

## AMINO ACID AND MINERAL MILK COMPOSITION OF SOWS FED WITH A MIXTURE OF ESSENTIAL OILS

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### Abstract

*The aim of the work is to find out the influence of essential oils in the diets of sows during farrowing and lactation on the amino acid and mineral composition of milk. The whole milk of sows obtained on the 21st day of lactation was studied, an increase of 9.69% of milk protein in the mass fraction of animals of the experimental group was observed. The amino acid and mineral composition of milk improved. The content of essential amino acids in milk increased: lysine - by 13.18%, alanine - by 13.11%, threonine - by 7.14%, histidine - by 22.22% compared to the control group. In the milk of the research group, an increase in iron content by 13.13%, phosphorus and zinc by 8% and 3.48%, respectively, was noted. The piglets of the research group had a greater increase: on the fifth day of life, the live weight was 5.4% higher; on the 14th day - by 0.4 kg, or by 12.5%, and at weaning (on the 28th day) - by 0.5 kg, or by 6.6% compared to animals of the control group.*

**Key words:** amino acid composition, essential oils, lactation, milk, sows.

### INTRODUCTION

The efficiency of pig farming in up to date economic environment largely depends on the sows fertility and lactation, as well as on the efficient rearing of suckling piglets and their safety.

The production of multiple litters and well-developed and viable piglets significantly depends on the organisation of complete sow nutrition during the preparation for insemination, farrowing and lactation periods. Gestating sows should be fed enough to meet their physiological need for nutrients for the embryos development and growth, as well as to make appropriate nutrient reserves in the body. The main focus in suckling sows feeding is maintaining good health, increasing lactation, saving all piglets born and achieving an average live weight of 6-9 kg per piglet at one month of age (Povod, 2022; Povochnikov, 2022).

It was proven (Camargo, 2023) that the sow productivity in each subsequent reproductive cycle is closely related to the weight loss during lactation level. When a sow loses less than 5% of her body weight during lactation, her piglets

will have a higher weight at weaning, and in addition, she will have a shorter period of barrenness, a productivity increase at the next farrowing, and an increase in the farrowing percentage.

Furthermore, poor productivity negatively affects the parity number per year, piglets born live number, the percentage of replacement stock, which together determine not only the overall productivity of the breeder herd, but also the enterprise profitability (Dang, 2022).

The sow's lactation is one of the important breeding features that largely determines the normal growth and development of suckling piglets, their preservation and further rearing results in the farm. All nutrients contained in colostrum and sow's milk are digested 90-98% and absorbed well by piglets. In this regard, the piglets have a higher growth rate in the first months of life compared to the young of other animal species. At the age of one month, the piglet's live weight increases almost 5 times and 3.6-4.0 kg of mother's milk is needed to consume for 1 kg of gain (Costermans, 2020).

Therefore, it is very important to provide sows with complete feeding, as biologically complete

nutrition and proper gestation and suckling sows housing is a key factor in achieving high milk production.

It is impossible to organise biologically complete feeding without the use of biologically active additives that contain the necessary energy and biologically active substances, eliminating their deficiency in feed and acting as catalysts (accelerators) of metabolic processes in the body. Their effective and rational use in pig feeding can significantly increase the digestion and absorption coefficients of feed nutrients, productivity improve and animal welfare (Vuhliar, 2020; Syrovatko & Vuhliar, 2020).

In order to improve the feed products quality and animal diets, it is important to introduce to the feed new non-traditional types of plant material, which contain a balanced complex of proteins, lipids, amino acids, minerals, vitamins and have not only high nutritional feed properties, but also a prophylactic effect (Rooney, 2020; Vuhliar, 2020).

Phytobiotics are phytogetic feed additives made from medicinal plants that perform the following main functions: preventive; therapeutic; tonic and vitamin; immunoprotective, strengthening and normalising; biostimulant; they are resistant to adverse exogenous factors. They have a variety of effects on the body: antimicrobial, antiviral, immunomodulatory, antifungal, anti-inflammatory and are used in animal feeding to increase productivity and improve product quality (Kryzhak, 2020).

The following groups of phytobiotics are distinguished by their biological origin, chemical composition and other characteristics: herbs, spices, essential oils and resins.

Essential oils have the greatest antimicrobial activity. Essential oils have immunostimulating and antimicrobial properties. The use of phytobiotic preparations improves appetite and absorption of nutrients contained in feed, improves digestibility, and stimulates the endogenous enzymes production (Santos, 2023). However, the widespread use of phytobiotics from non-traditional raw materials in farrowing and suckling sows feeding is constrained by the lack of research on their chemical composition, effect on metabolism and productivity. Therefore, research in this area is relevant and needs to be discussed.

The aim of the study was to determine the effect of feed additive "Activo" in the diets of gestating and suckling sows on the amino acid and mineral composition of milk.

## MATERIALS AND METHODS

The effectiveness of the feed additive "Activo" in the complete feed composition was studied in the conditions of the pig complex of LLC "Artsyzka Meat Company", located in the Voskresenka Persha village, Artsyzka district, Odesa region.

For the study, were selected 16 heads of gestating sows of French genetics ADN (meat productivity), divided into two groups of 8 heads each (Table 1). The main methodological technique used in the trial was similar groups method (Vlizlo, 2012). This method involves the selection of animals into groups based on their age, live weight, origin, breed and general condition. The sows were of 2-3 parity and had no overgrazing. The research began when the sows were transferred to the farrowing parlor 5 days before the planned farrowing, or on the 110th day of gestation, and they were kept in individual pens.

Table 1. Trial design

Group	Quantity of animals	Sows		Piglets
		Sows in gestation (110 days)	suckling sows (before weaning 28-days of age)	from 5 days of age and till weaning 28 days
Control	8	BD* (complete compound feed)		BD* (complete compound feed)
Trial	8	BD + 0.1 kg/t «Activo»		BD + 0.2 kg/t «Activo»

\*BD - Base Diet

Sows of both groups were fed a complete feed balanced in terms of biologically active substances and nutrients using the Danish premix Nutrimin A/C. The feed additive "Activo" in the amount of 0.1 kg/t of feed was introduced into the sows feed of the trial group from 110 days of gestation to weaning. The animals were fed in doses using feed dispensers. The frequency of feeding was 2 times a day before farrowing, and 3 times a day after farrowing. Access to water was *ad libitum*.

Piglets of both groups were fed pre-starter feed by adding it to the feeders from the fifth day after birth until weaning. The feed for the piglets of the trial group contained the feed additive

"Activo" in the amount of 0.2 kg/t of finished feed. Feed consumption was recorded during the trial.

To determine body weight loss during lactation sows were weighed at the beginning and end of the trial. At farrowing, litter size, litter weight and individual piglets weight at birth were determined. At weaning, litter weight, weight of one piglet, average daily weight gain and piglet mortality during the suckling period were determined. To study the amino acid and mineral composition of milk, sows were sampled on day 21 of lactation. The amino acid milk composition was determined by analysing amino acids on a Sycam S433 amino acid analyser with post-column derivatisation with ninhydrin in the laboratory of "ES Biolights" LLC.

An inductively coupled plasma atomic emission spectrometer (ICP OES) (Analytik Jena, Germany, model: PlasmaQuant PQ 9000 Elite ICP OES) was used to study the content of macro- and microelements.

The study was carried out according to generally accepted zootechnical and analytical methods (Vlizlo, 2012).

The feed additive "Activo" contains a mixture of essential oils, which is a combination of natural standardised biologically active substances extracted from aromatic herbs and spices, concentrated in one microcapsule. It contains:

- cinnamon essential oil, which is a taste stimulant and antioxidant that enhances the palatability of feed, reduces the stress and disease effects.

- rosemary essential oil, which is an antioxidant and anti-inflammatory agent that reduces oxidative and inflammatory reactions, regulates body temperature, and reduces pain in inflammatory processes.

- chilli extract, which improves digestion by increasing the digestive enzymes activity and gastric juice secretion. Thus, increasing the feed conversion and its taste.

- oregano essential oil, which has bactericidal and antioxidant properties, inhibiting the growth and development of pathogenic fungi and bacteria (Prudyus, 2023).

The statistical processing of the study results was carried out using the standard Statistica package in Microsoft Excel 2013, assessing the reliability of the indicators ( $p < 0.05$ ;  $p < 0.01$ ;  $p < 0.001$ ) according to the Student's criterion (Kramarenko, 2019).

## RESULTS AND DISCUSSIONS

The modern genetics achievements in terms of sow productivity allows to produce up to 30 piglets per sow per year. Additionally, the litter weight at birth increases to more than 25 kg. Accordingly, the body's resource expenses increase, and metabolic processes in the body are accelerated. Therefore, it is important to develop a feeding strategy that meets the animal's nutrient requirements at different periods of the reproductive cycle. Compound feed should contain high-quality and easily digestible components and have an optimal amino acid composition (Hall, 2021; Khalak & Hutyi, 2022).

Research has shown that less weight loss and greater muscle retention during lactation improves sow performance, milk composition and nutritional value, and increases piglet weaning weight.

During the lactation period, the sow's organism functions under a significantly greater physiological load. During 28 days of lactation, a sow produces an average of 250-300 kg of milk. Sow's mammary glands produce milk unevenly in lactation. Most of it is produced in the second and third decades of the lactation period (an average of 22% of the total amount), after which the intensity of lactation gradually decreases. The peak of lactation is considered to be 21 days. The chemical composition of pig milk differs significantly from that of other livestock species. It contains 50-60% more dry matter, proteins, fats and total energy. Compared to milk, colostrum has significantly higher amount of dry matter, protein, and contains up to 40% of  $\gamma$ -globulins, which are part of the immune system, providing piglets with natural immunity against various diseases. Colostrum and sow's milk contain little amounts of iron, copper, calcium and phosphorus, so it is necessary to provide piglets with iron-containing preparations and mineral supplements, otherwise their blood will lack haemoglobin leading to anaemia and rickets.

Addition of the feed additive "Activo" to the sow's diet in the amount of 0.1 kg/t has a positive effect on their productivity, feed intake and general condition (Table 2).

Table 2. Parameters of live weight of suckling sows during feeding «Activo», n = 8

Parameters	1 group (control)	2 group (trial)
Birth weight, kg	221.5 ± 1.04	220.0 ± 0.23
Weaning weight, kg	199.0 ± 1.34	202.0 ± 0.34
Weight loss during suckling period, kg	22.5 ± 1.14	18.0 ± 1.26
Feed quantity for a sow for suckling period, kg	214.5 ± 0.63	221.0 ± 0.38

Thus, the results of the study show that weight loss during the suckling period of sows in the trial group was 18 kg, or 8.2%, while sows in the control group lost 22.5 kg, or 10.1%. That is, the animals of the trial group that consumed essential oils in the feed lost 4.5 kg or 1.9% less weight during the suckling period. Lower consumption of finished feed also had an impact on the weight loss of sows in the control group. Animals in the control group ate 6.5 kg less feed during the suckling period compared to animals in the trial group. It can be confirmed that the feed additive "Activo" in the feed composition had an impact on the appetite improvement in the animals of the trial group, because sows often refuse the feed after farrowing and during lactation.

The same pattern was observed in the growth rate of suckling piglets. Thus, the piglets of the trial group had a higher live weight of 5.4% (P<0.01) on the fifth day of life compared to the control group. Whereas at birth piglets of the control group had a higher live weight by 3.85% compared to piglets of the trial group (Table 3).

Table 3. Sows productivity and piglets growth parameters

Parameters	1 group (control)	2 group (trial)
Sows quantity, heads	8	8
Total born piglets, heads	122	118
Born alive piglets, heads	111	110
Stillborn and mummified piglets, heads	11	8
Piglets live weight at birth, kg	1.3 ± 0.01	1.25 ± 0.03
Piglets live weight at 5 days, kg	2.22 ± 0.04	2.34 ± 0.02**
Piglets live weight at 14 days, kg	3.2 ± 0.03	3.6 ± 0.03***
Piglets live weight at 28 days, kg	7.6 ± 0.08	8.1 ± 0.05***
Mortality, %	-	-
Cases of diarrhea, heads	23	7
Quantity of consumed prestarter, kg (until the weaning moment)	12.15 ± 0.12	12.5 ± 0.07

\*P<0.05, \*\*P<0.01, \*\*\*P<0.001

The piglets of the trial group at 14 days and at weaning at 28 days had also higher live weight comparing to the control group: by 0.4 kg or 12.5% at two weeks of age and by 0.5 kg or 6.6% at weaning. They had 30.4% fewer cases of diarrhea compared to the control group, which suggests that they had a stronger immune system. Perhaps there was a maternal transfer of biologically active components of plant origin through milk, demonstrating an antimicrobial effect.

Reyes-Camacho et al. (2020) found high concentrations of thymol, anethole and p-cymene in the milk of sows supplemented with plant compounds rich in these components during lactation, suggesting a mother-to-child transmission through milk. There is evidence that the nutrients supply that improve gut health to suckling sows can influence the gut microbiota of the litter within two weeks after weaning (Balasubramanian, 2016). The result was also observed by Tokach (2019), who identified a reduction in the piglets diarrhoea incidence from sows treated with oregano essential oil.

In addition, the piglets of the trial group had a better appetite, they ate 2.88% more pre-starter feed.

One of the important factors in the period of growing suckling piglets is the sows milk yield and its quality. In the study of sows whole milk samples obtained on the 21st day of lactation, an increase of 9.69 % in the protein mass fraction in animals of the trial group was determined compared to the control group (Table 4).

Along with the increase in the protein mass fraction in milk, the amino acid composition has improved. Of particular importance is the increase in the content of essential amino acids in milk.

Thus, lysine, which is essential amino acid responsible for bone formation and growth, calcium absorption, and takes part in the synthesis of antibodies, hormones, enzymes, and collagen formation, was 13.18% higher in the trial group, alanine was 13.11% higher, threonine was 7.14% higher, and histidine was 22.22% higher than in the control group. As for the non-essential amino acids, it was admitted a significant increase in aspartic acid by 11.4%, arginine by 32.25%, and proline by 3.77%.

Table 4. Amino acid composition of milk of lactating sows, n = 3

Parameters	Group	
	1 control	2 trial
Protein mass fraction, %	16.51 ± 1.00	18.11 ± 0.10
Valine, %	0.76 ± 0.06	0.76 ± 0.04
Proline, %	1.59 ± 0.13	1.65 ± 0.05
Phenylalanine, %	0.58 ± 0.08	0.66 ± 0.01
Leucine, %	1.08 ± 0.12	1.17 ± 0.02
Isoleucine, %	0.39 ± 0.05	0.39 ± 0.02
Histidine, %	0.45 ± 0.08	0.55 ± 0.03
Glycine, %	0.50 ± 0.06	0.44 ± 0.18
Glutamic acid, %	2.62 ± 0.31	2.21 ± 1.44
Arginine, %	0.62 ± 0.27	0.82 ± 0.02
Aspartic acid, %	1.14 ± 0.13	1.27 ± 0.04
Alanine, %	0.61 ± 0.06	0.69 ± 0.02
Threonine, %	0.70 ± 0.10	0.75 ± 0.02
Methionine, %	0.20 ± 0.03	0.21 ± 0.01
Lysine, %	0.91 ± 0.11	1.03 ± 0.01
Tyrosine, %	0.47 ± 0.09	0.53 ± 0.02
Serin, %	0.72 ± 0.13	0.83 ± 0.02
Cystine, %	0.38 ± 0.07	0.44 ± 0.05

One of the most important components of the feed is the presence of mineral elements, which are involved in all processes of the body's vital activity. Without them, bone growth, muscle fibre contraction, respiration, bristle growth, etc. cannot take place. Mineral elements intake is ensured by the feed (colostrum, milk, compound feed) consumed by the animal. Another important factor regarding the elements is not only their availability, but also conditions for their assimilation and the process of assimilation and distribution in the body.

All micro- and macronutrients in sow milk are absorbed in the small intestine. The duodenum is responsible for the largest percentage of absorption, which is facilitated by hydrochloric and bile acids. For piglets at an early age, the small intestine is the main organ for nutrient absorption and transport, and a healthy mucosa is important to ensure normal digestive function, as nutrient absorption is largely dependent on small intestinal villi (Prudyus, 2023; Sun, 2022; Zhe, 2022). The level of macro- and micro-nutrients supplied by colostrum and milk has a significant impact on the growth and

development of piglets in the first days after birth.

Analysing the data in Table 5, we can see that the calcium level in the control group was 6.1% higher than in the trial group. However, this indicator did not have a significant effect on cell membrane permeability, enzyme synthesis activation and promotion of phosphorus and zinc absorption, and rickets cases, as evidenced by the piglets performance in the trial group before and after weaning.

Table 5. Macro and microelement milk composition of suckling sows, n = 3

Parameters	Group	
	1 control	2 trial
Calcium, g/kg	0.98 ± 0.11	0.92 ± 0.07
Sodium, g/kg	0.76 ± 0.29	0.83 ± 0.09
Ferum, mg/dm <sup>3</sup>	1.37 ± 0.50	1.55 ± 0.22
Zink, mg/dm <sup>3</sup>	16.07 ± 5.90	16.63 ± 2.40
Magnesium, g/kg	0.09 ± 0.04	0.09 ± 0.01
Phosphorus, g/kg	1.00 ± 0.38	1.08 ± 0.07
Potassium, g/kg	1.08 ± 0.43	1.24 ± 0.02

The first clinical signs of anaemia (iron deficiency) in young piglets appear as early as 5-7 days of life. The full clinical manifestation of this disease is observed in the period of 21-28 days of piglets' life, characterised by pale skin, weakness, diarrhoea, poor feed intake, and mortality. In our study, the iron content was higher by 13.13% in the sows milk of the trial group compared to the control group. In the whole milk sample of sows of the trial group, an increase in Phosphorus and Zinc by 8% and 3.48%, respectively, was noted in relation to the control group. The increase of Phosphorus content has a positive effect as it is a part of the nucleic acids of many enzymes, phospholipids, phosphoproteins, and is involved in metabolism, biological reactions and energy metabolism (Wang, 2022). Zinc prevents the hypotrophic births occurrence, parakeratosis, and reduces the stillbirth rate of piglets (Wei, 2020).

It is scientifically proven (Yang, 2019; Vuhlyar, 2020) that essential oils have antimicrobial, digestive and antioxidant effects. These substances have a significant impact on intestinal health, nutrient absorption through the influence on the stress factors occurrence in

these organs (Martyschuk, 2019), and therefore have an impact on milk production.

## CONCLUSIONS

The use of the feed additive "Activo" in the amount of 0.1 kg/t of feed for sows, starting from 110 days of gestation and during lactation, helps to improve feed intake and increase productivity. It was found that the sows weight loss during the suckling period of the trial group was 18 kg, or 8.2%, while sows of the control group lost 22.5 kg, or 10.1%.

On the fifth day of life, piglets of the trial group had a higher live weight of 5.4% ( $P < 0.01$ ) compared to the control group, at 14 days and at weaning (28 days), the live weight of the trial group also exceeded the control group: by 0.4 kg or 12.5% at two weeks of age and by 0.5 kg or 6.6% at weaning. In addition, they had 30.4% fewer diarrhea cases compared to the control group.

In the study of sows whole milk samples obtained on the 21st day of lactation, an increase of 9.69% in the protein mass fraction and an improvement in the amino acid milk composition was determined.

The use of the feed additive "Activo" in the feed composition for suckling sows has a positive effect on improving the milk quality in relation to its biological value, which has a positive effect on the growth and development of young piglets further.

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