Optimal levels of fish meal and lysine in maize based diets for growing pigs

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Diets containing three levels of fish meal (4, 6 and 8 %), each supplemented with synthetic lysine at four lysine levels (0,7; 0,8; 0,9 and 1,0 %) were formulated to contain 12,65 MJ of ME per kilogram air-dry feed and individually fed *ad lib.* to 48 Landrace × Large White pigs (24 boars and 24 gilts) for the live mass interval 20 to 60 kg.

Increasing the fish meal level significantly improved feed utilization but only non-significantly increased daily gain. The lysine level had no significant effect on any of the measured performance parameters, suggesting that in maize meal based diets at lysine levels above the basic level of 0,70 %, other essential or non-essential amino acids may be considered limiting. The identification of such limiting amino acids is an important prerequisite for recommendations on the optimal inclusion level of fish meal and lysine in maize meal based diets for growing pigs.

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Diëte bevattende drie peile van vismeel (4, 6 en 8 %), elk aangevul met sintetiese lisien tot vier lisien peile (0,7; 0,8; 0,9 en 1,0 %) en geformuleer om 12,65 MJ ME per kilogram lugdroë voer te bevat, is individueel *ad lib.* aan 48 Landras × Grootwit varke (24 beertjies en 24 soggies) oor die lewende massa interval 20 tot 60 kg gevoer.

Verhoogde vismeelpeil het voerbenutting betekenisvol verbeter maar slegs tot 'n nie-betekenisvolle daaglikse toename gelei. Lisienpeil het geen betekenisvolle effek op enige van die gemete produksieparameters gehad nie, wat daarop dui dat in mieliemeelgebaseerde diëte by lisienpeile bo die basiese vlak van 0,70 %, ander aminosure, essensieel of nie-essensieel, as beperkende faktore mag geld. Identifisering van hierdie beperkende aminosure is 'n belangrike voorvereiste alvorens enige aanbevelings oor die optimale insluitingspeil van vismeel en lisien in mieliemeelgebaseerde diëte gemaak kan word.

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Introduction

The pig, being a monogastric animal, cannot readily synthesize its essential amino acid requirements and is dependent on the diet for at least ten essential amino acids. For optimal production performance these amino acids should not only occur in the correct quantities, but also in the correct proportions.

Cereals like maize, barley and oats as well as their by-products make up the major part of the diet of pigs in the RSA and, although low in protein content and quality, they usually comprise 70 % and more of the total diet. A protein-rich supplement to the diet is therefore necessary to provide the balance of the protein and/or the required essential amino acids.

High quality protein sources are becoming scarcer and more expensive and the efficient use of protein-rich feeds should be encouraged. According to Kemm, Siebrits & Ras (1982) the total production of protein-rich feed in the RSA increased by only 5 % over the past decade, while the total production of stock feed mixtures almost doubled over the same period. Fish meal production, in fact, decreased by as much as 35 %. Available protein sources, and in particular fish meal, should therefore be used judiciously and only in quantities not exceeding those required for optimal production efficiency.

In the past, the optimal level of fish meal included in cereal-based diets for pigs was mainly based on its potential for supplying lysine, considered to be the first limiting amino acid in such diets (Van Wyk, Kassier & Vosloo, 1974). Being a particularly excellent source of most of the other essential and non-essential amino acids, the use of fish meal to supplement lysine, can however result in less efficient utilization of those over-supplied amino acids and thus the wastage of good quality protein (Braude, Mitchell, Myres & Newport, 1972).

Large protein savings can be accomplished by the use of synthetic lysine in growth diets for pigs. Braude *et al.* (1972) and Wahlstrom & Libal (1974) proved that by supplementing growth diets with synthetic lysine, 2 % less protein in the diet still maintained the production performance of pigs. Baker, Katz & Easter (1975) demonstrated that growth performance did not differ when growing pigs were fed either a 14 % crude protein diet, containing 0,77 % lysine, or a 16 % protein diet with the same lysine content. These results are in agreement with those obtained locally by Siebrits, Kemm & Ras (1980) in studying the optimal inclusion level of sunflower oilcake meal and synthetic lysine in pig growth diets.

Against this background a feeding trial was conducted to determine the optimal inclusion level of fish meal in maize meal

Table 1 Formulation and chemical composition of the treatment diets (as-fed basis)

	Diet number											
	1	2	3	4	5	6	7	8	9	10	11	12
Ingredients												
Maize meal	74,4	74,6	74,7	74,9	72,5	72,6	72,7	72,9	70,4	70,6	70,7	70,9
Pollard	18,9	18,6	18,3	18,1	19,2	19,0	18,8	18,5	19,8	19,5	19,2	18,9
Fish meal	**4,0**	**4,0**	**4,0**	**4,0**	**6,0**	**6,0**	**6,0**	**6,0**	**8,0**	**8,0**	**8,0**	**8,0**
Synthetic lysine	0,22	0,34	0,48	0,60	0,09	0,23	0,36	0,49	0,00	0,11	0,23	0,37
$CaCO_3$	1,3	1,3	1,3	1,3	1,2	1,2	1,2	1,2	1,1	1,1	1,1	1,1
Monocalcium phosphate	0,9	0,9	0,9	0,9	0,7	0,7	0 ,7	0,7	0,5	0,5	0,5	0,5
Salt	0,30	0,30	0,30	0,30	0,25	0,25	0,25	0,25	0,20	0,20	0,20	0,20
Min. – vit. premix	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
Chemical composition												
Crude protein %	12,6	12,5	12,5	12,5	13,7	13,8	13,7	13,7	15,2	15,3	15,2	15,4
Metabolisable energy (MJ/kg)	12,65	12,65	12,65	12,65	12,65	12,65	12,65	12,65	12,65	12,65	12,65	12,65
Lysine (%)	**0,70**	**0,80**	**0,91**	**1,00**	**0,70**	**0,80**	**0,91**	**1,01**	**0,72**	**0,80**	**0,90**	**1,01**
Threonine (%)	0,43	0,43	0,43	0,43	0,49	0,49	0,49	0,49	0,54	0,54	0,54	0,54
Tryptophan (%)	0,14	0,14	0,14	0,14	0,15	0,15	0,15	0,15	0,17	0,17	0,17	0,17
Methionine + cystine (%)	0,48	0,48	0,48	0,48	0,52	0,52	0,52	0,52	0,57	0,57	0,57	0,57
Calcium (%)	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80	0,80
Phosphorus (%)	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60	0,60

based growth diets for pigs as well as the effect of synthetic lysine supplementation on the production performance of pigs.

Experimental procedure

Forty-eight Landrace × Large White pigs (24 boars and 24 gilts) were randomly, within sex, allotted to twelve treatment groups at the age of eight weeks. Twelve treatment diets with equal ME-content were formulated in such a manner that three inclusion levels of fish meal (4,6 and 8 %) were each supplemented with synthetic lysine (L-lysine monohydrochloride) to contain lysine levels of 0,7; 0,8; 0,9 and 1,0 % respectively (Table 1).

Pigs were fed the experimental diets *ad libitum* in individual until they were slaughtered at a live mass of 60,7 ± 0,9 kg. Feed intake and live mass changes were recorded at three-day intervals during the experimental period. Feed and water were not withdrawn before mass determinations were done.

After slaughtering, the carcases were cooled at 4 °C for 24 hours, medially split and the following measurements were taken: backfat thickness, C + K fat measurement and the eye muscle (M. *longissimus dorsi*) area.

Statistical analysis

The model for the description of growth as proposed by Roux (1974, 1976) and described by Kemm *et al.* (1982) was used to determine the growth rate and feed utilization of each pig for the live mass interval 25 to 60 kg. These results, as well as the different carcase measurements for each pig, were analysed by standard statistical procedures (Snedecor & Cochran, 1967) for a 2 × 3 × 4 factorial design.

Results and Discussion

No significant interaction could be demonstrated between fish meal level, lysine level and sex for any of the various parameters studied. The effects of fish meal level, lysine level and sex on the feed intake, growth performance, feed utilization and certain carcase characteristics were thus pooled and are presented in Table 2.

The fish meal level significantly ($P \leqslant 0,05$) affected feed utilization, but had no significant effect on any of the carcase traits studied. Growth rate was only non-significantly improved by increasing protein levels, possibly due to a slight reduction in daily feed intake with increasing fish meal level. The lysine level had no significant effect on any of the parameters studied, while sex significantly ($P \leqslant 0,05$) affected growth rate, feed utilization and eye muscle area.

Results obtained regarding the effect of lysine level in pig growth diets on growth performance and feed efficiency thus

Table 2 The effects of fish meal level, lysine level and sex on feed intake, live mass gain, feed utilization, back fat thickness, C + K measure and eyemuscle area for the live mass interval 25 to 60 kg

	Fish meal level (%)			Lysine level (%)				Sex	
	4	6	8	0,7	0,8	0,9	1,0	boars	gilts
Feed intake (g/day)	2327	2210	2163	2272	2196	2231	2236	2274	2193
Live mass gain (g/day)	680	695	722	713	694	694	695	746^{a}	653^{b}
Feed utilization (kg/kg gain)	$3,47^{a}$	$3,23^{ab}$	$3,04^{b}$	3,21	3,21	3,25	3,29	$3,10^{c}$	$3,25^{d}$
Back fat thickness (mm)	13,4	14,0	14,1	12,5	14,2	13,0	15,8	14,0	13,7
C + K measure (mm)	27,6	28,9	24,6	23,8	27,9	25,1	31,2	29,0	25,1
Eyemuscle area (cm^2)	37,0	35,5	35,6	38,2	36,5	35,6	33,7	$34,5^{a}$	$37,5^{b}$

Significant ($P \leqslant 0,05$) effects are denoted by different superscripts.

contrasted with those reported by Braude *et al.* (1972), Wahlstrom & Libal (1974), Baker *et al.* (1975) and Siebrits *et al.* (1980), but were to some extent in accordance with the results of Kemm *et al.* (1982). The latter (who studied the optimal inclusion level of heated full fat soya bean meal and lysine in pig growth diets), reported non-significant improvements in growth rate and feed efficiency with increasing protein level but, similar to our findings, could not demonstrate any effects of lysine on growth performance or carcase quality at levels ranging from 0,70 to 0,90 %.

The contradictory results regarding the effect of lysine levels found in the present trial, can to some extent be explained by the statistically significant ($P \leqslant 0,05$) effect of protein levels on the performance of growing pigs. These results not only indicated that an increase in lysine level above the basic level of 0,70 % in maize meal based growth diets for pigs receiving supplemental fish meal, had no beneficial effect on any of the performance traits measured, but also suggested that in such diets at a minimum level of 0,70 % lysine, some other amino acids may be considered limiting.

Looking at tryptophan and threonine, the generally accepted secondary limiting essential amino acids in cereal based diets, it is evident that although their levels in all the treatment diets are above the minimum levels of 0,11 and 0,39 % respectively, as recommended by the NRC (1979) for optimal performance of growing pigs within the live mass interval 35 to 60 kg, threonine in particular may be marginal at the two lower fish meal levels. Taylor, Cole & Lewis (1975) and Fuller, Mennie & Crofts (1979) reported maximum daily gain and minimum feed conversion ration at threonine levels of 0,56 and 0,49 % respectively, while the ARC (1981) recommended threonine levels of 0,65 % for optimal performance of growing pigs within the live mass interval 15 to 50 kg, which is substantially higher than those used in the present experimental diets (Table 1). The ARC (1981) recommendations for 0,16 % tryptophan requirements is also above the tryptophan levels of many of the experimental diets. Apart from these two amino acids, methionine as well as some non-essential amino acids may be marginal which would lead to a positive response at higher fish meal levels. According to Henry, Duee & Seve (1979) the secondary limiting amino acids in cereal based diets for growing pigs, before threonine and/or tryptophan, are non-essential amino acids which is probably also the case for the low protein diets used in the present trial.

Conclusions

For both sexes, live mass gain and feed utilization improved with an increase in dietary fish meal level from 4 to 8 % while an increase in lysine level above the basic level of 0,70 % had no beneficial effect on any of the performance parameters studied.

It is thus concluded that at a minimum of 0,70 % lysine in maize meal based diets for growing pigs, some other amino acids may be considered limiting. Identification and supplementation of those limiting amino acids is an important prerequisite for recommendations about the optimal fish meal and lysine levels in such diets.

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