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EFFECTS OF DIETARY SYMBIOTICS AND ORGANIC ZINC ON TRACE MINERALS COMPOSITION OF PORK

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Abstract

An experiment was conducted to evaluate the effects of symbiotics and organic zinc on pork quality (five anatomical parts and three types of organs) of growing pigs. The 28 days study was conducted on 8 castrated Topigs growing pigs, males, with an initial bodyweight of 18.25 ± 0.43 kg. The pigs were assigned to 2 groups (C, E), housed in individual metabolic cages and fed on conventional diets with 18.54% CP and 3129.6 kcal/kg ME. The diets of E group contained organic Zn (E.C.O. Trace® Trace minerals, Biochem Zusatzstoffe Handels- und ProduktionsgesellschaftmbH Küstermeyerstr, Germany) and it was supplemented with 10 g/kg symbiotics (BiominR IMBO Pro/prebiotic, BIOMIN, GmbH Austria). At the end of experiment, all pigs were slaughtered and meat (tenderloin; loin; ham; shoulder; belly) and organ (liver, kidney and spleen) samples were collected. The mineral quality of the collected samples was evaluated. For the samples of loin, tenderloin and belly, the iron concentrations were significantly (P≤0.5) increased for E group, compared to C group (loin: 7.3 ± 0.4 ppm for C; 10.05 ± 0.8 ppm for E; tenderloin: 14.51 ± 2.3 ppm for C; 18.82 ± 0.9 ppm for E and belly: 14.31 ± 1.14 ppm for C; 19.89 ± 1.5 ppm for E). Similar results were obtained for iron concentrations in organs, but, the differences recorded were only numeric. No significant differences were noticed between groups for Zn, Cu and Mn concentrations in the collected samples. The conclusion of the study was that symbiotics and organic zinc had positive effects on mineral metabolism and these results confirm the synergistic interrelation of Zn and Fe.

Key words: *symbiotics, organic zinc, pigs, mineral quality.*

INTRODUCTION

The dramatic changes in the international market require high standards of quality assurance in terms of diversity of food and environmental issues, ethics and animal welfare in meat production. Both carcass composition and quality of products from pork depend on many factors: genotype, terms of growth (the feeding, housing and environmental production system), conditions of slaughter, handling and processing of meat and carcases (Sellier, 1998; Monin, 2003), storage time (Granit et al., 2001) and minimizing the growth of pathogens in the gastrointestinal tract (Engber et al., 2002). Also, food is the basic tool to manipulate the growth of animal also influencing the sensory characteristics of meat by increasing the intramuscular fat (DeVol et al., 1988).

Knowledge of the structure, chemical composition, biochemical transformations occurring in meat and factors responsible for changing the main characteristics of the meat, is an important milestone for establishing the nutritional quality of meat. Various biochemical transformations occur in meat and a number of other processes positively affect the organoleptic characteristics.

On the other hand, improper storage conditions lead to degradation through an inevitable deterioration of the quality. Probiotics are viable, defined microorganisms in sufficient numbers, which alter microflora in a compartment of the host and, by that, exert beneficial health effects in this host. Prebiotics are nondigestible food ingredients that beneficially affect the host. A symbiotic is a product containing prebiotics and probiotics and in which the prebiotic compound selectively favours the probiotic compound (Scholz-Arenz et al., 2007).

The purpose of this study was to evaluate the effects of symbiotics and organic zinc on pork quality (five anatomical parts and three types of organs) of growing pigs.

MATERIALS AND METHODS

The experiment was performed in compliance with Directive 2010/63/EU on the protection of animals used for scientific purposes and all procedures described and it was approved by Ethical Commission of National Research and Development Institute for Biology and Animal Nutrition, Balotesti, Romania.

The 28 days experiment was conducted on 8 growing male, castrated hybrid TOPIGS (Large White × Hybrid (Large White × Pietrain) female × Talent (mainly Duroc), aged 47±3 days, under conditions of experimental balance. Throughout the experimental period, the piglets were randomly assigned to 2 groups (4 animals per group), kept in individual metabolic cages (Agrico, Rybarska, Czech Republic) with an area of 0.87 m^2, placed in an experimental hall under controlled environmental conditions (temperature of 24^0C, humidity 50-60%). The piglets received their diets in one daily meal, at 8.00 a.m., *ad libitum*.

The amount of feed given to each pig was weighed daily, as well as the leftovers (collected each morning). Water was supplied *ad libitum* via drinking nipples. They received a commercial diet designed for this category of animals differing between groups by the level of symbiotic supplement (Tables 1 and 2).

The diets of E group contained organic Zn (E.C.O. Trace® Trace minerals, Biochem Zusatzstoffe Handels- und Produktions gesellschaft mbH Küstermeyerstr, Germany) and 10 g/kg symbiotics (Biomin^R IMBO Pro/prebiotic, BIOMIN, GmbH Austria).

The productive parameters (average daily gain, feed conversion) were calculated from the records of the body weights and feed intake.

At the end of experiment, after blood samples collection, all pigs were slaughtered in an experimental abattoir. Five cuts (tenderloin, shoulder, loin, ham and belly) and organs (liver, spleen and kidney) were dissected, deboned, external fat removed, frozen at -80^0C and kept until chemical analysis. Trace mineral concentrations were determined in meat and organ samples applying flame atomic absorption spectrometry (FAAS) as described by Untea et al. (2012) after microwave digestion. The used equipment was as follows: Atomic absorption spectrometer Thermo Electron – SOLAAR M6 Dual Zeeman Comfort (Cambridge, UK), with deuterium lamp for background correction and air-acetylene flame and microwave digestion system with remote temperature measurement, BERGHOF, Speedwave MWS-2 Comfort (Eningen, Germany). Stock solutions of Cu, Fe, Mn, Zn, 1000 ppm traceable to SRM from NIST, were used to standardize the flame atomic absorption spectrometer. Class A glassware was used for transvasation, dilution and storage.

Each pig was considered an experimental unit. All data are expressed as mean value ± standard error of the mean (SEM). The analytical data were compared performing analysis of variance (ANOVA), using STATVIEW for Windows (SAS, version 6.0). The differences between mean values in the groups were considered significant at $P<0.05$.

Table 1. Formulation and chemical composition of feed concentrates used for hybrid Topigs piglets

Item	C (%)	E (%)
Soybean meal, 46.0%	11.80	11.80
Lysine	7.20	7.20
Dl - methionine	1.00	1.00
Calcium carbonate 37%	36.00	36.00
Mono calcium phosphate	18.00	18.00
Salt	4.00	4.00
Premix 1%*	20.00	20.00
Choline 60%	2.00	2.00
Characteristics of the concentrate feeds – Chemical analysis (theoretical calculation)		
Dry basis, %	94.35	94.35
ME, Kcal/Kg	785.02	785.02
Crude protein, %	13.14	13.14
Crude fat, %	0.21	0.21
Crude fibre, %	0.71	0.71
Calcium, %	21.57	21.59
Phosphorus, %	4.13	4.13
Phosphorus available, %	3.98	3.98
Sodium, %	1.59	1.59
Chloride, %	3.81	3.81
Lysine, %	6.02	6.02
Methionine, %	1.07	1.07
Met + cis, %	1.16	1.16
Threonine, %	0.22	0.22
Tryptophan, %	0.07	0.07
Linoleic acid, %	0.11	0.11

*the premix of E group contained organic Zn

Table 2. Formulation and chemical composition of compound feeds used for hybrid Topigs piglets

Item	C (%)	E (%)
Maize	35.70	35.69
Wheat	26.00	26.00
Rice bran	9.00	9.00
Corn gluten	3.00	3.00
Soybean meal	17.30	17.30
Sunflower meal	4.00	4.00
Feed concentrate	**5.00**	**5.00**
Symbiotics	-	0.01
Chemical composition		
Dry basis. %	86.89	
ME, Kcal/Kg	3129.60	
Crude protein. %	18.54	
Crude fat, %	1.65	
Crude fibre, %	4.12	
Calcium, %	1.20	
Phosphorus, %	0.65	
Phosphorus available, %	0.33	
Sodium, %	0.11	
Chloride, %	0.07	
Lysine, %	1.11	
Methionine, %	0.36	
Met + cis, %	0.69	
Threonine, %	0.66	
Tryptophan, %	0.21	
Linoleic acid, (c18:2) (%)	1.06	

RESULTS AND DISCUSSIONS

Pig performance values showed no significant differences between groups. During the experimental period, all productive parameters, final weight, average daily gain (ADG), average daily feed intake (ADFI) and feed conversion efficiency were slightly increased (P > 0.05), for E group (Table 3). There was no effect on overall growth performance of pigs fed supplemental organic Zn and symbiotics.

Table 3. Production parameters

Parameter	C	E
Initial weight, (kg/head)	18.25 ± 0.433	18.375 ± 0.315
Final weight , (kg/head)	35.83 ± 2.553	37.00 ± 2.041
ADG, (g/head/day)	0.628	0.665
ADFI, (g/head/day)	1199.673	1422.054
Feed efficiency, (g/kg)	2.08±0.324	2.13±0.343

The copper, iron, manganese and zinc concentrations in piglet organs and meat were chosen to obtain an indicator for measurement of the trace elements bioavailability (Richards et al., 2010) from the diet supplemented with symbiotics. The deposits of Cu, Fe, Mn and Zn in the main organs (liver, spleen and kidney) were evaluated and the results are presented in table 4. No significant differences (P>0.05) were noticed between groups for mineral concentrations determined in the selected organs. A slight increase of Fe concentrations was observed, but due to a large range of values, the differences were inconsistent (P>0.05). Similar ranges of values of mineral organs concentrations in pigs were reported in the scientific literature (Luo and Dove, 1996; Jondreville et al., 2005; Apgar et al., 1995).

Table 4. Mineral composition of selected organs (liver, kidney, spleen)

Organs	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
Liver				
Control	4.36±0.49	102.23±20.48	3.98±0.16	39.10±4.76
Experimental	4.23±0.18	118.39±28.08	3.73±0.73	38.12±3.19
Kidney				
Control	5.84±2.55	40.20±9.36	1.13±0.30	20.54±2.47
Experimental	5.71±1.33	52.76±5.59	1.36±0.21	21.24±2.40
Spleen				
Control	0.64±0.07	101.10±18.63	0.26±0.06	21.58±1.24
Experimental	0.68±0.03	129.61±22.91	0.24±0.05	21.55±0.81

Results are expressed as a mean ± SD.

Table 5. Mineral composition of anatomical parts (tenderloin; loin; ham; shoulder, belly)

Anatomical parts	Cu (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Zn (mg/kg)
Ham				
Control	0.43±0.18	9.82±0.67	0.04±0.02	14.31±0.91
Experimental	0.41±0.11	10.66±1.32	0.04±0.05	15.75±2.29
Belly				
Control	0.67±0.05	14.31±1.14 [b]	0.35±0.10	21.22±2.22
Experimental	0.75±0.26	19.89±1.53 [a]	0.31±0.13	21.74±2.56
Shoulder				
Control	0.78±0.01	14.19±2.12	0.03±0.03	22.32±2.85
Experimental	0.69±0.08	14.62±2.37	0.02±0.02	22.19±2.62
Loin				
Control	0.35±0.09	7.30±0.40 [b]	0.20±0.09	12.21±0.51
Experimental	0.45±0.10	10.05±0.85 [a]	0.28±0.06	11.91±0.88
Tenderloin				
Control	0.59±0.10	14.51±2.29 [b]	0.18±0.14	13.63±0.21
Experimental	0.69±0.09	18.82±0.96 [a]	0.23±0.05	13.48±0.87

In the same column,different superscripts mean significantly different ($P<0.05$) from C (a) respective E (b).
Results are expressed as a mean ± SD.

Five anatomical parts were considered for the evaluation of symbiotics and organic zinc effect on carcass mineral properties: tenderloin; loin; ham; shoulder, belly.

The recorded trace mineral concentrations are presented in table 5. In the case of iron, significant differences ($P<0.05$) were noticed between groups for loin, tenderloin and belly. These results sustain the previous observation (Table 4) about the positive effect noticed on iron concentrations in organs.

Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and / or activity of one or a limited number of bacteria (probiotics) in the gastrointestinal tract, and thus exert a health promoter effect (Roberfroid, 2002).

It was shown that there is an increase in intestinal absorption of minerals due to indigestible carbohydrates (Coudray et al., 2006).

Vanhoof and DeSchrijver (1996) tested the effect of inulin on Fe and Zn absorption in rats and pigs and noticed that Zn absorption was significantly higher for experimental group. Yalçınkaya et al. (2012) performed a study on broilers and showed that prebiotics mannan-oligosaccharide facilitates absorption of Fe and Zn and stimulate Cu retention.

CONCLUSIONS

The results of the study indicate that symbiotics and organic acids supplements improve mineral parameters of pork quality. The concentrations of Fe were improved in meat and organ samples, indicating the symbiotic and organic zinc potential in developing functional foods.

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