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ILEAL DIGESTIBILITY OF AMINO ACIDS IN PIG FEEDS AND ITS USE IN DIET FORMULATIONS

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ABSTRACT

The effects of four protein sources (soybean meal, sunflower meal, pea and fish meal as the main protein source) were investigated on fattening performance, carcass and meat quality traits and body composition of pigs. Eight animals per treatment received the diets from 30 to 105 kg live weight at a level of 3.0 times maintenance requirement of energy. Diets were formulated on the basis of ileal digestible protein and amino acid content of feedstuffs. Protein sources resulted similar fattening performance from 30-105 kg body weight. From 30 to 60 kg soybean treatment had lowest performance. The protein source treatments did not alter the body composition, lean meat percentage, liver weight and meat quality (intramuscular fat content, pH 45 min and 24 hours after slaughter, drip loss, meat lightness and hue measured 24 hours and 4 days after slaughter). It can be concluded that protein sources can be replaced without affecting overall fattening performance, carcass and meat quality and body composition if diet formulation is based on the ileal digestible amino acid contents of feedstuffs. However the lower performance of the soybean treatment in the first phase may indicate that ileal digestible Lys content of heat treated protein sources may not characterise the feedstuffs well enough. It may be that young pigs are more sensitive to unavailable lysine by the way.

Keywords: protein source, performance, meat quality, pigs

INTRODUCTION

Protein sources are one of the most expensive components of animal diets. Soybean meal is used in highest extent as major protein source in pig feeds. Many countries have to import soybean meal, which further increase the price of pig diets. For that reason researchers and farmers are interested in alternative sources of protein. Substitution based on proportion in the diet or crude protein content fail with regard to fattening performance and final quality of carcasses. In the past the diet formulation was based on the crude protein and total amino acid contents of the ingredients. The digestibility of the nutrients was not accounted for. Numerous studies have shown that the faecal digestible amino acid content can not characterise well enough the feedstuffs - especially protein sources - for the optimal growth performance when components are substituted. This was introduced as the effect of protein sources. The studies where diets were based on ileal digestible amino acids showed, that the fattening performance does not change when different protein sources are used (Tanksley and Knabe,1984). However, there is no information in the literature with regard to meat quality and body composition. Therefore, the goal of this trial was to study the effect of ileal digestible amino acid based substitution of soybean meal with fishmeal, pea and sunflower meal on fattening performance, meat quality and body composition.

MATERIAL AND METHODS

Animals, housing and allotment..32 Dutch Landrace pigs (equal number of barrows and gilts) were used in this experiment. The pigs were housed individually in a half slatted floor pen. At the initial live weight (29.2±1.62 kg) each pig was allotted to one of the four dietary treatments (eight animals per treatment).
The experimental diets consisted of the combination of basic components (tapioca, barley, wheat, soybean oil, molasses) and one of four different protein sources as the main protein source (soybean meal, sunflower meal, peas meal and fish meal). Each diet contained 14.6 MJ DE, 10.4% ileal digestible protein, 0.63 % ileal digestible Lys, 0.75% Ca, 0.28% digestible P and 0.16% Na in the first phase and 14.6 MJ DE, 9.3% ileal digestible protein, 0.53 % ileal digestible Lys, 0.60% Ca, 0.20% digestible P and 0.16% Na. The amount of the following amino acids were set

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Diets and feeding. to the same ratio relative to ileal digestible Lysine by using crystalline amino acids: M+C = at least 59%, Threonine = at least 59% , Tryptophan = at least 21%, Valine = at least 80%, Histidine = at least 40%. The fattening period was divided into two phases: 30-60 kg (phase 1) and 60-105 kg (phase 2).
The pigs were fed twice daily at 8.00 a.m. and 3.30 p.m. Feed was supplied at a level of 3.0 times the daily maintenance requirement of energy (0.42 MJ ME/ $kg^{0.75}$). The pigs were weighed weekly and based on these weights the amounts of feed for each animal was calculated for the next week.

Sampling procedure

The pigs were slaughtered at 105±2 kg. At slaughter the pigs were classified according to the SEUROP classification system. The pH and temperature in the *musculus longissimus dorsi* at the grading site (between the 3rd and 4th rib, 6 cm off of the midline) were measured 45 minutes and 24 hours after slaughter. 24 hours after slaughter muscle samples were taken from the *musculus longissimus dorsi* (25 cm cranial from the last rib, a 10 cm long piece) to determine water-loss, intramuscular fat content and meat colour (24 hours and 4 days after slaughter).

Chemical body analyses

After electrical stunning the pigs was exsanguinated and the blood was collected. In the next step the bodies were scalded, but collection of hair was not possible. The internal organs and the GI-tract were removed and the body was split symmetrically along the backbones. The tail remained on the left carcass half. The weights of carcasses, blood, internal organs, full and empty GI-tract (stomach, intestines, gall-bladder) were recorded. For chemical analyses two fractions were made: the left carcass half and the organs (blood, internal organs, empty GI-tract). The two fractions were stored deep frozen in plastic bags. The preparation of samples for chemical body analyses was carried out according to the method of Kotarbinska (1971). The following determinations were made from the samples: dry matter (DM), crude protein (CP), crude fat (CF) and crude ash (CA). Based on the analysed values and the weight of the fractions the total nutrient mass and proportions were calculated in empty body (EB), carcasses (C) and organs (O).

Statistical analyses

Statistical analyses were performed using the GLM procedure of SAS (1989) for randomized complete block designs according to the following general model: $Y_{ij} = \mu + P_i + e_{ij}$ Where: Y_{ij} = measurements, μ = overall mean; P = protein source (i=1,2,3,4); e_{ij} = residual error.

RESULTS AND DISCUSSION

The average daily gain (ADG) and feed conversion ratio (FCR) of the experimental groups are given in Table 1. No effect of protein source was observed on the overall and second phase fattening performance. This shows that the origin of the amino acids has no influence on performance when diets are formulated on the basis of ileal digestible amino acid contents. This result is in close agreement with the observations of Tanksley and Knabe (1984). However, soybean treatment in the first phase had significantly lower performance than the other treatments. It has been demonstrated that inappropriate heat treatment applied to protein concentrates may render lysine in a form that is apparently absorbed but nutritionally unavailable to the animal (van Barneveld et al.,1994). Consequently, ileal digestibility values for lysine in heat-processed meals in such a case are unsuitable for diet formulations. However, in this experiment it was not possible to identify whether this was the real reason.
The lean meat % of carcasses of the four treatments (Table 2) are similar. All group means fall into the U class of the SEUROP classification system.
Intramuscular fat content influences tenderness and juiciness. Devol et al. (1988) reported that intramuscular fat content has the highest correlation with tenderness, however the correlation was low (r = 0.32). The authors postulated that there was a minimum level of intramuscular fat - approximately 2.5% - needed for sufficient pork tenderness. According to that result none of the experimental treatments meet this value. The protein source had no significant effect on intramuscular fat level. The drip loss is a major measure of PSE type meat. The measured values have a normal variance and statistical differences could not be detected.
The pH is an important measure of meat quality post mortem. All group means are falling into the normal range (pH 5.8 - 6.2 and 5.4-6.0 for pH_{45} and pH_{24} respectively). The appropriate lightness and colour of lean meat is an important demand of the customer. Neither the lightness nor the hue value were affected 24 hours or 4 days after slaughter by treatment and all group means fell into the normal range.The experimental diets formulated on the basis of ileal digestible amino acid content resulted in similar chemical composition of empty body (Table 3). The chemical body composition data were all within the wide range of published data (De Greef et al., 1994; Friesen et al., 1996; Tuitoek et al., 1997).

Table 1. ADG and FCR by treatment group

	Average daily gain, g			Feed conversion ratio, kg/kg		
Treatment	30-60 kg	60-105 kg	30-105 kg	30-60 kg	60-105 kg	30-105 kg
Soyabean meal	546[a]	725	638	2.70[a]	3.16	2.98
Sunflower meal	606[b]	741	680	2.41[b]	3.13	2.84
Peas meal	609[b]	722	667	2.40[b]	3.20	2.88
Fishmeal	596[b]	774	689	2.48[b]	3.06	2.82
RMSE	29.8	77.4	48.4	0.12	0.27	0.18

Means in a column with same superscript are not significantly different
RMSE=Root mean square error

Table 2. Lean meat% and meat quality parameters by treatment group

	Lean meat, %	IMF, %	Drip loss, g	pH_{45}	pH_{24}	L_{24}	Hue_{24}	L_4	Hue_4
Soyabean meal	54.1	1.09	112	6.00	5.54	55.9	47.6	57.1	53.0
Sunflower meal	53.4	1.23	140	6.08	5.57	59.1	50.8	61.3	57.5
Pea	53.8	1.21	137	5.99	5.63	60.1	50.9	61.2	57.2
Fishmeal	52.5	1.29	125	6.05	5.60	58.9	50.0	60.9	56.0
RMSE	1.89	0.46	28	0.26	0.09	3.47	3.62	3.78	5.36

Means in a column were not significantly different. RMSE: Root mean square error
IMF = intramuscular fat, pH_{45} and pH_{24} = pH in *musculus longissimus dorsi* (mld) at last rib 45 min and 24 hours after slaughter, L_{24} and L_4 = lightness of mld 24 hours and 4 day after slaughter, Hue 24 and Hue 4 = hue value of mld 24 hours and 4 day after slaughte.

Table 3. Empty body composition by treatment group g/kg

Treatment	Dry matter	Protein	Fat	Ash
Soyabean meal	403	143	229	27.4
Sunflower meal	413	148	231	29.5
Peas meal	421	147	245	27.1
Fishmeal	409	142	235	28.1
RMSE	18.8	6.8	20.9	3.1

Means in a column were not significantly different.
RMSE : Root mean square error

CONCLUSIONS

Pig diets should be formulated on the basis of ileal digestible amino acid content to achieve similar fattening performance when dietary components are substituted. Substitution of protein sources in such a way has no significant effect on body composition, lean meat percentage and meat quality parameters.

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REFERENCES

1. De Greef, K.H., Verstegen, M.W.A., Kemp, B., van der Togt, P.L. (1994): The effect of body weight and energy intake on the composition of deposited tissue in pigs. Anim. Prod. 58:263-270.
2. Devol, D.L., McKeith, F.K., Betchel, P.J., Novakofski, J., Shanks, R.D., Carr, T.R. (1988): Variation in composition and palatability traits and relationships between muscle characteristics and palatability in random sample of pork carcasses. J. Anim. Sci. 66:385-395.
3. Friesen, K.G., Nelssen, J.L., Goodband, R.D., Tokach, M.D., Schinckel, A.P., Einstein, M. (1996): The use of compositional growth curves for assessing the response to dietary lysine by high-lean growth gilts. Anim. Sci. 62:159-169.
4. Grala,W. (1998): Nitrogen utilization in pigs as affected by dietary induced losses of ileal endogenous nitrogen, PhD thesis, Animal Nutrition Group, Wageningen Institute of Animal Sciences, Wageningen University, Wageningen, Netherlands
5. Kotarbinska, M. (1971): The chemical composition of the body in growing pigs. Roczniki Nauk Rolniczych ser. B 9:129-135.
6. Tanksley, T.D. Jr., Knabe D.A. (1984): Ileal digestibilities of amino acids in pig feeds and their use in formulating diets. In: W. Haresign and D.J.A. Cole (Editors), Recent Advances in Animal Nutrition. Butterworths, London, 75-94.
7. Tuitoek, K., Young, L.G., de Lange, C.F.M., Kerr, B.J. (1997): The effect of reducing excess dietary amino acids on growing-finishing pig performance: An evaluation of the ideal protein concept. J. Anim. Sci. 75:1575-1583.
8. Van Barneveld, R.J., Batterham, E.S., Norton, B.W. (1994): The effect of heat on amino acids for growing pigs. 2. Utilization of ileal-digestible lysine from heat-treated field peas (Pisum sativum cultivar Dundale). Br. J. Nutr. 72:243-256
9. ……. SAS Institute Inc. (1989): SAS/STAT User's Guide. Version 6, Fourth Edition, Volume 2, 846pp.