Effects of zeolite supplementation on some fermentation process characteristics of growing pigs

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40 fattening pigs (meat hybrid; category 25 40 kg) of both sexes were divided into two treatments for evaluation of fermentation process after zeolite supplementation in the feeding. The treatments consisted of the incorporation of 0 and 2% natural zeolite in the feed. After the period of diet adaptation (21 d), the faeces were collected. The levels of total nitrogen substances – crude protein (CP), ammonia (NH3), dry matter (DM), and volatile fatty acids were determined in the faeces. There were (fresh and dry basis) higher values of CP (59.5 and 53.0 vs. 230.7 and 224.2 g kg^{-1}) and NH_3 (1.25 and 1.04 vs. 4.81 and 4.43 g kg^{-1}) in the faeces from the group given zeolite, as well as superior values of dry matter (25.78% vs. 23.61%).

Keywords: feeds, zeolite, fermentation process, faeces, growing pigs

1. Introduction

Zeolites are porous materials characterized by the ability to lose and gain water reversibly, to adsorb molecules of appropriate cross-sectional diameter and to exchange their constituent cations without major changes in their structure (Filippidis et al., 1996; Mumpton and Fishman, 1977). Owing to these properties, zeolites are used in a wide range of industrial and agricultural applications, particularly in animal nutrition (Mumpton, 1999). Clinoptilolite specifically adsorbs NH_4^+ and it is therefore believed having the ability improve feed protein digestion (Leung et al., 2007). However, the performance of zeolites is related to the type used, its purity and physicochemical properties, as well as the amount added to the diet. This study was conducted to evaluate the effects of natural zeolite on parameters of fermentation process in growing pig faeces.

2. Material and methods

2.1 Animals and diets

Forty fattening pigs (meat hybrid from Netherlands, crossbreed with Dutch Landrace) were divided in two groups (20 animals in control group and 20 animals in test group; 50% male : 50% female in both of groups). The experiment was conducted during 21 days, with initial mean body weight (BW) 28.44±2.41 kg (control) and 27.74±2.18 kg (test). The test group diets were supplemented with 2% natural zeolite (fraction 0–0.3 mm). The addition of zeolite into test diet was realized at the expense of barley. Composition of test and control diet and the calculated contribution of nutrients from the diets are shown in Table 1.

Table 1 Composition and contribution of the diets

	Test diet in %	Control diet in %
Corn	20.0	20.0
Wheat	28.0	28.0
Barley	24.0	26.0
Soybean meal	18.0	18.0
Rapeseed meal	5.0	5.0
Premixture vitamins and minerals	3.0	3.0
Zeolite	2	0
Analysis calculated in %		
CP	17.9	18.0
ME in MJ kg^{-1}	12.8	12.9
Lysine	1.04	1.04
Methionine + Cystine	0.59	0.59
Calcium	7.7	7.7

CP – crude protein; ME – metabolizable energy

2.2 Analysis

After 21 days of feed adaptation, the faeces were collected in plastic buckets. In the laboratory, they were homogenized and divided into six subsamples of each

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Table 2 Determination of crude protein, ammonia, pH, volatile fatty acids and dry matter in the faeces of pigs fed on zeolite and without it

	Test (± SEM)	Control (± SEM)	P
CP in g kg^{-1}	59.5±2.4	53.0±2.8	0.1109
NH_3 in g kg^{-1}	1.25±0.11	1.04±0.05	0.1181
pH	6.32±0.09	6.36±0.07	0.7806
Σ VFA in g kg^{-1}	10.02±0.18	9.99±0.42	0.9555
DM in %	25.78±0.72	23.61±1.03	0.1138
CP in g kg^{-1} DM	230.7±6.5	224.2±3.7	0.4026
NH_3 in g kg^{-1} DM	4.81±0.33	4.43±0.23	0.3704

S.E.M. – standard error; *P*-values – significance level; CP – crude protein; NH_3 – ammonia; VFA – volatile fatty acids; DM – dry matter

group, and the nitrogen substances (CP), ammonia (NH_3), dry matter (DM). For these determinations, the procedures of AOAC (2000) were used. Quantitative determination of VFA has been done by the method of isotachophoresis in a two-capillary isotachophoretic analyser EA100 (VILLA LABECO, Slovak Republic). Samples of faeces were analysed for pH (pH meter Consort C830, Belgium) from extract (4 hours / [2 g fresh faeces + 20 ml distilled water]).

2.3 Statistical analysis

The differences between means were determined, according to the unpaired *t*-test using GraphPad Prism 6 software.

3. Results and discussion

The levels of CP and NH_3 in the faeces of the pigs fed on zeolite were superior to the control group (Table 2). These results indicate higher total nitrogen retention in the pig faeces from the pigs fed on the zeolite. Insignificant difference in the parameters were found between the groups. This agreed with Giannetto et al. (2000), who stated that zeolites, due to their high capacity of cationic exchange, can catch NH_4 and other charged ions in their porous structure. As opposed to this, the ammonifying microflora seemed to start to act on the faeces of the control group, immediately after the dropping of the faeces. It transforms biogenic amines into ammonia (Silveira et al., 1987). Similar data were obtained by Ly et al. (1996), in growing pigs, in which the faecal concentration of ammonia, as well as the amount of its daily output, was increased in the treatments with zeolite. These results coincided with those of Hale (2005), but in hens, who obtained retentions of more than 70% of nitrogen in the faeces of hens supplemented with zeolite. This author attributes these outcomes to higher intestinal catch of nitrogen by the zeolite. These results also agreed with Lon-Wo et al. (2010), who results indicated higher total nitrogen retention in the poultry litter from the birds (Leghorn laying hens) fed on the zeolite.

Zeolites (natural and synthetic) have shown both positive and negative effects on animal performance. Mumpton and Fishman (1977) described the stimulating activity of zeolite particles in the stomach and intestinal tract and reported that they ultimately improved animal health. The binding of NH_4^+ to zeolites has been noted in pigs as well, and many researchers suggested this action as the possible mechanism for the observed improved performance of the animals receiving zeolites (Papaioannou et al., 2005). There are evidences that clinoptilolite elevates nitrogen excretion in faeces (Shurson et al., 1984; Poulsen et al., 1995) and reduces the ammonia concentration in blood serum (Shurson et al., 1984; Pond et al., 1988; Kyriakis et al., 2000), when supplemented to the basal diets of pigs.

The composition of the faeces also showed differences (non-significant) in the content of dry matter favoring the treatment with zeolite. The humidity reduction in the faeces can be explained by the capacity of the zeolites of absorbing more than 60% of their weight in water (Wilson and Mumpton, 1984). Evaluation of the fermentation process through determination of VFA and pH in the faeces showed insignificant differences between test and control group. The amount of VFA in faeces showed small variations between groups, which could be attributed to the variation in microbial activity and in absorption from the large intestine.

4. Conclusions

This work results proved that using 2% of zeolite in the growing pig diet increased ammonia uptake in faeces. Although the differences were not statistically significant, we observed a tendency with higher content of CP and NH_3 in the faeces from the group given zeolite.

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