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Influence of formic acid upon metabolism in an organism of piglet

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The purpose. To study influence of formic acid upon some links of metabolism at piglets during weaning from sows. **Methods.** Hematological, biochemical, zootechnical, statistical. **Results.** It is fixed that adding formic acid to standard ration of piglets beginning from the 10th and up to the 40-ty day of age stimulates respiratory function of blood, cell link of immunodefence, reinforces power and anabolic processes, promotes daily average gains and preservation. **Conclusions.** For activation of metabolic, adaptive and productive gears in an organism of piglet it is offered to add formic acid to standard ration during the first month after weaning from sows.

Key words: *formic acid, piglet, metabolism, weaning.*

The prohibition of the use of antibiotics, as growth stimulants since 2006 in the EU, has led to increased use of acidification in agricultural production. Organic acids (fumaric, citric, acetic, propionic, formic, lactic, etc.) increase the digestibility of feed and the intensity of animals growth, their prolificacy, preservation of newborn young, have antioxidant and neurotropic effects, normalize energy metabolism, general physiological state of animals, increase biosynthetic processes. Acidification of the feed increases gastric proteolysis, digestion of protein and aminoacids. Anions acids create complexes with Ca, P, Mg, Zn, which promotes the absorption of these minerals. In pigs the most powerful effect when they are added to the diet by lowering the pH and antimicrobial activity found in the stomach and small bowel [1, 2, 3].

Formic or methane acid – the simplest monoacid carboxylic acid, which plays an important role in the intermediate metabolism in animals, plants and microorganisms. In the process of metabolism in animal organism carbon formic acid used for the synthesis of purine bases of nucleic acids, porphyrins, methionine, choline and other biologically active substances [4, 5]. It more effectively from other organic acids reduces the pH of food and alkaline buffer capacity of its components improves the use of Nitrogen, Calcium and Phosphorus in the body. Formic acid counteracts the development of the lumen in of the gastrointestinal tract of yeast and bacteria, especially coliforms and salmonella [6, 7]. Studies concerning the properties of formic acid are limited to its positive impact on reducing the pH of the stomach, preserving and bactericidal effect and inhibition of growth of pathogenic microorganisms. However, data on the influence of this organic acid on metabolism in the body of animals is very small.

The purpose – study the effect of formic acid on hematological parameters, protein and energy metabolism and productive qualities of piglets during weaning from sows.

Materials and methods. The experiment was conducted on a private pig farm of the Lviv region, on piglets of Large White breed, which were kept under standard conditions. Manipulations with of animals were carried out according to the rules of the "European Convention for the protection of vertebrate animals used for experimental and other scientific purposes" (Strasbourg, 1986). It was formed 2 groups of animals of 10-days after birth – control and experimental by 8-10 heads in a nest, body weight 3-4 kg. Piglets keep with sows. After weaning, what is performed in a 28-day after birth, animals left in cages for 8-10 heads in each. The feeding was carried out with a standard diet, with free access to feed and water, using the Sano premix for the piglets of the weaning period (Ferkengold Forte) and removing the formic acid from its contents. During the 18 days before and 12 days after weaning piglets experimental group (E) was added to the diet of formic acid at a rate of 950 g/t of feed (feeding period – 30 days). Piglets of the control group (C) were kept on a standard diet.

Material for study – the blood of animals generated from the anterior vena cava at 10, 20, 30 (2 days after weaning) and 40 (12 days after weaning) days of life. In the blood hematological parameters (number of

erythrocytes, leukocytes, leukoformula) and hemoglobin concentration (Hb) were determined. The blood plasma of piglets was determined the content of glucose, total protein, alanine aminotransferase (ALT) activity, aspartate aminotransferase (AST) and alkaline phosphatase (AP) [8]. During the studies live weight and average daily gains of the two groups of piglets were monitored. The resulting digital data was calculating statistically using Microsoft EXCEL. To determine the probable change of parameters the criterion Student was used. A difference was considered statistically significant at $P < 0.05$.

Results. The emergence and development of dyspepsia in newborn piglets depends on the state of immune reactivity of their organism, which takes place in three critical periods. 1st occurs on 2-3 days after birth and is characterized by small content of immunoglobulin's in the organism. 2nd, the most dangerous – occurs in the 14-21- days after birth of piglets. It is characterized by low level of synthesis of own immunoglobulin's and intensive destruction those coming from the sow colostrum. 3rd – weaning piglets [9]. A small quantity of hydrochloric acid and digestive enzymes in their stomach, high levels of protein in the prestarter, which neutralize the acidity in the digestive tract, cause the problem of the period of weaning [10, 3]. In these conditions increases the biological significance of formic acid as substance of antiseptic, antibiotic and immunomodulatory actions.

Table 1. The content of hemoglobin and of erythrocytes count in the blood of piglets (mean±SD, n=5)

Parameters	Group of animals	Days of life			
		10	20	30	40
Erythrocytes, T/l	C	4,83±0,10	5,67±0,22	5,36±0,27	5,50±0,53
	E	5,10±0,41	5,12±0,17	4,67±0,16	4,88±0,16
Hb, g/l	C	62,08±6,12	69,20±1,15	77,61±6,66	102,17±6,45
	E	63,03±2,55	118,60±4,23***	99,63±7,29*	113,87±1,72**

Note: here and further statistically significant difference compared to control: * — *** P<0.05-P<0.001.

In the course of the research, the positive effect of formic acid on the hematological parameters of piglets was established. In the blood of animals E there was a significant increase in the concentration of Hb in 1.7 times on the 20 day after birth, in 1.3 times – on 30 day and by 11% on 40 day of life in relation to the group C (Table 1).

There were no probable differences of erythrocytes count in the piglets of C and E groups during the entire trial period (Table 1). Formic acid in animals E at 30 and 40 days of life causes an increase within the physiological range of leukocytes count by 30% and 9% respectively (Table 2).

Growth of the concentration of Hb in the blood of piglets by the action of formic acid indicates an increase in its synthesis and stimulation of the respiratory function of the blood [5]. The obtained data can be explained by the fact that formic acid promotes better assimilation by the body of microelements of Ferrum and Cuprum, which in turn are necessary constituents of hematopoiesis [4].

Table 2. The content of leukocytes and leucogram of piglets (mean±SD, n=5)

Parameters	Group of animals	Days of life			
		10	20	30	40
Leukocytes, G/l	C	6,83±0,73	10,33±0,13	7,33±0,18	9,33±0,10
	E	6,67±0,88	10,67±1,01	9,50±0,18***	10,16±0,13**
Basophils, %	C	1,00±0,02	1,00±0,05	1,00±0,03	1,00±0,02
	E	1,00±0,03	1,00±0,01	1,00±0,04	1,33±0,03
Eosinophils, %	C	1,33±0,33	1,33±0,33	2,67±0,67	1,67±0,12
	E	2,33±0,88	1,50±0,50	1,67±0,33	4,33±0,88*
Stab neutrophils, %	C	1,33±0,33	1,33±0,88	2,67±0,12	2,67±0,88
	E	1,05±0,21	1,50±0,50	1,50±0,50	1,67±0,33
Segmented neutrophils, %	C	34,33±3,18	36,67±3,18	38,67±1,45	43,00±2,08
	E	31,00±2,08	33,00±3,78	36,33±1,40	34,67±2,28*
Lymphocytes, %	C	61,33±1,05	59,33±1,76	54,67±1,13	50,67±1,45
	E	64,00±1,73	62,00±1,93	59,33±1,17*	57,67±2,60*
Monocytes, %	C	1,00±0,05	1,00±0,03	1,00±0,06	1,00±0,03
	E	1,00±0,01	1,00±0,04	1,00±0,01	1,00±0,04

In the analysis of leucogram of blood of piglets C and E groups of probable differences between individual types of leukocytes were not detected. The content of basophils, eosinophil's, monocytes and stab neutrophils in the blood of animals did not go beyond the limits of physiological norm. With the addition of formic acid observe a higher number of lymphocytes in group E piglets relative to C on 30 and 40 days of life by 9% and 14% respectively, indicating the activation of the cellular immunity [1, 9]. The content of segmented neutrophils in the blood on 40 day after birth piglets group E significantly decreased in 1.2 times relative to C (Table 2).

The positive influence of formic acid on the protein metabolism of piglets has been established. In the blood plasma of animals E, the total protein concentration relative to control was higher by 18% in 20-daily piglets, by 12% – in 30-daily and by 60% – on 40 day of life (Table 3). Attained results are consistent with the literature on the stimulation of protein synthesis in the body, since it is known that Carbon formic acid is actively used in anabolic processes [6, 7].

Table 3. Parameters of protein metabolism in blood plasma of piglets (mean±SD, n=5)

Parameters	Group of animals	Days of life			
		10	20	30	40
Protein, g/l	C	64,20±8,47	47,60±2,33	72,87±1,28	49,47±2,89
	E	66,97±3,21	56,09±0,50**	81,87±2,32*	79,03±3,07***
AST, U/l	C	11,92±0,76	5,18±0,92	8,28±0,18	8,59±0,93
	E	10,16±0,16	8,21±0,53*	8,26±0,14	7,71±0,67
ALT, U/l	C	9,00±1,16	3,42±0,44	3,21±0,12	3,87±0,27
	E	10,81±0,42	7,59±0,46**	3,10±0,19	3,27±0,09

Under the influence of formic acid in organism of the piglets the processes of transamination were activated. Within the physiological range, was installed a statistically significant increase in the activity of ALT in 2.2 times and of AST in 1.6 times in the blood of 20-daily animals relatively to control (Table 3). So, it is possible that formic acid stimulates the processes of thermogenesis (increased activity of AST) and gluconeogenesis (increased activity of ALT) in the piglet organism during the critical period of weaning from sows [3, 5].

Table 4. Parameters of energy metabolism in blood plasma of piglets (mean±SD, n=5)

Parameters	Group of animals	Days of life			
		10	20	30	40
Glucose, mmol/l	C	9,03±1,78	6,23±0,45	7,73±0,16	7,60±0,17
	E	9,63±0,12	8,40±0,32**	8,60±0,17**	8,40±0,35**
AP, U/l	C	92,25±5,33	26,03±1,02	26,74±1,11	29,54±1,14
	E	91,41±4,14	26,82±0,58	25,35±1,45	34,68±1,12*

In the course of the research within the physiological range established increase in the concentration of glucose in the blood in 20-daily piglets E to by 35%, and in the 30- and 40-daily – by 11% in relation to control. The activity of AP increased in the blood of piglets E relatively of control on 40 day of life by 17% (Table 4).

Additional introduction to the standard diet of piglets of formic acid cause in their body the activation of carbohydrate metabolism (intensification of gluconeogenesis and an increase in blood glucose content that is necessary for the body of the newborn). The obtained data coincide with the literature on the intensification of the absorption of Phosphorus by the action of formic acid. This is a prerequisite for the activation of oxidation-reducing and energy processes in the organism (an increase in the free phosphate stock by increasing the activity of AP) [4, 9].

During the studies, the productivity indexes of the piglets of both groups were taken into account. When setting to experiment live weight of 10-daily animals was 3.00-3.67 kg. On 40 day after birth piglets of the group C weighed an average of 6.50 kg (average daily gain – 163 g). Animals, what additionally received to the diet formic acid weighed 8.00 kg with an average daily gain – 200 g. So, feeding of formic acid leads to

an increase by 23% of live weight and average daily gain relative to animals kept on the standard diet. Preservation in animals E was higher relative to C by 10%.

Consequently, formic acid, increasing acidity in the gastrointestinal tract of pigs, inhibits the development of harmful bacteria and creates normal conditions for the growth of useful, thus forming the protective barrier against infections. It promotes the synthesis and activation of digestive enzymes, improves digestion, absorption and assimilation of nutrients (compared with other organic acids formic acid most contributes to the absorption of protein and amino acids from the diet).

Conclusions

Feeding the piglets from 10 days after birth within a month of formic acid causes the activation of anabolic processes, improved digestibility of nutrients, increased energy and protein metabolism, hematopoiesis, resistance, productivity and animal's preservation.

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