THE EFFECT OF FEEDING ADDITIVES WITH PLANT SECONDARY METABOLITES ON NUTRIENTS DIGESTIBILITY IN PIGS

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Abstract

In this work was an effect of anise and fennel essential oils as well as four plant by-products from spices on nutrients utilization evaluated in pig balance experiment. The trial was organized in authorized experimental stable Žabcice of Mendel University of Agriculture and Forestry Brno. The high level efficiency of experimental animals is mentioned through general parameters (average daily gain, feed intake and feed conversion). The results of nutrients utilization rate show slightly higher digestibility of nutrients in treatment with anise essential oil these improving are not higher then 1.0 %. We can see also improving on nitrogen retention in body mass on level of 5.6 % (anise treatment compared with control group). There is low variability between experimental animals (except nitrogen retention coeficient) but we cannot see any statistical significance. On base of these results we can say the used phytogennic additives do not affect negatively the nutrient utilization in used concentration (0.1 % of essential oil in feed mixture) and are from this point of view fully eligible for animal nutrition. These results are also supported by few research papers connected with similar topic. On second hand there were evaluated also four byproducts from spice industry that contain plant secondary metabolites and can be used in animal nutrition. There were spent from coriander, allspice, pepper and cumin evaluated. In general these additives decreased slightly the digestibility of monitored nutrients but it was not statistically significant and these additives can also be used in animal production if there will not be found out other negative effects.

Key Words: Pig, digestibility, essential oil, spent, secondary metabolites

Some feeding additives from plant substrates have positive effect on animal efficiency. These influences are based on different mechanisms connected with secondary metabolisms presence. It can work in store, in intestinal digestion as well as in tissue metabolism. It can affect also the nutrients digestibility in intestine by positive or negative sense. The processes can be connected with affection of microbial population in intestine, viscosity of digesta, enzymes function or by other influence on pathways). The evaluation of additives effect on nutrients digestibility was made during the experiments on pigs.

Material and methods

The balance experiment was realized at Accredited University Farm in Zabcice. The eight borrows of pig meat hybrid entered the trial. Experimental treatments (TR2 – TR7) were compared with untreated control (C1). The feed additive content in mixture was 0.5 %:

C1: Untreated control (0.5 % wheat)
TR2: Aniseed essential oil (0.1%) in maize starch (total 0.5 %)
TR3: Allspice spent (0.5 %)
TR4: Fennel essential oil (0.1%) in maize starch (total 0.5 %)
TR5: Coriander spent (0.5 %)
TR6: Black pepper spent (0.5 %)
TR7: Cumin spent (0.5 %)

The feed analyses were provided before the experiment start. The digestibility of base nutrients was evaluated: dry matter, crude protein, crude fiber, crude fat, non-nitrogen extracts crude ash. The analyses were provided according to Act No. 124/2001 on requirements for sampling and analyses processes (Czech legislation). All Laboratory analyses were realized at Department of Animal Nutrition and Forage Production Mendel University of Agriculture and Forestry Brno. Statistical evaluation of results was processed by one-factorial analyses of variance.

The experiment run in autumn months and all air temperature and humidity data was recorded in half-hour intervals automatically. Eight castrated barrows with the average initial weight 40.95 ± 1.05 kg were used as experimental animals. There were stabled in individual balance-cages that make able to exactly evaluate the feed intake, urine and faeces production. Before the experiment the animals were housed in quarantine, were treated by oral antihelmintics and antibiotics and fed by control feed-mixture before this period the pigs were housed in pig production farm and were fed with mixture with same base components.

Balance experiment was composed from 7 balance periods. The feed mixtures rotated between these periods according to Latin square. It means seven pigs were fed by one mixture in one balance period (including control mixture, eighth pig was fed by control mixture all experiment duration); see Table 1.

The duration of balance period composed 7 days including 3 days of preparation. The feed intake, urine and faeces production were precisely monitored during all experiment. The amount of feed mixture was offered to be eaten by pigs in 30 minutes without any rests. All pigs were feed by same amount of mixture in balance period two times per day to ensure similar growth intensity during all periods.

Feaces were preciously collected every morning and samples (20% of daily amount) were taken into polyethylene tubes and frozen. After all experiment were samples of one type (same pig and balance period) mixed and final sample (0.4 kg) was taken and lyophilized, milled and analyzed. Urine was also preciously taken from collecting polyethylene tub with HCl as conservation matter. Five percent from daily amount was taken as sample into sampling polyethylene tube and stored in refrigerator till end of period, after that was mixed all samples from one pig and final sample was immediately analyzed.

For each of balance period was an amount of feed determined during preparation days, the growth intensity, live body weight and appetite of animals were taken into account, but the feed mixture amount were same for all animals. The mixture was mixed with water and offered two times per day; water was available all day and the water intake was not measured. The weighing of animals was carried out every week. The cages were cleaned every day.

The feed mixture was composed from following main components: barley, wheat, maize, soya extract meal. The feed composition is mentioned in Table 2 in details. Two grams of Cr_2O_3 was added into kilogram of mixture to make able to use the indicator methods to obtain quality results in case some problems will be found in precise excrements collecting or for verifying of classic balance methodology. Results mentioned in this paper come from this classic methodology described through formulas mentioned bellow.

Table 1. Experiment design

Balance period	Experimental treatment							
	Pig No. 1	Pig No. 2	Pig No. 3	Pig No. 4	Pig No. 5	Pig No. 6	Pig No. 7	Pig No. 8
1	C	TR 2	TR 3	TR 4	TR 5	TR 6	TR 7	C
2	TR 2	TR 3	TR 4	TR 5	TR 6	TR 7	C	C
3	TR 3	TR 4	TR 5	TR 6	TR 7	C	TR 2	C
4	TR 5	TR 6	TR 7	C	TR 2	TR 3	TR 4	C
5	TR 6	TR 7	C	TR 2	TR 3	TR 4	TR 5	C
6	TR 7	C	TR 2	TR 3	TR 4	TR 5	TR 6	C
7	TR 4	TR 5	TR 6	TR 7	C	TR 2	TR 3	C

Table 2. Feed mixture composition

Feedstuff	Percentage amount in mixture (%)
Barley	26.0
Wheat	44.5
Soya extract meal (45% of crude protein)	23.8
Milk replacer	1.0
Calcium formate	1.0
Di-calcium-phosphate	0.5
Mono-calcium-phosphate	0.5
Salt	0.4
Limestone	0.6
Experimental treatment (see above)	0.5
Mineral-vitamin premix	0.5
Lysine (concentration 78%)	0.5
Chromium oxide	0.2

The nutrition value of experimental additives was not taken into account in calculation of nutritional value of mixtures that was same in all variants. The content of dry matter, crude fat, crude fiber, crude protein, ash and brutto energy was analyzed in feedstuffs and faeces for digestibility determination.

The crude protein content in urine was analyzed for evaluation of nitrogen retention in body. The coefficients of apparent digestibility of nutrients were found out according Formula 1. The Formula 2 shows the calculation principle to obtain retention coefficient of crude protein (CP).

Formula 1 – Calculation of apparent digestibility coefficient (ADC)

$$ADC = \left(\frac{\text{total nutrient intake} - \text{total nutrient content in feces}}{\text{total nutrient intake}} \right) * 100$$

Formula 2 – Calculation of retention coefficient of CP (RCCP)

$$RCCP = \left(\frac{\text{total CP intake} - \text{total CP content in faeces and urine}}{\text{total CP intake}} \right) * 100$$

Results and discussion

The initial body weight of experimental animals was 41.0 ± 1.0 kg. The average daily gain (ADG) during experimental period was 1.06 ± 0.06 kg and the average daily feed intake (FI) was 2.63 kg per day and animal. Then the feed conversion calculated as AVG/FI was 2.5 ± 0.1 kg of feed per kg of gain. The feed intake and feed conversion is similar to other experimental results with animals in this age category (40 – 90 kg of body weight) and we can say this values are standard (KRALIK et al., 1996 or POULSEN, 1994 that describe conversion on level 2.31 – 2,72 with pigs of 25 – 50 kg of body weight.

The dry matter digestibility in our experiment was in control group 84.77%, the only higher digestibility of dry matter comparing with control group was in treatment with anise essential oil 85.14%). The rest of treatments show slightly lower values, none of differences was statistically significant and the lowest digestibility was in treatment with coriander spent: 84.23%. Similar trends are found out in evaluated digestibility of crude protein (CP), the only higher values of CP digestibility was found in treatments with anise and fennel oils (85.3 and 84.1%), that are very similar in secondary metabolites composition. Digestibility of CP in treatments with plant spent additives was lower (83.66 – 84.63%) comparing with control treatment (84.64%). Energy digestibility was on level 84.78% in control group and on level 84.09 – 85.15% in treatments groups, again only higher digestibility was found out in anise oil treatment. Digestibilityof fat was generally low:
between 56.38 – 61.42 % and comparing with control group (59.69%) there were treatments decreasing the digestibility: anise and fennel oils and allspice spent and treatments increasing fat digestibility: coriander, pepper and cumin spent. Even low was the digestibility of ash (45.59 – 49.39%) and of crude fiber (28.74 – 36.59%). In case of ash nutrients the experimental treatments increased their digestibility comparing with control (46.28%) except the treatment with coriander spent (45.59%). In case of fiber digestibility was only higher value in anise oil treatment (36.59%) comparing with control (34.46%). We can see low variability between experimental groups in digestibility of mentioned nutrients that eliminated the statistical significance. The large variability between treatments as well as in frame of individual treatments was found out in calculation of protein retention in animal body. These values were between 39.48 – 43.14 % and the standard difference shows large variability between balance periods that can correspond with changing of growth intensity. On base of these results we can say that no of these treatments can influence the animal digestibility of base nutrients in negative sense. Also the improvement of digestibility is only very low in case of anethole essential oils (anise, fennel). All summaries are related to used concentrations of additives and allow to continue in further experiment in practical conditions.

Table 3. Values of general efficiency parameters

	Pig No. 1	Pig No. 2	Pig No. 3	Pig No. 4	Pig No. 5	Pig No. 6	Pig No. 7	Average ± standard difference
Initial body weight (kg)	41.45	39.80	41.85	42.80	39.95	40.80	40.00	40.95 ± 1.05
Final body weight (kg)	92.10	87.90	85.50	93.30	89.80	86.30	85.10	88.57 ± 3.01
ADG (kg/day)	1.13	1.07	0.97	1.12	1.11	1.01	1.00	1.06 ± 0.06
FI (kg/day)	2.63	2.63	2.63	2.63	2.63	2.63	2.63	2.63 ± 0
FC (ADG/FI)	2.34	2.46	2.71	2.34	2.37	2.60	2.62	2.49 ± 0.14

ADG – average daily gain;
FI – average daily feed intake;
FC – feed conversion

Table 4. Digestibility coefficients of base nutrients and retention coefficients of crude protein

	C	TR 2	TR 3	TR 4	TR 5	TR 6	TR 7
D of dry matter	84.77 ± 1.67	85.14 ± 1.37	84.42 ± 1.06	84.71 ± 1.3	84.23 ± 1.98	84.34 ± 1.57	84.73 ± 2.26
D of crude protein	84.64 ± 1.48	85.3 ± 1.8	83.66 ± 0.85	84.71 ± 1.49	83.99 ± 1.84	84.21 ± 1.2	84.63 ± 1.6
R of crude protein	39.9 ± 8.22	42.12 ± 6.56	41.39 ± 4.22	39.49 ± 7.32	39.48 ± 9.15	43.14 ± 10.49	40.3 ± 12.48
D of energy	84.78 ± 1.54	85.15 ± 1.47	84.2 ± 1.02	84.57 ± 1.41	84.14 ± 1.83	84.09 ± 1.48	84.4 ± 2.1
D of crude fat	59.69 ± 5.7	58.9 ± 7.91	56.38 ± 8.72	57.85 ± 5.8	59.05 ± 2.16	60.85 ± 5.54	61.42 ± 6.52
D of ash	46.28 ± 9.88	46.95 ± 8.15	48.34 ± 6.15	48.5 ± 5.33	45.59 ± 10.29	48.13 ± 8.45	49.39 ± 10.54
D of crude fiber	34.46 ± 11.73	36.59 ± 9.2	34.06 ± 8.01	29.64 ± 11.43	28.74 ± 11.44	33.91 ± 6.5	32.53 ± 11.22

D – digestibility (%)
R – retention (metabolizability - %)

The influence of plant additives is not so often mentioned in research papers but we can find relatively enough information about effect of some kind of these supplements on growth parameters. These papers usually describe positive effect of these additives that was not confirmed in our work. The decreasing of digestibility coefficients were found out after supplementation of feed by mixture of fennel, coriander plants substrates in rates of 1.5 %. The decreasing of crude proteins digestibility is described in experiments with laboratory rats (PRADEEP and GEERVANI, 1994). The team of authors (CROSS et al., 2007) evaluated the effect of different plant extract on nutrient digestibility and growth intensity in broilers production. Some methodological matters were used in our work. The statistical significant influence on growth efficiency but no influence on nutrients digestibility was found out after supplementation of plant products into feed mixtures (dry substrates and essentials oils of thyme, oregano, marjoram, rosemary and yarrow). Also HARTI (2006) did not find out any effect on digestibility after poultry feed mixture supplementation by cumin and black pepper, unfortunately the experimental feed ration was based on tropical feedstuffs. Digestibility was not influenced either in experiments of PRADEEP et al. (1991) that evaluated supplementation of cumin, black pepper, coriander and others on sorghum digestibility in poultry. HERNÁNDEZ et al. (2004) found out after supplementation of broilers feed mixture by pepper, oregano and cinnamon extracts the influence on dry matter digestibility, but not on crude protein digestibility.

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