EFFECTS OF THE DIETARY SWEET WORMWOOD *(ARTEMISIA ANNUA)* GIVEN TO WEANED PIGLETS ON THEIR BIOPRODUCTIVE PARAMETERS

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Abstract

The aim of this study was to evaluate the effect of sweet wormwood supplements on bioproductive parameters of piglets. Sweet wormwood (Artemisia annua) is an herbaceous plant from the family of Asteraceae/Compositae. Besides the main active substance, artemisinin, the sweet wormwood also is a source of antioxidants. Sweet wormwood was cultivated by S.C. TRANSAPICOLA S.A. It was established the chemical composition of the plant and it was used in piglets diets. An experiment was conducted on 39 weaned Landrace × Large White piglets, in the presence of mineral deficit. The piglets were assigned to 3 groups (C, E1 and E2) and received the same corn-sunflower soybean meal diet, however, with different mineral premixes: the diet for C group contained 1% vitamin-mineral premix IBNA Balotesti. The diet for group E1 contained 1% vitamin-mineral premix in which the salts of Cu and Zn were reduced by 50 compared to the standard formulation (C) plus 1% sweet wormwood. The diet for group E2 contained the same premix as E1 plus 2% sweet wormwood. Animal performance indicators recorded in the end of the experiment (average daily weight gain: C – 481.94 g/day; E1 – 487.50 g/day; E2 – 492.30 g/day) and the blood count (leukocytes concentration: C – 21.92 109 / L; 20.42 109 / L; 19.74 109 / L; haemoglobin concentration: C – 9.3 g/dL; 9.04 g/dL; 9.14 g/dL) showed that the dietary sweet wormwood replaced the deficit of Cu and Zn (with antimicrobial action) maintaining the physiological state of the animals within the normal parameters for that particular category.

Key words: sweet wormwood, piglet, antioxidant

INTRODUCTION

Piglet weaning and the post-weaning treatment are the most critical stages of pig rearing. Weaning is a complex stage in the life of a pig, stage with a lot of stress which affects feed intake, the development of the gastro-intestinal tract and the adaptation to solid food. The gastro-intestinal tract disturbances, the infections and diarrhoea are more often during piglet weaning period. .P. Lalles (2008) shows that the problems which appear during piglet weaning cause significant economic losses for the pig producers. During the post-weaning period, besides other stressing factors, the shift from the (liquid) sow milk to solid food is a major change for the piglets. The piglets weaned very fast (less than 21 days) are extremely sensitive to the anti-nutritional factors present in the conventional diets based on corn and soybeans.

The dietary trace elements are indispensable for piglets, supporting their health and growth performance. Pig diets are supplemented with trace elements in excess of the requirements and this excess is eliminated through the faeces. These excreted minerals, Cu and Zn particularly, used as growth promoters, are environmental pollutants. The nutritionists are seeking solutions to decrease the amount of contaminants resulting from animal farming. The plants and their extracts (such as essential oils) are used increasingly often as natural alternatives to the antibiotics used until recently to control diarrhoea and

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other digestive tract dysfunctionalities (Han et al., 2006), also being possible solutions to enhance the bioavailability of the dietary trace elements. Sweet wormwood (*Artemisia annua*) is nice smelling wormwood from Asteraceae/Compositae family. It grows frequently near houses, stables, on barren rural lands. Sweet wormwood artemisinin is the only natural compound second to quinine, vital in the control of malaria. The antioxidant capacity of *Artemisia annua* is also due to the flavonoids it contains.

MATERIAL AND METHODS

Animals

The experiment was conducted under farm conditions in the experimental farm of IBNA, on 27 weaned Landrace × Great White piglets with an average initial weight of 9.56 ± 0.06 kg. The piglets were assigned to three randomized groups (C, E1 and E2) depending on their body weight. All piglets were housed in pens located in an experimental house. At the beginning of the experiment, weekly and at the end of the experiment the piglets were weighed individually to determine their weight gain. The feed, provided with free access, given each day was weighed in order to determine feed intake. Throughout the 40 experimental days there were five periods (of 5 days each) when the manure was collected. Three piglets from each group were slaughtered in the end of the experiment and carcass and organ development were assessed by specific measurements. Samples of organs and blood were collected from each slaughtered piglet and assayed.

Feeds

The plants were grown, harvested and conditioned by the researchers from TRANSAPICOLA SRL from Targu Mures (Mures County, Romania), using a hybrid of *Artemisia annua* purchased from Germany (Anamed). The plants were harvested in early October. The plants were cut at the soil level and were left on the field to dry for two days, after which they were spread under a shelter. When the plants reached a humidity of 30-50%, the leaves were removed manually from the stems and processed with a device to extract the oil. Part of the plants were dried out fully and ground. The resulting product had a high concentration of artemisinin.

The dried, ground sweet wormwood was used to manufacture the compound feeds for the experimental groups (C, E1 and E2). All animals received the same basal diet with corn, sunflower meal and soybean meal as main ingredients (Table 1), but different levels of trace elements and sweet wormwood. The diets were formulated according to NRC 1998 requirements. The diet for the control group (C) had 1% vitamin-mineral premix Zoofort P1+2 manufactured by IBNA Balotesti. Diets E1 and E2 differed from diet C as follows: 1% sweet wormwood and 1 % Zoofort P1+2 in which the salts with Cu, Fe, Mn and Zn were reduced by 50% compared to the standard formulation from C (E1); 2% sweet wormwood and 1 % Zoofort P1+2 in which the salts with Cu, Fe, Mn and Zn were reduced by 50% compared to the standard formulation from C (E2).

Table 1 Compound feed structure and quality indices

Ingredients	C (%)	E1 (%)	E2 (%)
Corn	64.15	60.15	57.45
Sunflower meal	8.00	8.00	8.00
Soybean meal	14.00	14.00	14.00
Gluten	2.00	2.00	2.00
Milk powder	5.00	5.00	5.00
Oil	1.80	2.80	3.50
Monocalcium phosphate	1.40	1.40	1.40
Calcium	1.75	1.75	1.75
Salt	0.20	0.20	0.20
Methionine	0.10	0.10	0.10
Lysine	0.50	0.50	0.50
Choline	0.10	0.10	0.10
Premix Zoofort P1+2*	1.00	-	-
Premix Zoofort P1+2*(with 50% less Zn, Fe, Mn)	-	1.00	1.00
Sweet wormwood	-	1.00	2.00
Analysed:			
Crude protein (%)	18.52	18.48	18.49
Metabolisable energy (MJ/ kg)	13.49	13.29	13.17
Iron (mg/kg)	199.89	158.59	167.84
Manganese (mg/kg)	45.69	31.83	32.95
Zinc (mg/kg)	134.69	84.91	85.13

Provided per kg of diet: vitamin A 10000 UI, vitamin D_3 2000 UI, vitamin E 30 mg, vitamin K_3 3mg, vitamin B_1 2 mg, vitamin B_2 6 mg, Ca pantothenate 13,5 mg, nicotinic acid 20 mg, vitamin B_6 3 mg, vitamin B_7 0.06 mg, vitamin B_9 0.8 mg, vitamin B_{12} 0.05 mg, vitamin C 10mg, Mn 30 mg, Fe 110 mg, Cu 25mg, Zn 100 mg, Co 0.3 mg, KI 0.38 mg, Se 0.36 mg

Collected samples:

From each batch of compound feeds samples were collected and assayed. The analysis of the gross chemical composition (protein, fat, cellulose, ash, energy) was done by the lab of forage producer (IBNA Balotesti pilot station).

For the purpose of doing measurements on body and organ development, at the end of the experiment the piglets were slaughtered according to the provisions of the Law on animal protection and welfare (Dir. Cons. 93/119/CCE, Order 180/11.08.2006, M. Of. 721/23.08 2006). The following measurements were performed: semi-carcass, empty stomach, empty guts, heart, liver, spleen, lung, brain.

Blood samples were collected in EDTA bottle from the jugular vein of piglets and assayed for white blood cells (WBC), lymphocytes total count, lymphocytes percentage, haemoglobin (HGB), red blood cells (RBC), haematocryte (HCT), mean cell volume (MCV), mean cell haemoglobin (MHC), mean cell haemoglobin concentration (MCHC).

The analyses were made with a MINDRAY BC 2800 VET, AUTO HEMATOLOGY ANALYZER (China).

Minerals analysis – the samples of forages, faces and serum have been prepared for mineral determination using AAS (atomic absorption spectrophotometry).

Reagents – The atomic absorption spectrophotometer was prepared for analyses using stock solution, 1000 ppm Traceable to SRM from NIST, $Fe(NO3)2$ in HNO3 0.5 mol / L. Fr analyses we on used double distilled, deionised water (Milli-Q Millipore, 18.2 MΩ/cm). Other reagents that were used: HNO3, Merck 65%, density 1.39 kg/L; H2O2 30%, Merck.

Equipment:

● Atomic absorption spectrophotometer Thermo Electron – SOLAAR M6 Dual Zeeman Comfort (Cambridge, UK), fitted with deuterium lamp for background correction. Wave length was: 213.9 nm for Zn, 248.3 nm for Fe, 279.5 nm for Mn.

● Microwave digester, with remote measurement of temperature, BERGHOF, model Speedwave MWS-2 Comfort (Eningen, Germany);

● Analytical scales Sartorius (Gottingen, Germany);

● Stove BMT model ECOCELL Blueline Comfort (Neuremberg, Germany);

● Water distiller Milli-Q Ultrapure Water Purification System, Millipore (Billerica, USA).

Class A glassware was used for manipulation, dilution and storage.

Statistical analysis:

StatView software was used to analyse statistically the experimental results. ANOVA was used for the significant differences.

RESULTS AND DISCUSSIONS

The following parameters were monitored in order to evaluate animal performance: final weight, average daily gain, average daily feed intake. No significant ($p>0.05$) differences were noticed between the groups in terms of the monitored parameters.

Table 2 Animal performance (average values/ group)

	C	E1	E2
Weight: initial (kg) final (kg)	9.61 ± 1.22 28.89 ± 5.98	9.61 ± 1.36 29.11 ± 3.60	9.50 ± 1.29 30.15 ± 4.92
Average daily gain (g)	481.94 ± 16.1	487.50 ± 10.76	516.25 ± 13.29
Average daily feed intake (g)	1079 ± 35.5	1069 ± 37.6	1073 ± 35.3

Figure 1 show the evolution of the bioproductive parameters which shows that they were comparable between the three groups throughout the experimental period.

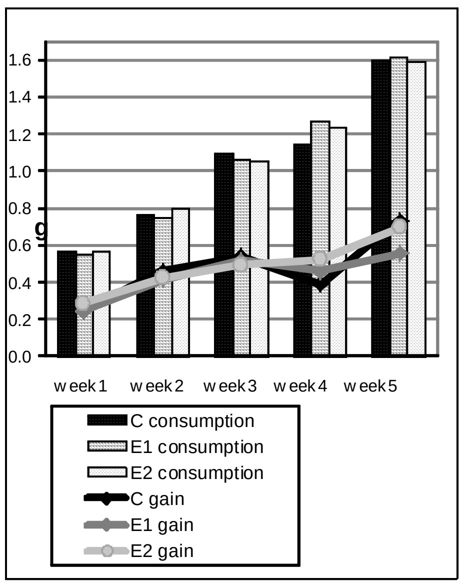

Fig. 1 Evolution of the bioproductive parameters throughout the experimental period

Organ and carcass development (Table 3) was adequate to the species and category of piglets. There were no significant differences ($P \geq 0.05$) between groups. This allow us, to appreciates that decreasing the amount of inorganic premix and supplementing the diet with sweet wormwood, irrespectively of the level, body development wasn't affected.

Table 3 Carcass and organ development (average values/ group, kg)

Organ weight	C	E 1	E 2
Half carcass	9.06 ± 1.25	9.28 ± 1.40	8.80 ± 1.48
	100	102.43	97.13
Empty stomach	0.30 ± 0.06	0.32 ± 0.06	0.26 ± 0.05
	100	106.66	86.66
Empty viscera	2.30 ± 0.23	2.48 ± 0.20	2.30 ± 0.19
	100	107.83	100
Heart	0.14 ± 0.02	0.13 ± 0.02	0.12 ± 0.02
	100	92.8	85.71
Liver	0.80 ± 0.12	0.85 ± 0.10	0.77 ± 0.11
	100	106.25	96.25
Spleen	0.07 ± 0.01	0.07 ± 0.01	0.06 ± 0.01
	100	100	85.71
Kidney	0.15 ± 0.03	0.15 ± 0.02	0.14 ± 0.02
	100	100	93.33
Brain	0.07 ± 0.01	0.07 ± 0.00	0.08 ± 0.00
	100	100	114.28

Table 4 shows the blood parameters determined by the full blood count. No significant ($p > 0.05$) differences were noticed between the experimental groups, the parameters ranging between the normal limits for this species and category. This is also due to the dietary artemisinin from the sweet wormwood. The presence of this active ingredient compensated particularly the deficient level of Zn, which is known to have antimicrobial action.

Table 4 Blood parameters (average values/ group)

	MU	C	E1	E2
WBC	109 / L	21.92	20.42	19.74
RBC	mil/mm3	6.90	6.58	6.82
HBC	g/dL	9.3	9.04	9.14
HCT	%	34.28	33.92	34.72
MCV	fL	51.18	51.7	51.08
MCH	pg	13.84	13.7	13.4
MCHC	g/L	271	266	263
RDW	%	16.8	16.68	19.2
PLT	109 / L	372	328	353
MPV	fL	7.76	7.54	7.32

The concentration of Cu, Fe, Mn and Zn in the manure was determined in order to evaluate the action of the dietary sweet wormwood when the dietary concentrations of trace elements were decreased.

Table 5 Trace elements concentration in the manure (average values/ group)

	C	E1	E2
Copper (ppm)	175.75 ± 17.66[bc]	117.44 ± 15.59[a]	109.41 ± 14.72[a]
% of C	100	68.82	62.25
Iron (ppm)	1834.89 ± 150.32	1613.41 ± 100.31	1774.63 ± 187.16
% of C	100	87.92	96.71
Manganese (ppm)	307.26 ± 32.03[bc]	223.43 ± 41.05[a]	219.49 ± 62.96[a]
% of C	100	72.71	71.43
Zinc (ppm)	627.86 ± 46.09[c]	483.29 ± 65.81	468.53 ± 46.46[a]
% of C	100	76.97	74.62

a – significantly different from C ($p \leq 0.05$);
b – significantly different from E1 ($p \leq 0.05$);
c – significantly different from E2 ($p \leq 0.05$)

Except for the Fe, the trace elements concentration in the manure decreased significantly for both experimental groups compared to the control group (Table 5). The strongest decrease was noticed for the Cu (more than 30%), which is a positive result since this trace element is one of the heavy metals incriminated by the European legislation as one of the major environmental pollutants. The decrease of Zn, another heavy metal, in pig manure was also strong, over 20% compared to the control group.

As Kornegoy and Harper show (1997) a concept must be formed in which animal diets have to be “cost-effective”, as accomplished by reducing the negative impact on the soil and water.

CONCLUSIONS

No significant differences were noticed in terms of the body weight gain, feed intake and organ development between the control groups and the groups treated with sweet wormwood.

Both the animals from group C and those from groups E1 and E2 had a proper health state throughout the experimental period. The dietary sweet wormwood action compensated for the deficit of dietary Zn particularly, known to have antimicrobial activity.

The use of sweet wormwood diets while decreasing the dietary level of trace elements didn’t affect the trace elements status in the animals, and the concentration of excreted minerals were lower.

REFERENCES

[1] Lalles, J. P. (2008). Nutrition and gut health of the young pig around weaning: what news. Archiva Zootechnica, 11, 5–15.

[2] Han Z.K., Wang G.J., Yao W., Zhu W.Y., 2006, Isoflavonic phytoestrogens – new prebiotics for farm animals: a review on research in China, Curr. Iss. Intest. Microbiol, 7, 53-60.

[3] NRC 1998 - Nutrient Requirements of Poultry, Ninth Revised Edition, NATIONAL ACADEMY PRESS, Washington, D.C., 1994.

[4] Norma sanitară veterinară privind protecția animalelor în timpul sacrificării sau uciderii, Dir. Cons. 93/119/CEE, Ordin 180/11.08.2006, M. Of. 721/23.08 2006

[5] Parvu Gh., Costea M., Pirvu M., Nicolae B., 2003, Tratat de Nutritia Animalelor. Coral Sanivet, Bucuresti, pp 883-886.

[6] Kornegoy E.T., Harper A.F., 1997, Environmental nutrition: Nutrient management strategies to reduce nutrient secretion of swine, Proc. Anim. Sci. 13:99-111.