S. Afr. J. Anim. Sci. 3, 161 - 164 (1973)

PROTEIN REQUIREMENTS OF THE GROWING PIG – A REVIEW OF SOUTH AFRICAN WORK

E.H. Kemm

Animal & Dairy Science Research Institute, Irene

The production of proteins for animal use has not kept pace with the needs of the animal industry in South Africa (Table 1). It is therefore of the utmost importance to use and utilize available protein feedstuffs both sparingly and efficiently. The aim of this paper is to summarize South African work on protein nutrition of the growing pig. Furthermore, to indicate what work needs to be done in the near future in this field if our dwindling supply of proteins is to be utilized efficiently.

Protein production and requirements

Since Van der Merwe reviewed "Proteins in relation to animal production in South Africa" in 1967, the production of proteins in relation to requirements has changed dramatically. It is evident from Table 1 that fish meal production has dropped while that from oil cakes has increased with a resultant increase in total production of fish, oil cake and carcass meals of just more than 16%. On the other hand the output of balanced feeds alone (not taking farm mixed concentrates into consideration) has increased by more than 53%. Should this trend continue demand will soon exceed supply. It is therefore important that we should not overfeed our livestock, but that protein and, more important, amino acid requirements be accurately determinded so that we can feed an exact amount of a protein that will fulfill the animals needs in terms of both quantity and quality.

Studies on quantitative protein requirements

Pieterse & Verbeek (1959), Pieterse & Penzhorn (1960), Matthis (1965) and Smith (1972) have investigated the quantitative protein requirements of the growing pig.

Porkers

Pieterse & Verbeek (1959) supplemented a basal diet of maize meal, lucerne meal and wheaten bran with 0%; 2,5%; 5,0%; 7,5%; 10,0% and 12,5% white fish meal to obtain diets with 11,3%; 12,6%, 13,8%; 15,1%; 16,3% and 17,5% protein and an energy content of 12,37 MJ/kgDE. Smith (1972) fed diets based on the same ingredients but with 14,0%; 16,7% and 19,3% protein and an average energy content of 14,54 MJ/kgDE.

The results achieved in the two independent studies were very similar as can be seen in Table 1. In both trials optimum performance as measured by daily gain, feed conversion ratio and carcass lean content (*longissimus dorsi* area) had not yet been attained although the improvement beyond 13,8% protein in the study of Pieterse & Verbeek and 16,8% in Smith's work was statistically insignificant. From the data presented it is, however, doubtful whether backfat would be improved with a further increase in dietary protein content.

Table 1.

Proteins produced and balanced feeds manufactured in South Africa.

	1966*	1972**
Proteins produced in metric ton:		
Fish meal	233 130	203 487
Oil cakes (Sunflower, Groundnut & Cottonseed)	65 963	141 897
Carcass meal (Including blood and meat meal)	9 219	11 200
Total	308 312	356 584
Balanced feeds manufactured	767 440	1 182 714

* Abstract of Agricultural Statistics, 1973.

** Quarterly Reports, Division of Agricultural Marketing Research, Pretoria, 1972.

Porker boars

Matthis (1965) fed porker boars diets containing 16,9% 18,7% or 20,8% protein and 14,02; 14,02 and 12,90 MJ/kgDE in an experiment conducted to determine an appropriate protein level for use in boar performance testing diets.

An increase in dietary protein from 16 to 18% (Table 3) had a significant effect on live mass gain ($P<0,05$), feed conversion ratio ($P< 0,01$) and average backfat thickness ($P< 0,01$). Carcass lean content (eye muscle area) was favourably affected ($P<0,01$) only when the protein content of the diet was increased from 18 to 20%.

Baconers

Diets compounded to contain between 0 and 10% fish meal (11,3 to 16,3% protein) were fed to baconers reared to 45 kg on a constant 15,1% protein content diet by Pieterse & Penzhorn (1960).

The result of their experiment, summarized in Table 4, showed a slight but insignificant increase in daily gain when dietary protein content was increased from 11,3 to 12,6% with no further increase beyond 12,6%, while feed conversion ratio was unaffected.

The tendency for backfat to increase with protein level must be ascribed to a rather big within treatment variation in this respect as there were no significant treatment differences. Eye muscle area improved with protein level but again treatment differences were found to be insignificant. The authors therefore concluded that diets excluding fish meal (or with no protein supplement) can be successfully fed to baconers from 45 to 90 kg live mass.

Table 2.

Summary of data on the feeding of different protein levels to porkers.

Pieterse & Verbeek (1959)						
Protein level, %	11,3	12,6	13,8	15,1	16.3	17,5
Slaughter mass, kg	46,0	45,6	45,6	45,9	46,1	45,6
A.D.G., kg	0,32	0,41	0,47	0,53	0,56	0,56
Feed conversion, kg/kg gain	4,55	3,51	3,01	2,61	2,51	2,47
Av. Backfat, mm	26	25	22	25	23	22
Eye muscle area, cm^2	10,3	11,8	12,8	13,2	14.5	14,3
Smith (1972)						
Protein level, %			14,0	16,8	19,6	
Slaughter mass, kg			46,8	47,4	48,3	
A.D.G., kg			0,57	0,66	0,69	
Feed conversion, kg/kg gain			2,76	2,36	2,34	
Av. Backfat, mm			22,4	21,0	20,8	
Eye muscle area, cm^2			13,1	15,5	16,3	
Carcass protein content, % of DM			14,0	15,9	16,4	
Carcass fat content, % of DM			34,0	29,1	27,4	

Boars

In a second experiment designed to determine an optimal protein level for boars in the mass range 54,5 to 95,5 kg, Matthis (1965) reared boars on a 18 or 20% protein diet to 54,5 kg and then fed finishing diets with 14%; 16% or 18% protein. As no significant treatment effect resulted, it was concluded that no apparent benefit accrued from feeding a diet having more than 14% protein to boars after they have been reared to 54,5 kg on either a 20% or 18% protein diet.

Protein: energy ratio.

Smith (1972) investigated the influence of varying protein and energy concentrations in the diet on the performance of porkers. Three protein levels, approximately 14%; 17% and 19,5% protein were fed at energy levels of approcimately 16,88 MJ/kgDE(HE); 16,25 MJ/kgDE(ME) and 15,33 MJ/kgDE(LE). Average daily gain increased with energy level at all three protein levels but at different rates. Significant differences occurred between LE and HE diets when fed at a 14% protein level and between LE, ME and HE diets at a 17% protein level, but the differences due to energy concentration were small and insignificant when fed in combination with a 19,5% protein diet.

Although HE diets effected an improvement of 12,3% in feed conversion ability, the improvement was statistically insignificant. Similarly pigs fed a higher energy diet had larger eye muscles which were statistically insignificant. Carcass protein content tended to decrease slightly when energy intake increased as opposed to a significant increase in carcass fat when the LE and HE treatments were compared.

Feed level.

Kemm, Pieterse, Griessel & Mammes (1971) fed a standard growth diet (17,2% protein and 13,69 MJ/kgDE)

Table 3

*Performance data of porker boars**

Protein level, %	16	18	20
Slaughter mass, kg	± 55	± 55	± 55
A.D.G. kg	0,52	0,55	0,55
Feed conversion, kg/kg gain	2,59	2,44	2,34
Av. Backfat, mm	18,4	17,0	16,2
Eye muscle area, cm^2	20,3	20,5	22,4

* Matthis (1965).

Table 4

*Performance data of baconers**

Protein level	11,3	12,6	13,8	15,1	16,3
Slaughter mass, kg	± 91	± 91	± 91	± 91	± 91
A.D.G., kg	0,68	0,71	,70	0,70	,70
Feed conversion, kg/kg gain	3,99	3,87	3,90	3,85	3,87
Av. Backfat, mm	38,3	38,0	39,3	43,3	42,0
Eye muscle area, cm^2	20,4	22,8	22,9	22,1	23,3

* Pieterse & Penzhorn (1960).

to two groups of pigs from an initial mass of approximately 24 kg to a final mass of about 87 kg on two feed intake levels. One group was individually fed a restricted amount of feed (which varied between 5,2 and 4,5% of live mass) per day to 50 kg live mass, while the other group had free access to feed up to a live mass of 50 kg. From 50 kg onwards all pigs were restricted to an intake of 2,27 kg of feed per day. The pigs initially fed *ad libitum* grew faster than the restricted group up to a live mass of 50 kg (0,63 of 0,55 kg per day). Although they maintained a slight advantage in growth rate when fed an equal amount of feed after 50 kg live mass, the overall average daily gain in mass between the two groups was insignificant. The pigs restricted throughout the experimental period had a better feed conversion ratio, less back fat, larger eye muscles, less fat and more protein in the DM of the carcass. All these differences were, however, small and statistically insignificant ($P<0,05$).

Kemm & Ras (1972) studied the effect of two isocaloric diets differing in protein content (16,4% or 11,7% protein) on the performance of bacon pigs fed *ad libitum* throughout the experiment or restricted (2,27 kg per day) during the finishing phase of growth. Rate of gain and carcass composition were influenced by protein content of the diet, the amount of feed fed during the finishing phase of growth (45 to 90 kg live mass), and the sex of the pig. Optimal rate of gain and carcass lean content (eye muscle area) was attained when the 16,4% protein diet was fed *ad libitum*, while chemically determined carcass protein and fat content was similar in two groups of pigs fed the 16,4% protein diet *ad libitum* throughout or *ad libitum* to 45 kg and then restricted to slaughter at 90 kg. Backfat and C + K fat measurements, were however adversely affected when pigs were fullfed on the 16,4% diet. During the finishing period from 45 to 90 kg, growth and feed conversion was not improved to any great extent by increasing the protein level above 12%, when fed at a constant level of energy intake. The authors felt that further research should be directed towards establishing to what extent fat deposition in *ad libitum fed pigs* can be restricted without unduly retarding live mass gain. Attention should also be devoted to the net efficiency of protein and energy utilisation by pigs slaughtered at different live masses, to establish at what mass the most efficient end product can be produced.

Source and quality of dietary proteins.

An experiment by Vosloo, van der Vyver & Steenkamp (1955) revealed that sweet lupin-seed meal can replace approximately half the fish meal in a diet consisting of yellow maize meal, pollards, lucerne meal and fish meal for bacon pigs from 10 weeks of age to a live mass of 45 kg and all the fish meal from 45 kg to slaughter at about 96 kg, without slowing down growth rate or adversely affecting carcass measurements. Florence (1965) determined the amino acid composition of sweet yellow lupin seed meal and white fish meal with the object of estimating the influence of protein quality on growth rate and carcass development. He then fed basic diets supplemented with varying proportions of these protein supplements to five groups of weanling pigs. Growth rate and feed utilization results showed that groups fed diets containing less fibre (lupins have 17,5% fibre and fish meal 1%) grew faster and had a better feed conversion efficiency. There were no important differences between the carcass measurements of the various groups. Type of protein did not affect carcass quality significantly, although it did affect growth rate and efficiency of feed utilization. Lysine and methionine were probably the most limiting amino acids in the diets containing mainly lupin seed meal as protein supplement, although if cystine is taken into account the combined methionine + cystine content of the lupins compared very favourably with that of the fish meal.

Van der Vyver (1950 & 1951) compared peanut oil cake and crayfish meal with fish meal as protein source in baconer diets. Unfortunately only three pigs per treatment were used, thus making valid conclusions from the data presented very difficult.

The use of protein sources with a high fibre content

In a series of experiments conducted at Potchefstroom (van Wyk & Verbeek 1951, 1952; van Wyk, Verbeek & Oosthuizen, 1951; Pieterse & Verbeek, 1957) the use of protein rich roughages in the diet of growing pigs was investigated. Diets containing up to 35% of finely ground lucerne-, groundnut- or cowpea hay were fed. As the diets were always fed at a restricted level of intake, differences in dietary energy concentration resulted in pigs fed the more fibrous supplements having a slower growth rate, poorer feed conversion rates but less backfat. These differences were, however, not always statistically significant thus suggesting that more attention could be devoted to the use of these materials in future. The sparing effect these feedstuffs have on protein concentrates (fish meal and oil cakes) may yet become an important consideration if our protein resources become less available and more expensive. Braude and his co-workers at Reading are presently investigating the use of lucerne juice as protein supplement in pig diets. If successful, this form of protein can and must surely play an important role in the nutrition of the monogastric animal in South Africa.

Protein quality evaluation

Dietary amino acid content has been badly neglected in pig diet experimentation in South Africa. Thus far, only Florence (1965); Kemm *et al.* (1971) and Kemm & Ras (1972) have determined the amino acid content of the diets used in their experiments. In a recent review of the biological availability of amino acids, Meade (1972) demonstrated the effect method of processing has on the availability of amino acids in a feedstuff. Severe overheating of protein supplemental feeds results in seriously depressed availability of all amino acids. On the other hand, amino acids are highly available if products such as soyabean meal, cottonseed meal and peanut meal are properly processed. An adequate supply of available amino acids are essential in diets that will support maximum performance in the pig. It is therefore of the utmost importance that work be done to establish

the amino acid content and availability of South African feedstuffs, with the emphasis on processed products such as fish meal, carcass meal, blood meal, soyabean meal and the oil cakes made from sunflowerseed and groundnuts.

In conclusion it is felt that future research should be conducted to:

1. Establish the content and availability of the amino acids as well as the biological value of our protein feedstuffs in order to ensure well balanced diets that will result in maximum performance at an efficient level of intake,

2. Determine the dietary concentration of protein (amino acids) and energy which would support maximum growth of lean tissue mass and a minimum quantity of fat at a defined level of feed intake.

References.

FLORENCE, W.G.S. 1965. The influence of varying proportions of plant and animal protein supplements on the growth of porkers. *S. Afr. J. agric. Sci.* 8, 661.

KEMM, E.H., PIETERSE, P.J.S., GRIESSEL, M. & MAMMES, P.A., 1971. The evaluation and standardisation of pig rations under South African conditions: 1. A chemical and biological evaluation of a standard growth ration. *S. Afr. J. Anim. Sci.* 1, 2.

KEMM, E.H. & RAS, M.N., 1972. The evaluation and standardisation of pig rations under South African conditions: 2. The influence of feeding protein and energy at different levels and ratios to baconers. *S. Afr. J. Anim. Sci.* 2, 59.

MATTHIS, D.B., 1965. *Studies on the protein requirements of boars.* MSc (Agric.) thesis, University of Pretoria.

MEADE, R.J., 1972. Biological availability of amino acids. *J. Anim. Sci.* 35, 713.

PIETERSE, P.J.S. & PENZHORN, 1960. The effect of feeding different levels of protein to baconers. *S. Afr. J. agric. Sci.* 3, 573.

PIETERSE, P.J.S. & VERBEEK, 1957. Feed more roughage to baconers. *Fmg S. Afr.* 32 (10), 34.

PIETERSE, P.J.S. & VERBEEK, W.A., 1959. The influence of feeding different levels of protein to porkers. *S. Afr. J. agric. Sci.* 2, 343.

SMITH, G.A., 1972. *Die doeltreffendheid van protein- en energiebenutting deur vleisvarke.* MSc (Agric) thesis, University of the Orange Free State.

VAN DER MERWE, P.K., 1967. Protein in relation to animal production in South Africa. *Proc. S. Afr. Soc. Anim. Prod.* 6, 31.

VAN DER VYVER, B.J., 1950 Rations for growing pigs. Nutritive value of fish meal and peanut oil cake meal. *Fmg S. Afr.* 25, 266.

VAN DER VYVER, B.J., 1951. The nutritive value of crayfish meal for young pigs. *Fmg S. Afr.* 26, 205.

VAN WYK, H.P.D., VERBEEK, W.A. & OOSTHUIZEN, S.A., 1951. Die voedingswaarde van grondboontjiehooi. *Bull. Dept. Agric. Tech. Serv. S. Afr.* No. 317.

VAN WYK, H.P.D. & VERBEEK, W.A., 1951. Lucerne hay as a source of protein in the rations of baconers. *Fmg S. Afr.* 26, 85.

VAN WYK, H.P.D. & VERBEEK, W.A., 1952. Cowpea hay and lucerne meal in pig rations. *Fmg S. Afr.* 27, 285.

VOSLOO, W.A., VAN DER VYVER, B.J. & STEENKAMP, D.J., 1955. Sweet, yellow lupinseed meal for baconers. *Fmg S. Afr.* 30, 221.