THE EFFECT OF PECTIN USAGE AS FEED ADDITIVE ON PIGS EXCRETION METABOLISM AND BLOOD BIOCHEMICAL PARAMETERS

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Abstract

It is well known that the enzymatic activity is dependent to the presence in the reaction environment of the activators and inhibitors. In most cases, the latter ones are represented by the heavy metals. This study hypothesis was that the usage of a feed additive may normalize the metabolic enzymatic processes in animals through the facilitation of the heavy metals excretion. The original findings have shown positive impact after 30 days of pectin usage as feed additive on piglets rearing, at an optimal dose of 0.3 g/kg body weight, in order to decrease cadmium, cooper, lead and mercury in all organs and tissues to the BAC levels (boundary acceptable concentration). Other effects were the normalization of metabolic processes, especially the level of mineral and albuminous metabolism and the overall improvement of the blood biochemical parameters.

Keywords: pectin, pigs, heavy metals, mineral and albumin metabolism, blood biochemistry

INTRODUCTION

Recently in veterinary science and practice considerable attention is given to animal health, sanitary status of the agricultural lands, farms and food processing plants of high quality. However, in some regions, Ukraine faces a complicated ecological situation, which leads to lower health quality of animal products as arriving at processing plants or used as feed [8].

Among the main substances - environmental pollutants the first places are occupied by the chemical elements that belong to the group of heavy metals. They pose the greatest threat to animals and humans - showed the analyses of recent research and publications [14], [16]. The very incipient and important solution of this problem would be the introduction of effective natural remedies to reduce the negative impact of intoxicants on animals and improve feed and consequently quality in the ecological sense [7], [11], [12], [13].

The issue of chemical pollution of the biosphere by heavy metals is “the red thread” in many spheres of modern scientific research [5], [17]. Many scientists have studied the problem of the negative impact of elevated concentrations of heavy metals in the body of animals [1], [10], [15], [18], [19]. Moreover, these pollutants could pass into edible animal products and, from there, toward the end of the food chain – the human consumers, endangering their health and life [2], [6]. Effective ways of excretion of heavy metals from the animal's body are quasi-inexistent, and this is the reason of finding solutions to improve the parameters of animal production, which is not always environmentally friendly [9].

The aim of the research was to assess the effect of pectin feed additive on the intensity of the withdrawal of heavy metals from the organs and tissues, on the level of excretion metabolism, mineral and protein metabolism in the body piglets reared for fattening.

The task of research was to investigate the background levels of heavy metals in the organs and tissues of piglets and in the faces; to test the effect of usage of pectin as feed additive on the intensity of heavy metals excretion; to establish the effect of pectin feed additive on biochemical traits of blood albumin metabolism.

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MATERIALS AND METHODS

The study was carried out on piglets belonging to the Ukrainian Large White breed (for fattening) in 20 individuals per the control and experimental groups, at a live weight of 25 kg. Piglets in the control group were fed the basic diet, pigs in the experimental group - the main diet with the addition of feed additives pectin at a dose of 0.3 g/kg body weight throughout 30 days.

The control of the intensity of withdrawal of heavy metals from the piglets organisms due to pectin usage as feed additive was performed on the 1st, 15th and 30th day of study, by sampling tissues and parenchymal organs of slaughtered pigs in the control and experimental groups.

The material for the studies consisted in samples of blood, feces, and tissues from the reared piglets. Content of heavy metals (cadmium, copper, of lead, zinc, mercury) in selected samples was determined by stripping voltammetry on the device ABA-2 after previous mineralization with "Temos Express".

The liver metabolic rate, as well as its impact on the blood biochemical pool, as consequences of pectin usage as detoxifying agent in piglets organisms was investigated through assessments related to certain enzymatic, minerals and protean traits, such as: total protein, amylase, AST, ALT, Ca, P, Na, creatinine, urea, albumin and globulin levels, using regular clinical biochemistry methods [4].

RESULTS AND DISCUSSIONS

Accumulation of heavy metals in the kidney of pigs is presented in Table 1.

The acquired results show that the content of cadmium in the kidneys of piglets in the experimental group throughout the first 15 days of pectin usage as feed additive exceeded 9.6 folds the maximum allowable concentration; on the 30th day reached normal tolerable levels.

Table 1 Contents of heavy metals in the kidney of piglets fed with pectin feed additive (n=3) (Mean±StDev)

Element	Period of research, days				
	1	15	30	1	30
	Experimental group mg/kg			Control group mg/kg	
Cd	0.916±0.065	0.48±0.067	0.017±0.002	0.62±0.040	0.70±0.067
Cu	4.17±0.45	3.02±0.38	0.621±0.081	4.64±0.07	8.74±0.12
Pb	0.22±0.033	0.122±0.017	0.104±0.06	0.20±0.03	0.23±0.033
Zn	14.3±0.48	13.04±0.22	9.7±3.39	14.60±0.27	19.8±0. 71

In the control group, this indicator on the 1st and 30th day exceeded the BAC (boundary acceptable concentration) of 12 and 14 folds respectively. The content of cooper, lead and zinc were within the BAC, indicating that the antagonistic effect of cadmium with respect to these elements.

Analysis of the data suggests that the usage of pectin feed supplement for 30 days had a positive impact on the intensity of the excretion of cadmium from the kidney of experimental group piglets, as evidenced by the reduction in the last 8 times, while the residual content of toxicants exceed the BAC 2.34 folds.

Research has shown that the content of copper and zinc in the liver of pigs in control and experimental groups on the 30th day of research, compared to the maximum permissible levels of cadmium and lead content was 1.3 and 3.74 folds higher, respectively, in the control group. In the experimental group was recorded moderate concentration for the entire period of the experiment and a downward trend. Therefore, we found that the content of all elements in the liver of piglets in the experimental group was within the boundary acceptable concentration, after 30 days of pectin usage through dietary inclusion.

The obtained research results show that the content of cooper and zinc in the spleen of the pigs in control and experimental groups throughout the study period was

within the BAC. Cadmium content in the spleen of pigs in the control group throughout the experiment exceeded the BAC and tended to increase. Research has established that in the spleen of piglets experimental group content of cadmium and lead on the first day of studies exceeded the norm by 3.9 and 4.05 folds, respectively, after 15 days of pectin feed additive usage, the excess relative to the BAC was 3.7 and 3.1 folds, indicating therefore a decrease of pollutant levels. After 30 days, the contents of cadmium and lead in the spleen of piglets in the experimental group decreased to the levels of BAC.

Levels of cadmium in cardiac muscle of pigs in the experimental group, during the 1st and 15th days of research exceeded the norm by 3.46 and 1.82 folds, while in the control group the exceeding was 1.98 and 4 folds respectively. Supplementary feeding of piglets in the experimental diets with pectin induced a decrease of Cd to the level of the BAC.

The content of cooper and zinc in cardiac muscle of pigs in the control and experimental groups was within the BAC.

The level of lead in the cardiac muscle of pigs in the experimental group had a moderate concentration, while in control group it was noticed an increasing tendency, to reach then 4 folds level compared to the BAC, on the 30th day.

Cadmium content in adipose tissue of pigs in the experimental group in the 1st and 15th day of pectin usage exceeded the norm by 1.6 and 1.2 folds, while on the 30th day it decreased to minimal levels and was in accordance with the BAC. In the control group, on the same kind of samples, this element was rapidly accumulated from the 1st to the 30th day of the experiment and exceeded the maximum permissible level of 3.2 and 3.4 folds.

The lead content in adipose tissue of pigs in control and experimental groups was situated at the upper limit of the BAC, with increases from the 1st till the 30th day of the study. The levels of copper and zinc were lower compared to BAC ones.

Excess of cadmium was found in the muscle tissue of pigs of the control and experimental groups on the 1st day of research, 1.34 and 1.52 folds respectively.

Usage of pectin as piglets feed additive contributed to the decrease of 1.2 and 2 folds after 15 days and 30 days of feeding, compared with the first BAC to the limits.

In the control group, the accumulation of toxic elements in muscle tissue continued to increase, and exceeded the norm by 1.8 folds after 30 days of experiment. The level of lead in muscle tissue of pigs in the control group exceeded the BAC levels in the 1st and 30th day of research by 1.6 and 1.3 folds.

There are the following ways of removing toxins from the body: the kidneys via urine, the gastrointestinal tract via feces and, for a small part the lungs via exhalation. In order to identify ways of removing heavy metals from the piglets were selected excrements in animal experiments, carried out sample preparation and method of stripping voltammetry investigated heavy metals in urine and feces. The research results indicate the particularity of pectin reaching the gut to bind and adsorb heavy metals and to turn them into insoluble complexes which are eventually evacuated from the body through defecation.

The original findings suggested that pectin facilitated the cadmium excretion more efficiently through the kidneys, via urine and also through the gastrointestinal tract via feces. So, in the 15th day, 15.87% of accumulated Cd was eliminated in feces and 31.27% in urine; 5.8 % of the lead was found in feces and 23.8% in urine, while 35.76 % of the copper was removed through the urinary system and 20.68% through defecation. The differences between the 1st and 15th day of feeding pectin as feed additive, related to all elements except for zinc in the urine reached the probability threshold of $P \geq 0.999$, while for Zn in the feces of $P \geq 0.99$. The difference between the 15th and 30th day for the content of all elements studied in feces and urine in addition to cooper revealed a probability of $P \geq 0.999$.

The difference between the 1st and the 30th day of feeding supplementary pectin, for all pollutant elements excreted via feces and urine of piglets is about $P \geq 0.999$, in addition to cadmium.

It was established that the use pectin feed additive for 30 days in fattening piglets facilitated the removal of heavy metals: cadmium, lead, copper from the body of animals to the levels of BAC.

Moreover, the usage of the same feed additive generated positive impact on normalizing albumin and mineral metabolism, as well as metabolic rate (Table 2).

Studies have shown that after 30 days of pectin usage, the amylase in the blood of pigs in the control group was 2.6 folds higher than normal while in the experimental group it was found 2.38 times higher. Comparing amylase on the 15th day of feeding pectin with the values assessed on the 30th day of research, a decrease of 7.6 % was noticed. However, the difference between the performances of the control and experimental groups was not statistically significant. The content of total protein in the blood of piglets of control and experimental groups was within normal limits.

In certain individuals, the total serum blood protein levels were found lower than the norm (piglets bearing the reg. nos. 01278; 01178; 01467), with proportional deviations of 5.14; 11.8; 1.88%.

Table 2 Biochemical blood parameters of pigs (30th day of the experiment) (n=10) (Mean±StDev)

Group	Blood biochemical traits								
	Total protein (g/l)	Amylase (g /h.l)	AST, (mmol / h.l)	ALT, (mmol/ h.l)	Ca	P	Na	Creatinine (mmol/l)	Urea (mmol/l)
Exp.	73.8 ±3.8	83.38 ±6.45	0.95 ±0.01***	1.196 ±0.02***	4.96 ±0.34***	2.39 ±0.08**	139.9 ±1.83	0.138 ±0.01	3.2 ±0.34
Control	61.3 ±4.7	92.42 ±8.37	1.59 ±0.16	1.99 ±0.19	2.68 ±0.29	1.77 ±0.11	138.6 ±1.45	0.117 ±17.1	1.99 ±0.15
Normal values	58.3-83.2	35	0.6-2.1	0.3-1.2	2.5-2.9	1.8-3.0	139-152.5	0.0696-0.207	2.9-8.8

Note: *, P ≥ 0,95; ** - P ≥ 0,99; *** - P ≥ 0,999

Research has established that the activity of transaminases AST in serum of piglets of control and experimental groups were within normal limits. ALT is mainly concentrated in the cytoplasm and AST majority located in mitochondria, ie packed deeper in the cell than ALT, so the inflammation and hepatocyte violating its penetration of membranes before all levels of ALT increases the content. In this connection, the activity of ALT in the control group exceeded the rate by 1.3 folds in development, however within normal limits.

It was established that the activity of enzymes AST and ALT in serum of experimental animals after 30 days of feeding, meets the norm, as evidenced by the de Rites coefficient and the termination of inhibitors and activators as heavy metals which were due to their pectin-binding and adsorption and excretion from the body. The difference between the indices of activity of transaminases AST and ALT of control and experimental groups had a high level of probability (P>0.999 And P>0.999).

The table shows that calcium, phosphorus and sodium in the blood of piglets in control and experimental group were within the physiological norms. However, the difference between the calcium and phosphorus levels in the blood of piglets belonging to control and experimental groups met a high level of probability, respectively (P>0.999 for both).

It was found that the content of creatinine in the blood of piglets in control and experimental group during the 30th experimental day was consistent with normal values, reaching 0.117 ± 17.1 and 0.138 ± 0/01 mmol/l, respectively.

The content of urea in the blood of pigs in the control group remained relatively lower standards in 1.5. It is known that a decrease in urea concentration observed in parenchymatous icterus, cirrhosis of the liver [3]. The concentration of urea in the blood serum of piglets experimental group conform with the standards and was 3.20 ± 0.34 mmol/l (normal range: 2.9-8.8 mmol/l). The differences between the performance of the control and experimental groups were not statistically significant.

Heavy metals that accumulate in organs and tissues affect metabolic processes in the body. Therefore, a more accurate understanding of the physiological condition of the body through conducting in deep research is available not only in total protein, but in protein fractions - albumin and globulin. Levels of total protein and protein fractions in the serum of piglets after 30 days of pectin usage as feed additive are presented in Table 3.

Table 3 Contents of total protein and protein fractions in the serum of piglets (30 days of a study) (Mean±StDev)(n = 10)

Group	The overall protein, g/l	Albumin content		Globulin content		A / G ratio
		g / l	% of the total protein	g / l	% of the total protein	
Experimental	73,8±3,8	31,7±2,1	42,95±1,21	42,1±2,1	57,04±1,22	0,76±0,04
Control	61,3±4,7	29,8±2,2	48,61±0,66	31,5±2,1	51,38±0,66	0,93±0,07

The results show that total protein in the experimental group after 30 days has increased by 20.4% compared with the control. Positive changes also occurred in the experimental group, related on the content of albumin. So, it the albumin in the blood serum of piglets experimental group was higher by 6.3% compared with the control group, indicating an improvement of the protective properties of the body.

Research has established that the content of globulin in the blood serum of piglets in the experimental group was higher by 33.36% compared to the control group.

The results indicate improved protein levels in the investigated pigs due to the normalization of metabolism in their bodies, as a consequence of the pectin usage as feed additive, hence the total serum protein of the pigs in both groups on the 30th day of research was found within the physiological limits.

CONCLUSIONS

1. Usage of pectin as feed additive for 30 days in piglets diet facilitated the removal of heavy metals cadmium, lead, copper from the body of animals to the levels of BAC.

2. Research has demonstrated the positive impact of pectin feed additive in normalizing the metabolic processes, the level of mineral and protein metabolism as well as the morphological composition of the blood in fattening piglets.

REFERENCES

[1] Donnyk I.M., 2008: Dynamics of accumulation of heavy metals in cattle, Veterinary Medicine, 4: 37-41.

[2] Hoha G.V., Costachescu E., Leahu A., Păsărin B., 2014: Heavy metals contamination levels in processed meat marketed in Romania; Environmental Engineering and Management Journal, 13 (9):2411-2415.

[3] Kahn M.C., Line S., 2015: Merck Veterinary Manual, 10th Edition, Merck & Co., Inc., Kenilworth.

[4] Kaneko J.J., Harvey J.W., Bruss M.L., 2008: Clinical Biochemistry of Domestic Animals, 6th Edition, Academic Press, San Diego.

[5] Klymenko M.O., 2008: Deposition of heavy metals in sediments of small rivers, Tauride sciences. Visn .zb.nauk. pr. Kherson Agrarian University. - Kherson: Ailant, 58:306-312.

[6] Radu-Rusu C.G., I.M. Pop, Albu A., Bologa M., Radu-Rusu R.M., 2013: Transferability of certain heavy metals from hens feed to table eggs laid within different rearing systems, Lucrări ştiinţifice, Seria Zootehnie, 59:218-222.

[7] Trachtenberg I.M., Talakin Y.N., Leskov G.E. et al., 1980: A prophylactic use of pectin in occupational mercury poisoning. Occupational Health and Proffesional Disease, 7:33-37.

[8] Tarasenko L.A., 2015: Sanitary-hygienic assessment of product safety and quail. Scientific Bulletin of Lviv National University of Veterinary

Medicine and Biotechnology named after S.Z. Gzhytsky. Lviv, 17.1(61)2:319-322.
[9] Tarasenko L.O., 2010: Effect of pectin-containing drug on the physiological condition of the body of pigs, growth and development indicators, the biological value of the meat, Bul. scientific. work/BSAA. Belgorod, 23: 94-96.
[10] Tarasenko L., 2013: Sanitary hygienic evaluation of the action of heavy metals on the morphological structure of piglets. Scientific Bulletin of National University of Life and Environmental Sciences of Ukraine, 174-178.
[11] Tarasenko L.A., 2007: Research raw materials from waste products for the manufacture of drugs and flour pektynovmisnyh, Problems zooengineering and veterinary medicine: Coll. Science. pr. Kharkiv zoovet Academy., 15 (40)Part 1:146-150.
[12] Tarasenko L.A., 2004: Impact pektynovmisnoho drug on blood biochemical indices and growth of calves. Agricultural Gazette Black Sea, 23:196-199
[13] Tarasenko L.A., 2015: Hygienic evaluation of raw materials and waste products for the manufacture of pectin. Problems zooengineering and veterinary medicine, Kharkiv, 30:366-369.
[14] Tarasenko L.O., 2013: Content of heavy metals in the water of different regions and areas south Ukraine. Scientific Herald Bilotserkivskyi National University. BilaTserkva, 11(101):147-151.
[15] Tarasenko L.O., 2013: Role of placental barrier to the migration of heavy metals in the body system sows – descendants. Animal Ukraine, 5:36-38.
[16] Shtabskyy B.M., 2000: Xenobiotics, chemical homeostasis and human security, Lviv: Nautilus, 308.
[17] Yanturin S.I., 2007: Accumulation of heavy metals in soils and plant products in the conditions of technogenic. Agrarian Russia, 6:23-27.
[18] Zasyekin D.A., 1999: The content of heavy metals in soils and the possibility of toxicosis in animals. Veterinary Medicine of Ukraine, 10:12-14.
[19] Zasyekin D.A., 2005: Sanitary importance of soil in the poisoning of animals salts of heavy metals. Veterinary Medicine of Ukraine, 4:39-42.