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ABSTRACT

The aim of the work was to determine digestibility, nitrogen balance and ammonia emission from excreta, in the typical Italian heavy pig during the last phase of growth, when fed diets with a high fibre content. In comparison with a traditional control diet (C), two diets with 12 and 24% wheat bran (WB12 and WB24) and two other diets with 12 and 24% dried beet pulp (BP12 and BP24) were tested.
Totally 76 Landrace x Large White fattening barrows, from 45 to 170 kg live weight distributed in 16 pens, were utilized in the trial.
Thirty pigs were allocated to 6 metabolic cages in 5 consecutive periods in order to have 6 observations per treatment. For diets C, WB12 and WB24 daily weight gain (DWG), feed conversion ratio (FCR) and slaughtering performances were also registered, on 20 pigs per dietary treatment.
Growing and slaughter performances were similar for pigs fed C and WB12 diets, whilst diet WB24 determined a significant ($P<0.05$) decrease in performances (growth and feed conversion) in the first period of fattening and a lower dressing percentage at slaughter (85.5, 84.4 and 82.5% for C, WB12 and WB24, respectively). Comparing the diets with the same level of inclusion of the fibrous feeds, WB diets had a lower OM and energy digestibility, while BP diets registered a lower protein but a higher fibre digestibility. Consistently with other experiments, BP diets determined an increase of faecal and a reduction of urinary N, as a percentage of the intake N, as well as a decrease of ammonia emission from the slurries (-16.6 and -25.3% for BP12 and BP24, in comparison with C diet).
For the WB diets the reduction of urinary N and the increase in faecal N were less marked and a reduction of ammonia emissions was not registered.

Key words: Pig, Fibrous diets, Ammonia emission, Growing performance, Slaughter performance.

RIASSUNTO

PRESTAZIONI ZOOTECNICHE, RESE ALLA MACELLAZIONE, BILANCIO AZOTATO ED EMISSIONI AMMONIACALI DAI REFLUI, IN SUINI ALIMENTATI CON DIETE AD ALTO TENORE IN FIBRA

Scopo del lavoro è stato quello di misurare la digeribilità, l'utilizzazione azotata e le emissioni ammoniacali delle deiezioni, nel suino pesante tipico italiano nella fase finale del ciclo di ingrasso, per una dieta tradizionale di controllo (C), due diete contenenti alti livelli di crusca di frumento, 12 e 24% (WB12 e WB24), e due contenenti polpe di bietola disidratate, 12 e 24% (BP12 e BP24).
Complessivamente sono stati utilizzati 76 suini maschi castrati Landrace x Large White, da 45 a 170 kg

di peso, ospitati in 16 box. Durante l'ultima fase del ciclo di ingrasso 30 di essi sono stati posti in 6 gabbie metaboliche in 5 successivi periodi di 14 giorni ciascuno allo scopo di avere 6 osservazioni per trattamento. Per le diete C, WB12 e WB24 sono stati misurati anche gli incrementi ponderali giornalieri (IPG), gli indici di conversione alimentare (ICA) e le rese di macellazione, misurando tali parametri su 20 suini per trattamento. Le prestazioni zootecniche non sono risultate sostanzialmente diverse per i suini che ingerivano le diete C e WB12. Relativamente alla dieta WB24 si registrano, invece, peggioramenti sia per l'IPG sia per l'ICA con differenze statisticamente significative (P<0,05) al primo controllo di peso. In modo analogo, per la resa alla macellazione si registra un peggioramento statisticamente significativo (P<0,05) per WB24 (85,5, 84,4 e 82,5% per C, WB12 e WB24, rispettivamente).

Mettendo a confronto le diete ad uguale livello di inclusione degli alimenti fibrosi, la digeribilità della sostanza organica e dell'energia è risultata peggiore per le diete WB, quella della proteina è risultata peggiore per le diete BP che però evidenziano la miglior digeribilità delle frazioni fibrose. Con tali diete, rispetto alla dieta C, si evidenzia anche una minor escrezione di N urinario, ma maggiore di quello fecale, e una ridotta emissione di NH_3 dalle deiezioni (per BP12 e BP24 rispetto a C la riduzione è stata pari al 16,6 e al 25,3%). Per le diete WB la riduzione di N urinario e l'aumento di quello fecale sono risultati meno marcati e non si registra una ridotta emissione ammoniacale.

Parole chiave: *Suini, Fibra dietetica, Emissioni ammoniacali, Prestazioni zootecniche, Rese alla macellazione.*

Introduction

The increasing intensification of pig production units determines a harmful concentration of slurries, and there is consequently great interest in the research of methodologies capable of reducing the resulting environmental pollution. This is consistent with the European Legislation no.96/61 (IPPC, Integrated Pollution Prevention and Control) acknowledged by Italy with the Legislative Decree no.372 of August 4th, 1999. The latter has the goal of preventing the pollution derived from various human activities including animal production, and regulating its reduction. This is particularly important in the intensive pig farms with more than 2000 fattening places (pigs weighing over 30 kg) or more than 750 sow places. This decree was later replaced by Legislative Decree n. 59 of February 18th 2005, which applies the procedure also to the new pig units.

Ammonia emissions from the slurry of intensive pig farms have an important impact on the environment negatively influencing human and animal health by damaging the respiratory apparatus, originating bad smells, and are also co-responsible for the formation of acid rain (Portejoie *et al.*, 2002).

What the acceptable limits for such emissions are, has not yet been defined; however the European Legislation no.96/61 introduces the Best Available Techniques concept, stating that the limits must be those obtainable from the use of such techniques, including those applied in the productive process to prevent environmental pollution. Among these techniques, feeding and nutrition play a major role influencing product quality, production cost, and the characteristics of animal slurries and their consequent polluting potential.

In the last few years some research has been done, particularly in northern Europe (Peet-Schwering *et al.*, 1999), to investigate the relationships between feeding and nitrogen excretion (Fernandez *et al.*, 1999) with particular reference to ammonia emissions (Canh *et al.*, 1997; Canh *et al.*, 1998a, 1998b; Kreuzer *et al.*, 1998; Ly *et al.*, 2003). In such works the influence of some dietetic factors, particularly the Non-Starch Polysaccharides (NSP), on pH and ammonia emissions from pig slurries, was highlighted.

To our knowledge, analogous experimental studies have not been conducted yet in Italy, testing diets suitable for the production of the typical heavy Italian pig, thus with ambient and physiological conditions different from those of northern Europe.

Material and methods

Altogether 76 barrows Landrace x Large White, chosen for size homogeneity and weighing initially about 45 kg, were used.

Five diets were tested: a control (C) traditional diet based on cereal and four high fibre diets: two with 12 or 24% milled wheat bran (WB12 and WB24), and two with 12 or 24% dried sugar beet pulp (BP12 and BP24). The overall composition and analysis of the five diets, fed as dry mash, are shown in Table 1. Including 12 or 24% of wheat bran or beet pulp in substitution of barley increased the NSP content and decreased the starch content of the diet. With WB the effect was less remarkable than with BP. The protein content of the diets including WB was higher than that of the BP diets, due to the different composition of the two raw materials. Obviously, both WB and BP diets registered a higher content of crude fibre and fibrous fractions than C.

Taking into account that in a previous trial we had already tested the growth and slaughter performances of pigs of the same weight fed diets with high levels of dried beet pulp (Galassi *et al.*, 2005), the present research was split into two experimental trials: in the first trial the growth and slaughter performances of pigs fed the diets C, WB12 and WB24 were evaluated, while in the second trial digestibility, N balance and ammonia emissions from slurries were studied for all 5 diets.

Therefore, 60 pigs were utilized to evaluate the growing performance associated with diets C, WB12 and WB24 (20 pigs/diet); these pigs were randomly allotted to 12 pens: 4 pens/treatment, with 5 animals/pen. For diets BP12 and BP24 4 other pens were utilized, two for each treatment, with 4 pigs per pen. Therefore, 8 animals were fed diet BP12 and other 8 animals were fed diet BP24 in order to select 6 pigs for diet BP12 and 6 pigs for diet BP24 to be allocated to individual metabolic cages for the determination of digestibility, N balance and ammonia emissions related to these diets. Eventually, in the last 70 days of the fattening period, 30 pigs (6 per each of the 5 diets) were moved from the pens to individual metabolic cages in 5 consecutive periods during the experiment, to determine digestibility, N balance and ammonia emission related to each diet. Each period lasted 14 days: 7 days of cage adaptation and 7 days of separate collection of excreta. During each period 3 dietary treatments were tested on the 6 pigs (2 pigs/treatment) and the diets selected changed from period to period in order to have 6 animals tested per dietary treatment throughout the trial.

Feeding was always restricted, as usually done in practice for the production of the Italian heavy pig: on average, for the whole experimental period, the individual daily intake was 2.5 kg of feed (equal to 2.25 kg of DM).

Growing performance of the 60 pigs fed diets C, WB12 and WB24 were evaluated on the basis of the average individual daily weight gain (DWG) and the average feed conversion ratio (FCR=DM intake/WG) of each pen. DWG was measured by means of 5 individual weighings done at the beginning, after 36, 77, 118 days, and at the end of the fattening cycle (4 phases in total). For each phase average daily feed intake of each pen was also calculated, to compute the FCR.

At an average live weight of 170 kg and after a fasting period of 12 hours, the pigs were carried to the slaughter house were measurements on different parts of the car-

Table 1. Composition and analysis of the experimental diets.

		C	WB12	WB24	BP12	BP24
Maize	%	51.5	51.5	51.5	51.5	51.5
Barley	"	36	24	12	24	12
Wheat bran, coarse	"	0	12	24	0	0
Beet pulp, dried	"	0	0	0	12	24
Soybean meal	"	8	8	8	8	8
Sugar cane molasses	"	2	2	2	2	2
$CaCO_3$	"	1.1	1.4	1.4	1.0	0.9
$Ca(H_2PO_4)_2$ hydr.	"	0.8	0.5	0.5	0.9	1.0
NaCl	"	0.25	0.25	0.25	0.25	0.25
L-Lys HCl	"	0.20	0.20	0.20	0.20	0.20
Vit./min. suppl.	"	0.15	0.15	0.15	0.15	0.15
DM	% as fed	91.0	91.0	91.0	90.5	91.1
Ash	% DM	4.6	5.5	5.4	4.9	5.3
CP	"	13.5	14.0	14.6	12.7	12.8
EE	"	3.5	3.6	3.6	3.9	6.2
NSP [1]	"	20.5	22.3	24.9	25.1	27.4
Crude fibre	"	3.2	4.1	5.4	5.3	6.7
NDF	"	11.8	14.4	17.2	13.3	16.1
ADF	"	4.8	5.0	6.4	6.8	8.5
ADL	"	0.8	1.1	1.6	1.0	1.5
Starch	"	54.4	50.9	47.4	49.0	43.0
Sugars	"	3.5	3.7	4.0	4.4	5.3
Gross energy	MJ/kg DM	18.27	18.29	18.24	18.18	18.16

[1] *NSP = OM – (CP+EE+Starch+Sugars).*

cass were made. Whole carcass, hams, loins, cured neck, liver, gastro-intestinal tract were weighed, and thickness of backfat and *Longissimus dorsi* (LD) muscle were registered, at 8 cm from the midline of the carcass, between the third last and the fourth last ribs, utilizing a Fat-O-Meater (FOM) provided with a drill of 6 mm diameter.

The average bodyweight of the 30 pigs confined to metabolic cages was 150.9±17.4 at the beginning and 156.9±17.1 kg at the end of the week of "collection" during digestibility. This is the typical average weight of the tradition Italian heavy pig in the finisher phase of fattening.

Digestibility trials were conducted according to the indications provided by the Italian Scientific Association for Animal Production (ASPA, 1982). DM fed was, on average, 6.2% of the metabolic weight ($MW=LW^{0.75}$) of the animals, with feed intakes similar to those of the animals in the piggery. Drinking water was always available. For practical reasons, all the animals were fed at 8.00 a.m. and 5.00 p.m. each day.

Before feeding, the feed rests of each animal were removed from the trough and weighed. Samples of the diet and of the feed rests were taken daily throughout the collection period to determine the dry matter content after drying for 72 hours in a forced ventilation oven at 60°C. During each collection period a sample of each diet and the feed rests from each animal were taken daily and pooled for chemical analysis. During the collection periods faeces and urine from each animal were separately daily weighed, sampled on weight basis (20% for faeces, 10% for the urine) pooled for each animal, and used for analysis. 150 ml of a 20% v/v H_2SO_4 solution were placed daily in each animal's urine collection vessel to keep the pH below 2.5 and avoid ammonia loss. Individual urine samples were also taken daily on the last three days of the adaptation phases (without H_2SO_4) for the determination of the ammonia emission. All the samples collected were frozen (-20°C) for the subsequent chemical analyses.

The analyses of feeds, faeces and urine were performed in accordance with the recommendations of the Italian Scientific Association for Animal Production (ASPA, 1980) for dry matter, ash, N and ether extract. The NDF, ADF and ADL were determined according to the procedure of Van Soest *et al.* (1991), using the ANKOM Fiber Analyser, ANKOM Technology Corporation, Fairport, NY. Starch content was determined by Megazyme total starch assay procedure according to the AOAC method 996.11 (1998). Sugar content was determined by phenol-sulfuric acid method (Dubois *et al.*, 1956).

The determination of the N faecal excretion was made on fresh samples avoiding ammonia nitrogen losses. The gross energy of diets and faeces was determined with an adiabatic calorimeter (IKA 4000, Staufen, Germany).

Ammonia emission from slurries was measured as indicated by Derikx and Aarnink (1993). Following this method 2 kg of fresh slurry were placed in a 10L vessel, 390 mm high, with 210 mm of diameter, covered by a circle lid of 120 mm of diameter and connected to a tube system. Faeces and urine were separately collected from animals kept in metabolic cages, after 1 week of dietary treatment. From the faeces and the urine the sample of 2 kg slurry was prepared, maintaining the respective proportions of the excreta, for the study of the ammonia emission.

Air entered the vessel by small holes at the edge of the lid and left the vessel in the centre. Ammonia was removed from this air by passing through 2 impingers, each containing 140 ml HNO_3 (0.5M). The second impinger served as a control and should not contain more than 5% of the amount of ammonia trapped in the first impinger. The air left the system after passing a water trap, a flow controller (Key Instruments MR 3000) at the rate of 4.2 L/min, and a vacuum pump (KNF Italia s.r.l, mod. N 035_18). The first impinger was replaced daily; the concentration of ammonia of the liquid was determined by an automatic analyzer (2300 Kjeltec® Foss Tecator) according to ASPA method for Ammonia Nitrogen using MgO. Ammonia emission and pH determination were calculated for 14 consecutive days, with daily recording.

Data from growing and slaughter performances were statistically analysed by GLM procedure of SAS statistical package (2001). For some dependent variables (liveweight at the end of the different phases, DWG, carcass weight) the statistical analysis was done including the covariance for the initial bodyweight. The model applied was the following:

$y_{ij} = \mu + t_i + \beta (x_{ij} - x) + e_{ij}$
where:
y_{ij} = dependent variable;
μ = general mean;
t_i = effect of the i-diet;
$\beta (x_{ij} - x)$ = effect of the covariate initial BW;
e_{ij} = residual error.

The effect of the "pen" variable within treatment was excluded from the model since not significant.

Data on digestibility, N balance and ammonia emissions were analysed with the following model:

$y_{ij} = \mu + t_i + e_{ij}$

The effect of the "period" variable within treatment was excluded from the model since not significant.

Results and discussion

The productive performances of the 60 pigs fed diets C, WB12 and WB24 are reported in Table 2. Animals fed diet WB24 showed the lowest performance in terms of DWG and FCR, although the difference with control is significant ($P<0.05$) only in the first period, i.e. when the animals weighed less than 70 kg. The gap with control animals gradually disappears as the animal's bodyweight increases.

On the other hand, no evident differences could be registered between diets C and WB12. This is consistent with the results obtained by Le Goff and Noblet (2001) and by Le Goff *et al.* (2003) in experiments where, in comparison with younger and lighter pigs, heavy and more mature fattening pigs and, even more, adult sows had a better digestive utilization of nutrients, particularly when the diets fed contained high levels of dietetic fibre. These findings are also consistent with a previous experiment we made feeding pigs (slightly heavier than those of the present trial) with diets which included 15 or 30% dried beet pulp (Galassi *et al.*, 2005).

It is evident that by reducing the starch and increasing the fibre (and consequently the NSP) content of the diet it is hard to maintain exactly the same productive performance of pigs. However, it should be considered that the Italian heavy pig for the production of traditional ham must reach 160 kg bodyweight in at least 9 months from birth, and therefore it should not grow faster than 590 g/day, on average. As a consequence, for such a typical production with these constraints, the inclusion in the diet of fibrous feeds can be interesting, particularly in the final phase of fattening, when the animal has a higher ability to digest the fibrous fractions.

Table 3 reports the data of the monitoring at slaughter.

In comparison with control, diet WB12, despite a slightly lower numerical dressing percentage (85.5 *vs* 84.4%, NS), had practically equivalent slaughter performances. On the contrary, pigs fed diet WB24 had a significantly lower dressing percentage (82.5%) and cure necks weight as compared to the other two dietary treatments. Hams and loins weight were also numerically lower for treatment WB24 in comparison with the other two diets; the higher ham percentage of treatment WB24 has to be attributed to the lower ($P<0.05$) weight of the carcasses of these animals in comparison with those fed diets C and WB12. The gastro-intestinal tract of the WB24 fed-pigs was similar, as absolute weight values, to the others, but when expressed as a percentage of the carcass, it results significantly higher (7.56 and 7.86 vs 8.66% for C, WB12 and WB24, respectively; $P<0.05$). These data are consistent with those reported in a work of Anugwa *et al.* (1989) conducted with lighter pigs and utilising

Table 2. Daily weight gain (DWG) and feed conversion ratio (FCR = kg DMI/kg WG) of the pigs fed the diets with 12 (WB12) or 24 (WB24) % wheat bran, in comparison with control (C).

		C	WB12	WB24	SEM
Liveweight at start	kg	45.4	43.8	43.3	0.64
Liveweight after 36 days[1]	"	72.4[a]	70.5[ab]	68.5[b]	1.20
Liveweight after 77 days [1]	"	101.3	97.7	94.8	2.37
Liveweight after 118 days [1]	"	129.1	127.1	122.3	3.55
Liveweight at the end [1]	"	179.3	179.4	169.9	4.82
DWG 1st period [1]	"	0.79[a]	0.73[ab]	0.68[b]	0.03
DWG 2nd period [1]	"	0.71	0.66	0.64	0.04
DWG 3rd period [1]	"	0.68	0.72	0.67	0.04
DWG 4th period [1]	"	0.72	0.75	0.68	0.04
DWG cumulative [1]	"	0.72	0.72	0.67	0.03
FCR 1st period		2.59[b]	2.65[b]	2.89[a]	0.04
FCR 2nd period		3.22	3.36	3.51	0.11
FCR 3rd period		3.44	3.30	3.49	0.13
FCR 4th period		3.70	3.75	3.82	0.14
FCR cumulative		3.36	3.35	3.47	0.07

[1] Analysis of variance using liveweight at start as covariate.
a, b: different letters on the same row = P<0.05.

lucerne meal as main fibrous feed. The results obtained in the present experiment suggest that the inclusion of 24% wheat bran in the diet (with a consequent 17.2% NDF on DM of the diet itself) is globally detrimental for the slaughter performances, whilst 12% of wheat bran does not decrease the slaughter parameters.

Table 4 shows the digestibility coefficients of the main nutrients for all the five diets tested. DM and OM were significantly less digested when wheat bran or beet pulp replaced barley in the diet; particularly, WB12 and WB24 resulted as having a lower digestibility of DM and OM in comparison with BP12 and BP24, respectively (P<0.05) and consistently with the results of a work by Högberg and Lindberg (2004). Protein digestibility was similarly reduced in comparison with control (P<0.05) by the fibrous feeds, but this time the reduction was greater for BP diets, with the lowest value for BP24.

The data referred to the digestibility of the fibrous fractions that have a different trend: the highest values are those of the BP diets, the lowest those of the WB diets, with C diet intermediate. These results are consistent with those obtained in a previous experiment at our Institute (Galassi *et al.*, 2004) and by other researchers (among others: Noblet and Bourdon, 1997; Ramonet *et al.*, 2000).

Similarly to DM and OM digestibility, energy digestibility resulted to be maximum for diet C and minimum for diet WB24. This trend is confirmed by the metabolizable energy content of the diets calculated as 16.0,

Table 3. Results at slaughter of the pigs fed the diets with 12 (WB12) or 24 (WB24) % wheat bran, in comparison with control (C).

		C	WB12	WB24	SEM
Liveweight at slaughter [1, 2]	kg	173	174	164	4.9
Carcass weight [1]	"	148[a]	147[a]	136[b]	4.4
Dressing percentage (before cooling)	%	85.5[a]	84.4[a]	82.5[b]	0.46
Backfat thickness	mm	39.7	38.9	40.4	2.70
Longissimus dorsi thickness	"	56.2	56.7	49.7	3.40
Hams weight	kg	36.6	36.5	34.1	1.14
Hams percentage	%	24.5[b]	24.8[ab]	25.4a	0.23
Trimmed hams weight	kg	29.4	29.4	27.7	0.84
Trimmed hams percentage	%	19.7[b]	20.0[b]	20.7[a]	0.22
Loins weight	kg	25.6	25.4	23.8	0.70
Loins percentage	%	17.2	17.4	17.8	0.29
Cured necks weight	kg	12.2[a]	11.7[a]	10.7[b]	0.37
Cured necks percentage	%	8.20	7.99	7.97	0.23
Liver weight	kg	1.65	1.73	1.62	0.06
Liver/carcass	%	1.11[b]	1.18[ab]	1.21[a]	0.03
Gastro-intestinal tract weight [3]	kg	11.3	11.5	11.7	0.40
Gastro-intestinal tract/carcass	%	7.56[b]	7.86[b]	8.66[a]	0.23

[1] Analysis of variance using liveweight at slaughter as covariate.
[2] Liveweight registered on the day of slaughter.
[3] Including tongue, pancreas and bladder.
a, b: different letters on the same row = P<0.05.

15.3, 14.7, 15.5 and 15.1 MJ/kg DM for C, WB12, WB24, BP12 and BP24, respectively.

Looking at the nitrogen balance (Table 5), the N faecal excretion explains the lower protein digestibility of the fibrous diets, particularly BP24. N faecal excretion is positively correlated to the level of inclusion of WB and BP in the diet, i.e. higher for 24% than for 12%. Because of a difference in the amount of N actually ingested with the experimental diets, it seems more correct to evaluate the N balance associated with the dietary treatments, in terms of percentages of the N ingested. All the 4 fibrous diets determine a significantly (P<0.05) higher N faecal excretion as compared to control (10.0%) and, among them, diet BP24 has the highest excretion (19.3%) and WB12 the lowest (12.3%). Such a higher N faecal excretion of pigs fed diets WB and BP in comparison with pigs fed diet C, is compensated for by a lower N urinary excretion. This is consistent with the findings of Bach Knudsen *et al.* (1991) which highlighted that the NSP are an excellent substrate for microbial fermentation in the large intestine, with a consequent increase in microbial faecal protein. The microbial growth requires ammonia N and therefore determines a drainage of urea from the blood to the intestinal lumen, with a consequent decrease of N excretion with the urine (Low,

Table 4. Apparent digestibility of the experimental diets (%).

	C	WB12	WB24	BP12	BP24	SEM
DM	90.1[a]	86.0[c]	83.5[d]	88.1[b]	86.0[c]	0.61
Ash	55.6[ab]	50.5	44.0[c]	53.0[b]	47.5[bc]	2.31
OM	91.8[a]	88.1[b]	85.7[c]	89.9[d]	88.1[b]	0.53
CP	90.3[a]	86.8[b]	84.1[c]	84.6[c]	80.1[d]	0.71
EE	81.1[a]	74.7[b]	69.9[c]	75.8[b]	81.3[a]	1.37
Crude fibre	45.3[b]	38.1[b]	40.6[b]	63.1[a]	66.9[a]	2.61
NDF	60.9[a]	51.3[b]	49.0[b]	64.9[a]	67.8[a]	2.45
ADF	54.2[b]	41.5[c]	43.3[c]	64.7[a]	67.5[a]	2.46
Energy	90.6[a]	86.6[c]	84.0[d]	88.4[b]	86.3[c]	0.57

a, b, c, d: different letters on the same row = P<0.05.

Table 5. Daily nitrogen balance.

		C	WB12	WB24	BP12	BP24	SEM
Intake N (IN)	g	57.9[b]	61.0[a]	62.3[a]	52.9[c]	53.7[c]	0.99
	g/kg MW	1.30[b]	1.38[a]	1.44[a]	1.27[bc]	1.23[c]	0.03
Faecal N	g	5.8[c]	7.5[b]	10.1[a]	8.6[b]	10.4[a]	0.41
	g/kg MW	0.13[c]	0.17[b]	0.23[a]	0.21[a]	0.23[a]	0.01
	% IN	10.0[d]	12.3[c]	16.3[b]	16.3[b]	19.3[a]	0.75
Urinary N	g	26.8[a]	25.2[ab]	27.5[a]	20.4[b]	22.5[ab]	1.89
	g/kg MW	0.60[ab]	0.57[ab]	0.64[a]	0.49[b]	0.51[b]	0.05
	% IN	46.2	41.3	44.2	38.7	41.9	3.26
N Excreted	g	32.6[ab]	32.8[ab]	37.7[a]	29.0[b]	32.9[ab]	1.77
	g/kg MW	0.73[b]	0.74[ab]	0.87[a]	0.70[b]	0.75[ab]	0.04
	% IN	56.2	53.6	60.6	55.0	61.3	3.11

a, b, c, d: different letters on the same row = P<0.05.

1985). The capacity of the dietetic fibre to reduce ammonia production in the caecum has been demonstrated by Malmlof e Hakansson (1984). This capacity is greater the more fermentable the fibre is, such as that of the beet pulp.

The data obtained in the present study confirm those of previous experiments (Scipioni *et al.*, 1993; Canh *et al.*, 1997; Galassi *et al.*, 2004) and indicate that the total N excretion is similar among the dietary treatments, with the exception of diet WB24 which determined a higher excretion (P<0.05) in terms of absolute values (g/d and g/kg MW); the negative effect of this diet might be due also to its having the highest protein content. No significant difference was registered among treatments in terms of percentage of the N ingested.

The daily ammonia emission from slurry is shown in Figure 1. For a 14 day period the average values of each treatment (6 pigs for each of the 5 treatments) are reported. Ammonia emission is expressed as mmoles emitted at the end of the experimental period from 2 kg slurry; one mmole of NH_3 corresponds to 0.01703 g.

It is evident that diet BP24 and, especially during the first days of monitoring, also diet BP12, determined a reduction of ammonia yield in comparison with diet C. On the contrary, diets WB12 and WB24 were not effective in reducing ammonia emission.

According to the conclusions of Canh *et al.* (1998a), in a trial with 80 kg BW pigs, daily emission of ammonia tends to reach the peak in the 4-5th day, and then decreases. Diets containing beet pulp reach their peak later, on the sixth day, confirming what observed in a previous experiment (Galassi *et al.*, 2005).

The cumulative ammonia emitted by the slurries of pigs fed diets C, WB12, WB24, BP12 and BP24 in the 14 days of the experimental period was 613, 603, 647, 511 and 458 mmoles, respectively (Figure 2), corresponding to 8.6, 8.4, 9.1, 7.2 and 6.4 g N. The highest value of ammonia emission was observed with diet WB24, whilst diets C and WB12 showed similar values. On the contrary, a numerically consistent decrease was observed for diets containing beet pulp, with the lowest value recorded for diet BP24. In comparison with control, this represents a reduction in ammonia emission of 16.6% for BP12 and 25.3% for BP24, and is consistent with a previous work by Sloth and Rom (1999) who registered a 12.4% reduction in ammonia emission with a diet containing 15% pelleted sugar beet pulp in substitution of cereal meal.

Considering that the daily productions of excreta (faeces and urine) during the digestibility period were 3818, 3473, 4282, 3162 e 3960 g/d for diets C, WB12, WB24, BP12 and BP24, respectively, and that the 2 kg of slurry used for the determination of the NH_3 emission contained 19.4, 16.6, 15.4, 19.4

Figure 1. Daily ammonia emission from 2 kg of slurry.

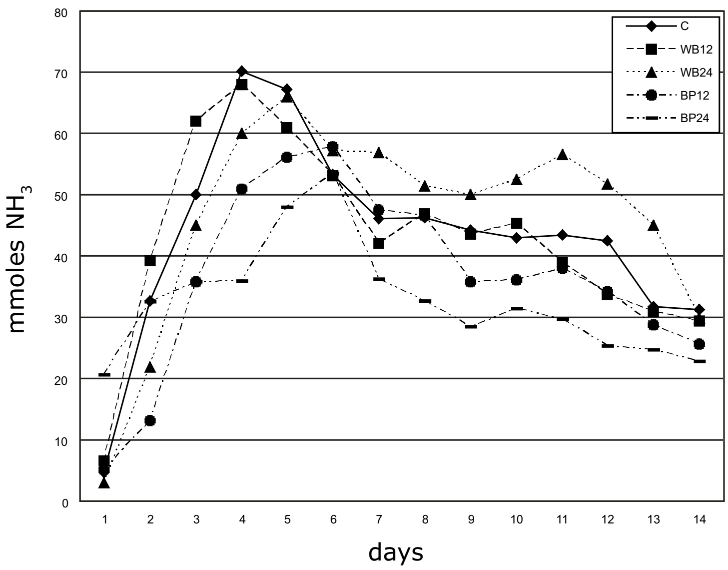
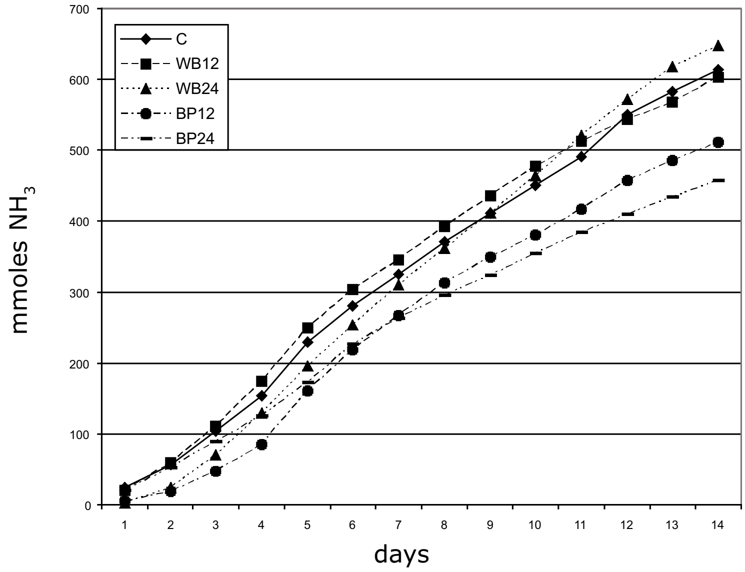


Figure 2. Cumulative ammonia emission in 14 days from 2 kg of slurry



and 18.0 g N, as a consequence N emitted as ammonia in 14 days was about 44, 51, 59, 37 and 35% of the total N daily excreted for C, WB12, WB24, BP12 and BP24, respectively.

The pH values of slurries from animals fed different diets were similar and they do not seem to be influenced by the diet; the average value of pH was 7.68 at the beginning and 8.80 at the end of the trial. At the end of the experimental period, pH tended to be lower for diets containing beet pulp in comparison with the others (8.95, 8.78, 9.00, 8.68 and 8.59 for C, WB12, WB24, BP12 and BP24, respectively). This effect is consistent with the results of previous experiments reported by Kreuzer *et al.* (1998) and Canh *et al.* (1998b); the latter, particularly, found a strict correlation between pH of the slurry and ammonia emission.

Conclusions

The inclusion of 24% of wheat bran in the diet depressed the productive and the slaughter performances significantly in comparison with control, while an inclusion level of 12% did not. The depressing effect of diet WB24 was particularly evident in the phase between 40 and 70 kg LW.

WB determined also a decrease in digestibility for all the parameters considered, whilst BP decreased DM, OM, CP and energy, but not fibre digestibility.

Total nitrogen excretion was not affected by the fibrous feeds, but a switch from urinary to faecal excretion was registered, particularly for the pigs fed the BP diet. This determined a reduction of ammonia emission from the slurry of the pigs fed diet BP as compared to control (16.6 and 25.3% for diets BP12 and BP24, respectively). On the contrary, WB was not effective in terms of reduction of the ammonia emission.

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