Use of activated charcoal feed supplement in diets of pigs

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Abstract. Pig farming is one of the most important and strategically valuable sub-branches of animal husbandry for ensuring food security of Russia and its regions as the special role of meat and meat products is determined with their significance as the main source of proteins of animal origin in human sensible nutrition. The novelty of the work is the use of an active coal feed additive as part of the diets of experimental piglets for growth and development and meat productivity during cultivation and fattening. Effective pig farming suggests use of high-quality feeds meeting requirements of presence of nutritional components and absence or minimum content of harmful and toxic substances. The conducted studies prove that the dose of activated charcoal feed supplement in the amount of 0.050 g/kg of live weight gives the highest results.

1. Introduction

To reduce the cost of production of products everywhere in the composition of mixed feeds include components of local production, such as grain cereals, cake and sunflower meal, and many others. However, due to the significant content of fiber and non-starchy polysaccharides, they have low nutritional value and poor digestibility. This problem is solved by including various biologically active substances (BAS) in the composition of mixed feeds, such as: enzymes and probiotics that help to increase the efficiency of the use of feed nutrients [1-3].

The main reason for the loss of products in the industry is the feeding of substandard feed, which may contain residues of pesticides, heavy and radioactive elements, mycotoxins, products of nitrate metabolism and other compounds that are dangerous to health. The negative impact of mycotoxins coming from feed on the performance indicators in pig farming is confirmed by scientific studies.

For the prevention of mycotoxicosis in farm animals and birds, various adsorbents have been used in practice. The adsorbents used today in pig farming are divided into three groups: inorganic (naturally occurring aluminosilicates – zeolites, bentonites, etc.), organic (components of yeast walls, lignins, activated charcoal) and combined (mixtures of inorganic and organic adsorbents in various ratios) [4-6].

To reduce the effect of mycotoxins in compound feeds, increase the content of lacto- and bifidobacteria and reduce the content of pathogenic intestinal microflora, we recommend the use of mycotoxin absorbent “Funginorm” in the diets of young pigs at a dose of 4.0 g/kg of compound feed [7-9].
At the same time, many researchers have proven that the higher the productivity of animals, in our case pigs, it is (average daily growth, multiple births, milk production, etc.), the more sensitive they are to various microtoxins in the feed [10].

Thus, in the practice of many branches of animal husbandry, there is some experience in the use of various feed additives by extensive mechanisms of their action. In pig farming, there are many studies on the use of natural adsorbents in pig diets, such as natural zeolites and others [11-12].

One of such preparations is activated coal feed supplement (ACFS). ACFS is finely-dispersed porous material with a unique ability to sorb significant quantities of substances of different chemical nature from gas, vaporous and liquid media. Having been administered in the organism, it intensively absorbs gases that form in the gastrointestinal tract, eliminates undesirable fermentation processes, contributes to proper digestion and creates favorable conditions to increase weight of animals. In addition, it has an ability to adsorb bacteria and thus prevent their growth in the organism. It also absorbs toxins and other poisonous substances that get into the intestine or form there. The above mentioned properties of activated charcoal are already successfully used in human and veterinary medicine [13-15].

The conducted studies of ACFS on broiler chickens of the Cobb 500 cross contribute to an increase in height-weight indicators. It is also noted that the use of ACFS contributes to the normalization of the average hemoglobin content in the red blood cell and the color index; biochemical studies indicate a tendency to normalize the indicators of the functional state of the liver of broiler chickens, as well as a favorable effect of the active coal feed additive on the indicators of mineral metabolism, which is most likely due to the ash residue of the additive. The use of ACFS at a dose of 600 and 800 g per ton of feed contributed to the normalization of protein and carbohydrate metabolism in experimental chickens [16-17].

At the same time scientific literature lacks information on issues of impact of activated charcoal feed supplement on growth and development rates of pigs by periods growing. Therefore there arises the need in studying them, which is a relevant problem of modern zootechnical practice [18].

The purpose of the study is to establish the effect of an active coal feed additive on growth and development in order to identify and establish its optimal dose during the rearing and fattening of young pigs.

2. Material and methods

To achieve the set goals in production conditions in the integrated agricultural production company “Novy Put” of Alikovsky Region of the Chuvash Republic a scientific and economic experiment was carried out. The material was normally developed, healthy piglets at the age of 60 days of a large white breed. For the experiment three groups of piglets, 10 heads in each, were formed based on the principle of analogue groups [19].

The experiment lasted 150 days. The microclimate parameters in the pig house during the scientific and economic experiments met the established zoohygienic regulations. During the experiment the animals were fed twice a day based on the schedule used on the farm (table 1).

Changes were made to the traditional piglet feeding technology and a fundamentally new feed ingredient was added – an active coal feed supplement (ACFS). The active coal feed supplement is made from activated charcoal, has a high adsorption capacity against mycotoxins and other harmful substances: it contains significant amounts of macro- and microelements in an accessible form for farm animals.

The pigs of the control group had the basic diet. Analogues from Experimental group I were given ACFS with the dose of 25 g/head per day with their basic diet, those of Experimental group II – 50 g/head per day. The experiment consisted of two periods: equalizing period (with the duration of 15 days) and basic (record) period. In the experiment pig growth intensity, feed intake and consumption, metabolism, hematological biochemical blood parameters of experimental animals were taken into account. To control the growth of experimental animals, they were individually weighed on a
mechanical scale Armalit chip VSH-2094 and calculated the absolute and average daily weight gain1 time per month.

| Groups          | Number, heads | Experiment duration, days | Age, days at the beginning of the experiment | Age, days at the end of the experiment | Feeding characteristics                                  |
|-----------------|---------------|----------------------------|---------------------------------------------|----------------------------------------|---------------------------------------------------------|
| Control         | 10            | 150                        | 60                                         | 210                                    | Basic diet*                                             |
| Experimental I  | 10            | 150                        | 60                                         | 210                                    | Basic diet + ACFS with the dose of 25 g/head per day    |
| Experimental II | 10            | 150                        | 60                                         | 210                                    | Basic diet + ACFS with the dose of 50 g/head per day    |

The development of animals, in addition to determining the live weight, was evaluated by measurements. Measurements were taken of the length of the torso, chest girth behind the shoulder blades, height at the withers, chest width, and pastern girth.

The length of the body was measured with a measuring tape from the occipital crest to the root of the tail at the moment when the pig's head is raised from the ground, and the lower line of the body is horizontal. The chest circumference behind the shoulder blades was measured with a measuring tape along an imaginary plane perpendicular to the torso, tangent to the posterior corners of the shoulder blades. The height at the withers was determined with a measuring stick at the highest point of the withers area at the moment of calm standing of the animal on a flat plane. The width of the chest behind the shoulder blades was measured with a measuring stick between the outer bumps of the shoulder-scapular joints. The circumference of the pastern is measured with a measuring tape at the lower end of the upper third of the pastern.

In order to get a more complete picture of the proportionality of the physique, the mutual development of different parts of the body relative to each other, and the typicality of the animal, the method of analyzing and comparing the indices of the physique is used, which are the ratio of one measurement to another anatomically related measurement, expressed as a percentage.

The indices of massiveness, elongation, knotting, and bony were calculated. The indices were determined using the following formulas:
- massiveness = chest circumference / height at the withers x 100;
- elongation = torso length / height at the withers x 100;
- knobbiness = chest circumference / torso length x 100;
- bony = pastern circumference / height at the withers x 100.

The research materials were processed by the method of variation statistics on a PC using the Microsoft Office Excel 2007 software.

The physiological state of the experimental animals was monitored by determining blood parameters. To do this, three heads of young pigs from each group were taken from the ear vein before morning feeding at the age of two months and at the age of seven months according to the method described by I P Kondrakhin (1985).

In whole blood, the content of red blood cells, white blood cells and hemoglobin was determined. The number of red blood cells, hemoglobin, and the total number of white blood cells were determined on the automatic veterinary hematological analyzer PCE 90 Vet.

PCE-90 Vet is a veterinary hematology analyzer. Veterinary fully automatic hematology analyzer with 18 parameters for the study of animal blood samples, including the differentiation of leukocytes by 3 subpopulations and the construction of histograms. The manufacturer is the Company HTI (High Technology Inc., USA).

The blood serum was examined for the content of:
- the level of total protein in the blood serum-refractometer IRF-22 (Kazan, Russia).
- total serum calcium-Wilkinson complexometric;
- inorganic phosphorus in protein-free blood filtrate-with vanadate-molybdenum reagent according to Ivanovsky;
- the level of glucose in the protein-free blood filtrate – by color reaction with orthotoluidine.

Laboratory tests were carried out in the Chuvash Republican Veterinary Laboratory of the State Veterinary Service of the Chuvash Republic.

3. Results and discussion

The study results showed high, 100% survival rate of all experimental animal groups.

It was established by the results of our studies that addition of ACFS to pig diets had a positive impact on liveweight dynamics of pigs in the period of their growing and fattening (table 2).

The maximum liveweight of animals at the age of 210 days was observed in Experimental group 2 – 115.5 kg (±0.33), which was 4.24% higher comparing to herdmates of the control group and 2.3% higher comparing to animals of Experimental group 1.

| Table 2. Weight gains of pigs throughout the experiment. |
|----------------------------------------------------------|
| **Groups**      | **Gross gain, kg** | **Mean daily gain, g** |
| Control         | 92.3 ± 1.76        | 615.3 ± 0.29           |
| Experimental 1  | 94.4 ± 1.67        | 629.3 ± 0.25           |
| Experimental 2  | 96.9 ± 1.92        | 646.0 ± 0.19           |

In total, there was 92.3 kg of absolute gain during the experiment in the control group. This parameter was 2.27% higher in Experimental group 1 and 4.9% higher in Experimental group 2. Mean daily gains of pigs in Experimental group 1 made up 629.3 g (±0.25), which is 2.27% higher than gains of herdmates of the control group, they made up 646.0 g (±0.19) in Experimental group 2, which is 24.9% higher than those of herdmates of the control group and 2.65% higher than pigs of Experimental group 1.

Comparing measurements by groups showed that different feed supplement doses had insignificant impact on body proportions of experimental animals (table 3).

| Table 3. Measurements of pig body constitution at the end of the feeding period. |
|-----------------------------------------------|
| **Groups of animals** | **Measurements, cm** |
|                  | **Body length** | **Height at shoulder** | **Chest girth behind shoulders** | **Pastern girth** |
| Control          | 116±0.66   | 66±0.45  | 111±0.81  | 16.5±0.14  |
| Experimental 1   | 116±0.68   | 67±0.37  | 113±0.86  | 16.5±0.12  |
| Experimental 2   | 117±0.93   | 68±0.58  | 114±0.98  | 16.7±0.13  |

It should be noted that the animals of Experimental group 2 at the age of 7 months that received ACFS in the amount of 50 g/head per day exceeded their analogs from the control group by the height at shoulder by 3.0%, body length – by 0.86%, chest girth behind shoulders – by 2.7%, and animals of Experimental group 1 – by 1.4%, 0.86 and 0.88%, respectively.

To analyze the obtained measurements in relation to each other, the body composition indices were determined – the percentage ratio of one measurement to another. The index method allows for a more accurate and detailed characterization of the animal's physique; it is easier to determine the differences in the constitutional features of the individuals compared with each other (table 4).

The indexes allow us to more fully characterize the exterior features of animals. As can be seen from Table 4, the bony index of the control group animals exceeded the first and second experimental groups by 9.3% and 9.7%, respectively. Thus, the animals of the control group were long-bodied, and the shortest-the experimental pigs of the second experimental group. According to the index of
massiveness and downness, the fat cells of the control group were inferior to the piglets of the experimental groups.

Table 4. Body composition indices in pigs (on average per 1 head by group).

| Parameters   | Control   | Experimental I | Experimental II |
|--------------|-----------|----------------|-----------------|
| massiveness  | 168.2±1.75| 168.7±0.82     | 167.6±2.30      |
| elongation   | 175.8±1.34| 173.1±0.68     | 172.0±2.25      |
| knobbiness   | 95.6±0.37 | 97.5±0.44       | 97.7±0.31       |
| bony         | 26.9±0.25 | 24.6±0.17*     | 24.5±0.23       |

*With P<0.05

In order to control the effect of the active carbon feed additive on the health and physiological state of experimental animals, we conducted a study of the blood composition (table 5).

Table 5. Blood composition of experimental animals at the beginning of the experiment.

| Parameters          | Control   | Experimental I | Experimental II |
|---------------------|-----------|----------------|-----------------|
| Hemoglobin, g/l     | 88.03±0.68| 85.75±0.93*    | 89.42±1.25*     |
| White cells, 10⁶/l   | 11.15±0.13| 11.24±0.14     | 11.31±0.26      |
| Red cells, 10¹²/l    | 6.09±0.06 | 6.13±0.11*     | 6.19±0.09       |
| Total protein, g/l   | 63.81±1.25| 64.11±0.88     | 65.06±0.92      |
| Calcium, mmol/l      | 2.56±0.05 | 2.66±0.03*     | 2.53±0.04*      |
| Phosphorus, mmol/l   | 2.69±0.04 | 2.26±0.03*     | 2.58±0.06*      |
| Glucose, mmol/l      | 3.05±0.36 | 2.97±0.46     | 3.14±0.55       |

*With P<0.0

The biochemical blood parameters of pigs of experimental groups at the beginning of the experiment were within permissible physiological standards and no significant difference was revealed.

At the end of the feeding period we again carried out blood analysis for hematological and biochemical parameters. It was established through pig blood analysis that the use of activated charcoal feed supplement contributed to hemopoiesis improvement in animals of experimental groups 1 and 2 comparing to control ones, namely increasing of hemoglobin level by 1.56% and 2.9%, respectively; red cell count – by 2.2% and 3.5%; white cell count – by 4.7% and 6.5%, total protein level – by 3.0% and 4.2%, total calcium level – by 1.5% and 4.4%, inorganic phosphorus – by 4.0% and 8.8% and glucose level – by 7.0% and 17.3% (table 6).

Table 6. Blood composition of experimental animals at the beginning of the experiment.

| Parameters          | Control   | Experimental I | Experimental II |
|---------------------|-----------|----------------|-----------------|
| Hemoglobin, g/l     | 109.1±0.78| 110.8±1.22*    | 112.3±1.28*     |
| White cells, 10⁶/l   | 11.82±0.42| 12.38±0.46     | 12.59±0.27      |
| Red cells, 10¹²/l    | 6.58±0.03 | 6.73±0.04*     | 6.81±0.08       |
| Total protein, g/l   | 66.17±0.87| 68.18±1.04     | 68.96±1.13      |
| Calcium, mmol/l      | 2.68±0.03 | 2.72±0.03      | 2.80±0.04       |
| Phosphorus, mmol/l   | 2.49±0.03 | 2.59±0.05      | 2.71±0.04       |
| Glucose, mmol/l      | 3.88±0.65 | 4.15±0.63     | 4.55±0.59       |

*With P<0.04

These data speak of improvement of redox processes of improvement of swine organism resistance that have positive influence on further state of the animals.
4. Conclusion
Thus, the use of an active carbon feed additive during the rearing and fattening of pigs contributes to an increase in the average daily gain in live weight, a reduction in the fattening period, an increase in the massiveness and churn index, and an improvement in hematological and biochemical blood parameters. Moreover, a dose of 0.025 g/kg of live weight has a weak effect on the growth and development of young animals, and doses of 0.050-0.075 g/kg favorably affect the growth and development of animals.

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