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INFLUENCE OF A DIETARY SUPPLEMENT OF LYSINE FED AT TWO LEVELS OF PROTEIN ON GROWTH, FEED EFFICIENCY AND CARCASS CHARACTERISTICS OF SWINE [1]

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MERTZ *et al.* (1949) demonstrated that lysine is essential in the nutrition of swine. Since then considerable research has been conducted to determine the level of lysine needed to promote optimum growth and feed conversion in swine. Recent investigations (Crum *et al.*, 1964; Wallace *et al.*, 1964; Jensen *et al.*, 1965) have been designed to measure the physical and chemical changes in the animal body which may accompany observed differences in performance due to varying lysine and protein levels.

The experiment reported herein was conducted to determine the effect of a dietary supplement of lysine fed at two levels of protein on growth, feed efficiency and certain carcass characteristics of finishing swine.

Experimental

One-hundred-twenty crossbred barrows and gilts were assigned at random to five replications of a 2×2 factorial arrangement of four treatments (six pigs per pen; 30 pigs per treatment). The pigs were started on experiment at an average bodyweight of 57 kg. and were removed at an average of 95 kg. The pigs were housed in concrete-floored pens which were equipped with self feeders and automatic waterers. The pens were bedded with straw and cleaned daily. The test was conducted during the winter of 1965.

Composition of the diets and protein and lysine levels are shown in table 1. As indicated, the milo-soybean meal diet was fed at two levels of protein (12 and 16%) with and without 0.1% added L-lysine. All diets were offered in meal form.

The lysine content of all diets was determined by the microbiological method of Kavanagh (1963). The protein analyses were determined according to the procedure outlined by A.O.A.C. (1960).

Fifty-six of the test barrows were slaughtered at a packing plant.[4] The carcasses were chilled for 24 hr. and the following data were obtained: cold carcass weight, dressing percent, carcass length and carcass backfat thickness. Dressing percent was calculated using cold carcass weight and the live weight of the pigs when terminated from the experiment 24 hr. or less prior to slaughter. Standard procedures were used for measuring carcass length and backfat thickness. The carcasses were then processed through the plant's cutting line. The trimmed hams and loins were weighed and percent ham and loin was calculated on the basis of the cold carcass weight. The right loin of each carcass was returned to the University of Nebraska Meat Laboratory for more detailed measurements. The area of the *longissimus dorsi* (LD) muscle was determined with a compensating planimeter from tracings taken at the 10th rib section. The 11th to 14th rib section of each loin was removed and the LD muscle was trimmed of excess fat and frozen. The frozen muscle samples were ground three times with a power grinder using a plate with 3.2 mm. holes. After grinding, the samples were analyzed for dry matter, protein and fat.

Dry matter and protein were determined by modified methods of the procedures outlined by the A.O.A.C. (1960). Fat was determined by a modification of the method outlined by Kelley *et al.* (1954). The original procedure designated a 9 gm. sample, however, only 4.5 gm. were used because of the high fat content of the meat. Since only one-half of the designated amount was used, the reading was doubled to give the percent fat in the sample.

A cross-section, 5.1 cm. thick, was taken from the 8th to 10th rib section of the LD muscle and used to determine firmness. Firmness was measured by an apparatus designed and constructed at the University of Nebraska

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[4] George A. Hormel Packing Plant, Fermont, Nebr.

TABLE 1. COMPOSITION OF MILO-SOYBEAN MEAL DIETS[a]

Ingredients	12% protein	16% protein
	%	%
Ground milo	91.5	81.6
Soybean meal (50% protein)	5.3	15.3
Ground limestone	0.6	0.7
Dicalcium phosphate	1.0	0.8
Salt (iodized)	0.5	0.5
Trace minerals[b]	0.1	0.1
Vitamin-antibiotic premix[c, d]	1.0	1.0

[a] Chemical analysis:

	% protein	% lysine	% lysine of protein
Diet 1	12.0	0.41	3.42
Diet 2	12.1	0.49	4.05
Diet 3	16.3	0.68	4.18
Diet 4	16.3	0.74	4.55

[b] Composition (%): Mn, 10.0; Fe, 10.0: Cu, 1.0; Co, 0.10; I, 0.30; Zn, 10.0 and Ca, 9.1. Calcium Carbonate Company, Quincy, Ill.

[c] Contributed the following amounts of vitamins and antibiotics per kg. of complete ration. Diets 1 and 2; vit. A, 2640 I.U.; vit. D_2, 264 I.U.; riboflavin, 2.4 mg.; niacin, 8.8 mg.; calcium panthothenate, 4.5 mg.; choline chloride, 176.0 mg.; vit. B_{12}, 11.0 mcg.; thiamine, 2.2 mg.; and antibiotic, 27.5 mg. Diets 3 and 4; vit. A, 2640 I.U.; vit. D_2, 264 I.U.; riboflavin, 2.2 mg.; niacin 8.8 mg.; calcium pantothenate, 4.5 mg.; vit. B_{12}, 11.0 mcg.; thiamine, 2.2 mg.; and antibiotic, 27.5 mg.

[d] Lyamine (20% L-lysine) added to supply 0.1% L-lysine in supplemented diets

Meat Laboratory (figure 1). The apparatus was designed so that firmness could be measured without penetrating the muscle. A piston, 2.54 cm. in diameter and weighing 55 gm., was allowed to rest on the muscle and the position of the piston was recorded. A 500 gm. weight was then added and the piston was allowed to settle into the muscle for exactly 2 minutes. These two positions were recorded and an estimate of firmness was taken from the difference between the readings. The lower the reading, the more firm the muscle. Previous testing showed that when less than 500 gm. were added (250 gm.) the piston did not depress the muscle. If more than 500 gm. were added (1 kg.) the piston would settle continuously into the muscle and an accurate reading could not be obtained. Readings were made parallel to the grain of the muscle at both cooler and room temperature (4° C. and 21.5° C., respectively) 48 hr. after slaughter. Temperature of the meat coincided with room temperature.

All data were analyzed by analysis of variance and correlation coefficients were calculated for certain of the carcass characteristics (Steel and Torrie, 1960).

Results and Discussion

Treatment means for criteria of response to the treatments are presented in table 2. Significantly ($P<.01$) higher average daily gains and improved feed efficiency were obtained with pigs fed the 16% protein diets compared to those fed 12% protein. This observation agrees with the work reported by Pond (1958).

Lysine supplementation did not have a significant effect on average daily gain and feed efficiency. However, pigs fed the 12% protein diet with supplemental lysine showed an increased average daily gain and feed efficiency compared to pigs fed the 12% basal diet. Aldinger and Roberts (1963) reported similar results with pigs fed a corn-soybean meal diet containing 11% protein. When a 16% protein diet was fed, daily gain and feed efficiency were not improved with supplemental lysine. These results are contradictory to those reported by Schnarre and Tribble (1962) for pigs fed corn-soybean meal diets.

Carcass length, backfat thickness, area of LD muscle, and percent dry matter, protein, fat and firmness of the LD were not significantly affected by the addition of lysine to the diet.

On the combined average, pigs fed treatments with supplemental lysine showed a significantly ($P<.05$) lower dressing percent (68.4% *vs.* 69.4%) than pigs fed the unsupplemented diets. Differences were even more apparent at the 16% protein level. According to Pearson *et al.* (1956) a lower dressing percent may indicate that the carcasses had a greater percentage of lean cuts.

The combined average shows that the percent ham and loin was significantly ($P<.05$) increased with the addition of lysine to the diets (39.0% *vs.* 39.9%). Within protein levels the increase was greater for carcasses of pigs fed the 12% protein diet. Zobrisky *et al.* (1959) reported a significant positive correlation for percent ham and loin with yield of lean cuts. An increase in percent of ham and loin then would also indicate an increase in yield of total lean.

Area of the LD muscle was smallest in carcasses of pigs fed the 12% protein diet (28.06 $cm.^2$) and was largest (29.16 $cm.^2$) in carcasses of pigs fed 16% protein. Dukelow *et al.* (1963) also reported an increase in loin-eye area in carcasses of pigs as the percent protein fed was increased from 12 to 16% in corn-soybean meal diets.

Area, percent protein and firmness of the LD muscle were increased in carcasses of pigs fed the 12% protein diet plus lysine. These measurements were decreased in carcasses of

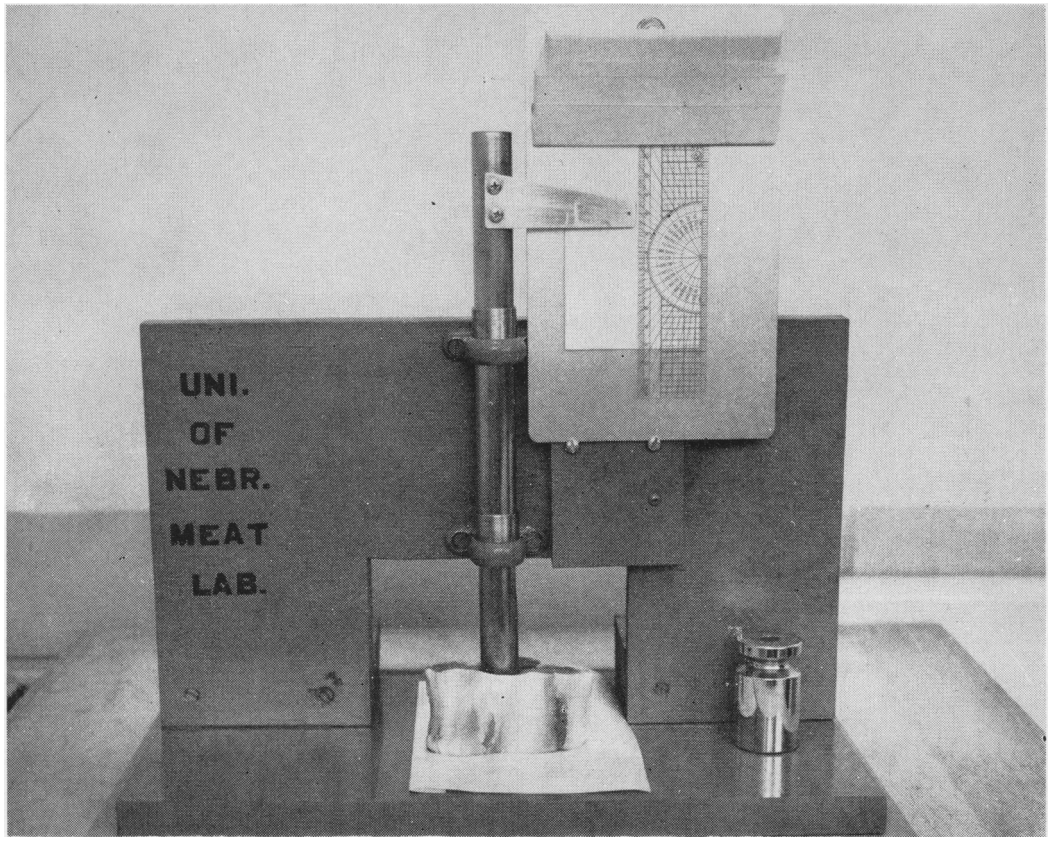

Figure 1. Apparatus for measuring firmness. Initial position of the piston at rest on longissimus dorsi muscle.

TABLE 2. EFFECT OF SUPPLEMENTS OF LYSINE AND PROTEIN LEVEL ON GAINS, FEED CONVERSION AND CARCASS CHARACTERISTICS OF G-F SWINE

	Diets				Significant difference due to		
Variable	1	2	3	4	Lysine	Protein	Interaction
Level of protein%	12	12+ 0.1% L-lysine	16	16+ 0.1% L-lysine			
No. animals	30	30	30	30			
Av. daily gain, kg.	0.83	0.92	1.03	1.04	...	***	...
Feed/gain, kg.	4.23	4.00	3.51	3.58	...	***	...
No. animals	13	14	14	15			
Dressing, %	69.58	68.94	69.21	67.97	**	...	...
Ham and loin, %	38.77	40.09	39.24	39.77	**	...	...
Carcass length, cm.	77.80	77.70	77.40	76.80	...	*	...
Backfat thickness, cm.	3.40	3.43	3.53	3.35	...	...	...
LD area, cm.[2]	28.06	28.45	29.16	28.90	...	...	...
LD dry matter, %	28.87	28.60	28.44	28.84	...	...	...
LD protein, %	20.94	21.33	22.13	21.86	...	***	...
LD fat, %	8.23	6.89	6.26	6.71	...	**	**
LD firmness, cm.[a]	1.25	1.14	1.11	1.16	...	...	...

[a] Smaller number indicates firmer muscle.
* P<.10.
** P<.05.
*** P<.01.

pigs fed 16% protein plus lysine. However, none of the differences were significant. The percent dry matter and fat decreased as muscle area increased, but the differences were small and were not statistically significant. Vipperman *et al.* (1963) reported similar results from pigs fed a corn-peanut oil meal diet containing 12% protein. The decrease of area, percent protein and firmness of the LD muscle in carcasses of pigs fed the 16% protein diet with supplemental lysine is difficult to explain, but may be related to an amino acid imbalance (Harper, 1958).

The percent protein of the LD muscle was significantly ($P<.01$) increased and the percent fat was significantly ($P<.05$) decreased in carcasses of pigs fed the 16% protein diets. The decrease in intramuscular fat observed at the higher protein level is in agreement with results reported by Wagner *et al.* (1963) for pigs fed 13, 19 and 25% protein corn-soybean meal diets. Kropf *et al.* (1959) also reported intramuscular fat of the LD was lower and percent moisture higher in carcasses of pigs fed a 16% protein diet when compared to carcasses of pigs fed 12% protein.

A decrease in dressing percent and carcass length, but an increase in percent ham and loin, and area and firmness of the LD were observed in carcasses of pigs fed the 16% protein diets. However, none of these differences were statistically significant.

The correlations between carcass traits are presented in table 3. A significant ($P<.05$) but small positive correlation ($r=0.27$) was obtained for the percent ham and loin of the carcasses with the area of the LD. Significant ($P<.05$) negative correlations were obtained for percent ham and loin with percent dry matter and fat of the LD ($r=-.26$ and $-.33$, respectively). These correlations are in agreement with results reported by Riley (1965). The correlations indicate that carcass lean increased as the percent ham and loin increased. The percent ham and loin was not significantly correlated with carcass length, backfat thickness or percent protein of the LD.

TABLE 3. SIMPLE CORRELATIONS BETWEEN CARCASS TRAITS [a]

Carcass traits	Simple correlations
% Ham and loin × length	−.13
% Ham and loin × backfat	−.12
% Ham and loin × LD area	0.27**
% Ham and loin × LD dry matter	−.26**
% Ham and loin × LD protein	0.11
% Ham and loin × LD fat	−.33**
LD area × length	−.11
LD area × backfat	−.16
LD area × LD dry matter	−.29**
LD area × LD protein	0.03
LD area × LD fat	−.18
LD firmness × backfat	0.25
LD firmness × LD area	−.01
LD firmness × LD dry matter	−.32**
LD firmness × LD protein	0.15
LD firmness × LD fat	−.39***
LD fat × backfat	−.06

[a] 55 degrees of freedom.
** $P<.05$.
*** $P<.01$.

Negative correlations were obtained for area of the LD with backfat thickness, carcass length and percent fat of the LD. However, none of these correlations was statistically significant. The area of the LD was not significantly correlated with the percent protein of the muscle, but a significant ($P<.05$) negative correlation was obtained between the area of LD and percent dry matter of the LD ($r=-.29$). This correlation indicates the area of the LD is increased as moisture content is increased in the muscle. Riley (1965) reported similar correlations for area and percent dry matter of the LD. Topel *et al.* (1965) reported that area of the LD muscle was a reliable measure of lean cuts. Yield of lean cuts was not measured in this study, however, an increased percentage of ham and loin was observed as the area of the LD increased.

Correlations for the firmness of the LD with backfat thickness, area and percent protein of the muscle were not statistically significant. Significant ($P<.05$) negative correlations were obtained for the firmness of the LD with the percent dry matter and percent fat ($P<.01$) of the LD ($r=-.32$ and $-.39$, respectively). These correlations suggest a firmer muscle is obtained when a lower percent of intramuscular fat and dry matter and a larger percent protein are present. These results do not agree with those of Judge *et al.* (1959), Naumann *et al.* (1960), and Wallace *et al.* (1964) who reported firmer carcasses for pigs exhibiting a greater degree of intramuscular fat deposition. These researchers performed the measurements of intramuscular fat and firmness subjectively on the carcass, whereas the measurements reported in this study were made objectively on the LD muscle. Also, the pigs fed milo-soybean meal diets in this experiment may have deposited an intramuscular fat of a different composition than that reported by other authors for pigs fed corn-soybean meal diets. These two facts may account for the differences reported in

firmness of the LD caused by the percent of intramuscular fat.

Summary

Twelve and 16% protein milo-soybean meal diets were used to determine the effect of protein level and supplemental lysine on rate of gain, feed efficiency and certain carcass characteristics of growing-finishing swine. Average daily gain and feed efficiency of the pigs were higher when fed 16% protein than on 12% protein but were not significantly affected by the addition of 0.1% L-lysine to the diets.

Protein and fat content were significantly higher and lower, respectively, in the LD muscle from pigs fed 16% protein compared to those fed 12% protein.

Dietary protein level did not produce a significant difference in dressing percent, percent ham and loin, carcass backfat thickness, LD area and LD firmness. Pigs fed diets containing supplemental lysine had a significantly ($P<.05$) lower dressing percent and ($P<.05$) higher percent ham and loin. These two measurements indicated an increase in yield of total lean due to lysine supplementation. The addition of lysine increased the area, percent protein and firmness of the LD muscle in carcasses of pigs fed the 12% protein diets, but decreased these measurements in carcasses of pigs fed 16% protein. However, the differences were small and were not statistically significant.

A significant positive correlation was obtained between the percent ham and loin of the carcasses with the area of the LD. Significant negative correlations were obtained between percent ham and loin and dry matter and fat content of the LD. Area of the LD was negatively correlated with the percent dry matter of the muscle. Also, the firmness of the LD had significant negative correlations with percent dry matter and fat of the muscle indicating that area, and firmness of the LD increased when a greater percentage of moisture and smaller percent intramuscular fat were present.

The data from this experiment indicate that the lysine level fed pigs for optimum daily gain may be different from that needed for optimum lean carcass development.

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