

# Productivity and parameters of blood of sows fed with probiotic supplements

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**Abstract.** Feeding lactating sows with the probiotic supplements "Citexflor-1" and "Sgol-1-40" at 14.4–13.1 MJ of exchange energy released from digesting 1 kg of dry matter of feed mixtures included in the diet had a positive effect on productivity, nutrient digestibility and morphological and biochemical parameters of blood. The inclusion of adequate amounts of "Citexflor-1" enhanced milk production by sows in the second trial group compared to the control by 2.03 %, in the third by 6.6 % and in the fourth by 3.9 %, with the survival in piglets observed at 89–92 %. Supplementation of probiotic preparation "Sgol-1-40" was carried out, the sows showed to produce more milk by 5.8 % in the second trial group, 16.3 % in the third, and 20.7 % in the fourth group compared to the control. In the study of morphological and biochemical parameters of blood in sows in the first experiment, the erythrocyte number was greater in the third trial group by 6.2 %, and in the fourth by 4.7 %. In the second experiment, with probiotic supplementation of "Sgol-1-40" fed to sows, the number of red blood cells was 4.2; 18.1 and 32.1 % greater, respectively, along with hemoglobin level higher at 2.8; 15.3; 24.1 %, respectively.

## 1 Introduction

Nowadays the development of the livestock industry with the focus on introduction of new technological methods is hardly possible without improving the conditions of feeding and keeping animals. In recent years, it has become apparent that high productivity expected from animals can be only achieved by using bioactive compounds in the diets and exchange energy of high concentration readily available. So far, significant data have been accumulated relative to the probiotic supplementation in pig breeding, not rarely regarded as an alternative to antibiotics treatment [1, 2] The bacteria that make up probiotic composition ingredients normalize the intestinal microflora by regulating pH, inhibiting the growth, development and colonization of pathogenic microorganisms [3, 4], improve the intestinal barrier function [5, 6], synthesize various bioactive compounds (amino acids, enzymes, B vitamins, antioxidants), inactivate toxic substances [7, 8], optimize mineral balance in body, [9] enhance the body's defense system [10–13]. Therefore, they are also used for prevention and treatment of intestinal diseases of both infectious and non-infectious nature [14, 15]. Diets supplemented with probiotic preparations boost metabolism, increase digestibility of dietary nutrients, ensure survival and enhance productivity of animals [16–20].

The aim was to study the characteristics of metabolism under probiotic supplementation using

different types of microorganisms contained in grain diets intended for lactating sows.

## 2 Material and research methods

The experiment was conducted at two agricultural enterprises: SPK Agrofirma "Culture" and Betovo subsidiary of Snezhka poultry farm in the Bryansk region. The study was focused on lactating sows of Large White breed, the piglets of which were weaned at 60 and 45 days. The first experiment was allocated in four groups of lactating sows with an average live weight of 180–185 kg at 2 years of age. In the second experiment, four groups of lactating sows with a live weight of 186.9–187.6 kg of the same age were similarly formed. The scheme of scientific and economic experiments is shown in Table 1.

In the first experiment, the trial groups of lactating sows received, according to the experiment design, the probiotic supplement "Citexflor-1", which included *Lactobacillus acidophilus*, calcium lactate, chalk, lactic acid, microbial polysaccharides, bacterial protein. In the second experiment, the trial animals were fed adequate amounts of hydrolyzed, lactate-enriched serum, with an established probiotic effect and highly rich in dry matter, protein, amino acids, sodium lactate, lactic acid, glucose, lactose, galactose and phosphorus.

Concentrate feed in the diet of lactating sows in the first experiment accounted for 73.7 %, the remainder was distributed between succulents and feed of animal origin. The released amount of exchange energy calculated

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from 1 kg of dry matter of the diet was 14.4 MJ, crude protein – 170.0 g, digestible protein – 137.3 g, lysine – 7.65 g, methionine+cysteine – 3.95 g, crude fiber – 53.2 g, calcium – 15.5 g, phosphorus – 8.25 g. For the second experiment, 5 kg diet ration per head was administered daily to sows. 1 kg of dry matter contained 13.1 MJ of exchange energy, 230 g of crude protein, 116.4 g of digestible protein, 17.4 g of lysine, 6.2 g of methionine + cysteine, 35.7 g of crude fiber, 7.0 g calcium and 7.7 g of phosphorus.

**Table 1.** Scheme of scientific and economic experiments.

Group	First experiment		Second experiment	
	Number of heads	Feeding conditions	Number of heads	Feeding conditions
I-control	4	OP-main diet	6	OP-main diet
II-trial	4	OP + 10ml "Citexflor-1" per head daily	6	OP + 1,5 % "Sgol-1-40" from the dry matter in the diet
III-trial	4	OP + 20ml "Citexflor-1" per head daily	6	OP + 3,5 % "Sgol-1-40" from the dry matter in the diet
IV-trial	4	OP + 30ml "Citexflor-1" per head daily	6	OP +3,5 % "Sgol-1-40" from the dry matter in the diet

During the experiment, control weightings were carried out and animal blood samples were examined. At the end of the experiments, studies were conducted to analyze the digestibility of nutrients based on the diets formulated. The digestibility coefficients of the main nutrients were calculated on the basis of the analysis of the presence of the indicated nutrients in feces and the diets employing generally accepted methods [21, 22]. Morphological and biochemical blood parameters were determined following the methods described in the reference literature [23]. All digital data obtained in the studies was statistically processed using variation statistics [24]. The results were considered valid at  $P \leq 0.05$ .

### 3 Research results

During the lactation period, the nature and intensity of the processes associated with milk production undergo significant changes. Therefore, the need for nutrients varies depending on a number of piglets suckling the sow, physiological condition, live weight, age and other factors. However, the growth performance and survival in piglets in the suckling period depend on the milk production by sows. Some indicators of the productivity of lactating sows under probiotic support are shown in Table 2.

Administration of amounts of the probiotic supplement "Citexflor-1" in the first experiment had a beneficial effect on the sows' milk production and survival rate of piglets. The milk production by sows in the second trial group was found to be higher by 2.03 %, in the third by 6.6 % and in the fourth by 3.9 % compared to the control. It should be noted that the intake of the probiotic supplement equal to 30 ml per

head daily did not tend to increase milk production compared to the third trial group, although the survival in piglets was greater and reached 89–92 %, which resulted in increase in the weight of the nest during weaning.

**Table 2.** Sow productivity indicators

Indicators	Group			
	I-control	II-trial	III-trial	IV-trial
<i>First experiment</i>				
Milk production, kg	34.36 ± 2.6	35.00 ± 1.9	36.64 ± 2.16	35.70 ± 2.2
Weight of 1 piglet at 2 months of age	12.38 ± 0.26	13.30 ± 0.32	13.75 ± 0.34	14.65 ± 0.26
The mass of the lying nest at weaning in two months, kg	123.05 ± 8.7	129.15 ± 6.1	136.83 ± 6.3	138.68 ± 7.0
Survival, %	83	89	90	92
<i>Second experiment</i>				
Milk production, kg	31.98 ± 1.35	37.80 ± 1.92	48.30 ± 1.73*	52.70 ± 1.72
Weight of 1 piglet at 2 months of age	9.75 ± 0.03	9.98 ± 0.01	12.00 ± 0.05	14.00 ± 0.04
The mass of the lying nest at weaning in two months, kg	80.50 ± 0.5	89.40 ± 0.8	118.80 ± 1.0	128.80 ± 1.5
Survival, %	81	87	89	90

\* –  $P \leq 0.05$  (here and further on)

In the second experiment, lactating sows were fed "Sgol-1-40" probiotic supplement and milk production was recorded in the range of 5.8 kg gain in the second group, 16.3kg ( $P \leq 0.05$ ) in the third and 20.7 kg in the fourth groups in relation to the control. The survival in piglets in the trial groups was also better at 6.0; 8.0; 9.0 %, respectively.

Thus, the use of the probiotic supplements in the diets formulated with different ingredient compositions for lactating sows with almost the same amount of exchange energy released from 1 kg of dry matter made it possible to increase milk production by sows and keep piglets alive.

The data obtained suggest that once balanced feeding is supplemented with probiotic preparations and biological indicators are given due attention to, high productivity is achieved and favorable conditions for digestion and assimilation of nutrients in the intestinal tract are created. The ingredients contained in probiotic supplements are involved in all biochemical processes in the body, affecting the digestibility, assimilation and ending up in products. To study the digestibility of nutrients in lactating sows under feeding adequate amounts of probiotic supplements, balance based experiments were carried out. For both experiments, three sows in each group were selected. Feeding and maintenance conditions were established in accordance with the daily diets requirements. The digestibility of nutrients is given in Table 3.

The study results showed that administration of probiotic supplements to lactating sows in the first and second experiments had a positive effect on the

digestibility of the main nutrients. Respectively, in the first experiment, "Citexflor-1" was included in the diets for sows in the third and fourth trial groups, the sows were fed diets with 20 and 30 ml of probiotic supplements per head daily, the digestibility coefficients of crude protein were determined higher by 3.1 % ( $P \leq 0.05$ ) and 3.9 % ( $P \leq 0.05$ ), crude fat – by 2.4 % ( $P \leq 0.05$ ) and 2.8 % ( $P \leq 0.05$ ), crude fiber – by 3.8 % ( $P \leq 0.05$ ) and 4.3 % ( $P \leq 0.05$ ) compared to the control. In the second experiment, lactating sows were fed "Sgol-1-40" included with the grain diet in portion rationing of 1.5, 2.5 and 3.5 % calculated from dry matter, the digestibility of organic matter in the second trial group improved by 1.17 %, in the third group by 2.20 % and in the fourth one by 2.66 %, respectively, relative to the control. In the third group, the animals received a 2.5 % probiotic supplement, the digestibility of crude protein was determined higher by 2.29 % ( $P \leq 0.05$ ), fat by 6.21 % ( $P \leq 0.05$ ) and fiber by 6.27 % ( $P \leq 0.05$ ) compared to the control. In the fourth trial group, the sows received a 3.5 % probiotic supplement in the diet, crude fat and fiber were significantly better digested, but these indicators were found to be lower than in the third trial group.

**Table 3.** Digestibility of nutrients

Indicators	Group			
	I-control	II-trial	III-trial	IV-trial
<i>First experiment</i>				
Dry matter	71.7±0.17	72.3±0.18	72.6±0.20	72.7±0.24
Organic matter	73.1±0.20	73.7±0.37	74.6±0.30	74.7±0.33
Crude protein	72.1±0.21	74.4±0.40	75.0±0.44*	75.2±0.75*
Crude fat	43.1±0.35	45.0±0.58	45.5±1.10*	45.9±1.30*
Crude fiber	23.3±0.18	24.1±0.29	27.1±0.42*	27.6±0.56*
BEV **	80.7±0.39	81.0±0.36	81.9±0.38	83.0±0.42*
<i>Second experiment</i>				
Dry matter	72.29±0.22	73.26±0.26*	73.68±0.21	73.96±0.19*
Organic matter	73.83±0.27	75.00±0.44	76.03±0.27*	76.49±0.12*
Crude protein	72.87±0.22	74.36±0.41*	75.16±0.43*	75.96±1.16
Crude fat	44.82±0.45	48.53±1.16*	51.03±1.12*	48.11±0.87*
Crude fiber	22.26±0.15	23.53±0.76	28.73±0.87*	28.46±0.95*
BEV **	81.96±0.41	82.23±0.32	82.93±0.29	83.33±0.29*

\*\* BEV – nitrogen-free extractive substances

Addition of adequate amounts of probiotic supplements in the diets of lactating sows resulted in improved digestibility of nutrients, which is probably due to an increased activity of beneficial microorganisms in the intestine and inhibition of undesirable microflora caused by pH adjustment by lactates contained in the supplements.

Changes in the blood of lactating sows that occur in probiotic supplementation are given Table 4.

During the study period in both experiments, the morphological and biochemical parameters of blood in sows varied within the designated physiological range, which gives proof of a good health condition and high productive qualities.

The administration of the probiotic supplement "Citexflor-1" was found to have increased number of red blood cells in the third trial group by 6.2 % ( $P \leq 0.05$ ), and in the fourth by 4.7 % compared to the control, the level of hemoglobin was determined to be higher by 7.2 % ( $P \leq 0.05$ ) and 5.0 %, respectively. The total protein content was significantly higher in the blood serum of sows in the third group by 10.8 % ( $P \leq 0.05$ ) and in the fourth group by 11.3 % ( $P \leq 0.05$ ).

When feeding the probiotic supplement "Sgol-1-40" included in the diet of lactating sows, the number of red blood cells increased by 18.1 % and 32.1 %, white blood cells by 24.5 and 35.5 %, hemoglobin by 15.3 % and 24.1 %, respectively, relative to similar indicators in the control group of animals. Administration of hydrolyzed serum to sows in doses of 2.5 % and 3.5 %, caused a significant increase ( $P \leq 0.05$ ) in almost all studied biochemical blood parameters, in particular, total protein by 42.9 and 52.9 %, glucose by 48.5 and 68.5 %, inorganic phosphorus by 30.4 and 40.1 % compared to the control group

**Table 4.** Morphological and biochemical parameters of blood in lactating sows

Indicators	Group			
	I-control	II-trial	III-trial	IV-trial
<i>First experiment</i>				
Erythrocytes, $10^{12}/l$	6.43 ±0.12	6.47±0.07	6.83±0.07*	6.73±0.14
Leukocytes, $10^9/l$	11.57±0.89	10.97±0.69	11.43±0.85	11.07±0.78
Hemoglobin, g/l	99.3±1.19	101.2±1.12	106.4±1.61*	104.3±0.90*
Total protein, g/l	66.77±1.18	71.23±1.27	71.93±1.24*	74.37±0.40*
Albumins, g/l	28.96±0.58	29.77±1.41	29.52±1.70	30.48±0.50
Globulins, g/l	37.81±0.13	41.46±0.51	43.84±0.19	43.84±0.19
Glucose, mmol/l	3.17±0.09	3.35±0.07	3.31±0.06	3.41±0.06
Total calcium, mmol/l	2.31±0.08	2.60±0.02*	2.61±0.06*	2.52±0.04
Inorg. phosphorus, mmol/l	2.64±0.09	2.62±0.06	2.64±0.13	2.51±0.35
<i>Second experiment</i>				
Erythrocytes, $10^{12}/l$	5.91±0.7	6.16±0.68	6.98±0.67	7.81±0.80
Leukocytes, $10^9/l$	10.28±0.05	10.13±0.07	12.80±0.28*	13.93±0.08*
Hemoglobin, g/l	93.70±2.78	96.30±2.56	108.0±3.59	116.3±3.98*
Total protein, g/l	54.20±0.14	67.2±0.13*	77.5±0.15*	82.9±0.03*
Albumins, g/l	32.65±0.13	34.18±0.33*	36.32±0.17*	38.32±0.35*
Globulins, g/l	21.55±0.89	33.02±1.14	41.18±1.79	44.58±1.29
Glucose, mmol/l	3.05±0.12	4.24±0.41*	4.53±0.21*	5.14±0.23*
Total calcium, mmol/l	2.3±0.20	2.3±0.21	2.6±0.14	3.0±0.28
Inorg. phosphorus, mmol/l	2.0±0.20	2.3±0.23	2.7±0.13*	2.9±0.31*

The research data are consistent with the results of other studies [25–28]. In particular, the supplementation of the probiotic preparation "Intestevit" to sows in the prenatal period and after farrowing has a positive effect on erythropoiesis, morphological and functional state of the liver and biochemical status, which was demonstrated by an increased number of red blood cells by 10.9 %, hemoglobin – by 9.2 %, total protein – by 2.3 %, albumin – by 3.2 %, globulin – by 7.8 %, glucose – by 7.1 %, total calcium – by 3.8 %, and tends to have a beneficial effect on productivity, which is noticeable in increased milk production – by 5.3 %, the average daily gain by piglets by 7.8 % and their survival rate by 5.6 % [28]. Research carried out by Ovchinnikova A.A. concludes that the probiotic supplements "Sinbilite" and "Sporotermin" increase the digestibility of dry matter by 3.51 and 2.57 %, organic matter by 2.46 % and 2.24 %, crude fiber by 14.88 % and 10, 97 % and crude fat – by 5.03 % and 0.95 %, [27] when given to farrowing sows. The use of the probiotic supplements "Monosporin", "Prolam" and "Bacell" improves the reproduction of sows [25].

## 4 Conclusion

Probiotic supplementation provided in different types and doses to lactating sows had a proven positive effect in term of increased milk production, survival in piglets and gaining a live weight at different days during weaning. We made a conclusion that administration of adequately increased amounts of the probiotic supplements "Citexflor-1" and "Sgol-1-40" resulted in better digestibility coefficients of crude protein, fat and especially crude fiber, morphological and biochemical parameters in the blood of trial animals were improved. It serves as a proof of increasing metabolism in the body due to the effects caused by the probiotic supplements use.

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