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The value of synthetic lysine in rations for fattening swine

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Summary

Supplementation of lysine in all-vegetable rations for fattening pigs has been studied in a series of 5 experiments involving 159 animals. *Table* 1 gives the composition of the rations, while the average results of the experiments are compiled in *table* 3.

The addition of 0,1 or 0,2 % lysine to rations, in which the fish meal or meat meal is replaced by several vegetable proteins had a positive effect on the growth rate and feed conversion. However it is possible that young animals show a somewhat better growth and feed conversion on rations containing normal amounts of animal protein. The explanation for this fact cannot yet be given.

1. Introduction

The manufacture of essential amino acids being steadily growing in volume, it was considered important to undertake a number of experiments on the supplementation of amino acids in rations for poultry and fattening swine.

The first investigations on this subject related solely to methionine because the price of lysine was prohibitive at the outset. Both abroad and in this country it was noted, however, that methionine alone fails to render rations for young fattening swine with little or no animal protein equivalent to the basal rations containing animal protein, although in some cases methionine was found to have a favourable effect on the growth of the test animals (DAMMERS, 1960 a). These facts justify the assumption that methionine, in conjunction with other substances, might play a part in the substitution of vegetable protein for animal protein.

Since then, methods have been developed permitting also lysine to be produced at a lower price, and it is owing to this achievement that attention in many research centres has turned to lysine because its content in swine rations without animal protein is usually more deficient than that of any other amino acid. In some cases addition of lysine to rations for fattening swine indeed had a positive effect, as was noted by ACKER *et al.* (1959), BELLIS (1961), BROOKS and THOMAS (1959), EVANS (1961), HALE and LYMAN (1961), MAGRUDER *et al.* (1961), MINER *et al.* (1955) and PFANDER and TRIBLE (1955). The first experiments on the subject carried out in this

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country confirmed the observations made abroad (DAMMERS, 1960 b; HOGENDOORN, 1960).
These favourable results induced "Staatsmijnen in Limburg" to establish a working group for the furthering of contact and consultation between the various bodies engaged on the study of the use of lysine in animal feed.
The working group is composed of Prof. Dr. Ir. M. J. L. DOLS, Cabinet Adviser to the Ministry of Agriculture and Fisheries, Chairman of the group, and the following members:

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Below, a brief survey will be given of feed tests carried out on pigs onder the auspices of the above "Working group Lysine".

2. Test programme

The experiments were carried out in 5 tests at the stations: Leersum (2 x), Maarheeze, Vreeland and Hoorn. All stations followed the same programme, which is given below:

Group I : positive check, normal quantity of animal protein.
Group II : negative check, exclusively vegetable protein.
Group III: as II + appr. 0,125 % lysine.
Group IV: as II + appr. 0,250 % lysine.

By supplementation of synthetic lysine the total lysine content in group III was raised to halfway between those of groups I and II. In group IV so much lysine was added until the percentage equalled that of group I. As a matter of course, the percentages used were based on the lysine contents calculated from literature data. The full composition of the rations is shown in TABLE 1. TABLE 2 gives the calculated contents of essential amino acids in conjunction with the spread in the

TABLE 1. Composition of rations

	1st period		2nd period	
	Group I	Groups II, III, IV	Group I	Groups II, III, IV
Ground maize	150	220	155	220
Ground barley	100	100	100	100
Ground oats	100	30	100	30
Ground rye	200	200	200	200
Ground milo grain	150	40	150	40
Wheat bran	100	65	85	65
Wheat flour, low grade	—	70	—	70
Soybean oil meal (extracted)	85	50	85	50
Sunflower-seed oil meal (id.)	—	70	—	70
Sesame oil meal (expeller)	—	80	—	80
Maize-gluten feed	—	20	—	20
Herring meal	60	—	—	—
Meat and bone meal	—	—	40	—
Blood meal	—	—	25	—
Dried whey, low lactose content	—	—	10	—
Grass meal	25	25	25	25
Vit. B premix	15	15 [1]	15 [1]	15 [1]
Vit. AD_3 mixture	0,36	0,36	0,36	0,36
Mineral mixture	15	15	10	15
Total	1000,36	1000,36	1000,36	1000,36
Calculated figures:				
Crude protein %	17,8	18,0	17,3	18,0
Starch equivalent	66,9	68,4	66,7	68,4

[1] Extra vit. B 12 added.

values as found analytically. The amino acid contents were determined by the method of STEIN and MOORE in the Central Laboratory of Staatsmijnen (see TABLES 1 and 2). All groups received a vitamin B mix, in the groups II, III and IV enriched with vitamin B 12. The rations in the tests A, B and E contained minerals for pigs I (without additional Cu) whereas in the tests C and D minerals with additional copper sulphate were used.

The maximum amount of pig meal supplied daily was 2 kg per animal. The remaining feed requirements were covered with ground rye. In the tests B, D and E the ground rye used in the B-period was supplemented with the following products:

0,7 % vitamin AD_3 mix, dry
0,5 % calcium carbonate
0,2 % common salt
1,5 % vitamin B mix
1,5 % extracted bone meal

3. Discussion of the tests

A and B, Leersum 1959 and Leersum 1960

The tests at the experimental farm "Schevichoven" were carried out on pigs from the F_1 generation of a 17 generations inbreed boar of wild orgin ("Wildstambeer") and Netherlands Landswine sows.

The groups in each of the two tests comprised 8 pigs kept in separate pens and fed individually. The feed was rationed and amounted to appr. 4 % of the body weight.

TABLE 2. Contents of essential amino acids in the different rations

	Ration gr. I (20—50 kg)			Ration gr. I (50—90 kg)			Ration gr. II, III and IV (20—90 kg)		
	calculated	determined		calculated	determined		calculated	determined	
		min	max		min	max		min	max
Arginine	1,06	0,90	1,08	0,93	0,62	0,90	1,17	0,61	1,28
Lysine	0,96	0,82	0,93	0,86	0,55	0,87	0,66	0,45	0,95
Lysine + 0,15 % synthetic (III A)	—	—	—	—	—	—	0,81	0,78	0,95
Lysine + 0,30 % synthetic (IV A)	—	—	—	—	—	—	0,96	0,79	0,92
Lysine + 0,10 % synthetic (III B)	—	—	—	—	—	—	0,76	0,56	0,69
Lysine + 0,20 % synthetic (IV B)	—	—	—	—	—	—	0,86	0,62	0,73
Histidine	0,40	0,39	0,44	0,43	0,29	0,52	0,39	0,28	0,44
Methionine	0,40	0,28	0,31	0,25	0,19	0,31	0,39	0,14	0,35
Cystine	0,29	—	—	0,30	—	—	0,27	—	—
Tryptophane	0,22	—	—	0,21	—	—	0,24	—	—
Glycine	0,44	0,79	0,87	0,91	0,85	1,00	0,72	0,52	0,90
Phenylalanine	0,77	0,70	0,76	0,82	0,60	0,85	0,95	0,55	0,94
Tyrosine	0,49	0,53	0,58	0,50	0,45	0,54	0,58	0,36	0,71
Leucine	1,45	1,36	1,52	1,48	1,16	1,54	1,45	1,13	1,68
Isoleucine	0,82	0,63	0,69	0,76	0,50	0,58	0,87	0,46	0,71
Threonine	0,55	0,58	0,68	0,61	0,45	0,64	0,62	0,43	0,67
Valine	0,96	0,59	0,85	0,94	0,63	1,01	0,92	0,57	0,88

C. Maarheeze

The groups at the Maarheeze station of the Instituut voor Veevoedingsonderzoek (Institute for Farm Animal Feeding Research) comprised 7 pigs of the Landswine type. All animals were fed by the wet feeding method. In the second half of the fattening period a pig in group II (negative check), which had not been well for quite a while, died. In calculating the results, this animal was left out of account. With the exception of some cases of illness of a passing nature, no serious troubles were encountered.

D. Vreeland

At the experimental farm "Groot Kantwijk" test group III (lower lysine dosage) was omitted owing to lack of accomodation.
The experiments were carried out on 4 home-bred litters of appr. 9 weeks old Landswine pigs. One litter consisted of 10 pigs, the other three comprising 11 pigs each. Each litter was divided over three pens which were classed in the three test groups. All in all, therefore, 12 pens were involved in the experiments. Feeding was done by the wet method, the amount supplied increasing from 0,95 kg per day for an animal weighing 20 kg to 2,75 kg for a pig weighing 70 kg or above.

E. Hoorn

The groups at the Instituut voor Veevoedingsonderzoek (Institute for Farm Animal Feeding Research) at Hoorn comprised 6 animals of the Large white type. The pigs were fed individually by the wet method.
At the outset the pigs were in a middling condition because prior to the experiments they had been suffering from gut oedema. Gradually, however, their condition improved and no further troubles occurred. Being of the Yorkshire type, the pigs were finished to a slightly higher weight than those at the other experimental stations.

4. Results

The principal average results of the various experiments are given in TABLE 3. The results of all experiments have been elaborated statistically.
In *test A* the pigs of group II showed a considerably slower growth and a lower feed conversion than the others. The differences between the three other groups were insignificant, implying that in this test vegetable rations with lysine gave an equally good result as the positive check ration.
Test B did not reveal any significant differences throughout the whole fattening period, although it should be stated that in the weight range between 30 and 50 kgs and between 30 and 85 kgs, the pigs in group I and in groups III and IV resp. showed a considerably better growth and feed conversion than those in group II. Here again, no appreciable difference was noted between the animals in the two test groups and in the positive check group.
The average growth figures show that in *test C* supplementation of lysine to the ration without animal protein indeed stimulated the growth but also that the positive check ration still yields a better result. The effect was slightly more distinct in pigs fed on rations with the higher lysine content (group IV).
A mathematical treatment of the data demonstrated that the groups III and IV did not show an appreciable difference in growth rate as compared either with the

TABLE 3. Average live-weight gain, feed conversion and some slaughter data

	A. Leersum 1959				B. Leersum 1960			
	I	II	III	IV	I	II	III	IV
Initial weight kg	22,6	22,5	22,6	22,5	19,6	19,4	19,5	19,8
Final weight kg	98,4	94,5	99,4	98,8	96,0	94,8	92,0	93,9
Average daily growth g								
20—ca 30 kg	—	—	—	—	—	—	—	—
ca 30—ca 50 kg	—	—	—	—	520	436	495	536
ca 30—ca 90 kg	636	554	646	633	—	—	—	—
ca 50—ca 90 kg	—	—	—	—	635	627	658	656
Whole experiment	588	525	594	582	523	492	508	520
Feed conversion kg								
20—ca 30 kg	—	—	—	—	—	—	—	—
20—ca 50 kg	—	—	—	—	—	—	—	—
ca 30—ca 50 kg	—	—	—	—	2,87	3,49	3,02	2,84
ca 30—ca 90 kg	3,37	3,76	3,37	3,34	—	—	—	—
ca 50—ca 90 kg	—	—	—	—	3,65	3,82	3,60	3,56
Whole experiment	3,43	3,74	3,42	3,40	3,59	3,74	3,62	3,61
Loss on slaughter %	—	—	—	—	23,7	24,5	24,5	24,8
Length cm	—	—	—	—	85,3	85,9	86,1	85,6
Thickness of backfat cm	—	—	—	—	2,5	2,5	2,4	2,5
Amount of meat	—	—	—	—	7,0	6,5	6,4	6,9

I = control with animal protein II = control without animal protein

positive or with the negatieve check group. The difference in average daily growth between the positive and negative check groups was almost significant.

Calculated over the total test period, *Test D* revealed a significant difference in growth rate between the positive and negative check groups. The growth of the test group came halfway between the figures for the latter two. It is remarkable that in the first three weeks the positive test group showed a considerably better feed conversion and growth than the two other groups. In growth range 30—50 kg the effect of the lysine supplementation becomes noticeable, whereas in the subsequent period both the negative check group and the test group yielded even slightly better results than group I.

In *test E* the differences in growth rate between the positive and negative check groups in the period covering the weight range up to 50 kg and throughout the whole experimental period are considerable and almost significant. The differences in growth between the test groups and the check groups are smaller than those between the check groups themselves and consequently are not significant.

In the period covering the weight range up to 50 kg therefore the negative check ration was improved by supplementation of lysine. Using rations with the higher dosage of lysine, the effect became slightly more marked. The results achieved with the ration containing animal protein, however, are more favourable. In the period after 50 kg the growth in all groups was virtually equal.

5. Discussion of the results

A study of the results shows that in two tests supplementation of lysine to a ration without animal protein gave an equally good growth and feed conversion as those

C. Maarheeze				D. Vreeland			E. Hoorn			
I	II	III	IV	I	II	IV	I	II	III	IV
20,9	20,8	20,8	20,7	24,4	24,4	24,4	24,9	24,9	24,9	24,8
89,4	89,7	87,5	87,0	87	87	87	115,6	109,2	110,9	113,0
524	414	452	479	439	350	355	474	351	382	382
—	—	—	—	636	589	618	624	510	562	600
694	634	648	659	—	—	—	—	—	—	—
—	—	—	—	740	758	779	712	711	703	714
657	588	605	620	651	629	642	657	611	623	640
2,38	2,81	2,76	2,61	2,52	3,06	3,07	—	—	—	—
—	—	—	—	—	—	—	2,81	3,22	3,00	2,77
—	—	—	—	2,63	2,75	2,71	—	—	—	—
3,42	3,89	3,56	3,41	—	—	—	—	—	—	—
—	—	—	—	3,55	3,45	3,36	3,74	3,56	3,63	3,49
3,21	3,59	3,41	3,26	3,19	3,22	3,13	3,42	3,46	3,42	3,26
—	—	—	—	24,9	25,0	24,0	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—
2,9	2,9	2,8	2,7	—	—	—	—	—	—	—
7,0	6,5	7,3	7,4	—	—	—	—	—	—	—

III = as II + 0,125 % lysine IV = as II + 0,25 % lysine

achieved with the positive check ration. In the three other tests the supplementation of lysine indeed distinctly improved the purely vegetable ration, but still failed to make it quite equivalent to the mix containing the normal amount of animal protein. In these tests the feed enriched with fish meal gave a better effect in the period up to 50 kg, especially so in the first three weeks. Since the content of methionine and vitamin B 12 was sufficient in all rations, this observation might suggest that for young animals not only the amino acid lysine is determining in the substitution of vegetable protein for animal protein.

It may be useful to point out here that especially in the experiments A and B, where vegetable protein + lysine gave the same result as animal protein, the growth rate of the animals was lower than in the other tests. This may possibly be explained by the fact that tests A and B were both carried out in winter, when the temperature of the pig house was often far below the optimum value, the more so as the pigs were kept separately and in consequence could not profit from each other's body heat.

For the rest it can be no matter for surprise that the results of the five experiments were not equivalent in all respects. For, there are various factors that may affect the reaction of pigs to the supplementation of the ration with a given amino acid, and it are exactly these factors that may have differed in the various experiments. In the first place, the amino acid pattern of the total ration is a point of importance. Determinations of the content of the various amino acids carried out by the Central Laboratory of Staatsmijnen have demonstrated that differences have arisen in these amino acid patterns. (See TABLE 2). The relations between the other amino acids, and also the available amount of some given vitamins (*e.g.* vit. B 12 and choline), may have an effect on the reaction of the animals to an increasing supply of the

most deficient amino acid. As to the various interrelations in this field, only little is known so far.

The differences in the amino acid patterns of the test mixtures may perhaps be ascribed to differences in the amino acids contents of the basic materials used. The feed ingredients for the five experiments were obtained from different suppliers. Furthermore, it should be born in mind that fully homogeneous mixing of a given component — in our case the lysine — is extremely difficult to realize. One may wonder therefore whether all of the samples taken were actually representative for the whole lot.

Beyond the weight of 50 kg the test group animals showed an equally good development — as far as their growth was concerned — as the positive check group, while also group II lagged only slightly behind during the final fattening period. Considering the feed consumption per kg of growth, a slightly different tendency is noted. Reckoned over the full fattening period, the result for the test groups approximately equals that for group I, whereas group II shows a less favourable figure in all cases. In the three experiments for which separate data are known on the feed consumption per kg of growth in the B-period, the test groups appeared to have had an even better growth rate in that period than the positive check group I.

In three tests the larger addition of lysine was found to give a slightly better result than could be achieved with half that amount. This will be understood when the calculated lysine contents of the various rations (meal for young pigs) are considered more closely. These contents were:

I positive check	0,96 %
II negative check	0,66 %
III as II, supplementation of half the lysine deficiency 0,66 + 0,15 = ...	0,81,%
IV as II, supplementation of the whole lysine deficiency 0,66 + 0,30 = ...	0,96 %

According to BECKER (1959) a weaned pig fed on a ration containing 18 % total protein needs 0,88 % lysine. In group III this figure was not quite reached. In practice the amount of lysine to be supplemented would naturally depend on the lysine content of the basal ration.

It is unfortunate that the number of observation made on the effect of lysine on the slaughter quality is rather limited and does not permit of a conclusion. CLAUSEN *et al.* (1961), by means of extensive experimental work, have demonstrated that supplementation of methionine and lysine has a favourable effect on the amount of meat and on the thickness of backfat even when the pigs were fed on a ration containing animal protein (bone meal or skimmed milk). BROOKS and THOMAS (1959) also report to have noted a positive effect of lysine on the slaughter quality.

Finally, one may wonder whether it will ever become possible to produce lysine at such a price as will render general application justified economically. Some years ago this problem also presented itself with regard to methionine, and it is encouraging to note that this amino acid has by now become definitely adopted as an additive to poultry feed.

The extensive calculations carried out by BERKHOFF and OTTENHEYM (1961) show that supplementation of lysine to mixed feed for pigs may, under certain conditions, be profitable. Of course the volume of the turnover will also play a very important part in this respect.

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