thermoplastic properties [9]. Then, as a result of its rapid movement from the high-pressure zone to the atmospheric pressure zone, the process of adiabatic expansion occurs (the so-called "explosion"), as a result of which the homogeneous mass forms a product of a microporous structure, the most favorable to the effect of gastric juice, and therefore ensures a more complete assimilation of nutrients by the body animals (25...30% more than usual). Extrusion takes less than 30 seconds. During this time, the raw material has time to go through the stages of grinding, mixing, heat treatment, disinfection, dehydration, stabilization and homogenization and volume increase. [9-11]. In the process of extrusion (Fig. 2), protein denaturation, inactivation of anti-nutrients (protease inhibitors, phytohemagglutenins, etc.) occurs.), starch dextrinization, destruction of cellulose-lignin formations, fiber partially disintegrates, the level of urease activity in soybean grains decreases (urease activity 0.1...0.2 units of pH). At the same time, the amount of starch decreases by 12...15%, and dextrins increases more than 5 times, the amount of oligo- and monosaccharides increases by 11...12%. The sanitary quality of grain and compound feed improves, as the final products contain virtually no microorganisms. [7, 10].

Taking into account the useful properties of extruded products, we developed a method of enriching grain crops with biologically active substances (Fig. 3), namely with active feed yeast EnzActive. As a result, experimental samples of feed additives for farm animals were produced, in which physical properties were determined before and after extrusion. [5, 12]

Samples of feed additives were studied according to the indicators that most characterize the technological properties of the finished products, namely the angle of natural slope, flowability, volumetric weight, and the efficiency of the extrusion process was determined by the extrudate expansion index, the degree of starch dextrinization, and the mass fraction of moisture. Table 1 shows the results of the study of changes in the physical properties of the feed additive, which includes corn grain with active feed yeast EnzActive, during the extrusion process.

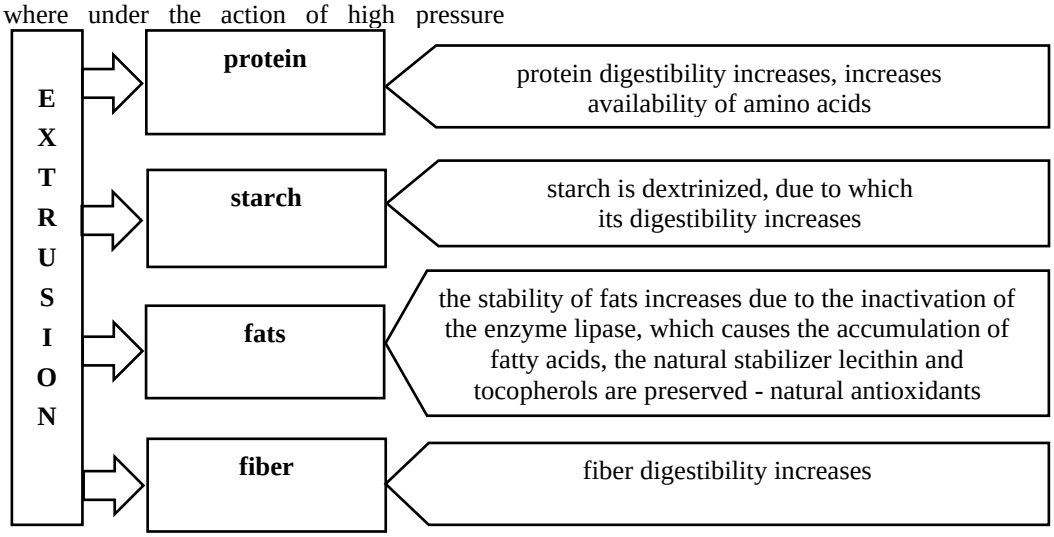

Fig. 2 – Effect of the extrusion process on feed nutrients

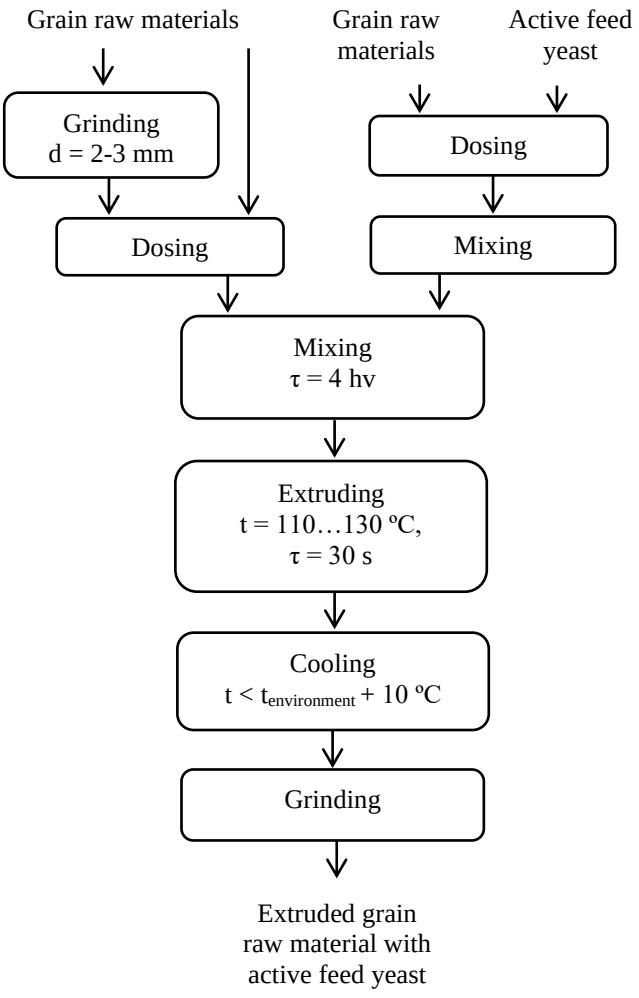

Fig. 3 – Functional scheme of extruding grain raw materials with active fodder yeast

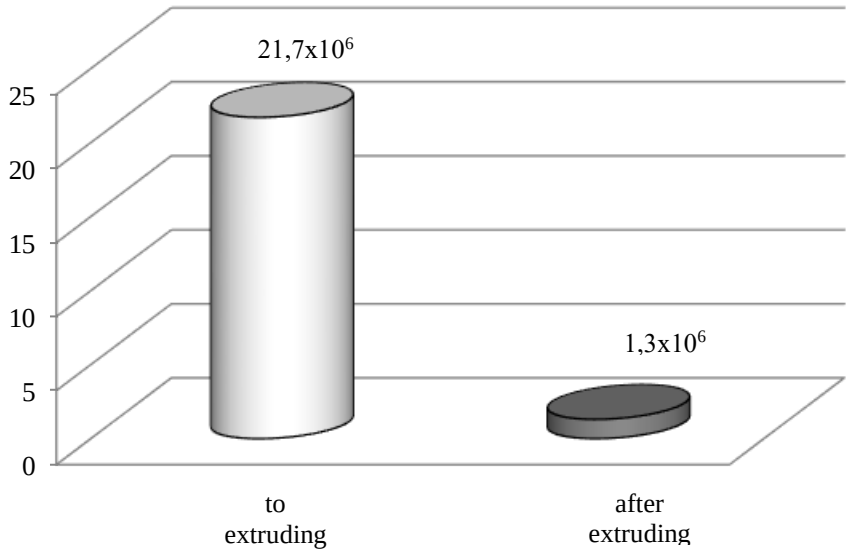

Fig. 4 - Number of yeast cells (pcs x 106/g) in corn grains with active feed yeast EnzActive before and after extruding

Analysis of the data given in the table. 1, shows that in the process of extruding the feed additive, the mass fraction of moisture decreases by 24.4%, the angle of natural slope increases by 11.6%, the flowability decreases by 48.2%, and the volumetric mass decreases by 24%. When extruding corn grain with active fodder yeast, the degree of starch dextrinization is 59%, and the extrudate expansion index is 2.3.

Table 1 – Physical properties of the feed additive in the extrusion process

Indexes	Feed additive		Changes
	to extruding	after extruding	
Mass fraction of moisture, %	16,8	12,7	-24,4
Angle of natural slope, degrees	43	48	+11,6
Flowability, cm/s	8,5	4,4	-48,2
Volumetric mass, kg/m^3	643	489	-24,0
Size module, mm	1,9	1,2	-37,0
The degree of starch dextrinization, %	0	59,0	59,0
Extension index	2,3		

To determine the total number of yeast cells, samples of raw corn grain with active feed yeast EnzActive and samples of extruded corn grain with active feed yeast EnzActive were taken. The number of yeast cells in the samples is shown in Fig. 4, which were determined by the method of direct counting of cells of microorganisms using the Goryaev counting chamber. [13]

The number of yeast cells in extruded grain with EnzActive active feed yeast was only 6% compared to the number of yeast cells in untreated corn grain with active feed yeast. Therefore, the temperature during extrusion significantly affects the activity of active feed yeast EnzActive, despite the fact that the extrusion process lasts up to 30 seconds. The surface coat of the yeast pellet, consisting of inactivated yeast cells, does not protect the active yeast cells contained within the active yeast pellet from the effects of temperature.

Conclusions

Live active probiotic feed additive EnzActive is an innovative product whose addition to feed is aimed at reducing, and in the future, completely eliminating the use of antibiotics in animal feeding. EnzActive helps to increase the efficiency of fattening and the nutritional value of livestock products.

One of the ways to introduce a small amount of feed additive EnzActive into compound feed is to prepare a preliminary mixture with crushed grain raw materials to

obtain a highly homogeneous mixture, so that in each portion of compound feed the ratio of components according to the recipe is ensured during the guaranteed period of storage and transportation. The use of heat treatment will increase the feed value of grain raw materials and will allow to maintain a stable composition of feed supplement with active feed yeast EnzActive.

The physical properties of the feed additive, which includes corn grain and EnzActive active feed yeast, show that, compared to loose, extruded feed additive, it has the following advantages: the mass fraction of moisture decreases by 24.4%, the angle of natural slope increases by 11.6%, the flowability decreases by 48.2%, and the volumetric weight decreases by 24%. When extruding corn grain with active fodder yeast, the degree of starch dextrinization is 59%, and the extrudate expansion index is 2.3.

Microbiological indicators show that the number of yeast cells in extruded grain with active feed yeast EnzActive is only 6% compared to the number of yeast cells in untreated corn grain with active feed yeast.

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ВПЛИВ ЕКСТРУДУВАННЯ НА ПРОБІОТИЧНУ КОРМОВУ ДОБАВКУ

Анотація

Сьогодні в Україні питання виробництва якісної та безпечної тваринницької продукції вирішується впровадженням інтенсивних технологій, які передбачають застосування різноманітних кормових добавок, серед яких вітаміни, пробіотики, пребіотики, макро- та мікроелементи. Останніми роками, велику увагу вчених привертає розробка кормових добавок з використанням живих культур мікроорганізмів, так званих пробіотичних продуктів. Стратегія в створенні цих продуктів спрямована, перш за все, на забезпечення фізіологічної потреби організму тварин в біологічно активних речовинах. Додавання пробіотичних добавок до кормів підвищує біодоступність поживних речовин, стан здоров'я, імунітет, продуктивність та збереження тварин. Пробіотична кормова добавка EnzActive – особливий продукт на ринку кормових добавок, додавання в корм якого націлене на зменшення, а в подальшому – повне усунення використання антибіотиків у годівлі тварин. В статті розглянуто механізм дії активних кормових дріжджів на організм сільськогосподарських тварин та доведено, що використання активних кормових дріжджів в годівлі тварин сприяє зменшенню вартості корму за рахунок кращого засвоєння організмом тварини та зменшення захворюваності серед тварин. Проаналізовано способи введення активних кормових дріжджів у технологічний процес виробництва комбікормової продукції. На основі теоретичних та експериментальних даних запропоновано структурну схему екструдування зернової сировини з активними кормовими дріжджами, яка передбачає попереднє змішування з подрібненою зерновою сировиною для одержання високооднорідного та стабільного складу. Експериментально визначено фі-

зичні властивості кормової добавки, яка включає зерно кукурудзи та активні кормові дріжджі EnzActive, які свідчать, що в порівняні з розсипною, екструдована кормова добавка має наступні переваги: масова частка вологи знижується на 24,4 %, кут природного укосу зростає на 11,6 %, сипкість зменшується на 48,2 %, а об'ємна маса знижується на 24 %. При екструдуванні зерна кукурудзи з активними кормовими дріжджами ступінь декстринізації крохмалю складає 59 %, а індекс розширення екструдату 2,3. Визначено мікробіологічні показники, які свідчать, що кількість дріжджових клітин в екструдованому зерні з активними кормовими дріжджами EnzActive склала лише 6 % в порівнянні з кількістю дріжджових клітин в необробленому зерні кукурудзи з активними кормовими дріжджами.

Ключові слова: пробіотична кормова добавка, екструдування, поживні речовини, сільськогосподарські тварини, якість, фізичні властивості, дріжджові клітини.

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2 червня 2023 року у київському гольф-центрі пройде **V Міжнародний Grain Storage Forum ELEVATOR 2023** – найбільший в Україні форум в галузі зберігання, переробки, логістики і трейдингу зерна.

Організатори: ProAgro Group та Асоціація елеваторів України.

Подія покликана зібрати якнайширше коло фахівців зернової галузі разом з представниками влади, великих і малих агровиробників, технологічних і сервісних компаній для обговорення сучасного стану й перспектив аграрного ринку.

Завдання форуму – аналіз поточної ситуації, виокремлення головних проблем, пошук і напрацювання рішень для забезпечення стабільної роботи й підвищення ефективності зерновиробництва, переробки, трейдингу і логістики агропродукції у воєнний час.

Метою заходу є визначення пріоритетних шляхів відбудови українського АПК у повоєнний період з урахуванням сучасного рівня розвитку агровиробництва у світі та потреб внутрішнього й зовнішніх ринків.

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Реєстрація: docs.google.com/forms

Форум включатиме:

• **Діалогові панелі зі: Зберігання зерна; Переробки зернових та олійних; Трейдингу і логістики; Енергозабезпечення та біоенергетики.**

• Презентаційні семінари від компаній-лідерів ринку.

• Виступи провідних фахівців галузей з кейсами ефективного ведення агробізнесу, представників влади та експертного середовища.

• Виставку технологічних рішень і обладнання від провідних виробників.

• VIP зону для бізнес-переговорів.

• Живу музику, лаунж зону.

• Кава-паузи, фуршети, коктейлі.

Запрошуємо всіх учасників ринку долучитися до **Grain Storage Forum ELEVATOR 2023** та сформувати спільне бачення розвитку елеваторної галузі, переробки, логістики та трейдингу аграрної продукції України!

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