Effect of the addition of activated charcoal on the nutrient digestibility in fattening pigs

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Abstract

A physiological experiment for determining nutrient digestibility with three groups was carried out, each group with 3 male castrated pigs (58.333–58.667 kg live weight). The pigs were positioned in specialized cages for a 6-day preparatory and a 5-day report period. The animals from the separate groups were fed with the same compound feed, with added supplement Carbovet (activated charcoal) to the rations of second and third groups. The dosage was 5 and 10 g per day per animal, respectively. The pigs were fed twice a day – receiving 1.8 kg feed per animal per day. Feaces were collected twice a day. The addition of Carbovet in compound feeds for fattening pigs (5 and 10 g per day per animal) decreased the digestibility coefficients of crude fats with 16.11 ($p = 0.080$) and 20.05% ($p = 0.039$); and for phosphorus with 10.43 ($p = 0.044$) and 6.66% ($p = 0.157$), respectively. Correlation coefficients and determination coefficients in crude fats and in phosphorus were high and indicate a strong negative connection between Carbovet and the correlation coefficients.

Key words: activated charcoal, digestibility coefficients, pigs

Introduction

Phytogenic feed additives are plant products used in animal nutrition in order to improve productivity. This class of feeds has recently gained interest, especially after the complete ban on antibiotic feed additives by the European Union (EU) in 2006. Phytogenics is a relatively new class of feed additives that do not include organic acids and probiotics, which are already well studied in animal nutrition. There is limited knowledge about phytogenic additives regarding their action and aspects of their application, also in terms of botanical origin, processing and composition (Windisch et al., 2007). Activated charcoal is a similar product that is used in pig breeding.

Struhsaker et al. (1997) stated that activated charcoal adsorbs a wide range of compounds. Adsorption therapy with activated charcoal as an indigestible carrier is one of the important methods for neutralizing the absorbed toxic substances or harmful substances formed in the gastrointestinal tract (McLennan & Amos, 1989; McKenzie, 1991; Jindal et al., 1994).

Chu et al. (2013) found that the inclusion of bamboo charcoal in the rations of fattening pigs had increased productivity and feeding efficiency by reducing gas emissions and harmful microflora in the faeces, which led to reduced stress (lower cortisol levels) and increased Ig G concentration in the serum.

Natural plant charcoal – *Carbovet* is a feed supplement obtained from specially selected

French oaks through the process of carbonization. The product has a good absorption capacity and captures enterotoxins produced by harmful bacteria and mycotoxins from feed, as well as some pathogenic bacteria such as *clostridia*, *salmonella* and *E. coli*.

The addition of activated charcoal supplement in feeds for fattening pigs has not tested in our country. In our experiments (Nedeva & Yordanova, 2013) with growing pigs, we have established that the addition of plant charcoal (3 kg/t feed) for periods of 14, 21, 35 and 49 days after weaning increased growth intensity with 17.65–24.81% and also decreased the consumption of feed and nutrients with 5.47–18.17%. The addition of plant charcoal had a significant effect in decreasing the cases of digestive disorders in the conditions of our experiment.

The aim of the experiment was to establish the effect of the addition of *Carbovet*, a product containing activated charcoal, on the nutrient digestibility in fattening pigs.

Material and methods

The physiological experiment for nutrient digestibility was conducted with three groups of 3 male castrated pigs with 58.333–58.667 kg live weight from the cross ♀ Danube white x ♂ Duroc. The pigs were reared in special cages in a 6-day preparational and 5-day reporting period. The scheme of the experiment is presented in Table. 1.

Animals from the individual groups were fed the same compound feed presented in Table 2, with added *Carbovet* in the rations for the second and third groups, at a dosage of 5 and 10 g/day per animal, respectively.

Carbovet is a feed supplement designed to be added to poultry and pig feeds. Active ingredient is: 80% charcoal consistency obtained by carbonization of French oak wood. It acts in the digestive tract. Due to its large adsorbing surface, it quickly binds myco- and enterotoxins, which prevents them from penetrating the blood, liver and other organs.

The pigs were fed twice a day – 1.8 kg of feed/per animal/day. The rations of compound feed for the preparational and reporting periods were set aside in advance and stored in buckets with lids that close tightly.

Faeces were collected twice a day. Thirty samples per group or a total of 90 samples were taken. The collected faeces were weighed for half a day, homogenized and a sample of 10% was taken. The samples were stored in a tightly closed container (laboratory beakers), preserved with 10% HCL solution and 1% chloroform. At

Table 1. Experiment scheme

Indicators	Groups		
	I	II	III
Control	+	-	-
Carbovet, 5 g/per animal/day	-	+	-
Carbovet, 10 g/per animal/day	-	-	+

Table 2. Component composition, energy and nutrient content in kg of compound feed

Components, %	Groups – I, II, III
Maize	18.88
Barley	20.00
Wheat	25.00
Wheat bran	10.00
Bioconcentrate mixture – 14	26.00
Synthetic lysine, 98	0.12
Total:	100.00
1 kg of compound feed contains:	
Metabolizable energy, MJ	12.62
Crude protein, g	18.01
Lysine, g	0.95
Methionine + cystine, g	0.64
Threonine, g,	0.64
Tryptophan, g	0.10
Crude fats, g	1.93
Crude fibres, g	6.74
Calcium, g	0.85
Phosphorus, g	0.78

the end of the experiment, the collected samples were homogenized and 200 g of fresh faeces were taken to determine the dry matter. The rest was dried at 65 °C. Digestibility was calculated for each animal individually, separately for each nutrient, as well as the difference between that ingested with feed and that excreted in the faeces.

Results were calculated using the variation statistics method. Established were the following: regression coefficients, correlation and determination to establish the strength and direction of influence of the tested variable, as well as the level of its significance accepted for $p \leq 0.05$. The software for statistical calculations and graphs R was used for the analysis.

Resuts and discussion

Figure 1 indicates that there are differences between the groups in the amount of total faeces excreted, which was greater in the experimental animals. The correlation coefficient (R = 0.656) indicates that there is a significant connection with the test factor.

The nutrient digestibility coefficients are presented in Table 3.

Data shows that differences between the coefficients for dry and organic matter digestibility, as well as those for crude protein between the groups were minimal and can be considered as practically identical. In general, we can assume that activated charcoal did not have a significant effect on their digestibility. While Kutlu et al. (2001) also found that wood charcoal added to rations improved body weight of broiler chickens, nutrient digestibility, and utilization of compound feed. And Ruttanavut et al. (2009) reported that bamboo charcoal powder slightly increased growth intensity due to the increased surface area of, intestinal villi in ducks. Long villas are thought to have an increased surface area for the absorption of available nutrients in humans (Caspary, 1992) and pigs (Zijlstra et al., 1996).

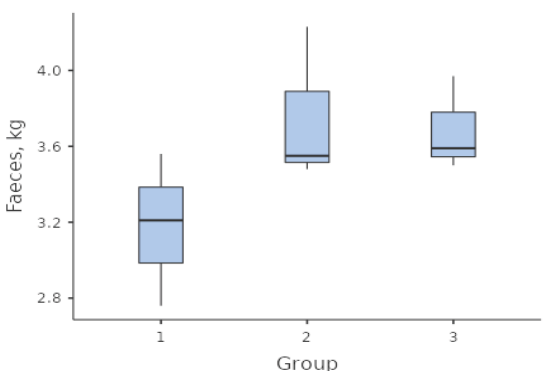

Fig. 1. Total faeces, kg

Table 3. Nutrient digestibility coefficients

Groups Indicators	Group I – Control			Group II – 5 g *Carbovet*/day/per animal			Group III – 10 g *Carbovet*/day/per animal		
	$\bar{x}$	$S\bar{x}$	C	$\bar{x}$	$S\bar{x}$	C	$\bar{x}$	$S\bar{x}$	C
Dry matter	88.463	0.939	1.84	87.053	1.063	2.12	86.663	0.697	1.39
Organic matter	89.427	0.855	1.66	88.067	0.971	1.91	87.707	0.690	1.36
Protein	89.077	0.778	1.51	89.737	0.661	1.28	89.510	0.659	1.28
Fats	54.813	3.182	10.06	45.980	1.810	6.82	43.823	3.595	14.21
Fibres	64.837	3.535	9.45	58.270	2.771	8.24	57.480	2.247	6.67
Mineral substances	75.073	2.080	4.80	72.887	2.464	5.86	72.083	1.612	3.87
Calcium	74.237	1.001	2.34	71.773	3.677	8.87	72.157	3.614	8.68
Phosphorus	76.730	1.730	3.91	68.730	1.989	5.01	71.620	2.831	6.85
NFE	92.950	0.816	1.52	91.677	0.939	1.77	91.373	0.606	1.15

Table 4 shows that *Carbovet* reduced the digestibility of crude fibre in both experimental groups, but this was not statistically proven (p = 0.160 and p = 0.123, respectively).

These results are close to the reliable ones and it can be assumed that there is a tendency, assuming that the probable administration of a higher dose of 10 g/per animal/day may influence in this direction.

The lower digestibility coefficients of crude fats in the experimental groups are presented in Table 4. In animals from the second group, the digestibility coefficients of fat were lower by 16.11%, and in animals from the third group – by 20.05%, compared to the control group, which did not receive the *Carbovet* supplement. The differences between the first and second groups are close to the proven p = 0.080, and between the first and third are statistically significant p = 0.039. The correlation and determination coefficients are high and show a strong connection between the tested factor and the obtained results

Table 4. Coefficients of correlation, determination and regression

Predictor	Estimate	SE	t	p	R	R^2
Model Coefficients – Faeces						
Intercept [a]	3.177	0.209	15.17	< 0.001	0.656	0.431
2 – 1	0.577	0.296	1.95	0.099		
3 – 1	0.510	0.296	1.72	0.136		
Model Coefficients – Dry matter						
Intercept [a]	88.46	0.912	96.95	< 0.001	0.514	0.264
2 – 1	-1.41	1.290	-1.09	0.316		
3 – 1	-1.80	1.290	-1.39	0.213		
Model Coefficients – Crude protein						
Intercept [a]	89.077	0.702	126.912	< 0.001	0.266	0.071
2 – 1	0.660	0.993	0.665	0.531		
3 – 1	0.433	0.993	0.437	0.678		
Model Coefficients – Crude fibres						
Intercept [a]	64.84	2.90	22.36	< 0.001	0.627	0.393
2 – 1	-6.57	4.10	-1.60	0.160		
3 – 1	-7.36	4.10	-1.79	0.123		
Model Coefficients – Crude fats						
Intercept [a]	54.81	2.96	18.50	< 0 .001	0.750	0.563
2 – 1	-8.83	4.19	-2.11	0.080		
3 – 1	-10.99	4.19	-2.62	0.039		
Model Coefficients – Mineral substances						
Intercept [a]	75.07	2.08	36.073	< 0 .001	0.394	0.156
2 – 1	-2.19	2.94	-0.743	0.486		
3 – 1	-2.99	2.94	-1.016	0.349		
Model Coefficients – Phosphorus						
Intercept [a]	76.73	2.23	34.36	< 0.001	0.723	0.523
2 – 1	-8.00	3.16	-2.53	0.044		
3 – 1	-5.11	3.16	-1.62	0.157		

[a] *Represents reference level*

– R = 0.750 and R^2 = 0.563. In this case we take into account the influence of the applied dose in the ration. In a previous study (Nedeva et al., 2014) with a lower dose of *Carbovet*, no effect on fat digestion coefficients was found.

We observed lower digestibility coefficients for phosphorus in the experimental groups with 10.43 and 6.66%, respectively. The assessment for the second group is statistically significant – -8.00, p = 0.044 and for the third group – -5.11, p = 0.157. The correlation and determination coefficients for phosphorus are also high and, together with the estimates, show a strong negative connection between *Carbovet* and digestibility coefficients – R = 0.723 and R^2 = 0.523.

No significant differences were reported for the digestibility coefficients of calcium, mineral substances and nitrogen-free extract (NFE), even though the assessments of the regression analysis for the experimental groups were negative.

The added *Carbovet* in the two experimental groups had an effect on essential nutrients, with a stronger effect on the digestibility of crude fat, phosphorus and to some extent crude fibres and a minimal effect on crude protein. We attribute this influence to the high adsorption capacity of activated charcoal and the ability of the adsorbent to export various substances through the digestive system outside the body.

Conclusions

The addition of *Carbovet* in the compound feed for fattening pigs in a dosage of 5 and 10 mg/day/per animal decreased the digestibility coefficients of crude fats with 16.11 (p = 0.080) and 20.05% (p = 0.039) and for the phosphorus with 10.43 (p = 0.044) and 6.66% (p = 0.157), respectively.

Coefficients for correlation and determination in crude fats and phosphorus were high and indicated a strong negative connection between *Carbovet* and digestibility coefficients.

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