Advantages of feeding pregnant sows with biologically active substances based on folic acid and trace elements

N V Titova, A A Belookov*, O V Belookova, S A Vakhmyanina and R A Maksimova
South-Ural State Agrarian University, 13 Gagarina st., Troitsk, 457100, Russian Federation

*E-mail: belookov@yandex.ru

Abstract. The nutrition of sows has a significant impact on their productivity and milk production, as well as the multiple, large-fruited and the viability of the litter. The influence of folic acid and salts of microelements was studied by including them in diets, on the reproductive function of pregnant sows and the quality of offspring. The sows of the 1st control group received the basic diet adopted on the farm, the animals of the 2nd experimental group received folic acid in addition to the basic diet, the 3rd group received salts of trace elements (cobalt, manganese, zinc, copper and iodine), the 4th group was fed by a complex consisting of folic acid and mineral salts. It was found that the use of folic acid and a complex of salts of microelements had a beneficial effect on metabolic processes in the body of pregnant sows, improved their physiological state and increased the safety of piglets by 12.72%. The complex use of mineral salts and folic acid had a positive effect on the synthetic function of the liver. The increase in fertility, the number and live weight of piglets at birth and weaning in sows of the experimental groups can be explained by the improvement of feeding conditions, in particular, the enrichment of compound feed with biologically active substances, an improvement in the digestibility of the main dietary substances and, as a consequence, the activation of metabolism. In order to improve metabolism, reproductive function, increase fertility, nest weight at birth and weaning, preservation of piglets, we recommend adding trace element salts to the diet of pregnant sows in the following doses: CoSO4 - 10 mg, MnSO4 - 50 mg, ZnSO4 - 50 mg, CuSO4 - 50 mg and KI - 10 mg per 100 kg of body weight and folic acid - 35 mg/head during the entire period of pregnancy.

1. Introduction
Balanced nutrition (including the mineral composition) is important in the issue of adequate feeding of all types of farm animals and birds and affects the quality of animal products [1-5]. Micro-and macroelements in the body of animals and birds, in food systems and biological objects affect hormonal secretion, defense reactions, the process of hematopoiesis, the population of the microflora of the digestive tract, regulate metabolism, participate in protein biosynthesis, permeability of cell membranes, etc. [6-9]. Often, with a lack or excess of micro- and macroelements, it leads to a decrease in productivity, fertility, deterioration in product quality and the efficiency of using available feed [10-12].

The main source of trace elements for animals is feed. However, the mineral composition of the latter depends on the type of soil, climatic conditions, plant species, vegetation phase, agrochemical measures, harvesting technology, storage, preparation for feeding and other factors [13-16].
The second reason for the deficiency of minerals in the body of animals is the pathology of the gastrointestinal tract, where the absorption of nutrients and vitamins of feed occurs.

For normal life, pigs need minerals throughout their life. Pregnant sows are especially sensitive to the lack of essential nutrients. The nutrition of sows has a significant impact on their productivity and milk production, as well as multiple births, large fruit and litter viability [17-19].

With the development of the fetus in the body of pregnant sows, the work of internal organs increases, the metabolism and the use of nutrients increase in comparison with idle queens. With the course of pregnancy, the uterus' need for macro- and microelements and vitamins increases. When feeding pregnant sows, which does not provide the animals' need for mineral nutrition, it is impossible to obtain high productivity.

The aim of the research was to study the effect of folic acid and microelement salts on the reproductive function of pregnant sows and the quality of offspring by including them in the diets.

2. Materials and methods

To solve the set tasks, a scientific and economic experiment was carried out in the conditions of LLC "Agrofirma Ariant" on 4 groups of sows of large white breed, selected taking into account age, live weight, physiological state.

The scheme of the experiment is shown in figure 1. The animals were fed with SK-1 complete feed.

![Figure 1: Experimental setup.](image)

The scientific and economic experiment was carried out in a standard room of a pig-breeding complex with the placement of pregnant sows in pens of group housing, 10 heads each. A comparative method of analog groups was used. The conditions of keeping the animals were the same for all groups. Drinking was carried out from teat drinkers.

During the preparatory period, which lasted 10 days and on the 45th and 95th day of pregnancy, blood was taken from the animals.

The studies were carried out by standard methods on registered test equipment.

3. Research result

The composition of feed for pregnant sows included grain feed - 90.21%, waste from the grain processing and flour-grinding industry - 6.43%, synthetic amino acids - 0.32%, mineral additives and enzymes - 2.54%, vitamin and mineral premix - 0.5%.

Analysis of the actual ration of feeding of pregnant sows shows that the concentration of metabolic energy in 1 kg of dry feed was 12.2 MJ / kg, crude protein - 14.0%, lysine - 0.68%, methionine with
cystine - 0.54%, crude fiber - 6.31%, calcium - 0.67%, phosphorus - 0.54%, table salt - 0.51%. The ratio of calcium to phosphorus is 1.6.

We have found that the composition of the compound feed does not provide the physiological need of animals for microelements, which is confirmed by the deficiency in the blood of essential trace elements cobalt by 40%, manganese and copper by 50% and zinc by 30%. This is the reason for the need to use salts of trace elements in our research.

The blood tests of pregnant sows on the 95th day of gestation showed: in the group of animals receiving folic acid, hemoglobin was 107.3 ± 2.3 g/l, micronutrient salts - 120 ± 2.1 g/l, a complex of minerals and folic acid salts - 118 , 0 ± 2.0 g/l, while in the control group this indicator was reduced to 88.0 ± 1.8 g/l.

The highest erythrocyte counts were recorded in the group of animals receiving salts of trace elements, which amounted to 6.65 ± 0.1 mln/μl, they were inferior to animals of the fourth group, receiving a complex of salts of trace elements and folic acid (6.29 ± 0.1 mln/μl). The advantage of the animals of the third and fourth experimental groups relative to the control analogs for this indicator was 26.0 and 21.8%.

Blood tests of pregnant sows on the 95th day of gestation showed that the additional introduction of folic acid into the feed ration made it possible to increase the total protein level in comparison with the control by 7.2% compared to the control (or 89.9 ± 0.1 g/l). salts of microelements - by 6.2% (or 88.9 ± 0.1 g/l), salts of microelements and folic acid in the complex by 13.2% (or 96.1 ± 0.1 g/l).

Thus, the most favorable effect on the synthetic work of the liver was provided by the complex use of salts of trace elements and folic acid. Additional use of folic acid and micronutrient salts had the most beneficial effect on carbohydrate metabolism. In this group, an increase in glucose was noted by 33.8% (4.85 ± 0.3 mmol/l) compared to the control group (3.21 ± 0.1 mmol/l).

The use of folic acid contributed to a decrease in glucose concentration in relation to the control by 6.9% (2.99 ± 0.1 mmol/l). The use of microelement salts made it possible to increase this indicator by 30.5%.

We did not observe significant deviations in the content of urea and cholesterol.

The alkaline blood reserve on the 95th day of the experiment in the control group was 41.8 ± 09 vol% CO₂, against the background of the use of folic acid - 40.3 ± 1.9 vol% CO₂, mineral salts - 46.0 ± 1.7 vol% CO₂, folic acid and salts of trace elements 43.3 ± 0.9 vol% CO₂, at a rate of 40-65 vol% CO₂.

![Figure 2. Reproductive indicators of sows.](image-url)
An important economic indicator of the use of farm animals is the reproductive functions of the uterus. To obtain the maximum number of piglets, intensive rearing of offspring, gilts and boars, it all depends on the breed and breeding qualities of the animals, as well as on the correct keeping and, most importantly, on the feeding conditions of the pigs. That is, the reproductive functions of pigs are influenced not only by the genetics of parental traits, but also by the full, balanced feeding of pigs.

The catalysts of metabolism in the body of animals are feed biologically active substances that come from the feed, they affect the proliferation of queens, the large-fruiting and the safety of piglets.

The results of the reproductive functions of sows are shown in figure 2.

According to the data obtained, under the same conditions for keeping the experimental groups of animals and feeding them with only one complete feed, as in the control group (group 1), it allows the farm to receive 11.00 piglets per sow, while with the introduction of vitamin B into the diet - folic acid in the 2nd experimental group increases uterine fertility by 1 head, microelements in the 3rd experimental group - by 1.5 heads, and when they are used together in the 4th experimental group - by 2.20 piglets. With the data obtained, it should be borne in mind that the total number of live pigs in the 1st experimental group was 8.80 heads per uterus, then in the 2nd experimental group the same indicator was 10.40 piglets, which is more by 1.6 heads, in the 3rd experimental group - 11.00 is more by 2.2 pigs and in the 4th experimental group - 12.30 - this is 3.5 heads more.

Figure 3. Dynamics of live weight of piglets' nests.

The large-sized piglets in the nest at birth increased in comparison with the control group by 0.07 kg in the 2nd experimental group, by 0.06 in the 3rd experimental group and by 0.11 kg. This is due to the use in the complex of salts of trace elements and folic acid during the gestation period of sows, since they are biologically active substances that are involved in the metabolism of the body and for the synthesis of animal DNA. Folic acid is involved in the development and growth of the placenta, which makes it indispensable in the development of the immune and circulatory systems of piglets. Figure 3 shows the dynamics of live weight of piglets.

Accordingly, the weight of the nest of piglets was different in the 1st experimental group was - 14.19 kg, and in the 2nd experimental group it was higher by 2.49 kg, then in the 3rd experimental group - by 2.94 and in the 4th experimental group - by 5.39 kg.

With the control weighing of piglets at 28 days, the following results were obtained in the 1st experimental group - 74.32 kg, then in the other experimental groups there was a tendency to increase
in the 2nd experimental group - by 12.98 kg, in the 3rd experimental group - by 13.78 kg and in the 4th experimental group - by 39.40 kg. The data obtained on the difference in the absolute increase in live weight of piglets during the sucking period are explained by their average daily gain, which was 2127.5 g in the 1st experimental group, then in the 2nd experimental group the same indicator was higher by 394.64 g, in the 3rd experimental group - by 407.14 g and in the 4th experimental group - by 1234.64 g. Piglets of all experimental groups were superior in growth to animals of the control (1) group by 18.54% - in experimental group 2, by 19.13% - in the 3rd experimental group and by 58.03% in the 4th experimental group.

It is very important to understand that there is a relationship between the safety and live weight of a piglet and, as a consequence, an improvement in the qualities of piglets is an increase in the level of safety of animals (figure 4).

Figure 4. The safety of piglets.

Based on the studies carried out at the time of farrowing, 110.00 piglets were obtained in group 1, then in experimental group 2 the same indicator was already 120.00, and in experimental group 3 - 125.00 and in experimental group 4 - 132.00 piglets. At weaning, respectively, this indicator in group 1 was at the level of 81.00 piglets, in group 2 - 91.00, in group 3 - 92.00 and in group 4 - 114.00 heads, which in turn ensured the safety of the livestock at the level - 73.64% in the control group, in group 2 - 75.83, in group 3 - 83.64 and in group 4 - 86.36%.

The profitability of pig farms directly depends on the multiple births of pigs, on the number and safety of young animals and on their growth rate.

Taking into account the data obtained on the difference between piglets in live weight at weaning, we calculated the payment for feed with products of an increase in their live weight, according to the results of natural expression, that is, for each fed 1000 ECE feed, the following increase in live weight of piglets was obtained 95, 80 kg in group 1, in group 2 - 111.63 and 3 - 112.10, and in group 4 - 146.20, which in percentage terms was in all experimental groups from 2 to 4 groups - 116.52; 116.91; 152.40% compared to group 1. Based on the calculation for each fed 1000 rubles of feed in the control, it was produced - 17.20 kg of live weight gain of piglets, then in group 2 this indicator is higher by 8.54%, in 3 - by 16.39 and in 4 experimental group - by 41.80% higher.

4. Conclusions

The introduction of folic acid into the diet of pregnant sows contributed to an increase in the number of uterus in comparison with the control animals by 1 head, microelements - by 1.5, and with their combined use - by 2.20 heads of a piglet.
The introduction of folic acid into the diet of pregnant sows contributed to an increase in the total number of live piglets relative to the control group by 1.6 heads, microelements - by 2.2 pigs, and with their combined use - by 3.5 heads.

The use of folic acid in the feeding of pregnant sows made it possible to increase the large size of piglets in the nest at birth by 0.07 in comparison with the control group (1) and by 0.06 with the introduction of microelements, and by 0.11 kg when used together. In this case, the mass of the nest increased by 2.49, respectively: 2.94 and 5.39 kg.

The absolute growth of piglets in the 2nd experimental group was higher than in the control analogs by 394.64, in the 3rd experimental group - by 407.14 and in the 4th experimental group - by 1234.64 grams. Piglets of all experimental groups exceeded the growth of the control animals by 18.54 - 58.03%.

As a result of the use of biologically active additives based on folic acid and microelement salts in the diets of sows, there was a decrease in ECE costs per 1 piglet by 10.3 - 11.21%.

References
[1] Gorelik O, Rebezov M, Gorelik A, Harlap S, Dolmatova I, Zaitseva T, Maksimuk N, Fedoseeva N and Novikova N 2019 Effect of bio-preparation on physiological status of dry cows International Journal of Innovative Technology and Exploring Engineering 8(7) 559-62
[2] Khaziakhmetov F et al 2018 Effect Of Probiotics On Calves, Weaned Pigs And Lamb Growth Research Journal of Pharmaceutical, Biological and Chemical Sciences 9(3) 866-70
[3] Morozova L et al 2020 Improving the physiological and biochemical status of high-yielding cows through complete feeding International Journal of Pharmaceutical Research Supplementary Issue 1 2181-90 https://doi.org/10.31838/ijpr/2020.SP1.319
[4] Khaziakhmetov F, Khabirov A, Rebezov M, Basharov A, Ziangulov I and Okuskhanova E 2018 Influence of probiotics "Stimix Zoostim" on the microflora of faeces, hematological indicators and intensitivity of growth of calves of the dairy period International Journal of Veterinary Science 7(4) 178-81
[5] Rebezov Y, Gorelik O, Bezhanin T, Safronov S, Vinogradova N, Ermolova N, Shcherbakov P, Gritsenko S and Stepanova K 2020 Mineral Metabolism Features in Turkeys International Journal of Psychosocial Rehabilitation 24(8) 7550-7 DOI: 10.37200/IJPR/V24I8/PR280766
[6] Harlap S J et al 2020 The relationship of hematological parameters with growth indicators of young laying hens IOP Conf. Ser.: Earth Environ. Sci. 548 082011 doi:10.1088/1755-1315/548/8/082011
[7] Kuramshina N, Rebezov M, Kuramshin E, Tretyak L, Topuria G, Kulikov D, Evtushenko A, Harlap S and Okuskhanova E 2019 Heavy metals content in meat and milk of Orenburg region of Russia International Journal of Pharmaceutical Research 11(1) 1301-5 DOI: 10.21668/health.risk/2019.2.04.eng
[8] Konushkin S V et al 2020 Study of the physicochemical and biological properties of the new promising Ti–20Nb–13Ta–5Zr alloy for biomedical applications Materials Chemistry and Physics 30 July 2020, 123557 doi:10.1016/j.matchemphys.2020.123557
[9] Rebezov M et al 2020 Improvement of Laboratory Services When using Sample Preparation in Microwave System International Journal of Current Research and Review 12(16) 29-33 doi:10.31782/IJCRR.2020.12167
[10] Chaves E R 1985 Nutritional significance of selenium supplementation in a semipurified diet fed during gestation and lactation to firstlitter gilts and their piglets Can. J. Anim. Sci. 65 497-506
[11] Sedilo H M 2018 Dynamics of morphological and biochemical indicators of blood of sucking
piglets at different levels of iodine citrate in sows rations hunchak Scientific messenger of Lviv national university of veterinary medicine and biotechnologies named after S.Z. Gzhytskyj 20(84) 27-32

[12] Li N-Y et al. 2020 Impact of maternal selenium supplementation from late gestation and lactation on piglet immune function Biological trace element research 194(1) 159-67

[13] Belookov A, Belookova O, Zhuravel V, Gritsenko S, Bobyleva I, Ermolova E, Ermolov S, Matrosova Y, Rebezov M and Ponomarev E 2019 Using of EM-technology (effective microorganism) for increasing the productivity of calves International Journal of Engineering and Advanced Technology 8(4) 1058-61

[14] Khabirov A, Khaziakhmetov F, Kuznetsov V, Tagirov H, Rebezov M, Andreyeva A, Basharova A, Yessimbekov Z, Ayaz M. 2021 Effect of Normosil Probiotic Supplementation on the Growth Performance and Blood Parameters of Broiler Chickens Indian J of Pharmaceutical Education and Research 55(1) DOI: 10.5530/ijper.54.2s.x

[15] Sharipova A, Khaziev D, Kanareikina S, Kanareikin V, Rebezov M, Kazanina M, Andreeva A, Okuskhanova E, Yessimbekov Zh and Bykova O 2017 The effects of a probiotic dietary supplementation on the amino acid and mineral composition of broilers meat Annual Research & Review in Biology 21(6) 1-7 DOI: 10.9734/ARRB/2017/38429

[16] Sharipova A, Khaziev D, Kanareikina S, Kanareikin V, Rebezov M, Okuskhanova E, Suychinov A and Esimbekov Zh 2017 The effects of a probiotic dietary supplementation on the livability and weight gain of broilers Annual Research & Review in Biology 19(6) 1-5 DOI: 10.9734/ARRB/2017/37344

[17] Titova N V 2017 Trace elements and folic acid in the feeding of gestating sows Feeding of farm animals and feed production 6 37-42

[18] Titova N V 2018 Economic justification for the use of trace elements and folic acid in the diets of pregnant sows Feeding of farm animals and feed production 5 65-70

[19] Titova N V 2015 Reproductive functions of sows when adding a mineral and vitamin Supplement to the diet Materials of the international scientific and practical conference of young scientists and specialists "Young scientists in solving actual problems of science" Troitsk pp 281-4