NUTRIENT BALANCE STUDY IN A PIGLET DIET SUPPLEMENTED WITH A MIXTURE OF FRUITS

T. Gavriş[1*], Arabela Untea[1], Gabriela Cornescu[1], Tatiana Panaite[1], Iulia Vărzaru[1], Margareta Olteanu[1], Cristina Șoica[1], Mihaela Sărăcilă[1]

[1]National Institute for Research Development in Animal Biology and Nutrition (IBNA- Balotesti), Romania

Abstract

The objective of this study was to evaluate the effect of a mixture of dehydrated fruits (bilberry, blackcurrant, quince,) and essential oils (Bitter fenel fruit oil, Peppermint oil) on nutrients apparent digestibility coefficients on weaned piglets. A 4-week study on 8 piglets (18.69 ± 1.25 kg), male, castrated, half brothers, TOPIGS hybrid, randomly assigned in two groups (C and E). The piglets were housed in individual digestibility cages that allowed daily recording of ingesta and excretion, placed in a controlled microclimate hall (temperature of 22.9 ± 1.00 ° C, humidity 43.9% ± 3.37%). Both groups received diets with the same basic structure (corn, soybean meal - ME 3214 kcal/kg of feed and 18.00% CP). The diet of E group was supplemented daily with 1.65g mixture of fruits. During the experimental period, in the fourth week, a balance (5 days) was carried out to determine the apparent absorption coefficients of the nutrients. The balance parameters determined for protein, fat, ash and non nitrogen extractives substances decreased for experimental group, but the differences were not significant between groups. The same tendency was for digestibility of the amino acids, the differences being not statistically supported. The absorption coefficients of E group, for Cu, Mn, Zn decreased significantly compared to the C group. In conclusion the mixture of fruits does not improve the digestibility of nutrients, other benefits remaining to be studied.

Key words: pigs, plant mix, nutrients, absorption coefficients

INTRODUCTION

Feed additives represents an alternative to antibiotics baned, being used to stabilize the health and performance of young animals. Schöne et al. (2006) consider that weaning in the presence of pathogenic micro organisms leads to the post-weaning syndrome, which may include diarrhoea, oedema and endotoxin shock [13]. Phytogenic feed additives comprise a wide variety of spices, herbs and products derived thereof. In lower doses, essential oils may increase the feed intake [2]. Fennel essential oil stimulates potassium channels in smooth muscles and inhibits calcium channels [1], which increases the intestinal motility and produces a significant shortening of food transit time [9]

Blackcurrant (*Ribes nigrum*) berries are known to be rich in polyphenolic compounds (on average 250 mg/100 g of fresh fruit), which have been demonstrated to be potent antioxidants and cardioprotective [10]. Experimental studies suggest that the proportion of polyphenols absorbed in the small intestine is small, up to 20% (depending on the structure and origin of the polyphenol), and most of the ingested polyphenols reach the large intestine where they face the microbiota, potentially catalytic and hydrolytic [14]. From several studies [8],[11],[20] has been shown that plant extracts possess a spectrum of activity against different pathogens. The beneficial effects of medicinal plants can be observed in farm animals by increasing food intake, improving digestion, stimulating immunity, antibacterial, anti-inflammatory and antioxidant effects. Most of the active metabolites of plants, belong to the class of isoprene, flavonoid and glucosinolate derivatives, and a large number of these compounds have been suggested to act as antibiotics or as antioxidants in vivo as well as in feed [18]

[*]Corresponding author: teogavris@gmail.com
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MATERIAL AND METHOD

The experiment was performed comply 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 castrated TOPIGS male pigs. Throughout the experimental period, the piglets were randomly assigned in 2 groups (experimental group E and a control group C) with initial bodyweight of 18.69 ± 1.25 kg, 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 22.9±1.00°C, humidity 43.9±3.37%). The piglets were fed the respective diets daily, at 8.00 a.m., ad libitum. Water was supplied *ad libitum* via drinking nipples. At the end of the experiment, pigs from the control group had a body weight of 45.0±2.68 kg and those in the experimental group had a body weight of 45.25±0.96 kg. The pigs were fed on corn-soybean meal-based diets (18.00% CP; 3214 kcal/kg ME). The diet of E group was supplemented with 1650 mg of mix plants and essential oils (billberry fruit, black currant fruit, quince fruit, peppermint oil, bitter fennel fruit oil) every day. During the experiment, one balance of 5 days were performed, in the fourth week. The samples of excreta (faeces) were collected and weighted daily from each animal and average weekly samples were formed. During the balance, ingesta was recorded daily for each animal. Feeding samples from both groups were analyzed for the nutrients used in the balance. The faeces samples were stored at 4°C. At the end of the collection period, the faeces were weighed and homogenised. Faeces samples were dried at 65°C in stove BMT model Ecocell Blueline Comfort (Nuremberg, Germany) and ground with a Grindomix GM 200 mill (Retsch, Germany). The coefficients of apparent absorption of nutrients were calculated using the data from the chemical analysis on the feeds and faeces, corroborated with the daily records of the intake and excreta, using digestibility equations proposed by Schiemann et al. (1981).[12]

At the end of experiment, all piglets were slaughtered and spleen and kidney samples were collected.

The basic chemical composition of the phytoadditives, feed ingredients, compound feeds and faeces was assayed: dry matter (DM) was determined with the gravimetric method, according to SR ISO 6496:2001; crude protein (CP) was determined with the Kjeldahl method using a Tecator Kjeltek auto 1030 analyser (SR EN ISO 5983-2, 2009); the ether extractives (EE) were determined by extraction in organic solvents, according to SR ISO 6492:2001; the crude fibre (CF) was determined by successive hydrolysis in alkali and acid environment, according to SR EN ISO 6865:2002; the ash (Ash) was determined with the gravimetric method, according to SR EN ISO 2171:2010.

HPLC Surveyor Plus Thermo Electron, (Massachusetts, United States) and HyperSil BDS C18 column (Thermo Electron, Massachusetts, United States), dimensions 250mm X 4.6 mm X 5 µm were used in order to determine the amino acids profile of meat samples. Each sample was prepared as described previously (Varzaru et al., 2013) [17].

Spleen and kidney samples were analysed for trace mineral concentrations applying flame atomic absorption spectrometry (FAAS) as described by Untea et al., (2012) after microwave digestion[16]. The used equipment was as follows: Atomic absorption spectrometer Thermo Electron – SOLAAR M6 Dual Zeeman Comfort (Cambridge, UK), with deuterium lamp.

Statistics: 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 $P<0.05$.

RESULTS AND DISCUSSIONS

The plant mixture used to supplemented the diet of experimental group, was composed by: Bilberry (Vaccinium myrtillus L.) 54,3%, Blackcurrant (Ribes nigrum) 22,55% Quince (Cydonia Oblonga) 22,55%, Peppermint Oil/Menthae piperitae aetheroleum 0,3%, Bitter fenel fruit Oil/ Foeniculi amari fructus aetheroleum 0,3%. Chemical composition of plants and essentials oils mitxt used in piglets diet. Dry matter (DM) 97.16%, crude protein (CP) 7.03%, crude fat (EE) 14.02%, Ash 11,96%, Calcium (Ca) 0,24%, phosphorus (P) 0,25%, copper (Cu) 7,33%, manganese (Mn) 62,66 ppm, zinc (Zn) 18,07 ppm.

The registered data showed there were no significant ($P \leq 0.05$) differences for the production parameters (data unpublished). The use of the plant mixture didn't have a significant effect on the dietary nutrients digestibility.

The values of aparent absortion presented in Table 1 showed intestinal digestibility coefficients higher in the group C then the coefficients registered for group E, for crude protein (CP), crude fat (EE), ash, and copper. The differences were not statistically significant ($p<0.05$). Significant differences ($p<0.05$) were calculated for cellulose, organic matter (OM), non-nitrogen extractive substances (NES), calcium (Ca), phosphorus (P), manganese (Mn) and zinc (Zn) between goups. Mroz et al.(1994) reported results in the same value range for DM, CP, OM.[7]

In table 2 are presented the results obtained for amino acids absortion coefficients. As it previously observed, a decrease tendency was noticed for digestibility of amino acids, the differences being not stastically supported. The results obtained are simmilar with those found in the literature [19]. This authors studied ileal digestibilities of amino acids in early weaned piglets and the values obtained were lower then coefficiets presented in table 2. The differences observed may be attribute to the digestibility determination method used in the studies.

Table 1 Apparent absorption coefficients for nutrients and minerals (%) from ingesta (average values/ group)

	Absortion coefficinet (%)			
Specification	C	E	SEM	P-value
DM(%)	62.25	62.29	0.727	0.9821
CP (%)	86.69	84.45	0.738	0.1384
EE (%)	76.35	71.80	1.229	0.0536
Celulose (%)	70.32^{b}	67.17^{a}	0.66	0.0021
Ash (%)	69.44	64.21	1.416	0.545
OM (%)	96.21^{b}	95.37^{a}	0.173	<0.001
NES (%)	93.92^{b}	92.60^{a}	0.271	<0.001
Ca (%)	72.85^{b}	68.12^{a}	1.199	0.024
P (%)	70.67^{b}	66.48^{a}	1.111	0.0454
Mn (%)	54.52^{b}	43.52^{a}	2.522	0.0076
Zn (%)	45.72^{b}	36.61^{a}	2.451	0.0424

In the same column, different superscripts means significantly different. Results are expressed as a mean for each group. Dry matter-(DM), crude protein-(CP), crude fat-(EE), organic matter (OM), non-nitrogen extractive substances (NES), calcium (Ca), phosphorus (P), manganese (Mn), zinc (Zn)

Table 2 Apparent absortion coefficients for amino acids (%) from ingesta (average values/group)

	Absortion coefficient, %			
	C	E	SEM	P
Aspartic acid	84.130	81.511	0.98	0.1997
Glutamic acid	87.948	87.267	0.71	0.6678
Serine	87.398	85.708	0.84	0.355
Glycine	85.471	84.213	0.86	0.5063
Threonine	86.299	83.547	0.84	0.1024
Arginine	92.673	91.885	0.49	0.4668
Alanine	79.857	77.213	1.32	0.3529
Tyrosine	87.273	85.998	0.78	0.4546
Valine	80.433	77.928	1.17	0.3183
Phenylalanine	85.007	83.743	0.81	0.4765
Isoleucine	79.474	76.699	1.06	0.211
Leucine	85.730	83.753	0.75	0.2069
Lysine	86.496	84.317	0.74	0.1537
Cystine	90.993	89.287	0.63	0.1926
Methionine	93.555	93.225	0.35	0.6769

Results are expressed as a mean for each group

In table 3 are presented results for chemical analyzes for spleen samples. In this case significant higher values were recorded for E group in terms of crude fat (EE), and mangansese. The concentrations of crude protein decreased significantly for E group compared to C group. Similar results were found by other researchers regarding mineral concetrations in spleen[15].

In table 4 are presented data obtined for kidney samples. Concerning the proximate and mineral composition, there were no significant differences (P>0.05) between experimental and control group. Lindeman et al. (2008) found the same range of values for mineral concentrations (Mn and Zn) in kidney, obtained on pigs from the same category.[4]

Table 3 Chemical composition of spleen samples

	Spleen			
	C	E	SEM	p-value
DM(%)	23.02	26.28	1.123	0.1584
CP(%)	66.24^{b}	56.95^{a}	1.808	<0.001
EE(%)	19.14^{b}	27.87^{a}	1.742	0.004
Ash(%)	5.72	4.87	0.354	0.2576
Mn(ppm)	1.14^{b}	2.95^{a}	0.344	<0.0001
Zn(ppm)	86.07	84.33	0.883	0.3651

Results are expressed as a mean. In the same column, different superscripts means significantly different. Dry matter-(DM), crude protein-(CP), crude fat-(EE), manganese (Mn), zinc (Zn)

Table 4 Chemical composition of kidney samples

	Kidney			
	C	E	SEM	P-value
DM(%)	20.43	20.44	0.676	0.9965
CP(%)	64.17	64.23	0.491	0.9567
EE(%)	19.08	19.68	0.620	0.6649
Ash(%)	5.19	5.25	0.132	0.8468
Mn(ppm)	3.79	3.98	0.059	0.1071
Zn(ppm)	95.54	94.84	0.421	0.4515

Results are expressed as a mean. Dry matter-(DM), crude protein-(CP), crude fat-(EE), manganese (Mn), zinc (Zn)

CONCLUSIONS

In conclusion, the mixture of fruits does not improve the digestibility of nutrients or nutrients concentrations in organs, other benefits remaining to be studied.

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