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COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA  
AGRICULTURAL EXPERIMENT STATION  
RESEARCH BULLETIN 100

## **The Utilization of Food Elements by Growing Chicks**

**V. A Comparison of Cottonseed Meal and Linseed Oil Meal as Portions  
of the Protein Concentrate**

C. W. Ackerson, M. J. Blish, and F. E. Mussehl

LINCOLN, NEBRASKA  
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## SUMMARY

1. Two lots of newly hatched chicks were fed rations differing only in five per cent of their make-up. In the ration of one lot five parts of linseed oil meal were added to 95 parts of the base, and in the other ration a mixture of 4.5 parts of cottonseed meal and 0.5 part of starch was added, to keep the protein level the same. The remaining portions of the two concentrates were made up of five parts each of meat scraps and fish meal.

2. The amounts of feed consumed by all chicks of both lots were kept identical by hand feeding all chicks equal amounts daily.

3. The compositions of the chicks at the end of six weeks' feeding trial were determined, and the compositions of the gains calculated.

4. The lot fed cottonseed meal made slightly better gains per unit of feed and nitrogen fed.

5. The retention of nitrogen, calcium and phosphorus was slightly higher for the lot fed cottonseed meal.

## CONCLUSIONS

1. The rate of gain (gain in weight divided by the weight of dry matter fed) was slightly lower when linseed oil meal instead of cottonseed meal was fed as one-third of a concentrate in conjunction with meat scraps and fish meal in a ration for growing chicks. Neither linseed oil meal nor cottonseed meal are as efficient supplements to meat scraps and fish meal as are dried buttermilk and soybean meal used in earlier feeding trials.

2. The lot fed cottonseed meal retained 38 per cent of the nitrogen fed, while the linseed-oil-meal lot retained about 36 per cent. These figures are lower than previous ones obtained when dried buttermilk or soybean meal were fed as five per cent of rations otherwise identical.

3. The retentions of calcium and phosphorus were slightly greater by the chicks of the lot fed cottonseed meal.

4. With the base used cottonseed meal is somewhat more efficient as a supplement to meat scraps and fish meal than is linseed oil meal, but neither is as good as dried buttermilk or soybean meal. Where rapid growth is desired the latter are to be preferred, but where the rate of growth is not so important cottonseed meal and linseed meal may be used.

# The Utilization of Food Elements by Growing Chicks

## V. A Comparison of Cottonseed Meal and Linseed Oil Meal as Portions of the Protein Concentrate

C. W. ACKERSON, M. J. BLISH, AND F. E. MUSSEHL

A continuing series of experiments at this Station is concerned with the utilization of food elements by growing chicks. In this series the base of the rations fed has been mixed from corn meal, shorts, bran, oats, alfalfa meal, calcium carbonate, and sodium chloride, and has made up 85 per cent of the ration. Variations in the concentrate constituted the experimental variable. Some of the results have been as follows: the growth of chicks was better on a mixture of animal proteins than when vegetable proteins were used as the concentrate (1); a mixture of meat scraps, fish meal and dried buttermilk was better than meat scraps alone (2), while it was found that soybean meal could be substituted for a third of a mixture of meat scraps and fish meal without altering the growth rate up to six weeks of age (3).

Berry (4) concluded that in a growing mash containing ten per cent of dried buttermilk, cottonseed meal produced satisfactory growth as efficiently as did meat and bone scraps, but that growth of the chicks during the first eight weeks was slower. Goff and Penquite (5) found that when supplemented with dried buttermilk or meat scraps, cottonseed meal gave satisfactory results with growing chicks, but that corn gluten meal was a poor supplement. Ringrose and Morgan (6) concluded that cottonseed meal may be used satisfactorily in a starting ration for chicks when properly supplemented. Work at the Ohio station showed that the proteins of cottonseed meal were more efficient than those of linseed meal (7).

The purpose of this experiment was to compare the utilization of the nitrogen, calcium, and phosphorus when one-third of the concentrate of the ration of growing chicks was furnished by cottonseed meal or linseed meal respectively, the remainder of the concentrates being composed of equal parts of meat meal and fish meal. It was planned to test the practicability of substituting cottonseed or linseed meal for dried buttermilk or soybean meal fed in conjunction with meat meal and fish meal as the concentrate.

### PREPARATION OF THE RATIIONS

The base of the rations fed in this experiment was composed of the same ingredients used in the earlier papers of this series. The protein concentrate consisted of meat and fish meals plus either cottonseed or linseed oil meal. Thus 95 per cent of each ration was identical with the other. This portion of the ration was mixed in quantity sufficient for the two lots, and to half was added five pounds of linseed oil meal (protein

content 37.6 per cent) and to the other four and one-half pounds of cottonseed meal (protein content 41.5 per cent) plus one-half pound of starch. The cottonseed meal was diluted with starch to bring it to the same protein content as the linseed oil meal, thus keeping the protein levels of the two rations identical. The rations were mixed as follows:

The rations were mixed by compounding the ration minus either cottonseed meal or linseed meal, and adding these later. After mixing, the mash was pelleted by means of a 5/32-inch die. The five parts of cottonseed meal or linseed oil meal contained 1.88 parts of protein, and this difference constitutes the experimental variable of the ration. The composition of the rations is given in Table 1.

Ingredients	Ration	Ration
	CSM	LOM
	<i>Lbs.</i>	<i>Lbs.</i>
Yellow cornmeal.....	32	32
Shorts .....	20	20
Bran .....	10	10
Pulverized oats.....	10	10
Alfalfa meal.....	10	10
Meat meal.....	5	5
Fish meal.....	5	5
Linseed oil meal....	0	5
Cottonseed meal....	4.5	0
Cornstarch .....	0.5	0
Pulverized calcium carbonate .....	2	2
Sodium chloride.....	1	1

TABLE 1.—Analyses of the rations.

Ration	Water	Ash	Nitrogen	Calcium	Phosphorus
	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>
CSM .....	11.2	6.6	3.11	1.21	0.70
LOM .....	12.2	6.6	3.11	1.29	0.69

  

Ration	Crude fat	Crude fiber	Protein	N-free extract	Ratio Ca:P
	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	<i>P.ct.</i>	
CSM .....	4.3	6.8	19.5	51.6	1.73
LOM .....	3.9	6.8	19.5	51.0	1.87

## EXPERIMENTAL FEEDING

The chicks used in the experimental feeding were single-comb Rhode Island Reds chosen in a weight range of 37 to 41 grams, with an average weight of 38 grams initially in each lot. The practice of feeding all chicks in both lots the same quantity of food daily was continued. Forbes, Voris, Bratzler, and Wainio (8) in work with rats kept the intake of feed within quadruplets the same but permitted the intake to vary among sets of quadruplets. They state that "this method of food assignment was designed to be as nearly equitable as possible, but in the course of its use it becomes somewhat inequitable to those individuals that have received the more efficient diets." They also observed that the variation in intake among quadruplets affected the use of food energy and protein, so that the data were interpreted on the basis of the data derived from the quadruplets of rats which ate essentially the same quantity of food. Their

work confirms our belief that the intake of the chicks should be identical both among and within lots fed experimental rations. However, marked differences in the nutritive values of rations being compared will undoubtedly result in refusals of food by the lot fed the poorer of the rations, and prevent a direct comparison.

The chicks in this experiment were not force fed. Instead, the pellets were withheld for a day, and then small amounts were weighed out by lot and placed in a shallow feeding pan in the brooder. The chicks quickly learned to take the pellets. Such pellets as were scattered were retrieved from the paper-covered dropping pan below the half-inch wire mesh which forms the bottom of the brooder. Feeding in this manner was continued for four days, during which time the average consumption of food per chick was 17 grams. On the fifth day each chick was assigned to an individual feeding can seven inches square and eleven inches deep in which a shallow feeding pan containing five grams of feed was placed. Each chick was placed in its feeder three or four times daily for its ration. The ration for each chick was stored in its own diet bottle, from which allocations of feed were made three times daily. The amount of feed offered daily corresponded to the feeding schedule observed in previous work where the feed was force-fed. The chicks consumed their quota in five minutes at most, and fouling of feed by droppings was very infrequent. Loss of feed was prevented by the tall sides of the feeder.

The average amount of feed taken by each chick during the four days of feeding by lot was 17 grams, an amount equal to less than two per cent of the total amount fed during the experiment. The loss of feed by scatteration was negligible because of the frequent retrieving of pellets from the tray. Inequalities in the intake of the feed could not have been significant, and they in turn would have but a relatively small effect on the feed consumption over the whole period.

Twenty chicks were started in each lot on March 23. Three chicks of the linseed-meal lot refused to eat at the required rate of the group and were discarded at the end of the first week. During the remainder of the feeding trial all chicks were kept on schedule, and no losses were recorded. The lots were kept in separate electrically heated brooders in a room in which the minimum temperature was kept above 70° F. Cod-liver oil was fed individually by burette at a level of 0.5 per cent of the ration. No abnormalities due to vitamin deficiency or nutritional failure were observed. Records of interval weights of individual chicks were kept, and by comparison with the food-intake record rates of gain of all chicks were calculated. The averages are presented for both sexes of each lot in Table 2. Up to the end of the experimental period the rate of gain of the chicks of the lot fed cottonseed meal was slightly higher than that of the other lot. It is to be noted, however, that the rate of gain on the last increment of 142 grams of dry matter was substantially lower in the cottonseed-meal lot than in the linseed-oil-meal lot. In earlier work at this station the base of the rations fed was mixed ac-



ording to the formula used in this work. In addition two-thirds of the concentrate in all cases was composed of equal parts of meat scraps and fish meal. In three experiments (1, 2, 9) the other protein was dried buttermilk. In another case (3) soybean meal furnished the remaining third of the concentrate. Thus comparisons can be made covering rations differing only in the source of five per cent of the ration and involving one-third of the concentrate. So far dried buttermilk, soybean meal, cottonseed meal, and linseed oil meal have been fed in conjunction with meat scraps and fish meal. Based on the rates of gain of chicks on these rations, the order of preference of concentrate to supplement the meat scraps and fish meal is soybean meal, dried buttermilk, cottonseed meal, and linseed oil meal.

At the end of the 42-day feeding trial the chicks were killed by ether anesthesia, at which time the sex of the chicks was verified and the net weight of each determined. Table 3 shows the net weights of the chicks by sex and lot, together with their standard errors. Differences between lots are not large, but an analysis of the net weights shows that the value of "F" is 3.97, which lies between the one per cent point of 4.44 and the five per cent point of 2.89, indicating a significant difference (Table 4).

TABLE 2.—Rates of gain of chicks.

RATES OF GAIN ON SUCCESSIVE INCREMENTS OF DRY MATTER						
Age of chicks ( <i>days</i> ) .....	18	24	30	34	38	42
Dry matter increment ( <i>g.</i> ).....	152	117	145	115	123	142
LOT CSM						
11 males, rate of gain ( <i>p.ct.</i> ).....	48	49	46	40	42	29
9 females, rate of gain ( <i>p.ct.</i> ).....	50	45	43	41	43	28
LOT LOM						
12 males, rate of gain ( <i>p.ct.</i> ).....	48	44	42	39	38	36
5 females, rate of gain ( <i>p.ct.</i> ).....	44	46	40	33	37	34
RATES OF GAIN OF CHICKS, CALCULATED AT ATTAINED WEIGHT ON GAIN OVER INITIAL WEIGHT						
Total dry matter fed ( <i>g.</i> ) .....	152	269	414	529	652	794
LOT CSM						
11 males, rate of gain ( <i>p.ct.</i> ).....	48	48	47	46	45	42 <sup>1</sup>
9 females, rate of gain ( <i>p.ct.</i> ).....	50	48	46	45	44	42 <sup>1</sup>
LOT LOM						
12 males, rate of gain ( <i>p.ct.</i> ).....	48	46	45	43	42	41 <sup>1</sup>
5 females, rate of gain ( <i>p.ct.</i> ).....	44	45	43	41	40	39 <sup>1</sup>

<sup>1</sup> These values differ from the ones in Table 5, since the latter are based on the net-weight and these on the live-weight figures.

TABLE 3.—*Mean net weights<sup>1</sup> at slaughter and their standard errors.*

Lot	Males	Females	Males and females (unweighted mean)
	<i>Grams</i>	<i>Grams</i>	<i>Grams</i>
CSM .....	356.55±4.11	351.00±4.55	353.78±3.05
LOM .....	348.50±3.94	331.40±6.10	339.95±3.31
Unweighted mean...	352.53±2.85	341.20±3.65	348.87±2.24

<sup>1</sup> The net weight is the weight of the chick after removal of contents of the digestive tract.

TABLE 4.—*Primary analysis of the net body weights.*

Source of variation	Degrees of freedom	Sum of squares	Variance	Standard deviation
Subclass .....	3	2,212.75	737.58	....
Error .....	33	6,136.93	185.97	13.64
Total .....	36	8,349.68	231.93	....

The analytical procedure was not changed from that used in earlier work. Two chicks of like sex and equal weight were analyzed together by digesting both in concentrated hydrochloric acid which required about two days on the steam bath. This resulted in a mixture which was homogeneous save for the layer of fat which rose to the surface. Chilling the whole digest makes it possible to draw off the material below the fat layer, and by transferring the fat and adherent matter to a smaller tall form beaker the process was repeated, leaving a residue containing only small amounts of the original acid digest. From this the fat was separated by dissolving in ether and drawing off the solvent plus fat. By using a tared flask from which the ether can be distilled, solvent losses are not unduly large, and a weighing of the dried flask yields a good estimate of the fat content of the carcass.

However, the chief reason for the removal of the fat is that its presence in the digest makes sampling difficult. With its removal, the digest can be made to volume and aliquots used for subsequent analysis. In the case of calcium and phosphorus, aliquots representing five per cent of the chicks are digested, first with nitric, and after the readily oxidizable material has been oxidized a mixture of nitric and perchloric acids is used, resulting in complete oxidation of organic matter. Care must be used to prevent too violent oxidation by the perchloric acid. Aliquots have been lost through deflagration but no serious explosions have resulted. If the mixture gives indications of oxidizing too rapidly after the addition of perchloric acid, the reaction may be effectively slowed down by the addition of some nitric acid.

The estimations of the content of nitrogen, calcium, and phosphorus in the gains of the chicks were made by comparing the amount found in the chicks by analysis for these elements at the end of the test and the initial content of 0.95, 0.15, and 0.11 gram of nitrogen, calcium and phosphorus in the newly hatched chick (2). The growth data, rates of

gain, and percentage composition of chicks and gains, together with the retentions of nitrogen, calcium, and phosphorus are given in Table 5.

TABLE 5.—*Summary of growth and analytical data on chicks.*

Item	Cottonseed meal		Linsced oil meal	
	Male	Female	Male	Female
Number of chicks	11	9	12	5
Net weight (g.)	357	351	348	331
Gain in weight (g.)	318	313	310	293
Dry matter fed (g.)	799	799	790	790
Rate of gain (p.ct.)	39.9	39.1	39.2	37.1
Gain per gram nitrogen fed (g.)	11.4	11.2	11.1	10.5
Nitrogen in chicks (p.ct.)	3.26	3.30	3.23	3.23
Calcium in chicks (p.ct.)	0.98	0.95	0.94	0.93
Phosphorus in chicks (p.ct.)	0.68	0.65	0.65	0.64
Ratio, Ca:P in chicks	1.44	1.46	1.45	1.45
Nitrogen in gain (p.ct.)	3.35	3.40	3.33	3.33
Calcium in gain (p.ct.)	1.05	1.02	1.00	1.00
Phosphorus in gain (p.ct.)	0.72	0.70	0.69	0.69
Ratio, Ca:P in gain	1.46	1.46	1.45	1.45
Ether extract (p.ct.)	4.6	5.2	4.2	4.6
Nitrogen intake (g.)	27.97	27.97	27.97	27.97
Nitrogen in gain (g.)	10.67	10.64	10.32	9.74
<b>Nitrogen retained (p.ct.)</b>	<b>38.2</b>	<b>38.0</b>	<b>36.9</b>	<b>34.8</b>
Calcium intake (g.)	10.87	10.87	11.58	11.58
Calcium in gain (g.)	3.36	3.19	3.11	2.92
<b>Calcium retained (p.ct.)</b>	<b>30.9</b>	<b>29.3</b>	<b>26.9</b>	<b>25.2</b>
Phosphorus intake (g.)	6.29	6.29	6.15	6.15
Phosphorus in gain (g.)	2.30	2.18	2.15	2.02
<b>Phosphorus retained (p.ct.)</b>	<b>36.6</b>	<b>34.7</b>	<b>34.9</b>	<b>32.7</b>

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