Eco-friendly ways to feed pigs without antibiotics

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Abstract. The reduction in the use of feed antibiotics in animal husbandry to prevent a number of diseases and increase the productivity of pigs predetermined the need to search for alternative means in feeding that could be similar to antibiotics in terms of their effect on the pigs' organism. In this regard, the widespread use of acidifiers based on organic acids. Due to the biological characteristics of pigs, piglets aged 28-30 days after weaning from sows produce an insufficient amount of hydrochloric acid in the body. The introduction of acidifiers helps to increase the digestibility of feed, and has an antimicrobial effect. A positive effect on the increase in live weight gain and the safety of piglets was shown by the results of the use of feed concentrate "Furor-T" for growing and fattening. This feed additive, obtained using a special technology from natural organic substances, is a mixture of fulvic and humic acids. The introduction of concentrate into feed in an amount of 5 to 20 g per 1 kg of feed in different periods of growth increases the average daily gain by 10-13% and ensures 100% safety of the livestock.

1. Introduction
The efficiency of pork production with the achievement of the delivery weight of pigs of 110-115 kg at the age of 165-175 days is possible under a number of conditions, among which the main role, along with genetics and technology, belongs to feeding [1]. For the formation of bone and muscle tissues, animals, especially during the period of rearing and fattening, require a balanced diet in a certain ratio of nutrients and the capabilities of the digestive system of animals, as well as the level of metabolic processes, an age-appropriate diet [2, 3].

The use of intensive production technologies can negatively affect the immune status of newborn piglets, which makes them vulnerable to disease. The change in feeding especially affects when weaning piglets from sows. Therefore, it is especially important to know the potential of the organism at an early age and in time to increase its protective properties [4]. The problem of increasing the safety of piglets as a very important indicator of the economy of the entire industry is relevant here. The need to obtain 27-32 business piglets from a sow per year is becoming a necessary indicator of modern pig breeding. It is especially important to ensure the preservation of piglets at early weaning, when they are faced immediately with a number of stress factors associated with weaning from a sow, changing feeding and environmental conditions that affect the metabolism and subsequent productive qualities of pigs [5, 6].
The safety of piglets largely depends on the body's resistance to the effects of opportunistic microflora and the supply of mother's milk, which carries immune protection. Sows' milk is a powerful factor in energy nutrition and the establishment of acid-base balance in the stomach of piglets. Until recently, the most common technique in the fight against pathogens was the use of feed antibiotics [7]. However, they inhibit not only pathogenic, but also beneficial microflora, and the effectiveness of their application decreases due to the formation of antibiotic-resistant pathogen strains.

In addition, antibiotics cause "dysbiosis" due to a failure in the development of microflora of the gastrointestinal tract, which is one of the causes of diarrhea in “monogastric” animals. Violation of the microflora balance during “dysbiosis” entails a temporary decrease in the absorption of nutrients, which reduces the growth rate of the livestock [8]. We must not forget that the use of antibiotics in animal husbandry has been banned in European countries since 2006, which will subsequently lead to restrictions on the export of products for countries that ignore this ban.

Monitoring the results of scientists' research in the field of pig feeding indicates the need to find new ways to optimize diets and feeding technologies using additives of natural origin.

2. Materials and methods
The purpose of the research was: 1) to evaluate the effectiveness of use as an acidifier of formic acid on 3-breed young growth and fattening (Landrace × Yorkshire × Duroc) at early weaning from sows in the conditions of industrial technology; 2) justification of the feasibility and development of the scheme of application dry fodder organic concentrate "Furor-T" in feeding pigs. The objects of research were piglets in growing and fattening. The research was carried out at the educational and production complex "Piglet" of the Kuban Agrarian University.

In the course of the research, general methods of scientific knowledge were used, as well as zootechnical methods of conducting experiments.

3. Results and discussion
Acidifiers based on organic acids containing one or more carboxylic groups are among the most widespread in pig breeding [9]. These include formic, propionic, lactic, butyric, other acids, as well as mixtures thereof. In this case, it should be noted their multifunctional impact. The presence of acidifiers in the diet stabilizes acidity in the stomach, disinfects feed and water, promotes protein hydrolysis, stimulates the development of beneficial microflora and destroys pathogenic microflora [10]. It should be noted also the gustatory, genetically determined addictions of pigs, which eat acidified feed with great appetite.

Different acids have different properties, so their use must be carefully studied. Combining the properties of acids and the remoteness of their action, it is possible to achieve a synergistic effect and an effective effect on bacteria, mold fungi, yeast, etc. Thus, the selection of acidifiers is not only an important, but also a necessary factor in animal feeding. the activity of enzymes involved in the synthesis of proteins during the growth of pigs.

One of the main vectors for the use of acids is the normalization of acidity in the stomach due to its increase, as a result of which microorganisms either lose their ability to reproduce or die. At the same time, the ability to change the acidity in the gastrointestinal tract is different for different acids and depends on the buffering capacity of the acids used.

Especially important is the use of acidifiers during the feeding period of suckling pigs and young animals, when the synthesis of gastric juice is still at an insufficient level, and there is a risk of disturbances in the functions of the digestive system, due to the lack of sow milk, which not only provides the piglets' need for nutrients a is a natural immune modulator. The creation of an acidic environment in the gastrointestinal tract solves several problems. Thus, the use of acidifiers in feeding suckling pigs is aimed at adapting them to conditions after weaning, when their digestive tract is not yet fully developed.

During the suckling period, piglets experience intensive growth and development of digestive organs and tissues. Due to insufficient secretion of hydrochloric acid in the stomach, the digestion of proteins
does not occur to the full extent, which can create a favorable environment for the growth of pathogenic microorganisms in the intestine. In addition, a feature of piglets is the tendency to overeat, which also leads to indigestible feed and the creation of conditions for the development of pathogenic intestinal microflora. Piglets acquire the ability to produce the required amount of hydrochloric acid only by 12 weeks.

After weaning of piglets, the diet changes and their saturation with the plant part. Due to the feeding stress experienced by the piglets, they have a poor appetite and, as a result, do not gain weight well. Low feed intake leads to villous atrophy and reduced nutrient absorption and available feed energy. It is common knowledge that feed composition and feeding patterns have a large impact on animal growth rates and pork quality. Given the fact that in industrial pig breeding, breeds with high growth rates are used, animals already at a physiologically very early age must consume and digest a huge amount of feed. Therefore, the introduction of appropriate acids into the feed is required to normalize the pH in the stomach and stabilize digestion.

Increased acidity in the stomach contributes to the suppression of unwanted bacteria and molds. It should be especially noted that bacteria do not develop resistance against organic acids, which allows them to be used successfully for a long time.

After weaning piglets from sows, the pH of the stomach contents rises, a large number of E. coli bacteria accumulate in it, which causes severe and prolonged diarrhea, as a result of which the loss of piglets can reach 12-15%. In addition, another pathogenic microflora begins to develop intensively, and the substances produced by it damage the intestinal epithelium, reducing its absorption capacity. When organic acids are used, an acidic environment is created in the stomach at pH = 4.5-5.0, which suppresses pathogens and reduces the amount of toxic metabolites they produce.

To combat them, it is advisable to use formic acid, which has strong antibacterial properties. This is especially true when using a liquid type of feeding to suppress yeast growth. Due to the anatomical structure of the gastrointestinal tract and the physiological characteristics of digestion, the greatest efficiency is observed when using acids in feeding piglets - weaners.

Another important aspect of using acidifiers is the activation of digestive enzymes that improve the digestibility of feed. With the introduction of acids, the process of protein breakdown is accelerated, which increases the digestibility of feed and the growth rate of young pigs. In an acidic environment, the activity of enzymes increases 2-3 times, which improves the absorption of nutrients, and also creates a protective barrier against infections. At the same time, due to the stabilization of the acid barrier of the stomach, the entry of microorganisms into the small intestine is reduced. It must be remembered that too high a concentration of acids can adversely affect the state of beneficial microflora, for example, lactic acid bacteria, therefore, it is necessary to closely control the acidifier dose.

An important property of organic acids is that when the development of pathogenic microorganisms is suppressed, the beneficial microflora of the gastrointestinal tract is not affected. Organic acids, as a natural alternative to antibiotics, improve the absorption of nutrients, which helps to increase animal growth and reduce their incidence.

Despite the available information on the use of acidifiers, there is insufficient information on the use of formic acid in the feeding of three-breed piglets, which prompted the production experiment. It should be noted that this acid is approved for use in organic animal husbandry, which also arouses additional interest in its study.

For the experiment, a 3-breed young growth was taken (Landrace × Yorkshire × Duroc). Two groups of weaning pigs were formed. Piglets of the experimental group were given formic acid in an amount of 0.5% to the feed weight in addition to the basic diet (BD). The results of the experiment are shown in Table 1.

It was found that the introduction of formic acid into the diet of weaned pigs in an amount of 0.5% to the feed weight increases the average daily gain by 14.0%, the average weight at the end of the experiment by 10.1%, safety by 3.0%. Compared with the control, the number of cases of gastrointestinal diseases decreased by 2.0%.
The trends in the development of industrial pig breeding require the search for new solutions to optimize the feeding and rearing of rearing and fattening pigs. In the context of the ban on the use of antibiotics, feed innovations are directed towards the use of various groups of additives of natural origin, including those based on organic acids.

Promising is, in our opinion, the use of organic fodder concentrate "Furor-T" of natural origin, consisting of a mixture of fulvic and humic acids and a number of substances of organic origin.

| Table 1. Zootechnical indicators of piglets. |
|-------------------------------------------------------------|
| **Indicators** | **1 group (control)** | **2 group (experiment)** (+ 0.5% formic acid to BD) |
| Piglet age at the beginning of the experiment, days | 30 | 30 |
| Piglet age at the end of the experiment, days | 80 | 80 |
| Number of piglets in each group: | | |
| at the beginning of the experiment, heads | 30 | 30 |
| at the end of the experiment, heads | 28 | 29 |
| Average live weight at the beginning of the experiment, kg | $8.35 \pm 1.19$ | $8.3 \pm 1.21$ |
| Average live weight at the end of the experiment, kg | $30.8 \pm 1.12$ | $33.9 \pm 1.14$ |
| The amount of feed consumed per 1 head per day, kg | $0.67 \pm 0.10$ | $0.71 \pm 0.12$ |
| Average daily gain, g | $449.0 \pm 2.20$ | $512.0 \pm 2.24^\text{**}$ |
| Safety, % | 94.0 | 97.0 |
| Number of piglets suffering from digestive tract disorders, % | 3 | 1 |

It should be noted that the artificially obtained sodium, potassium, and ammonium humates are widely used in crop production as growth stimulants. At the same time, due to the chemical extraction technology, these substances have an alkaline pH level of more than 8 units. In crop production, this is due to the need to prevent soil acidification.

In contrast to them, feed concentrate "Furor-T" is produced using a unique technology without the use of chemicals and salts and does not contain heavy metals. Its production technology completely excludes heat treatment and the use of alkali and hydrochloric acid. Its high efficiency is achieved due to the content of biologically active substances that restore the electrical potential of cells, increase the permeability of cell membranes. In addition, fulvic acids are powerful chelates capable of absorbing heavy metals and removing them from the body.

To assess the effectiveness of the use of "Furor-T" an experiment was carried out to determine the intensity of growth and safety of piglets. In conditions of high intensity of growth and development of piglets with weaning weight of 8.7-9.2 kg, we have formed groups of analogous piglets. Piglets growing from the 30th to the 40th day were given a concentrate in the amount of 5 g/head once a day together with the feed, from the 41st to the 62nd day the dose was increased to 20 g/head. The fattening animals were given the concentrate in the amount of 15 g/head from the 63rd to the 120th day, and in the amount of 20 g/head from the 121st to the 153th day. During the experiment, the growth rate and safety of the piglets were monitored. The results of the experiment are shown in Table 2.
Table 2. Growth intensity piglets.

| Indicator                  | Control group | Experienced group |
|----------------------------|---------------|-------------------|
| Number of heads            | 50            | 100               |
| Live weight of rearing pigs, kg: |               |                   |
| at the beginning of the experiment | 8.78          | 8.62              |
| at the end of the experiment  | 31.5          | 34.3              |
| Average daily gain, g       | 366           | 414               |
| Live weight of fattening pigs, kg: |         |                   |
| at the beginning of feeding | 31.5          | 34.3              |
| at the end of feeding       | 112           | 122               |
| Average daily gain in fattening, g | 874          | 964               |
| Safety, %                   | 98.0          | 100               |

It was found that the average daily gain in growing up in the experimental group was 13.1% higher than in the control group. This indicator was more than 10% higher in the experimental group compared to the control in fattening pigs. In addition, 100% safety of the livestock was recorded in the experimental group.

4. Conclusion
The results of the experiment showed that the introduction of organic acidifiers into the main ration of feeding pigs does not cause a negative effect and contributes to an increase in live weight gains in livestock with high safety of animals. It is likely that due to the suppression of a number of pathogenic and opportunistic microorganisms and the enhancement of the action of enzymes involved in the breakdown of the plant part of the feed, the animals used the nutrients of the diet more efficiently. The introduction of a concentrated feed concentrate of organic origin "Furor-T" into the diet provided an increase in average livestock gains in comparison with the control by 13% in rearing pigs and by 10% in fattening. This was facilitated by the fulvic and humic acids of the preparation, which activate the assimilation of feed nutrients in the gastrointestinal tract of piglets.

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