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Effects of Energy and Protein Levels and Antibiotics on Growing Turkeys

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Poultry Department

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South Dakota State College of Agriculture and Mechanic Arts
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EFFECTS OF

Energy and Protein Levels and Antibiotics on Growing Turkeys

C. W. CARLSON, WM. KOHLMEYER, CATHRINE HENDRICK, and R. A. WILCOX[1]

Much attention has been given recently to the use and value of high energy rations for poultry, particularly for broilers and to a limited extent for laying hens and young turkeys. Although the general fundamentals of the findings may appear applicable in formulation of diets for growing turkeys beyond the age of 8 weeks, little direct evidence has been available to justify such application. Actually, there is some evidence to indicate that the higher energy diets may not necessarily promote a more rapid rate of gain for the older birds.

Carlson and Kohlmeyer (2) reported that maximum feed efficiency for growing Broad Breasted Bronze turkeys from 12 to 28 weeks of age was obtained with a diet containing approximately 850 calories of productive energy per pound. Growth rate was not influenced over a range of approximate caloric contents of from 720 to 920 calories per pound of diet. This range was obtained by varying the amount of oats or corn in the cereal portion of the ration. Feed efficiency was reduced 10-15 percent when an oats diet containing 720 calories per pound was used as compared to the diet containing 850 calories.

Almquist (1) reported an experiment with Beltsville Small White turkeys over 10 weeks of age which were fed diets containing various proportions of barley and milo. He found the ratio of feed to gain was practically independent of mash fiber level for toms and also for hens at fiber levels above 6 percent. The ratio actually increased for hens fed mash fiber levels lower than 6 percent. Weight gains were independent of mash fiber levels. As

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was pointed out in his report, high energy does not necessarily mean higher performance.

On the other hand, Draper (4) reported that barley could not replace corn in a diet for growing turkeys without reducing growth rate and increasing the amount of feed required per pound of gain. Earlier work at the Utah station had indicated that a large portion of the corn could be replaced by barley, yet in the later work reducing the corn from 40 percent to 30 percent and adding 10 percent barley markedly reduced the growth rate. However this study involved raising the turkeys from 12 to 180 days of age, and it might be expected that the younger turkeys would show a more acute need for energy.

The work to be reported herein, a continuation of that reported earlier (2), considers the possible effect of protein level and antibiotics on this problem. The calorie-protein ratio optima, as recently discussed by Combs et al (3) and others for broilers and which is also being applied to diets for laying hens, appears to be of importance for growing turkeys also.

Experimental

All stock used in these trials was from the same strain, a medium-sized Broad Breasted Bronze, bred at this station for the past several years. The poults were grown under uniform conditions to 11 weeks of age on standard turkey starter and grower diets containing antibiotics and formulated according to the National Research Council standards (5).

At about 11 weeks of age the turkeys were placed on lush green oats and rape range, which usually provided good forage during the first half of the trial periods. The turkeys had worked it to a bare range toward the end of the trials.

At 12 weeks of age the control diets were replaced by the experimental diets as shown in tables 1 and 2. Free access to oyster shells and granite grit were provided. Individual weights were taken at 28-day intervals and feed consumption records were kept for each period.

Findings of the previous studies were considered in planning the subsequent trials, as will be discussed under results.

Breast width measurements of the stretched out live birds were taken at 24 weeks of age. The measurements were made about 2 inches from the point of the keel towards the rear and 1¾ inches in from the surface edge of the keel. These measurements were 10 to 20 percent below those obtained on cooled carcasses.

Skin samples from identical positions on the breast were taken for chemical analyses as was the entire coccygeus muscle. Analyses were made for protein, fat, and water composition by adaptations of the A.O.A.C. methods (1950).

A comparison of the composition

Table 1. Formulae for Turkey Growing Diets Used in Trials

Ingredient	Diet No. 401	402	403	404	405	406	407
	%	%	%	%	%	%	%
Grd. Yellow Corn	58	—	58	—	58	57	—
Grd. Oats	10	70	—	60	7	—	62
Wheat Bran	5	5	5	5	5	—	—
Wheat Flour Midds	—	—	—	—	—	5	5
Wheat Standard Midds.	5	5	5	5	5	5	5
Meat Scraps (55%)	5	5	5	5	5	5	5
Soybean Meal (44%)	8	6	18	16	11	18	13
Alfalfa Meal	5	5	5	5	5	5	5
Dried Buttermilk	2½	2½	2½	2½	2½	—	—
Dried Whey	—	—	—	—	—	2½	2½
Salt Mix	½	½	½	½	½	½	½
Steamed Bonemeal	1	1	1	1	1	—	—
Dicalcium Phosphate	—	—	—	—	—	1	1
Vitamin Supplement*	—	—	—	—	—	+*	+*
Bentonite	—	—	—	—	—	1	1
Calculated Calories/lb.†	**875**	**676**	**855**	**656**	**870**	**851**	**662**
Calculated % Protein†	**16.2**	**16.5**	**18.9**	**19.3**	**16.6**	**18.8**	**18.9**

*Amounts of the following, added per pound of diet, vitamin A 1,500 I.U., riboflavin 2 mg., calcium pantothenate 2 mg., and niacin 12 mg.

†Figures used in calculations were taken largely from the data in the 1955 Feedstuffs Analysis Table by C. H. Hubbell.

Table 2. Plan of the Experiments

Year	No. Birds	Pen No. and Diets Used 1	2	3	4
1952*	73-81	401† (875 Cal. —16% Prot.)	402† (675 Cal. —16.5% Prot.)	403† (855 Cal. —19% Prot.)	404† (655 Cal. —19% Prot.)
1953	61-75	401	402	401‡	402‡
1954	140-151	405 (870 Cal. —16.5% Prot.)	402	405†	402†
1955§	107-115	406 (840 Cal. —19% Prot.)	407 (660 Cal. —19% Prot.)	406†	407†

*All pens placed on 20% protein mash and corn diet at 24 weeks of age, approximately 2 parts of corn to 1 part of mash.

†Diets supplemented with 5 mg. chlortetracycline per lb.

‡Diets supplemented with 2.4 mg. penicillin per lb.

§All diets pelleted, diluted during 20-26 weeks period with 1 part of corn (diet 406) or 1 part of oats (diet 407) to 2 parts of pellets.

of a number of breast muscles and coccygeus muscles indicated that both muscles showed the same trends, comparing one bird with another; but where differences appeared to exist between low and high energy diets, they were greater and more consistent with the coccygeus muscles. Therefore, the coccygeus muscles were used in all determinations. Representative hens were slaughtered and sampled at 24 weeks of age, toms at 26 weeks.

Since the percent protein of the coccygeus muscle was a rather constant value (about 22 percent) and the amount of protein in skin was a small constant figure also, it was felt that an accurate and clearer picture of carcass composition would be available if the ratios of fat to water were determined. All results on fat and water were therefore expressed as such.

Results

The trials were terminated when the turkeys were 28 weeks of age, except in 1955 when they were 26 weeks of age. Because of the more rapid growth of the birds in 1955, particularly the hens, they were ready for market earlier.

Attention should be called to the fact that for the 1952 trial only, the experimental diets were fed for a 12-week period to 24 weeks of age. After that all birds were fed a common diet consisting of approximately 1 part of a 20 percent protein mash to 2 parts of whole yellow corn. Thus, they were grown to near market size on "low" or "high" energy diets but finished off on a relatively "high" energy diet.

1952 TRIAL

As is shown in table 3, there were no consistent differences with respect to final weight of the toms in this trial, although at 24 weeks it had appeared that the turkeys on the corn diets were heavier. The hens continued to show this trend, even after having been on a common diet 4 weeks.

The levels of protein used did not affect final weights as is shown here, although at 24 weeks there were small differences in favor of the 19 percent protein diet. The degree of fleshing appeared to be better on the 19 percent protein diets, as is substantiated by the greater breast widths shown in the table. This is particularly true for the comparisons between the birds on the lower energy diets. Finish also appeared better, which is substantiated by the greater ratio of fat to water in the breast tracts of the slaughtered birds.

As would be expected, feed efficiency was better for the high energy (mostly corn) diets. However, the best efficiency was obtained on the lower protein high energy diet. Adding 10 percent of soybean meal to this diet (mostly corn) in place of the 10 percent of oats, reduced the caloric value by approximately 20 calories per pound.

Since protein did not appear to be greatly limiting, feed efficiency might be expected to be somewhat poorer on the slightly lower energy diet. Making the identical change with the low energy (mostly oats) diet improved feed efficiency, however. No consideration was given to protein quality, which may have been a factor here. No great differences in dressing percentages were noted.

1953 TRIAL

In this trial, which was in part a repetition of the first part of the 1952 trial, antibiotics were not used in one series. It was considered desirable to determine whether or not antibiotics would influence the results and incidentally to determine whether they would be required during the latter stage of growth of the turkeys. The lower protein level was used, since there had been no great final differences in the earlier study. Also it was felt desirable to continue the treatments through to 28 weeks.

The results are shown in table 4. There was a marked and significant improvement in growth with the high energy (corn) groups of toms but not for the hens. At 24 weeks of age there had been a slight similar advantage for the hens, but only in the presence of penicillin did it carry through to 28 weeks. For the toms, there appeared to be an advantage in using penicillin during

Table 3. Effect of Protein and Energy Levels on Growing Turkeys, 1952 Trial

Criteria	L.S.D.*	Dietary Condition (to 24 wks.)†			
		875 Cal./lb.	675 Cal./lb.	855 Cal./lb.	655 Cal./lb.
		16% Protein		19% Protein	
Lbs. Feed per lb. Gain (12 to 24 wks.)		4.7	6.1	5.1	5.5
Toms					
Wt. @ 24 wks., lbs.		21.0	20.7	21.6	21.1
Wt. @ 28 wks., lbs.	1.1	25.5	25.8	25.8	25.8
24 wk. Breast Width, mm.	2.8	66.7	61.3	66.2	68.1
Skin Fat:Water Ratio‡		2.74	4.52	3.55	4.77
Muscle Fat:Water Ratio‡		.289	.373	.386	.415
Dressing Percentage‡ §		69.1	70.4	67.9	70.9
Hens					
Wt. @ 24 wks., lbs.		13.6	13.3	13.9	13.5
Wt. @ 28 wks., lbs.	0.5	15.3	15.0	15.4	15.0
Breast width, mm.	2.5	69.3	64.6	71.4	71.8
Skin Fat:Water Ratio‡		4.63	5.94	7.33	6.34
Muscle Fat:Water Ratio‡		.436	.669	.503	.416
Dressing Percentage‡ §		69.1	71.3	72.3	70.4

*Least significant difference, t=.05.
†All groups on a common diet, 24 to 28 wks.
‡Two birds of each sex slaughtered from each pen for chemical analysis and dressing percentage calculations, hens @ 24 wks. and toms @ 26 wks.
§Dry-cooled eviscerated carcass wts. compared to live wts. 24 hrs. before slaughter.

Table 4. Effect of Energy Level and Penicillin on Growing Turkeys, 1953 Trial

Criteria	L.S.D.*	Dietary Condition: No Penicillin, 875 Cal./lb.	No Penicillin, 675 Cal./lb.	2.4 mg. Diamine Pen./lb., 875 Cal./lb.	2.4 mg. Diamine Pen./lb., 675 Cal./lb.
Lbs. Feed per lb. Gain (12 to 28 wks.)		5.4	6.3	5.3	6.3
Toms					
Wt. @ 24 wks., lbs.		22.1	21.3	21.8	21.8
Wt. @ 28 wks., lbs.	1.1	25.1	23.9	25.8	25.0
24 wk. Breast Width, mm.	2.9	73.1	73.5	74.7	70.4
Skin Fat:Water Ratio†	1.11	2.29	1.51	2.19	1.72
Muscle Fat:Water Ratio†	.024	.078	.060	.068	.058
Dressing Percentage† ‡		69.7	70.6	69.3	70.2
Hens					
Wt. @ 24 wks., lbs.		14.9	14.8	14.9	14.6
Wt. @ 28 wks., lbs.	0.6	16.2	16.3	16.7	16.2
24 wk. Breast Width, mm.	2.3	73.5	72.9	76.0	72.9
Skin Fat:Water Ratio†	.81	1.75	1.68	1.53	1.44
Muscle Fat:Water Ratio†	.039	.104	.088	.098	.114
Dressing Percentage† ‡		72.4	70.8	70.3	70.5

*Least significant difference, t=.05.
†Four birds of each sex slaughtered from each pen for chemical analysis and dressing percentage calculations, hens @ 24 wks. and toms @ 26 wks.
‡Dry cooled eviscerated carcass weights compared to live weights 24 hrs. before slaughter.

the growing period on both types of diets but with a greater advantage on the low energy (oats) diet being evident. The hens seemed to respond to penicillin only on the high energy diet, however.

There may have been slight advantages in the high energy diets for fleshing and finishing, as shown by the breast width measurements (table 4) and the ratios of carcass fat to carcass water (table 6). Again, better feed efficiency was noted with the high energy diets, in this case about 18 percent better. Penicillin had no influence on feed efficiency. As before, the variations in dressing percentage were not very great.

1954 TRIAL

Because the carcass analyses of the 1952 trial as compared to the 1953 trial had indicated a greater fat deposition, it was felt desirable to determine why that may have occurred. The method for fat determinations was revised for trials subsequent to the 1952 trial. However, that did not account for the differences in results.

All diets in 1952 were supplemented with chlortetracycline, whereas penicillin was used in 1953 but only for one series. Thus, the 1953 trial was repeated essentially. A slight change in the high energy (corn) diet was made to bring the protein content up to 16.5 percent

and chlortetracycline was used instead of penicillin.

The data on growth for this trial (table 5) indicate an advantage again for the high energy (corn) groups, this time significant for both toms and hens. Chlortetracycline improved growth only with the low energy (oats) diets.

Only in the case of toms in the series without the antibiotic was there any advantage of the high energy diet for fleshing. With the skin from the breast feather tracts and the coccygeus muscle, the ratios of fat to water were again higher in the high energy fed groups, thus indicating better finish. There were no consistent differences in carcass composition due to the antibiotic, although the hens on the high energy diet and chlortetracycline deposited significantly more fat in the coccygeus muscle.

Feed efficiency was in general poorer for this trial than for the earlier trials. That was partly due to there being much less forage available; actually there was no forage available from the age of 20 weeks to the end of the trial. Nearly 25 percent more feed was required by the low energy groups under these conditions. Again, there were no great differences in dressing percentages although hens from the

Table 5. Effect of Energy Level and Chlortetracycline on Growing Turkeys with Protein Level at 16 Percent, 1954 Trial

		Dietary Condition			
		No Chlortetracycline		5 mg. Chlortetracycline/lb.	
Criteria	L.S.D.*	870 Cal./lb.	675 Cal./lb.	870 Cal./lb.	675 Cal./lb.
Lbs. Feed/lb. Gain (12 to 28 wks.)	.....	6.2	8.4	6.4	8.2
Toms					
Wt. @ 24 wks., lbs.	.....	22.8	21.5	23.2	21.5
Wt. @ 28 wks., lbs.	0.8	26.8	23.8	26.7	24.8
24 wk. Breast Width, mm.	1.7	70.8	66.2	69.3	69.5
Skin Fat:Water Ratio†	.56	1.97	1.67	1.77	1.77
Muscle Fat:Water Ratio†	.022	.071	.060	.081	.088
Dressing Percentage‡	.....	74.1	75.5	74.0	74.0
Hens					
Wt. @ 24 wks., lbs.	.....	14.5	14.3	14.5	14.3
Wt. @ 28 wks., lbs.	0.4	16.6	15.8	16.7	16.3
24 Wk. Breast Width, mm.	1.8	70.6	70.7	72.1	72.5
Skin Fat:Water Ratio†	.58	1.65	1.45	1.72	1.41
Muscle Fat:Water Ratio†	.058	.107	.093	.161	.067
Dressing Percentage‡	.....	72.2	71.6	73.3	73.7

*Least significant difference, t=.05.

†Six birds of each sex slaughtered from each pen for chemical analysis, hens @ 24 wks. and toms @ 26 wks.

‡16 toms and from 22-26 hens were slaughtered for dressing percentage determinations, figures represent dry-cooled eviscerated carcass weights compared to live weights immediately before slaughter.

low energy group without chlortetracycline appeared to dress out poorer.

1955 TRIAL

One criticism of the previous trials had been that the diets containing oats in such great quantity (over 60 percent) were extremely bulky and were therefore less palatable. This trial was designed similar to the previous one. Exceptions were that the feed was to be pelleted and that a 19 percent protein diet would be used to 20 weeks of age. At that time it would be diluted with 1 part of the respective whole cereal grain to 2 parts of pellets, thus producing a 16-17 percent protein finishing ration.

Other changes involved using dried whey rather than dried buttermilk, dicalcium phosphate in place of steamed bonemeal, and the addition of bentonite as a pellet stabilizer and some vitamin A, riboflavin, calcium pantothenate, and niacin.

The diets used earlier were not deficient in minerals or vitamins according to the NRC requirements figures, particularly considering the amount and high quality of the lush green forage available. However, because of the dry season it was not anticipated that much forage would be available, especially during the latter part of the trial; so the diets were fortified with the vitamins as listed. In view of the fact that there was little or no forage available after the birds were 16 weeks old, it was fortunate that this had been done.

With the more concentrated diets, which were higher in protein and fortified with the vitamins, a more rapid rate of growth was experienced than ever before (table 6). The hens were ready for market at 24 weeks; they made little or no gain from 24-26 weeks. Actually only the antibiotic-fed groups of hens gained at all in this period. All groups of toms produced gains in this period. However, more gain was noted with the antibiotic fed groups, and especially with the high energy (corn) fed groups of toms.

Where earlier trials had indicated less advantage from using antibiotics under these conditions with high energy diets, the conditions of this trial allowed for expression of considerable value. Also noted was an improvement in feed efficiency not consistently obtained with antibiotics earlier. A severe cold wave struck right after the 24-week weights had been taken, which undoubtedly placed a stress on the turkeys.

Where both high energy and chlortetracycline were used, the best growth rates were obtained and fleshing was superior as indicated by the breast width measurements. Finish also appeared superior on the high energy fed birds and was substantiated by the higher fat to water ratio of the skin. Dietary energy level did not consistently affect the fat to water ratio of the coccygeus muscle.

There apeared to be a consistent slight advantage for the antibiotic-fed turkeys with respect to dressing percentages. Again, hens from the low energy diet without antibiotics appeared to have poorer dressing percentages.

Table 6. Effect of Energy Level and Chlortetracycline on Growing Turkeys with Protein Level at 19 Percent to 20 Wks. of Age, 1955 Trial

Criteria	L.S.D.*	Dietary Condition†			
		No Chlortetracycline		5 mg. Chlortetracycline	
		850 Cal./lb.	660 Cal./lb	850 Cal./lb.	660 Cal./lb.
Lbs. Feed/lb. Gain					
(12-24 wks.)	.....	5.1	6.0	4.9	6.1
(12-26 wks.)	.....	6.0	7.1	5.6	6.9
Toms					
Wt. @ 24 wks., lbs.	.....	24.0	23.9	23.9	23.7
Wt. @ 26 wks., lbs.	0.7	25.1	24.7	26.0	24.9
24 wks. Breast Width, mm.	2.1	72.7	73.2	75.4	72.6
Skin Fat:Water Ratio‡	.96	2.40	1.91	2.43	2.29
Muscle Fat:Water Ratio‡	.034	.058	.095	.044	.034
Dressing Percentage‡ §	.....	79.9	80.5	80.7	80.7
Hens					
Wt. @ 24 wks. lbs.	.....	15.9	15.4	15.7	15.6
Wt. @ 26 wks., lbs.	0.5	15.7	15.3	16.4	15.9
24 wk. Breast Width, mm.	3.0	76.4	77.8	80.1	77.4
Skin Fat:Water Ratio‡	.91	2.09	2.09	1.97	1.49
Muscle Fat:Water Ratio‡	.024	.048	.053	.039	.037
Dressing Percentage‡ §	.....	82.1	78.1	82.4	82.8

*Least significant difference, t=.05.

†At 20 weeks of age the diets were diluted with ⅓ part grain, corn for the 850 calorie diets and oats for the 660 calorie diets.

‡Six birds of each sex slaughtered from each pen for chemical analysis and dressing percentage calculations, hens @ 24 wks., toms @ 26 wks.

§Ice-water cooled (by submersion 12 hrs.) eviscerated carcass weights compared to live weights immediately before slaughter.

Discussion

In none of the work herein reported has there been an attempt to determine to what extent oats could replace corn in diets for growing turkeys. Neither was an attempt made to determine what exact level of energy and protein is optimum for growing turkeys.

Earlier work (2) had indicated that growth was not impaired at caloric levels as low as 720 calories of productive energy per pound. The data given in this report indicate that growth is impaired by diets containing only 675 calories per pound. It is not likely that these differences in caloric value account entirely for the differences in results. More likely is that the improved growth rates, resulting from using antibiotics during the early growth period as well as starter diets more adequate in protein and vitamin contents, accentuated the energy requirements for later growth.

The previous work had indicated that some diets which contained up to 40 percent oats or about 850 calories per pound promoted maximum feed efficiency. Under the later conditions, however, diets of higher density were much more efficient although there was little difference in relative caloric value on the weight basis.

Other considerations such as vitamin fortification and protein level may have also affected these results. Although a higher protein level was of little effect under the conditions of the 1952 trial, the over-all results may have been greatly affected by the higher protein level in 1955.

With the concept of a definite calorie to percent protein ratio optima set forth by Combs et al (3) and others, it appears quite likely that

Figure 1. Typical range condition for trials after about eight weeks on experiment. Note that the pen of turkeys on the right has consumed the most forage—typical of turkeys on low energy diets.

Figure 2. None of the pens had forage by the end of the experimental periods.

protein did influence the results of the 1955 trial. The calorie to percent protein ratio was 45:1 on the high energy diets and 35:1 on the low energy diets to 20 weeks of age, whereas from 20 to 26 weeks the ratios were 58:1 and 40:1, respectively. Insufficient data are available to establish an optimum calorie to percent protein ratio. However it would appear that a ratio of 45:1 from 12 to 20 weeks of age, widened afterwards to at least 55:1, should promote rapid growth and a good feed efficiency in turkeys.

The data in this report have not thus far taken into consideration the economics of the relative value of high energy (corn) and low energy (oats) diets. In general, only high quality heavy oats was used. It was demonstrated that low energy diets made up with oats could be used to 24 weeks of age without greatly impairing the growth rates and that the birds could be finished off uniformly on high energy diets. However, corn may be the most economical carbohydrate source in the diet unless the relative cost per pound of oats is about 70 percent or less than that of corn. As an example, with prices as they prevailed in Brookings during a large part of the 1955 season (oats $1.70 and corn $2.30 a cwt.), feed cost alone from 12 to 24 weeks of age was about 19 cents per pound of gain for the corn diets and 20.6 cents per pound of gain for the oats diets. To really establish what might be the most economical diet, a graded series of levels of oats replacing corn in the total ration should be used under today's conditions. This should preferably be done with a pelleted feed to minimize the bulky condition of oats diets.

Summary

Relatively high energy diets (850 calories of productive energy per pound) for growing turkeys from 12 to 28 weeks of age supported superior rates of growth compared to that of relatively low energy diets (675 calories of productive energy per pound).

Feed efficiency was from 10 to 25 percent better on the high energy diets, depending on the season and amount of green forage available.

A greater degree of fleshing and finish was evident with the high energy diets. This was substantiated by the greater breast width measurements and the greater percent fat to percent water ratio obtained by skin analysis.

Antibiotics showed greater and more consistent advantages with low energy diets than with high energy diets under these conditions. Under conditions of environmental stress (cold weather) the value of antibiotics appeared to be greater.

Using protein levels of either 16 or 19 percent in mash diets for turkeys from 12 to 24 weeks of age had little effect on growth rate. However, with pelleted feed that contained 19 percent protein, growth was more rapid than had been experienced before. Growth to 24 weeks of age was only slightly affected by energy level with either type of pelleted feeds but was significantly greater on high energy diets at 26 weeks of age. The high energy diet (57 percent corn–850 calories per pound) promoted cheaper gains than the low energy diet (62 percent oats–660 calories per pound) in 1955.

Diets with a calorie to percent protein ratio of 45:1 from 12 to 20 weeks of age, then widened to 58:1, produced satisfactory weight gains, feed efficiency, fleshing, and finish.

The diets used had no great effect on dressing percentages except that hens fed the low energy diets without chlortetracycline did not yield quite as well. Chlortetracycline appeared to enhance carcass yield of hens with either low or high energy diets.

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