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A COMPARISON OF HIGH LYSINE CORN AND NORMAL CORN IN COMBINATION WITH PEANUT MEAL FOR SWINE GROWING RATIONS

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The opaque-2 mutant gene of corn first reported about 34 years ago by Emerson et al. (1935) improves the amino acid deficiencies in corn by increasing the lysine and tryptophan content. Protein levels were also found to be increased 25% to 35% when the opaque-2 gene was bred into normal corn.

Since high lysine corn (opaque-2 corn) supplies a higher level of balanced protein than normal corn, it could be of great economic importance in diets for swine, poultry and humans. Several studies have been conducted comparing high lysine corn and normal corn in various combinations with soybean meal (Beeson et al., 1966; Cromwell et al., 1967; Gallo et al., 1968; Mertz et al., 1964; Sihombing et al., 1968).

The objective of this study was to compare high lysine corn and normal corn in combination with peanut meal for swine growing rations. All corn was produced in southeast Virginia during 1968.

Experimental Procedures

High lysine corn (HLC)[c] was planted in an isolated field in southeast Virginia where pollination from normal corn could be held to the minimum. The HLC produced was compared to normal corn (NC) in rations for growing pigs.

In trial 1, 144 crossbred pigs averaging 23.5 kg. were randomly assigned by weight and sex to 18 groups. Six treatment rations were used: 1) 14% crude protein HLC, 2) 16% crude protein HLC, 3) 14% crude protein NC, 4) 14% crude protein NC plus 0.2% synthetic lysine, 5) 16% crude protein NC and 6) 16% crude protein NC plus 0.2% synthetic lysine. Composition of the rations is shown in table 1. Peanut meal was used as the only protein supplement due to its low lysine content. Rations were self-fed and water was allowed free choice. Pigs in each group were housed in concrete-floored pens, 2.1 by 4.9 meters. Body weight and feed consumption was recorded at 2-week intervals. The duration of the test was 56 days. Amino acid analysis was determined and is shown in table 2.

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[a] Both are Associate Professors in the Department of Animal Science.

[b] Appreciation is expressed to Mr. C. E. Babb for caring for animals and to Dr. C. Y. Kramer for statistical analysis.

[c] Purchased from Illinois Foundation Seed, Inc., Urbana, Illinois.

In trial 2, 56 pigs averaging 18.5 kg. were randomly assigned by weight and sex to eight groups. Four treatment rations were used: 1) 15% crude protein HLC, 2) 15% crude protein HLC plus 0.2% synthetic lysine, 3) 15% crude protein NC and 4) 15% crude protein NC plus 0.2% synthetic lysine. Composition of rations is shown in table 3. Peanut meal was used as the only protein supplement. Rations were self-fed and water was allowed free choice. Body weight and feed consumption was recorded at 2-week intervals. Pigs in each group were housed in totally slotted pens, 1.2 by 4.9 meters, inside a partially enclosed building. The duration of the test was 76 days. Amino acid analysis of the complete rations is shown in table 4.

Data was statistically analyzed using analysis of variance and Duncan's (1955) multiple range test.

Results and Discussion

The average yield per hectare for HLC was 61 hektoliters (70 bus./acre) as compared to 110 hektoliters (126 bus./acre) for NC grown on the same farm. Contamination of HLC from pollination with NC was approximately 4% for the HLC. The keeping quality of the HLC was poor which may have been due to the poor shuck covering and the soft grain. The low yield of HLC may have been due to its not being adapted to conditions in southeast Virginia.

Trial 1 - Average daily gain, feed intake and efficiency data are summarized in table 5 for trial 1. Pigs fed the 16% crude protein NC plus lysine ration (6) consumed more feed and grew significantly faster than pigs fed the other rations. Gain produced by pigs fed the 14% and 16% crude protein HLC rations (1 and 2) and the 14% crude protein NC plus lysine ration (4) were not significantly different from each other, but they were significantly different from gain produced by pigs fed the 14% and 16% crude protein NC rations (3 and 5). Feed efficiency values were similar to average daily gains. The calculated and analyzed lysine content of the HLC rations were very similar. However, it appears that the analyzed lysine content of the normal corn rations was higher than the calculated values.

Rations 1 and 2 consisting of high lysine corn were slightly deficient in lysine (0.63 and 0.65% respectively) when compared to the amino acid requirement of the pig which is approximately 0.7%. The content of ration 6 (.75%) would appear to be slightly greater than needed by the pig.

Trial 2 - Average daily gain, average feed intake and feed efficiency data for trial 2 are shown in table 6. There was a significant response to synthetic lysine additions to both the HLC and NC rations as shown by average daily gain, feed intake and feed efficiency data. Average daily gain was greatest in pigs fed the HLC-peanut meal ration plus 0.2% synthetic lysine.

The analyzed lysine content of the rations was less than the calculated content with the HLC plus synthetic lysine having the highest lysine content (table 4).

Discussion - If the average daily gain, feed intake and efficiency means are averaged across protein levels in trial 1 and compared to the same ration in trial 2, it can be seen that the performance was the same for the two trials.

The lack of a significant response to increased protein levels in trial 1 may have been due to the fact that the crude protein levels analyzed 1.5% higher than the calculated levels in the ration. The level of protein actually being fed to the pigs, even at the lower protein level, may have been more than adequate to supply all the protein needs with the exception of the lysine. In trial 2 the analyzed crude protein levels were again higher than the calculated protein levels (1%), however, not as high as in trial 1.

Suboptional gains and feed efficiency have been reported by Brooks *et al*. (1964) and Kornegay *et al*. (1968) when corn-peanut meal rations were fed to growing swine. Brooks *et al*. (1964) have shown that the addition of L-lysine will overcome this reduction in performance with the optimum supplemental level about 0.9% for a total lysine content in the diet of 1.0%. In figure 1, note that there is a positive relationship (r^2 = .848) between lysine content of the rations and average daily gains. Also feed efficiency was improved (r^2 = .781) as the lysine content increased. From the data in these trials it can be stated that the lysine requirement is in excess of 0.75% for maximum average daily gains and feed efficiency.

It can be concluded from this study that high lysine corn does not completely overcome the lysine deficiency of a corn-peanut meal ration when peanut meal is the only source of protein supplement, although performance of pigs fed HLC-peanut meal rations is greater than that of pigs fed NC-peanut meal rations. Cromwell *et al*. (1957) have reported that *opaque*-2 corn is comparable to normal corn-soybean meal when substituted on an equal percent protein basis and is superior to normal corn when substituted on an equal weight basis. HLC and NC-peanut meal rations were improved when synthetic lysine was added, indicating that lysine is probably the first limiting amino acid in both HLC- and NC-peanut meal rations. The optimum supplemental lysine level can not be determined from these trials.

Summary

Two trials using 200 crossbred pigs weighing from 18.5 to 23.5 kg. initially were used to compare high lysine corn and normal corn rations when peanut meal was the only protein supplement. Synthetic lysine was also supplemented to both types of corn. Average daily gain, feed intake and feed efficiency were improved when synthetic lysine was added to both high lysine corn and normal corn with the high lysine corn producing significantly greater gain, feed intake and efficiency as

compared to normal corn. Gain, feed intake and efficiency were also greater for the high lysine-peanut meal rations as compared to the normal corn-peanut meal rations without lysine addition. It was concluded that although the lysine content of high lysine corn was greater than that of normal corn it is not high enough to overcome completely the lysine deficiency of peanut meal as the major source of protein for growing pigs.

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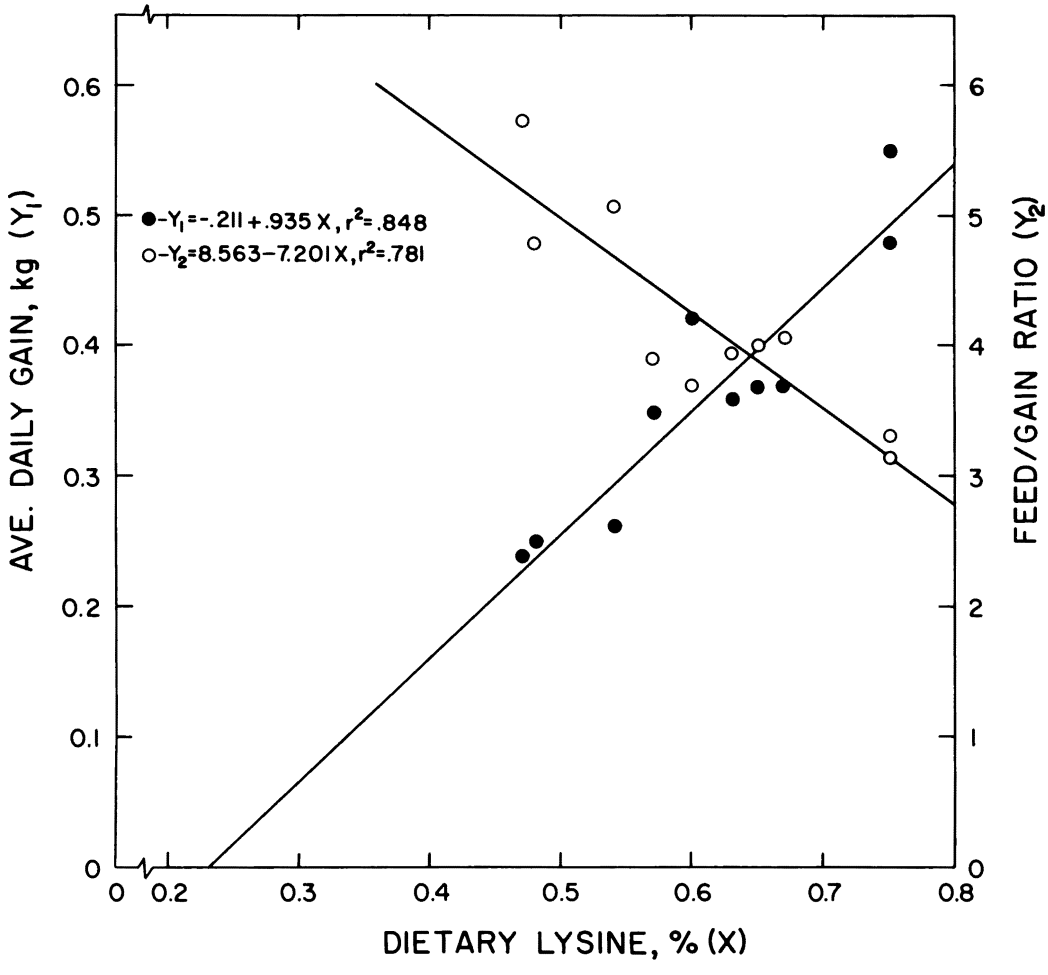
●-Y1=-.211+.935 X, r2=.848
○-Y2=8.563-7.201 X, r2=.781
AVE. DAILY GAIN, kg (Y1)
FEED/GAIN RATIO (Y2)
DIETARY LYSINE, % (X)
0
0.1
0.2
0.3
0.4
0.5
0.6
1
2
3
4
5
6
0.2
0.3
0.4
0.5
0.6
0.7
0.8

Table 1. COMPOSITION OF RATIONS Trial 1

Ingredients	Rations 1	2	3	4	5	6
	HL Corn		Normal Corn			
Crude Protein, %	14	16	14	14+L[a]	16	16+L[a]
High lysine corn (10.3%), %	85.7	79.6	--	--	--	--
Normal corn (9%), %	--	--	82.6	82.2	76.9	76.5
Peanut meal (45%), %	11.5	17.6	14.6	14.6	20.3	20.3
Defluorinated phosphate, %	1.9	1.9	1.9	1.9	1.9	1.9
Trace mineral salt, %[b]	0.5	0.5	0.5	0.5	0.5	0.5
V.P.I. vitamin premix, %[c]	0.4	0.4	0.4	0.4	0.4	0.4
Zinc sulfate, gm/100 kg.	22.0	22.0	22.0	22.0	22.0	22.0
Copper sulfate, gm/100 kg.	1.3	1.3	1.3	1.3	1.3	1.3
Lysine (50%), %[d]	--	--	--	0.4	--	0.4

[a] Lysine added, 0.2%.

[b] Contained (%): 0.2 Mn, 0.16 Fe, 0.033 Cu, 0.01 Co, 0.007 I, 0.005 Zn, 96.5 NaCl.

[c] Supplied (per kg. of ration): 2.4 mg. riboflavin, 12.4 mg. pantothenic acid, 12.4 mg. niacin, 400 mg. choline chloride, 19.2 mcg. vitamin B_{12}, 2400 USP Vitamin A and 400 I.C.U. Vitamin D_3.

[d] Supplied by Merck & Co., Rahway, N. J.

Table 2. AMINO ACID COMPOSITION OF NORMAL AND HIGH LYSINE CORN RATIONS Trial 1

Amino Acids	Ration, % of total					
	1	2	3	4	5	6
	HL Corn		Normal Corn			
Crude Protein[a], %	14	16	14	14+L[b]	16	16+L[b]
Lysine	0.63	0.65	0.47	0.67	0.54	0.75
Histidine	0.51	0.45	0.44	0.44	0.48	0.43
Arginine	1.23	1.47	1.12	1.10	1.35	1.18
Aspartic Acid	1.62	1.76	1.33	1.42	1.79	1.56
Threonine	0.49	0.57	0.41	0.40	0.49	0.44
Serine	0.58	0.63	0.52	0.48	0.60	0.58
Glutamic	2.86	3.06	2.70	2.76	3.27	3.20
Proline	1.10	1.23	0.98	0.99	1.14	1.10
Glycine	0.85	0.91	0.70	0.73	0.94	0.85
Alanine	0.85	0.87	0.81	0.85	0.99	0.92
Valine	0.81	0.84	0.67	0.71	0.82	0.79
Methionine	0.14	0.12	0.14	0.09	0.11	0.16
Isoleucine	0.57	0.61	0.52	0.55	0.67	0.61
Leucine	1.22	1.24	1.29	1.36	1.51	1.40
Tyrosine	0.34	0.39	0.33	0.35	0.41	0.40
Phenylalanine	0.62	0.64	0.63	0.65	0.78	0.71

[a] Calculated

[b] Lysine added, 0.2%.

Table 3. COMPOSITION OF RATIONS Trial 2

Ingredients	Rations 1	2	3	4
	HL Corn		Normal Corn	
Lysine, 0.2%	-	+	-	+
High lysine corn (10.3% CP), %	82.7	82.3	--	--
Normal corn (9.0% CP), %	--	--	79.8	79.4
Peanut meal (45% CP), %	14.5	14.5	17.4	17.4
Defluorinated phosphate, %	1.9	1.9	1.9	1.9
Swine trace mineral salt, %[a]	0.5	0.5	0.5	0.5
V.P.I. vitamin premix, %[b]	0.4	0.4	0.4	0.4
Lysine (50%), %	--	0.4	--	0.4

[a] Contained (%): 0.01 Co, 0.08 Cu, 0.01 I, 0.4 Fe, 0.8 Mn, 1.0 Zn, 95.9 NaCl.

[b] Supplied (per kg. of ration): 2.4 mg. riboflavin, 12.4 mg. panthothenic acid, 12.4 mg. niacin, 400 mg. choline chloride, 19.2 mcg. vitamin B_{12}, 2400 USP Vitamin A and 400 I.C.U. Vitamin D_3.

Table 4. AMINO ACID COMPOSITION OF NORMAL AND HIGH LYSINE CORN RATIONS Trial 2

Amino Acids	Ration, % of total 1	2	3	4
	HL Corn		Normal Corn	
Lysine, 0.2%	-	+	-	+
Lysine	0.57	0.75	0.48	0.60
Histidine	0.51	0.53	0.46	0.50
Arginine	1.20	1.40	1.13	1.30
Aspartic Acid	1.70	1.70	1.40	1.60
Threonine	0.45	0.47	0.45	0.48
Serine	0.57	0.54	0.60	0.52
Glutamic Acid	2.80	2.80	2.90	2.90
Proline	0.90	1.10	1.20	0.93
Glycine	0.79	0.85	0.78	0.79
Alanine	0.77	0.73	0.91	0.81
Valine	0.72	0.78	0.73	0.72
Methionine	0.18	0.17	0.21	0.16
Isoleucine	0.56	0.58	0.56	0.64
Leucine	1.10	1.20	1.40	1.40
Tryrosine	0.49	0.47	0.48	0.58
Phenylalanine	0.65	0.73	0.72	0.76

Table 5. AVERAGE DAILY GAIN, FEED INTAKE AND FEED EFFICIENCY OF GROWING PIGS FED HIGH LYSINE CORN AND NORMAL CORN WITH LYSINE SUPPLEMENTATION — Trial 1

Criteria	Ration 1	2	3	4	5	6
	HL Corn		Normal Corn			
Crude Protein %	14	16	14	14+L[a]	16	16+L[a]
No. of pigs[b]	21	20	22	22	22	24
Av. initial wt., kg.	23.7	23.7	23.7	23.2	23.6	23.7
Av. final wt., kg.	46.7	47.9	39.2	48.3	40.4	45.8
Av. daily gain, kg.	0.36[c]	0.37[c]	0.24[d]	0.37[c]	0.26[d]	0.48[e]
Av. feed intake, kg.	1.51	1.43	1.31	1.48	1.30	1.57[f]
Feed per gain	3.95[c]	4.00[c]	5.73[d]	4.06[c]	5.07[d]	3.28[e]

[a] Initially 24 pigs were started per ration. Several pigs were removed from the experiment. The cause was believed to be unrelated to treatments.

[b] Lysine added, 0.2%

[cde] Means on the same line with different superscripts are significantly ($P<.01$) different.

[f] Significantly ($P<.05$) different from the other means.

Table 6. AVERAGE DAILY GAIN, FEED INTAKE AND FEED EFFICIENCY OF HIGH LYSINE CORN AND NORMAL CORN WITH AND WITHOUT LYSINE SUPPLEMENTED — Trial 2

	Rations 1	2	3	4
	HL Corn		Normal Corn	
Lysine, 0.2%	-	+	-	+
No. of pigs	14	14	14	14
Av. initial wt., kg.	18.4	18.7	18.6	18.5
Av. final wt., kg.	44.9	60.4	37.7	50.8
Av. daily gain, kg.	0.35[b]	0.55[d]	0.25[a]	0.42[c]
Av. feed intake, kg.	1.36[ab]	1.75[c]	1.18[a]	1.57[bc]
Feed per gain	3.90[b]	3.16[b]	4.81[a]	3.71[b]

[abcd] Means with different superscript are significantly different ($P<0.01$).