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INCREASING THE RESISTANCE OF COMPOUND FEED DURING STORAGE

Abstract

Analysis of experimental studies has shown that the shelf life of loose compound feed is determined by the physical properties of the mixture, moisture exchange function, oxygen sorption and carbon dioxide desorption parameters, which can be calculated using the empirical expressions given. A summary of studies on gas exchange in loose compound feeds leads to the conclusion that an increase in their moisture content and storage temperature contributes to the intensification of sorption and desorption processes, creates favourable conditions for the development of microorganisms, and causes a decrease in the quality of compound feeds as the storage period increases. Antioxidants in compound feed. We processed the results of experimental studies on the storage of loose compound feed and protein-vitamin supplements based on the results of work carried out in laboratory and production conditions. Research on changes in vitamin content. The results of storing compound feed of different recipes are determined by changes in vitamin content,

amino acid composition, microbiological indicators, crude fat content, total acidity, acid, peroxide and iodine values. When assessing the quality of compound feed, changes in the content of water- and fat-soluble vitamins are often used.

Antioxidants are chemical compounds or substances that can inhibit oxidation processes, thereby neutralising potentially harmful oxides in living organisms. Even in extremely low concentrations, these substances are effective in preventing or stopping oxidation reactions, which highlights their critical importance in biological systems. Antioxidants play an important role in maintaining health and developing an optimal diet for animals. In addition, they are widely used in the production of feed additives and premixes, helping to extend their shelf life and maintaining the stability and quality of these products.

Keywords: *compound feed vitamins antioxidant index, dependence.*

Introduction. Animal feeding methods require producers to use feed that is stable during storage and guarantees high-quality utilisation when used.

Problem statement, analysis of current studies. Pet food contains fats, proteins and various organic substances that are susceptible to oxidation when exposed to air, light or heat. These oxidation reactions can lead to a deterioration in feed quality, a reduction in its nutritional value and the formation of toxic compounds that pose a serious health risk to animals after consumption.

Purpose of the study: In this context, antioxidants play a key role in preventing or slowing down oxidation processes due to their ability to neutralise harmful free radicals. In addition, the use of antioxidants in feed can have a significant positive effect on animal health. In particular, an animal's body may be prone to oxidative stress due to external factors such as high temperatures, disease or consumption of excessively high-calorie food.

Presentation of the main material. Antioxidants present in feed help reduce oxidative stress due to their ability to neutralise free radicals and protect cells from damage. This action can have a positive effect on the immune system, reproductive function and overall physiological condition of animals [2,3,4.6]. Among the most common antioxidants added to animal feed are vitamins A, E, B, selenium, and various plant compounds such as flavonoids and carotenoids. The choice of a specific type of antioxidant and its dosage depends on several key factors, including the type of animal, the characteristics of the diet, and the production objectives. Antioxidants play an important role in ensuring the quality of premixes and feed additives, keeping them usable. Thanks to their ability to protect ingredients from the harmful effects of oxidation, they contribute to the long-term storage of feed. In addition, these compounds maintain the organoleptic properties of feed, preventing discolouration, unpleasant odours and rancidity. Antioxidants are also critical for preserving nutrients, particularly vitamins and amino acids. Vitamins play a key role in creating a balanced diet for farm and pet animals. They are indispensable micronutrients that ensure the normal flow of physiological processes, such as growth, development of the body, reproduction of offspring and maintenance of general health. Since most animals are not able to synthesize vitamins on their own, the only source of their intake remains feed. However, nutrition often does not provide the optimal amount of necessary vitamins. Vitamin deficiency can occur due to various factors: low or

unstable vitamin content in feed, reduced bioavailability of nutrients, as well as negative impact of feed storage and processing conditions. All these factors significantly worsen the vitamin status of animals. Vitamin deficiency can lead to a significant decrease in productivity, weakening of the immune system, problems with reproduction, and in severe cases even to fatal consequences [1,3,5.]. This not only harms animal health, but also significantly increases costs in animal husbandry due to direct and indirect economic losses. To solve the problem, manufacturers are recommended to carefully monitor the vitamin content in animal diets and use high-quality vitamin supplements to ensure that the body is provided with the necessary nutrients. When applying vitamins to feed, numerous factors that affect the formation of a balanced diet should be taken into account. For the most part, this involves detailed determination of the optimal level of vitamins, which is a difficult task and requires systematic analysis. Given the risks associated with vitamin deficiencies or insufficient concentrations, as well as their potential consequences for animal health, producers are coming under increasing pressure to ensure the necessary levels of nutritional components in feed. One of the key influencing factors is genetics. Modern genetic improvements have had a positive effect on the growth and productivity of animals, which has significantly changed their need for vitamins. In view of the constant genetic transformations of poultry and pigs and the improvement in the increment efficiency with respect to feed consumed, leading scientists and experts suggest that the overall vitamin requirement potentially increases each year by about 1% [1,3,9,11]. Feeding animals with the same amounts of vitamins as in previous periods can lead to a decrease in their consumption per unit of meat produced, as well as a significant reduction in egg production — up to 33%. Actually, the need for vitamins is additionally affected by the interaction between them. For example, fat-soluble vitamins require careful dosing because they compete for absorption in the intestines. In addition, vitamins of group B also play an important role.B vitamins play a key role in regulating metabolism, particularly proteins, fats and carbohydrates. Insufficiency of at least one of these vitamins can increase the body's need for others.

The balance and level of vitamins are affected by a number of factors, including diseases, conditions of keeping animals, antivitamin substances, air purity and ambient temperature. Ensuring optimal levels of vitamins can be no easy task, but it is of fundamental importance. Vitamins provide numerous benefits, including maintaining health, improving well-being, increasing animal productivity, and improving meat quality. Scientific studies confirm the positive effect of high doses of vitamin E on poultry and pigs, which improves the functioning of the immune system and improves the quality of meat at the final stages of production. Optimizing the level of vitamins also makes economic sense: the share of costs for vitamins in feed is less than 2% of its cost or only a few eurocents per animal. At the same time, they significantly affect growth, health and reproductive performance. The search for inexpensive and safe vitamin supplements allows not only to improve production in animal husbandry, but also to significantly increase farmers' profits.

Most of the vitamins included in compound feed partially lose their biological activity over time. This trend is due to the high reactivity and general instability of

many organic compounds. Exposure to heat, the presence of oxygen, increased humidity, as well as ultraviolet radiation are key factors that can cause their denaturation under certain conditions. The rate of vitamin loss of activity in the specific recipe composition of the feed depends on their nature, source of origin and storage conditions of the finished product. In most cases, feed manufacturers are aware of the potential losses of biologically active substances and seek to compensate for them by adding excessive amounts of vitamins to their products. This allows you to ensure the necessary level of vitamin activity during the specified shelf life of the feed. An analysis of changes in the content of vitamins in feed undergoing long-term storage was carried out. The results showed that the amount of vitamins in balanced diets can meet the standards or even exceed them. The only indicator that demonstrated negative dynamics was the activity of vitamin C. Its level fell below the minimum permissible value after doubling the recommended storage period, which is confirmed by further studies of the loss of vitamin activity in these feeds. In doing so, it is important to understand that a decrease in vitamin activity during storage does not necessarily render the feed unusable. The body's real need for vitamins is determined not only by the concentration of vitamins in the feed, but also by the volume of its consumption and the desired biological effect. Feeds that have been stored longer than the recommended period can remain useful, provided that the only manifestation of their quality reduction is the loss of vitamins. Most importantly — absence of other significant problems such as mold growth or rancidity of fats [1, 5, 10, 14]. Feed with a reduced vitamin content can be used in a variety of conditions. For example, it is used short-term as part of a standard diet or long-term in conditions of intensive animal breeding. However, such feed becomes ineffective in situations where a high level of vitamin activity is necessary to maintain the body's adaptive capabilities. This is relevant, say, to strengthen immunity or ensure optimal tissue structure, which is critically important, for example, for the brood herd. Vitamins are an integral part of biochemical processes and metabolism in animals, acting as catalysts. They are key micronutrients that ensure the normal functioning of physiological processes, the growth and development of organisms. Scientific observations confirm the importance of vitamins in the reproductive capacity of sows. In particular, the study showed that the use of β-carotene in a dosage of 100 mg/kg of feed has a positive effect on reproductive performance [1, 2, 3, 12]. This helps to reduce differences in the development of piglets during the same farrowing. In addition to proteins, amino acids and energy value, vitamins are extremely important for ensuring the quality of feed.

High-quality feed containing all the necessary nutrients plays a critical role in preventing nutritional deficiencies, stimulating growth, increasing milk and egg production, and shaping high-quality food products such as meat, meat products, eggs and dairy products. In today's European animal production system, the relationship between nutrition and health status is of growing importance. This has been reflected in regulations which emphasize the importance of animal welfare and health and the compulsory consideration of these aspects in the production process of animal products. According to the reports, animal feed must meet the same quality standards as products for human consumption. The diet of pigs must contain sufficient vitamins

to guarantee effective absorption of nutrients, maintenance of body health, promotion of growth and development, vitality and ensuring high productivity. Vitamin deficiency has been found to slow down live weight gain in pigs during their rearing. At the same time, an excess of vitamins is also capable of adversely affecting animal health. For example, excessive amounts of vitamins can contribute to the deterioration of sow productivity. Taking into account the cost of feed and the numerous benefits to the farm, it is important to ensure an optimal level of vitamins in the diet, which will contribute to increase profitability and improve the overall productivity of the herd [1,2,7,12]. To achieve a balanced content of vitamins in feed, a careful assessment of their amount in the components of the pig diet is necessary. You should also make sure that the needs of animals for each vitamin are fully met. In modern production, such components as corn, wheat and their derivatives, as well as oilseed processing products, are actively used. In the development of diets, consideration of nutrient content is often based on data from databases and nutritional standards used in the US or Europe. However, the nutritional value of individual feed constituents can vary significantly depending on a number of factors, such as geographical location, soil properties, genetic characteristics of crops and processing conditions, including temperature, pressure and process duration.

It is worth noting that the issue of assessing the content of vitamins in feed ingredients remains insufficiently studied until now. Meanwhile, detailed and accurate information about the level of these vitamins is extremely important for the development of balanced rations for pigs. Feed antioxidants are additives used to extend the shelf life of feed. Their main function is to prevent unwanted oxidative processes both in the feed itself and in the digestive tract of animals. Thanks to antioxidants, the feed retains its nutritional and energy value, preventing rancidity of fats. In addition, these supplements contribute to the preservation of important components of the diet, such as lipids, vitamins and pigments. The processes that occur during the storage of feed and compound feed often cause rancidity of fats, degradation of vitamins A, D and E, pigments (in particular, carotenoids) and amino acids, as well as a decrease in the biological and energy value of the diet. If these destructive changes are allowed to unfold without proper control in the feed or even in its individual components, this can lead to a decrease in animal feed consumption, which in turn can cause an acute shortage of nutrients. A significant number of researchers have devoted attention to the analysis of problems associated with uncontrolled oxidation and have developed effective methods of combating these processes. Note that oxidative rancidity itself, in contrast to hydrolytic rancidity, significantly reduces the energy value of fat or oil. Prevention of unwanted oxidation of feed is carried out in various ways. The basic condition is to ensure that the ingredients used to make the feed provide adequate protection for vitamins A and E, as well as other natural antioxidants like lecithin [3,4, 8, 15]. If possible, you should avoid adding unstable fats and oils to your diet, as well as substances with pro-oxidant properties. The antioxidant used in feed must meet clear requirements: effectively protect animal and vegetable fats, vitamins and other elements of feed that undergo oxidative deterioration; be safe for humans and farm animals (in particular poultry,

pigs, fish, etc.); act even in minimum concentrations; and, of course, have an affordable cost. With the development of diets enriched with animal and vegetable fats, the need for antioxidant protection has become more urgent. Much of current research focuses on ethoxyquin as a preservative or antioxidant. Along with this, other chemical preservatives are used, such as ascorbic acid, propionic acid, benzoic acid, citric acid and their salts. However, the introduction of these substances may cause certain technological difficulties, for example related to the moisture level of the feed (s).

In order to increase the level of safety of compound feed, many scientific studies recommend the use of various antioxidants. On the basis of the obtained empirical formulas, provided that the high accuracy of experimental data is ensured, it became possible to predict changes in the content of vitamins in the composition of compound feed during their storage, provided that antioxidants are added. The analysis of changes in content was carried out separately for each vitamin, which allows a more accurate assessment of the effect of the administered additives on their stability.

In laboratory and production conditions, a study of changes in vitamin A content in compound feed for animals during their storage was conducted. Initial vitamin level values were 9.18 and 10.12 IU/g. To generalize the obtained results of experiments, changes in vitamin content are described using empirical models. These models are based on exponential dependencies that have been determined by the least squares method and are presented in the following form:

$$C_i = 100\ e^{-\beta i \tau x} \qquad (1)$$

βi - coefficient of vitamin loss during storage of combined feed ;
τ_x - duration of storage (months).

Experiments were conducted with and without the antioxidant santoquine, evaluating the results over a period of six months. With an increase in the shelf life in each experiment, a decrease in the concentration of the vitamin was observed, as well as a change in the value of the half-period of losses, which was determined on the basis of the obtained data. In the case of storage without santoquine and under the conditions of use of santoquine with a concentration of 0.02 % (Fig. 1),

According to half-life calculations, the antioxidant was found to have a significant inhibitory effect on the reduction of vitamin A content, which allows to increase the shelf life of compound feed by almost five times. The combined feed for SK-1 pigs with an initial vitamin A content of 8.7 and 10.43 IU/g was chosen as the object of study. Santoquine has been found to exhibit a significant antioxidant effect, on the basis of which empirical formulas for storage conditions using this antioxidant have been formulated. The mentioned formulas reflect the change in the level of vitamin A during the storage of compound feed for four months at a humidity of 8.9–10.9 %, a relative humidity of 44–65 % and a temperature within 14–27 °C at a concentration of santoquine of 0.02 %. Based on the results of these calculations, the half-life with added antioxidant is 8.7 months, while without it — is only 1.96 months. This confirms the feasibility of using santoquin to extend the shelf life of compound feed.

During the storage of loose compound feed, it was established that the concentration of vitamin A decreases by approximately 7.0% every month. The expected shelf life of compound feed without added antioxidants is only two months, which corresponds to the results of other studies. According to the obtained data on changes in the level of vitamin A in compound feed during their storage, a half-life of two months was determined. However, when using santoquin, this indicator improves significantly, increasing by 4–5 times. Analysis of the results of studies that were carried out to assess changes in the content of vitamin E in compound feed under storage conditions without the addition of antioxidants indicates its sufficient stability. In particular, a half-life of more than four months was found, which confirms the low degree of destruction of vitamin E according to typical storage conditions. The dependence of the change in the concentration of vitamin E during storage for the specified period of time was determined by the authors using an empirical expression. Studies have also shown that the addition of the antioxidant santoquine at a concentration of 0.08 % provides an effective slowing down of both oxidative and hydrolytic processes, which contributes to increasing the storage stability of vitamin E. Under conditions of temperature variation over a monthly period ranging from 6.3 to 24.0 °C and relative air humidity in the range of 59–72 %, a substantially constant value of compound feed humidity (CBW) was observed, which remained between 9.07 and 10.5 %. When storing BVD without antioxidant, the half-life, which is 6.6 months, is consistent with the results of the studies. The addition of santohine at a concentration of 0.08% significantly increases this figure, continuing it almost twice. Vitamin losses during storage of compound feed were calculated using the formula:

$$m_i = 1 - C_i = 100\ (1 - e^{-\beta i \tau x}) \qquad (2)$$

Depending on the real scatter of experimental data, the resulting empirical formulas may have an error within ±3–8%.

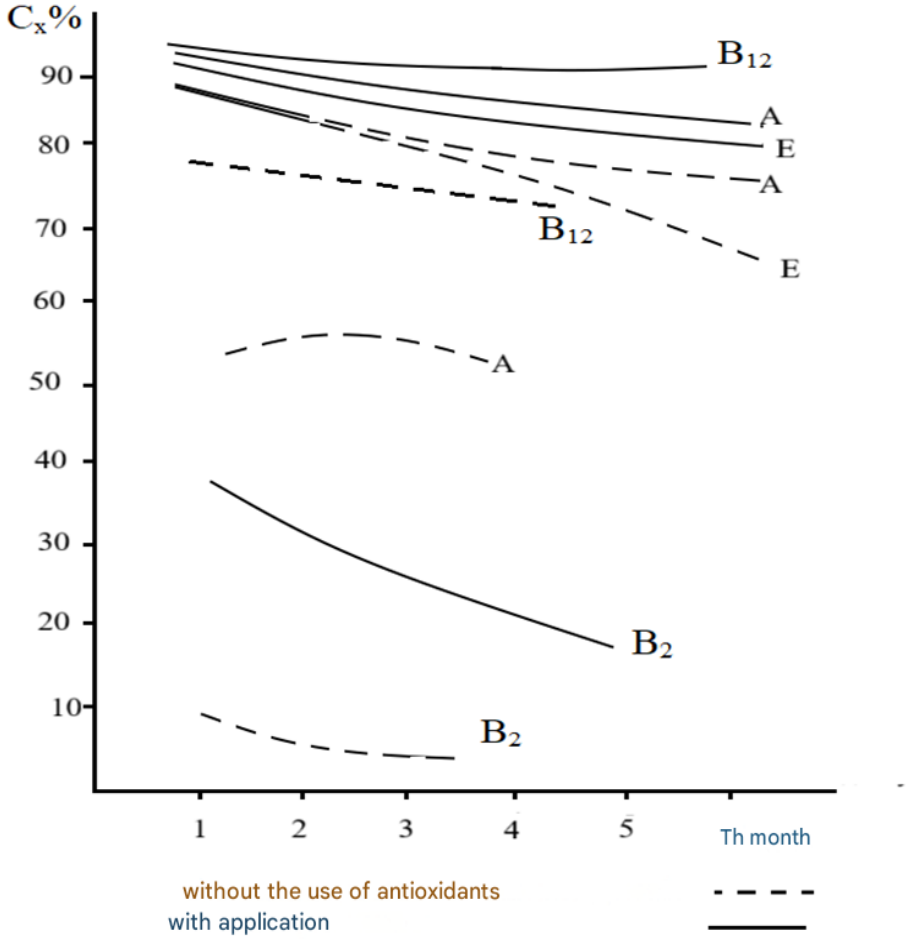

Fig. 1. Change in the content of vitamins A, E, B2, B12 in loose compound feed, during storage with and without the use of antioxidants.

Conclusions and prospects for further research. An analysis of experimental studies addressing changes in vitamin E content during storage of compound feed and BVR without antioxidants showed that its half-life is 6.06–6.6 months. At the same time, the use of santohine ensures a doubling of this period. The efficacy of santoquine and diludine in vitamin E preservation was found to be essentially the same.

On the basis of the obtained data, a model was compiled (Figure 1), which reflects the empirical dependence of changes in vitamin B content on the duration of storage up to six months. In particular, when stored without antioxidants and with the addition of santoquin at a concentration of 0.5%, the half-life of the vitamin This indicates the high stability of vitamin B during storage. The concentration of the antioxidant does not significantly affect the preservation of vitamin B in premixtures, but the positive effect of santoquine is more pronounced.

The study revealed a significant antioxidant effect of santoquin on the preservation of vitamins in compound feed. The most pronounced antioxidant properties of this preservative were observed at its concentrations of 0.02% and 0.05%. The paper examines in detail the influence of different concentrations of the preservative on the quality indicators of compound feed for its storage during a six-

month period. A critical concentration of santoquine was established, which is 0.08%; at this concentration, the process of oxidation of the fat fraction practically stops.

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ПІДВИЩЕННЯ СТІЙКОСІ КОМБІКОРМУ ПРИ ЗБЕРІГАННІ

Анотація

Аналіз виконаних експериментальних досліджень дозволив встановити, що тривалість зберігання розсипних комбікормів визначається фізичними властивостями суміші, функцією вологообміну, параметрами сорбції кисню та десорбції вуглекислого газу, які є можливим розраховувати за наведеними емпіричними виразами. Узагальнення досліджень з газообміну в розсипних комбікормах призводить до висновку, що підвищення їх вологості і температури середовища зберігання сприяє інтенсифікації процесів сорбції десорбції, створює сприятливі умови для розвитку мікроорганізмів, обумовлює зниження показників якості комбікормів при збільшенні терміну. антиоксиданти у комбікормах. Обробка результатів експериментальних досліджень зберігання розсипних комбікормів та білково-вітамінних добавок, виконана нами за результатами роботи проведеної в лабораторних та виробничих умовах.

Дослідження щодо зміни вмісту вітамінів. Результати зберігання комбікормів різних рецептів визначають зі зміни вмісту вітамінів, амінокислотного складу, мікробіологічних показників, вмісту сирого жиру, загальної кислотності, кислотного, перекисного та йодного чисел. Оцінюючи якості комбікормів часто користуються зміною вмісту водо- і жиророзчинних вітамінів

Антиоксиданти становлять собою хімічні сполуки або речовини, які здатні інгібувати процеси окислення, тим самим нейтралізуючи потенційно шкідливі оксиди в живих організмах. Навіть у надзвичайно малих концентраціях ці речовини демонструють ефективність у запобіганні або припиненні реакцій окиснення, що підкреслює їх критичну значущість у біологічних системах. Антиоксиданти відіграють важливу роль у підтримці здоров'я та формуванні оптимального раціону харчування для тварин. Крім того, вони широко використовуються у виробництві кормових добавок і преміксів, сприяючи продовженню терміну їх придатності, підтримуючи стабільність і збереження якості цих продуктів.

Ключові слова: *комбікорм вітаміни .показник антиоксидант, залежність.*

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