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Application of vitamin-mineral supplement in intensive use of boars and its effect on reproductive qualities

Stepan Batanov[1*], Aleksandr Perevozchikov[2] and Lyudmila Novikova[1]

[1]*Izhevsk State Agricultural Academy, 426000, Izhevsk, Russia*
[2]*Izhevsk State Agricultural Academy, LLC "Kigbaevsky bacon", 426000, Izhevsk, Russia*
[*]*Corresponding author:* stepanbatanov@mail.ru

Abstract

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The aim of the research was to study the influence of the vitamin-mineral supplement with amino acids on reproductive qualities of breeding boars in their intensive use as well as the comparative analysis of reproductive qualities of sows inseminated with sperm of breeding boars of control and experimental groups. The results of scientific and practical experiment have shown that the application of the vitamin-mineral supplement promoted the increase of ejaculate volume of boars, sperm concentration, and sperm motility and survival capacity. The ejaculate volume of Yorkshire boars has increased by 5.8% ($p \leq 0.05$), of Landrace boars by 12.0% ($p \leq 0.05$). Sperm concentration in 1 ml of ejaculate in boars receiving the vitamin-mineral supplement has increased respectively by 3.6% ($p \leq 0.05$) and 1.0% ($p \leq 0.05$).

The sows inseminated with sperm of boars of the experimental group had better reproductive qualities. Conception rate has increased by 2.7-2.9%, prolificacy by 4.2-4.4% ($p \leq 0.05$), and large fetus ability by 0.06-0.08 kg or 5.3-6.4% ($p \leq 0.05$).

Key words: breeding boars; sows; conception rate; prolificacy; large fetus; spermatozoids, ejaculate; vitamins

Introduction

Nowadays the pig industry is based on specification of feed standards, selection of animal genetic breeding background, and competent veterinary service of animals (Kondracki et al., 2006a; Kondracki et al., 2006b; Mysik, 2013; Mysik et al., 2014; Perevozchikov et al., 2017).

The main objective of rationed feeding of breeding boars is to obtain high quality sperm. Systematic inaccuracy in boars feeding decreases the level of sows' conception rate and deteriorates the progeny-viability. Lack of biologically active substances in the diet including vitamins leads to production decrease of animals and in effective usage of feed supplies (Perevozchikov et al., 2013; Mysik et al., 2014; Starkov, 2017; Belyaev, 2017; Wang et al., 2017).

Full nutritional value of feeding influences the semen quality (volume, thickness, motility of spermatozoids) (Kondracki et al., 2006b; Wysokinska et al., 2006; Ghaderzadeh et al., 2016). Failure of reproductive activity of boars often results from the deficiency of energy, protein, mineral nutrition. The formation of sperm cells and seminal fluid, mount and coitus, intense nervous activity, and hypermetabolism in boars determine their larger demand for biologically full value protein, various vitamins, and mineral substances including minor nutrient elements. Deficiency of these substances leads to deterioration of sperm quality resulting in weakening of prenatal growth and survival ability of piglets. Vitamins A, B, D, E have great influence on quantity and quality of boar's sperm. Vitamins A and D are of particular importance. It has been established that boars kept on the diets with sufficient quantity of digestible protein and mineral substances but not provided with vitamins A, B and D, as a rule, have poor quality sperm. The ration of breeding boars should include vitamin A which takes part in spermatogene-

sis and also influences the motility of sperm cells; B vitamins involving in the formation of reproductive organs; vitamin E being the main antioxidant in the body and preventing the formation of large quantity of fatty acids affecting reproduction in a negative way. Sulfur containing amino acids (cystine and methionine), calcium and phosphorus contribute to the increase of quantity of sperm cells in ejaculate (Perevozchikov et al., 2013; Mysik et al., 2014; Starkov, 2017; Szuba-Trznadel et al., 2017; Gudev et al., 2012).

Chelate forms of minor nutrient elements, vitamins and amino acids have been recently of particular interest. The generated compounds of amino acids and metals possess greater biological activity than in a free state. Metal ions in conjunction with amino acids also develop novel properties – they become less toxic and they are able to catalyze biochemical processes (Dzhamaldinov et al., 2015; Szuba-Trznadel et al., 2017; Gudev et al., 2012; Ghaderzadeh et al., 2016; Wang et al., 2017; Perevozchikov et al., 2017).

Therefore, the issue of efficient use of chelate forms of minor nutrient elements, vitamins, amino acids is relevant and challenging for further study.

Materials and Methodology

The scientific and practical experiment was conducted on service boars of Yorkshire and Landrace breeds at pig farm 'Kigbaevsky bacon', LLC, in the Udmurt Republic, Russian Federation, in 2017.

Two groups of breeding boars (control and experimental) were selected according to the principle of couples-analogues for conducting this scientific and practical experiment. Breeding background, age and live weight of animals were taken into account when allocating them to groups. All animals were keeping under the same conditions in accordance with the conventional technology at the enterprise. Animals used in the experiment received the same ration, the experimental group of boars additionally received 30 g of the vitamin-mineral supplement per head a day. The supplement was given with a measuring spoon during the morning feeding. The supplement dosage is determined by actual content of vitamins, minerals, amino acids in the diet and also by physiological requirement of breeding boars.

For semen collection we used a manual method which provides strict hygiene of obtained sperm due to single use of expendable materials and also check of blood and urine into a bucket for semen collection. The mode of using boars was the same – twice a week.

Freshly obtained sperm was assessed in the laboratory of the artificial insemination station. The assessment was conducted according to GOST 33827-2016 'Fresh-received diluted boar's semen'. We assessed the visual appearance, color, smell, survival capacity at a temperature of 16-18°C.

The sperm activity score was conducted in the process of visual assessment with the use of a microscope. The sperm concentration was measured on the photometer SDM 6. The diluent BTS+ was applied. The survival capacity of sperma-

Table 1. Composition of complex vitamin-mineral supplement (content in 30 g)

Indicator	Quantity	Indicator	Quantity
Vitamin A	201000 IU	Isoleucine	not less than 105 mg
Vitamin D3	1590 IU	Alanine	not less than 66 mg
Vitamin E	540 mg	Leucine	not less than 192 mg
Vitamin C	162 mg	Phenylalanine	not less than 239 mg
Vitamin B1	13.2 mg	Tyrosine	not less than 64 mg
Vitamin B2	48 mg	Aspartic acid	not less than 72 mg
Vitamin B6	28.5 mg	Glutamic acid	not less than 501mg
Vitamin B12	0.6 mg	Copper	24 mg
Vitamin PP	162 mg	Iodine	1.8 mg
Vitamin K3	17.7 mg	Cobalt	0.3 mg
Threonine	not less than 90 mg	Selenium	0.9 mg
Serine	not less than 288 mg	Calcium Pantothenate	120 mg
Valine	not less than 132 mg	Biotin	1.7 mg
Proline	not less than 474 mg	Folic acid	45 mg
Methionine	not less than 63 mg	Choline	225 mg
Glycine	not less than 549 mg	Zinc	255 mg
Lysine	not less than 336 mg	Manganese	96 mg
Histidine	not less than 129 mg	Iron	225 mg
Histidine	not less than 78 mg	Filler	calcium carbonate up to 1 kg

tozoids was estimated after storing them in a thermostat at a temperature of 38°C in 24 hours, and also in a climobox at a temperature of 17°C in 72 hours.

Sows inseminated with the semen of breeding boars of the control and experimental groups were assessed on reproductive qualities. In this regard we considered the conception rate (determined by the farrowing results), fertility (the quantity of piglets in a litter at birth), prolificacy (the quantity of live piglets in a litter at birth) and large fetus ability.

The composition of the vitamin-mineral supplement is shown in Table 1.

Results

Qualitative and quantitative indicators of sperm production of animals used in the experiment are presented in Table 2. The duration of spermatogenesis in boars according to various data ranges from 34 to 49 days. That is why the comparative analysis of sperm quality was conducted after 60 days from the starting of feeding this supplement. The assessment was carried out in the laboratory of the artificial insemination station at the enterprise.

Research findings did not reveal essential interbreeding differences in such indicators of sperm quality of Yorkshire and Landrace breeding boars as ejaculate volume, activity and survival capacity both before the supplement usage and during the supplement usage. It should be noted that sperm concentration was reliably ($p \leq 0.05$) higher by 12.9-19.4% in Landrace breed.

These studies found that during the period of feeding this vitamin-mineral supplement the ejaculate volume of Yorkshire and Landrace boars of experimental groups reliably increased by 4.0% and 6.8%, and sperm concentration increased respectively by 8.7% ($p \leq 0.05$) and 2.4%. The survival capacity of spermatozoids in diluted semen after storing for 72 hours at a temperature of 170°C remained within normal limits. In addition, it was established that the survival capacity of spermatozoids in semen of boars receiving vitamin-mineral supplement in their diet was higher by

Table 2. Indicators of sperm quality of breeding boars

Indicators	Breed			
	Yorkshire, n = 10		Landrace, n = 10	
	Control group	Experimental group	Control group	Experimental group
	before the supplement usage			
Ejaculate volume, ml	214.0±3.1	208.0±4.3	223.2±4.4	218.4±4.8
Concentration, mln in 1 ml	434.9±10.1	438.8±9.1	506.9±8.7	496.3±11.2
Activity, score	8.6±0.04	8.8±0.06	8.8±0.07	8.6±0.09
Survival capacity, score	6.7±0.07	6.6±0.08	6.7±0.11	6.8±0.10
	during the supplement usage			
Ejaculate volume, ml	211.1±2.2	219.6±3.1*	218.6±5.4	233.5±4.1*
Concentration, mln in 1 ml	418.2±11.7	454.6±9.3*	499.5±7.6	511.4±9.2
Activity, score	8.9±0.09	8.7±0.13	8.9±0.08	8.9±0.08
Survival capacity, score	6.9±0.04	7.1±0.07*	6.9±0.11	7.2±0.06*

*$P \leq 0.05$

Table 3. Reproductive qualities of sows, n = 50

Estimated indicator	Breed of a service boar			
	Yorkshire		Landrace	
	Control group	Experimental group	Control group	Experimental group
	before the supplement usage			
Conception rate of sows, %	91.0	90.7	89.8	91.1
Fertility, head	13.1±0.3	13.0±0.2	12.9±0.4	12.9±0.2
Prolificacy, head	12.1±0.2	12.3±0.1	11.8±0.3	11.9±0.3
Large fetus ability, kg	1.12±0.02	1.14±0.03	1.09±0.04	1.11±0.03
	during the supplement usage			
Conception rate of sows, %	88.9	91.6	90.4	93.3
Fertility, head	13.1±0.3	13.2±0.1	13.0±0.2	13.2±0.1
Prolificacy, head	12.0±0.2	12.5±0.2*	11.4±0.1	11.9±0.2*
Large fetus ability, kg	1.13±0.01	1.19±0.02*	1.08±0.03	1.16±0.02*

* $P \leq 0.05$

3.0% and 4.3 % ($p \leq 0.05$) in Yorkshire and Landrace breeds respectively. We did not find out significant differences in a dynamic pattern of sperm activity during the research period.

As can be seen from the above, usage of the vitamin-mineral supplement in the feeding diet of breeding boars greatly influenced the improvement of semen production quality. In continuation of our research the evaluation of reproductive qualities of sows inseminated with semen of breeding boars of control and experimental groups was conducted (Table 3). Yorkshire breeding sows were used in the experiment.

It has been established that usage of the vitamin-mineral supplement in feeding diet of breeding boars made it possible to increase the conception rate of sows of experimental groups by 2.7-2.9%. No significant differences in the fertility level of sows of different groups being found, prolificacy reliably increased by 4.2-4.4% ($p \leq 0.05$), and large fetus ability by 5.3-6.4% ($p \leq 0.05$) respectively. It provides evidence that the semen of breeding boars of experimental groups possesses higher qualitative indicators of reproduction. Significant differences in reproductive qualities of sows inseminated by boars of different breeds were not found.

Conclusions

Thus, the usage of vitamin-mineral supplement in feeding of breeding boars had a positive influence on the quality of sperm production. The increase in ejaculate volume and concentration of sperm cells in boars of experimental groups both Yorkshire and Landrace breeds was observed. Spermatozoids had better survival capacity with non-significant difference in their activity. All of this influenced the productivity indicators of sows, promoted higher conception rate and birth of healthy progeny.

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