Effects of peat feeding on the performance and health status of fattening pigs and environmentally derived mycobacteria

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ABSTRACT: The purpose of the present study was to investigate the effects of feeding peat as a supplement in the period after weaning on the performance and health status of pigs. Also to assess the risk of the development of tuberculous lesions in the lymph nodes and parenchymatous organs, caused by conditionally pathogenic mycobacteria present in peat. Twenty Large White × Landrace pigs in equal numbers of barrows and gilts (mean live weight 18.0 ± 1.7 kg) were used in the experiment. The experimental group was fed a diet containing commercial underground peat in the dose of 80 g peat/kg dry matter for 30 days. Subsequently, they were fed an identical diet with the control group without peat for 60 days. A short-time feeding peat did not significantly affect the growth and performance of pigs. From day 21, a statistically highly significant ($P < 0.01$) increase in the consumption of the experimental diet was recorded, however, without a positive effect on the growth of experimental animals. The conversion of the peat containing diet was comparable to the conversion of the control diet. It follows from the results of biochemical analysis of blood that peat feeding for 30 days did not adversely affect the metabolic profile and health status of experimental animals. No tuberculous or tuberculoid lesions in lymph nodes or parenchymatous organs were detected in any of 20 slaughtered animals. Despite that, mycobacteria were isolated from 10 (25.0%) tissues of 5 (50.0%) pigs from the experimental group. One isolate was identified as *Mycobacterium avium* subsp. *hominissuis* (IS*901*– and IS*1245*+). Seven of nine isolates were determined as conditionally pathogenic atypical mycobacteria: *M. fortuitum* ($n = 2$) and *M. xenopi* ($n = 5$). It follows from the present results that feeding of a peat supplemented diet to pigs may be considered as economically non-effective and due to the findings of mycobacteria as risky.

Keywords: humate; humic substances; performance; feed conversion; health status; tuberculosis; *Mycobacterium avium* complex; food safety

Peat and various peat preparations are used in farm animal herds, above all, as efficient absorbents of poisonous gas from the pig shed environment and a number of environmental pollutants (Abbes et al., 1993; Rizzuti et al., 1999; Hartikainen et al., 2001; Picot et al., 2001; Rizzuti et al., 2002). Recently, interest in the use of peat as a feed supplement with health-dietetic effects has increased. Various peat preparations are produced and particularly recommended for growth stimulation and the increase of the immune system activity of piglets and sows, also for prevention of enteric diseases in weaned piglets (Matlova et al., 2005; Trckova et al., 2005).

A stimulating effect of peat preparations on the performance of a number of animal species was documented in some experiments on broiler chickens (Stepchenko et al., 1991; Zhorina and Stepchenko, 1991; Bailey et al., 1996; Kocabagli et al., 2002), laying hens (Yoruk et al., 2004) and pigs (Fuchs et al., 1995). It is possible to assume from

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the literature data available, that this positive effect is, above all, associated with the presence of humic substances. Aromatic polyfunctional compounds with medium to high molecular weight such as humic acids, fulvic acids, ulmic acids and humates rank among humic substances. Despite the fact that the mechanism of growth stimulation has not been fully clarified yet, it is assumed that humic substances due to their chelating capability ameliorate the resorption of certain nutrients such as N, P, Mn, Fe and Zn by the organism (Visser, 1973; Fuchs et al., 1990, 1995; Stepchenko et al., 1991; Anonymous, 2002; Kocabagli et al., 2002).

Besides humic substances (that constitute 60 to 80% of peat), peat contains a series of macro-, microelements and other biologically active substances that may exert a positive effect on the health status of animals: streptomycin, penicillin, estrogenic compounds, vitamins, enzymes and non-saturated fatty acids (Andriesse, 1988; Lotosh, 1991; Anonymous, 2002). Accordingly, biological activity of natural peat is viewed as being more beneficial compared to isolated humic acids (Banaszkiewicz and Drobnik, 1994).

From a dietary aspect, the low pH of peat (3.0 to 5.5) causes a reduction in the pH of the intestinal contents. This plays an important role by stimulating digestion, regulating intestinal microflora and limiting the growth of animal pathogenic bacteria of the Enterobacteriaceae family (Fuchs et al., 1995; Shermer et al., 1998). A stimulating effect of peat on spontaneous contractility of smooth muscles of the digestive tract was also observed (Beer and Lukanov, 1998; Beer et al., 2000, 2003; Zagorchev et al., 2000). Humic acids present in peat cover open nerve endings in the intestinal mucosa causing a reduction in potentially stressful conditions of animals with lesions of the intestinal mucosa (Slavik, 1999). Accordingly, peat is recommended for the prevention of diarrhoeal diseases of animals (Lenk and Benda, 1989; Kuhnert et al., 1989, 1991; Roost et al., 1990).

After feeding peat preparations, some authors observed an improvement in the general health state of animals (Roost et al., 1990; Stepchenko et al., 1991; Fuchs et al., 1995) and a reduction in nonspecific deaths (Lenk and Benda, 1989; Stepchenko et al., 1991; Yoruk et al., 2004). Besides changed lipid metabolism (Lotosh, 1991; Stepchenko et al., 1991; Banaszkiewicz and Drobnik, 1994; Bailey et al., 1996), improved metabolism of proteins and minerals and increased immunity and adaptability of animal organisms have been documented after feeding peat preparations (Lotosh, 1991; Stepchenko et al., 1991).

In the majority of available studies, that confirmed a stimulating effect of peat on the growth and production performance, various preparations and extracts of peat were fed for a long time, particularly to broiler chicken. Feed supplementation with natural peat is quite unusual. Enueme et al. (1987) used peat as an alternative carrier-type feed ingredient added into liquid feed products for turkeys. Feeding higher doses (15%) caused depression of growth in turkeys, which has also been observed in cases of other commonly used carriers (sunflower hulls, peanut hulls, soybean mill feed, wood flour and corn cobs). Such an adverse effect was not observed if the diet was restricted to 5% peat content. The conditions regarding the use of natural peat in pig nourishment, focusing on functionality and safety, have not been established yet.

The potential risk of peat feeding is represented by its primary or secondary contamination with mycobacteria (Horvathova et al., 1997; Pavlik et al., 1999; Kazda, 2000; Matlova et al., 2003, 2005; Trckova et al., 2005). Despite the fact that Czech Republic has been declared to be a bovine tuberculosis-free EU state in 2004 (Anonymous, 2004a; Pavlik et al., 2005; Pavlik, 2006), tuberculous lesions in lymph nodes are consistently found in slaughtered pigs (Pavlik et al., 2003, 2005). These lesions are usually caused by the member of *Mycobacterium avium* complex *M. a. hominissuis* of genotype IS*901*– and IS*1245*+ (Matlova et al., 2003, 2005). Veterinary meat inspections reveal tuberculous lesions in animals fed peat as a supplement (Matlova et al., 2005).

Peat in natural deposits may be massively contaminated with mycobacteria due to favourable survival and propagation conditions in peatbogs despite the low pH value. This is due to a higher temperature than on the peatbog surface and a sufficient supply of nutrients produced by the decomposition of peat sphagnum. The concentration of mycobacteria in the grey layer of a peatbog reaches 10^6/g peat (Kazda, 2000). The highest concentration of mycobacteria (65 to 74%) was found in commercially available peat packed in unsealed plastic bags, intended for gardening or as a feed supplement for pigs. The most commonly isolated species was *M. a. hominissuis* (Matlova et al., 2003, 2005; Trckova et al., 2006). Certain companies started to treat peat-based feed supplements with ionising irradiation with the aim to decrease contamination of peat with conditionally pathogenic mycobacteria (non-published data).

The first purpose of the present study was to investigate the effect of commercial peat, as a feed supplement, on the performance and health status of weaned pigs. The second purpose was to assess the potential risk of the development of tuberculous lesions in the lymph nodes and parenchymatous organs of pigs caused by conditionally pathogenic mycobacteria present in the environment.

MATERIAL AND METHODS

Experimental animals

Twenty Large White × Landrace pigs in equal numbers of barrows and gilts (mean live weight 18.0 ± 1.7 kg) were used. Experimental animals were housed in pens of 10 pigs each (5 barrows and 5 gilts), under good hygienic conditions of accredited animal facilities in the Veterinary Research Institute in Brno, the Czech Republic (experiment authorisation No. 588). The average surface space was 1.7 m^2 and the length of feeding place per pig was 0.3 m. Straw was used as bedding. Conditions of animal hygiene were monitored by continuous measurements of ambient temperature and relative humidity in the environment of the experimental animals.

The experiment was preceded by an 11-day pretreatment period, during which the pigs gradually adapted to the new diet and environment concurrently, their performance and growth uniformity were monitored. They were once preventively dewormed (Ivomec, inj.; MSD, Agvet, USA) during that period and earmarked by tattooing.

Feeding, weighing and health status of pigs

Before biological testing commenced, the animals were weighed and based on individual live weight, they were allocated into two groups: one control (C) and one experimental (E) group. The average weight of the pigs in the control and experimental group was 24.2 ± 1.4 and 24.8 ± 1.8 kg, respectively. The variation coefficient (< 10%) was consistent with the requirements of biological testing (Anonymous, 2004b).

The control group (C) was fed with a diet suggested for fattening of meat type pigs for the entire period of experiment (90 days). The experimental group (E) was fed with a diet containing underground peat (Baby Vig, INOBIO, Romilly Sur Andelle) intended for piglet feeding by the manufacturer in the dose of 80 g peat/kg dry matter for 1 month (day 0 to 30 of experiment). Subsequently, from day 31 to 90 they were fed an identical diet to the control group, produced for fattening of meat type pigs, without peat supplementation. The diets were analysed for the content of basic nutrients (Anonymous, 2000).

Both groups of pigs were fed twice a day, partially *ad libitum*. The amounts of feed were regulated according to the current intake and weight of the animals so that food refusals could be kept low. The diets were mixed with drinking water 1:1. Thirty minutes after feeding began; the refusals were removed, weighed and taken into account in subsequent calculations.

Pigs were weighed at the beginning of the trial and then on days 10, 20, 30, 60 and 90 of the experiment with an accuracy of 0.1 kg, always 2 h after feeding. Individual and group body weight gains and relative growth rates (q) were calculated from the detected live body weight of the animals according to Karakoz (1986):

$$q = \frac{yt - yo}{yo} \times 100$$

where:

yo = weight at the beginning

yt = weight in a particular period

The feed conversion was calculated from feed consumption and the average body weight gains of the respective groups of animals.

The health status of the animals was monitored daily by observation at regular intervals. Occasional morbidity and mortality were recorded. Dead animals were examined *post mortem*.

Biochemical analysis of pig blood serum

At the beginning (days 0 and 30) and at the end of the trial (day 90), always 3 h post feeding, blood samples were drawn from *vena cava cranialis* for biochemical analysis. Total protein, albumin, glucose, triacylglycerols, cholesterol HDL and LDL lipoproteins, alkaline phosphatase (ALP, EC 3.1.3.1), transferases (AST, EC 2.6.1.1; ALT, EC 2.6.1.2), calcium and phosphorus blood plasma levels were determined by spectrophotometry using Bio-La-Tests (PLIVA-Lachema Brno Ltd., Czech Republic).

Laboratory examination for the presence of mycobacteria

At the beginning of the experiment, 10 samples of peat containing diets and 10 samples of diets without peat were analysed. Microscopic examination of each sample for acid-fast rods (AFR) by Ziehl-Neelsen (ZN) staining and by culture for presence of mycobacteria after treatment with HCl-NaOH at 24°C and 37°C was performed. The growth of mycobacteria was inspected after the first week and then every second week during the following two months (Fischer et al., 2001).

All AFR positive isolates were examined by the PCR method for the detection of *dnaJ* gene specific for *Mycobacterium* genus using primers 5´-GGG TGA CGC GAC ATG GCC CA-3´ and 5´-CGG GTT TCG TCG TAC TCC TT-3 (Nagai et al., 1990). Previously described primers (Bartos et al., 2006) were used for IS*901* and IS*1245* detection for the identification of *M. avium* complex members. Mycobacterial isolates that were not members of the *M. avium* complex were identified by DNA STRIP technology according to Hain (Hain Lifescience, Nehren, Germany).

Veterinary-meat inspection after slaughter

After slaughter (day 90 of the experiment), submandibular, hepatic, jejunal and ileal lymph nodes were collected from each animal. Gross examination, microscopy for AFR detection and culture examination for detection of mycobacteria were performed.

Table 1. Components, nutrients and metabolisable energy in diets

	Control concentrate	Concentrate with peat
Components (%)		
Fodder wheat	43.0	48.5
Fodder barley	40.0	20.0
Extracted soy meal	11.0	13.7
Fish meal	3.0	3.0
Peat Baby Vig	0	8.0
Sunflower oil	0	4.0
Threonin 20%	0.1	0.1
Lysine 60%	0.1	0.1
Unimak P1-M[1]	2.8	2.8
Characteristics (g/kg)		
Dry matter	893.2	882.1
Nitrogenous compounds	171.2	180.2
Lipids	19.1	18.7
Fibre	31.7	34.8
Ash	53.9	42.4
Nitrogen-free extract compounds	617.3	606.0
Organic matter	839.3	839.7
ME (MJ)	13.2	13.2

[1]Unimak P1-M per kg was of the following composition: 335 000 IU vitamin A, 45 000 IU vitamin D, 125 mg vitamin K, 2 665 mg vitamin E, 5.3 mg vitamin B1, 165 mg vitamin B2, 14 mg vitamin B6, 1.10 mg vitamin B12, 165 mg niacin, 250 mg pant. calcium, 1 000 mg choline chloride, 0.8 mg biotin, 6 600 mg vitamin C, 110 g L-lysine HCl, 33 g D,L-methionine, 55 g L-threonine, 15 mg Co, 65 mg J, 11 mg Se, 660 mg Cu, 1 585 mg Mn, 3 500 mg Zn, 2 080 mg Fe, 56 g Na, 12 g Mg, 80 g P, 205 g Ca, 833 mg Endox, 11 250 mg Bio-plus 2B, 2 900 mg Natuphos 5000G, 665 mg Saccharin

Statistical assessment

The results obtained were processed and verified by statistical methods using statistical and graphic software STAT Plus (Matouskova et al., 1992). Basic statistical data such as arithmetic average and standard deviation were calculated. Significance of differences between the detected averages were evaluated ($P < 0.05$, $P < 0.01$).

RESULTS

Laboratory examination of the diets

The results of analyses of the diets confirmed that they were isoenergetic (Table 1). The level of nitrogen compounds was slightly higher in the experimental diet. Examination of 10 samples of the control diet did not reveal any AFR and the culture for mycobacteria was likewise negative. In 1 of 10 combined samples for experimental diet, mycobacteria were detected by microscopy, but not by culture.

Diet intake by the animals

The experimental peat containing diet intake by pigs was very good. During the first 20 days of feeding, the experimental diet consumption was comparable to that of the control diet without peat supplementation. From day 21 to 30, a statistically highly significant ($P < 0.01$) increase in the consumption of the experimental diet was recorded. Despite that the experimental pigs were fed an identical diet as control group pigs from day 31 on, their consumption of the diet from day 31 to 60 was consistently significantly increased ($P < 0.01$). In the last stage of the experiment (from day 61 to day 90), consumption of both the diets was comparable again (Table 2).

Body weight gains of pigs

The average body weight of the pigs at the beginning of the experiment was 24.6 ± 1.8 kg and the between-group differences were non-significant. No statistically significant differences in the average body weight of pigs were recorded between groups in respective intervals (day 10, 20, 30, 60 and 90). Between days 11 and 30 of the experiment, increased body weight gain was observed in the experimental group of pigs; however, weight gain was not statistically significant. When peat was withdrawn from the diet (from day 31 to day 90 of experiment) a non-significant growth depression occurred in the experimental group due to a change in the diet (Table 2).

Table 2. Feed consumption, body weight gains and relative growth performance of pigs

Days		Feed consumption (kg/day)		Body weight gains (kg)						Relative growth performance (%)					
				CG[1]			EG[2]			CG[1]			EG[2]		
		CG[1]	EG[2]	♂	♀	total	♂	♀	total	♂	♀	total	♂	♀	total
0–10	$\bar{x}$	1.30	1.30	0.74	0.77	0.75	0.72	0.60	0.66	29.3	31.5**	30.4	29.4	24.8**	27.1
	SD	0.17	0.17	0.19	0.10	0.14	0.08	0.07	0.10	5.41	4.11	4.68	3.46	1.76	3.56
11–20	$\bar{x}$	1.67	1.69	0.49	0.57	0.53	0.62	0.58	0.60	48.7	55.1	51.9	55.8	49.0	52.0
	SD	0.10	0.14	0.17	0.04	0.13	0.13	0.22	0.17	9.48	5.42	8.00	3.48	9.26	7.75
21–30	$\bar{x}$	1.91**	2.12**	0.76	0.82	0.79	0.87	0.84	0.85	79.0*	88.8	83.9	96.8*	83.6	89.5
	SD	0.10	0.11	0.11	0.08	0.10	0.10	0.32	0.24	7.38	8.09	8.95	12.9	8.22	12.0
0–30	$\bar{x}$	1.63	1.70	0.65	0.71	0.68	0.74	0.67	0.70	52.3	58.5	55.4	58.3	52.5	55.2
	SD	0.28	0.36	0.19	0.14	0.17	0.14	0.24	0.20	22.3	25.0	23.5	29.9	25.9	27.4
31–60	$\bar{x}$	2.33**	2.51**	1.01	0.90	0.95	0.92	0.92	0.92	199.2	198.7	199.0	207.1	196.6	201.3
	SD	0.16	0.13	0.10	0.14	0.13	0.13	0.11	0.11	11.2	25.1	18.3	8.79	9.80	10.4
61–90	$\bar{x}$	2.82	2.88	0.88	0.84	0.86	0.77	0.78	0.78	305.2	299.4	302.3	299.1	294.2	296.4
	SD	0.19	0.15	0.04	0.18	0.13	0.15	0.04	0.10	11.7	23.1	17.5	28.8	10.0	19.2

[1]control group fed a diet without the peat supplement

[2]experimental group fed peat as a supplement between day 0 and 30

*differences between values in the rows are statistically significant ($P < 0.05$)

**differences between values in the rows are statistically significant ($P < 0.01$)

Relative growth performance of pigs

Statistically significant differences in the relative growth performance of gilts and barrows were observed between control and experimental groups. Relative growth performance of experimental gilts was significantly lower during the first 10 days of peat feeding ($P < 0.01$) in comparison with the control group of gilts. During days 11 and 20 of feeding, relative growth performance in both the groups was comparable. From day 21 to 30, a slightly higher relative growth performance in the experimental group was recorded; it was statistically significant ($P < 0.05$) in barrows from this group. After peat withdrawal from the diet, differences in the growth rates were not statistically significant (Table 2).

Conversion of feed, N-compounds and metabolised energy

The conversion of the peat containing diet and control diet without peat was comparable (2.43 kg) during the entire period of feeding, i.e. 30 days. A transient non-significant increase in the conversion of the peat containing diet between day 11 and 20 of feeding resulted from a higher body weight gain in the experimental group. From day 21 to 30, feed conversion of the experimental diet was comparable to the control group diet due to statistically highly increased ($P < 0.01$) experimental diet consumption. A lower feed conversion, up to the end of the investigated period, was observed when peat was withdrawn from the experimental diet on day 31 of the experiment and replaced by the control diet. A significantly higher ($P < 0.01$) conversion of nitrogen compounds, detected in the experimental group at the beginning of peat feeding (days 0 to 10), was revealed when conversion of nitrogen compounds and energy were evaluated (Table 3).

Health status of pigs

The health status of animals was monitored by observation; no serious health problems were detected. No mortality of the control group was recorded. On day 20 of the experiment, one pig from the experimental group was died during an acute

Table 3. Feed and nutrient conversion

Days		Feed conversion (kg/kg)		Nutrient conversion			
				CG[1]		EG[2]	
		CG[1]	EG[2]	N-compounds (kg/kg)	MEp (MJ/kg)	N-compounds (kg/kg)	MEp (MJ/kg)
0–10	$\bar{x}$	1.73	1.97	0.31*	23.9	0.36*	25.9
	SD			0.05	4.08	0.05	4.18
11–20	$\bar{x}$	3.15	2.82	0.59	45.7	0.56	41.0
	SD			0.20	15.1	0.21	15.3
21–30	$\bar{x}$	2.42	2.49	0.42	32.4	0.48	35.0
	SD			0.06	4.46	0.14	10.4
0–30	$\bar{x}$	2.43	2.43	0.44	34.0	0.46	33.7
	SD			0.17	12.8	0.16	12.2
31–60	$\bar{x}$	2.45	2.73	0.42*	32.8	0.50*	36.3
	SD			0.06	4.61	0.06	4.03
61–90	$\bar{x}$	3.28	3.69	0.57*	44.2	0.68*	49.6
	SD			0.10	7.33	0.09	6.70

[1]control group fed a diet without the peat supplement

[2]experimental group fed peat as a supplement between day 0 and 30

*differences between values in the rows are statistically significant ($P < 0.05$)

epileptoid attack. No clinical signs of disease during the entire experiment were observed. That gave evidence of a good health state of the animals.

Biochemical analysis of pig blood serum

Biochemical analyses of the blood serum showed that a short-time supplementation of the diet with peat (a dose of 80 g/kg) did not adversely affect the metabolic profile or health status of experimental animals. At the end of the experiment, significantly higher values of the total protein ($P < 0.05$) and triacylglycerols ($P < 0.01$) were detected in the blood serum from experimental group pigs (Table 4).

Veterinary-meat inspection after slaughter

No tuberculous or tuberculoid lesions in lymph nodes or parenchymatous organs were detected in any of the 20 slaughtered animals. Microscopic

Table 4. Pig blood plasma content of selected biochemical characteristics

Characteristics		Control group[1]			Experimental group[2]		
		Day 0	Day 30	Day 90	Day 0	Day 30	Day 90
Total protein (g/l)	$\bar{x}$	53.5	61.8	54.0*	51.9	60.8	57.8*
	SD	4.63	4.13	3.20	3.26	4.22	3.63
Albumin (g/l)	$\bar{x}$	23.2	17.0	30.8	22.8	16.9	32.7
	SD	2.86	2.78	3.33	2.04	1.30	1.66
Glucose (g/l)	$\bar{x}$	5.80	4.77	4.10	5.91	4.67	3.99
	SD	0.85	0.49	0.39	0.96	0.48	0.33
Triacylglycerols (mmol/l)	$\bar{x}$	0.30	nt	0.22**	0.32	nt	0.29**
	SD	0.08	nt	0.04	0.14	nt	0.05
Cholesterol (mmol/l)	$\bar{x}$	2.14	1.68	1.78	2.32	1.59	1.75
	SD	0.29	0.12	0.27	0.59	0.18	0.29
HDL (mmol/l)	$\bar{x}$	0.62	nt	0.56	0.61	nt	0.60
	SD	0.13	nt	0.08	0.12	nt	0.08
LDL (mmol/l)	$\bar{x}$	1.12	nt	0.97	1.07	nt	1.00
	SD	0.19	nt	0.14	0.24	nt	0.14
Ca (mmol/l)	$\bar{x}$	2.32*	3.03	3.03	2.67*	2.83	2.98
	SD	0.33	0.35	0.24	0.25	0.44	0.27
P (mmol/l)	$\bar{x}$	2.56	3.15	2.42	2.42	3.09	2.35
	SD	0.24	0.26	0.12	0.33	0.29	0.17
ALT (µkat/l)	$\bar{x}$	0.35	0.42	0.45	0.31	0.30	0.44
	SD	0.07	0.11	0.05	0.06	0.04	0.09
AST (µkat/l)	$\bar{x}$	0.37	0.32	0.18	0.31	0.22	0.20
	SD	0.09	0.13	0.12	0.05	0.06	0.15
ALP (µkat/l)	$\bar{x}$	1.75	5.75	1.83	1.81	5.93	1.77
	SD	0.38	1.06	0.41	0.23	0.57	0.21

[1]control group fed a diet without the peat supplement

[2]experimental group fed peat as a supplement between day 0 and 30

*differences between values in the rows are statistically significant ($P < 0.05$)

**differences between values in the rows are statistically significant ($P < 0.01$)

nt = not tested

Table 5. Mycobacteria detection in pig lymph nodes

Examined animals					Examined tissues			Mycobacterial isolates			
Group		No.	positive	%	No.	positive	%	*M. a. h.*	*M. fortuitum*	*M. xenopi*	M. sp.
CG[1]	♂	5	0	0	20	0	0	0	0	0	0
	♀	5	0	0	20	0	0	0	0	0	0
Subtotal		10	0	0	40	0	0	0	0	0	0
EG[2]	♂	5	1	20.0	20	2	10.0	0	1	1	0
	♀	5	4	80.0	20	8[3]	40.3	1	1	4	2
Subtotal		10	5	50.0	40	10[3]	25.0	1	2	5	2
Total		20	5	25.0	80	10[3]	12.5	1	2	5	2

[1]control group fed a diet without the peat supplement

[2]experimental group fed peat as a supplement between day 0 and 30

[3]AFR were detected in one animal after the ZN staining from two of three lymph nodes from which atypical mycobacteria were cultured later

M. a. h. = *Mycobacterium avium* subsp. *hominissuis* (IS*901*– and IS*1245*+)

M. sp. = atypical (conditionally pathogenic) mycobacteria that were not members of *Mycobacterium avium* complex

examination revealed AFR by ZN staining in only two samples of mesenteric lymph nodes from one experimental gilt. Mycobacteria were isolated from ten (25.0%) tissues of five (50.0%) pigs from the experimental group (Table 5). In contrast, mycobacteria were not isolated from any of the animals from the control group. One isolate was identified as *M. a. hominissuis (*IS*901*– and IS*1245+)*. Seven of nine isolates were determined as conditionally pathogenic atypical mycobacteria: *M. fortuitum* (n = 2) and *M. xenopi* (n = 5).

DISCUSSION

It follows from the above results (Table 1) that the diets used in the present study were in accordance with the requirements for feed intended for the fattening of meat type pigs with 56% proportion of lean musculature (Simecek et al., 1993). Good acceptability of the peat containing diet (Table 2) is consistent with the conclusions of several authors (Enueme et al., 1987; Fuchs et al., 1995; Kocabagli et al., 2002; Yoruk et al., 2004). A short-time (30 days) supplementation of the diet with peat (dose of 80 g/kg) did not show a statistically significant effect on the growth of pigs (Table 2). Body weight gains of experimental group pigs in the second and third decade of peat feeding (days 11 to 30) were not significantly higher in comparison to the control group. This may be due to the fact that pigs with a body weight of 25 kg were fed peat for a short-time (one month) only. Fuchs et al. (1995) documented a stimulating effect of a peat preparation given to piglets from the age of 6 days for 100 days.

During the first 28 days of peat feeding, they did not observe any statistically significant differences in the live body weight of piglets. High growth stimulation of pigs was seen in the period between day 29 and 59, presented by an increased body weight gain. Despite the fact that no significant differences in daily weight gain from day 60 was recorded, the body weight of pigs fed with peat as a supplement was higher at the end of the experiment due to a more intensive growth. Stepchenko et al. (1991) and Bailey et al. (1996), likewise, observed a significantly higher body weight at the end of the fattening period when a broiler diet was supplemented with humic substances. During the feeding of broilers with a diet supplemented with humic substances in various stages of fattening, Kocabagli et al. (2002) recorded an increase in body weight gain in the second part of fattening, between 22 and 42 days of age. During supplementation, for the entire period of fattening or in the first half of fattening only, they also recorded growth stimulation, however this was less significant. Similar studies on various peat application techniques in pig diets are still missing in the literature. Results of this study show a slightly positive effect of peat on the growth ceased when it was withdrawn from the diet on day 31 of the experiment (Table 2).

The feed conversion of the peat supplemented diet during the entire period of peat feeding (30 days) was comparable to the control diet conversion (Table 3). The conversion of respective nutrients (N-compounds and metabolised energy) was likewise comparable (Table 3). In contrast, an increase in feed conversion is usually observed after supplementation with a humic preparation (Fuchs et al., 1995; Bailey et al., 1996; Kocabagli et al., 2002). Published data demonstrated that the increased conversion of humic substance containing diets is usually based on increased body weight gains of animals fed these diets (Fuchs et al., 1995; Kocabagli et al., 2002) and only occasionally on a different consumption of such diets (Bailey et al., 1996). A higher percentage of fibre in the natural, non-processed peat containing experimental diet might have exerted an adverse effect on the pigs to a certain degree (Table 1).

Biochemical values within reference ranges were detected in both control and experimental groups (Table 4; Tluchor, 2001). Stepchenko et al. (1991) observed positive changes in the values of total protein, mineral substances and total lipids in blood sera, liver, breast and leg muscles of chicken broilers after long-term feeding of a peat preparation.

Results demonstrate that a short-time supplementation of a diet with 8% peat for pre-fattened pigs did not significantly stimulate the growth and performance of market pigs (Table 2 and 3). Based on the fact that only a moderate positive effect of peat fed as a supplement on the monitored parameters was recorded and ceased the moment peat was withdrawn from the diet, it may be assumed that a higher effect could be reached if peat supplementation in the diet was maintained for longer. Despite that the culture examination of 10 samples of a peat supplemented diet for mycobacteria were negative, occasional presence of mycobacteria both in peat fed as a supplement and pure diet, bedding (straw was used as bedding in pens) or drinking water cannot be excluded. In the Czech Republic, mycobacteria have been isolated from all of these materials that constitute the life environment of pigs during fattening (Matlova et al., 2003). From the aspect of animal hygiene, the fact that mycobacteria have been isolated from lymph nodes without pathologic lesions in all the cases may be consequential (Table 5).

Based on this knowledge, further studies should be conducted to elucidate the effect of long-term feeding of peat as a supplement or feeding peat as a supplement to piglets in early stages of rearing. Young animals are sensitive to potential dietary changes and the period after weaning is critical due to the frequent occurrence of gastrointestinal infections (Hedemann and Jensen, 2004). As mycobacterial contamination of peat is quite common (Matlova et al., 2003, 2005), its use as a feed supplement for piglets, without previous efficient disinfection targeted at devitalisation of mycobacteria, is highly risky due to the occurrence of tuberculous lesions in the lymph nodes (Pavlik et al., 2003). Its use may only be recommended in specified cases of recurrent health disorders in piglets, particularly those affected by diarrhoea (Trckova et al., 2005).

CONCLUSIONS

The study concludes that the short-term feeding of peat did not result in a significant positive effect on the performance of pigs. Feed conversion was not changed by a diet supplementation with 8% peat. A highly significant increase ($P < 0.01$) in the consumption of the experimental diet from day 21 of feeding did not positively affect the growth performance of experimental animals. Therefore, short-term feeding of a peat supplemented diet to pigs may be considered as economically non-effective. Due to the fact that mycobacteria were detected in the lymph nodes from peat fed pigs, the present authors view feeding peat to animals without previous efficient disinfection as risky.

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