2-1938

# The Utilization of Food Elements by Growing Chicks. IV. Meat Meal and Fish Meal Compared with Meat Meal, Fish Meal, and Soybean Meal as Protein Concentrates

C. W. Ackerson

M. J. Blish

F. E. Mussehl

COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA
AGRICULTURAL EXPERIMENT STATION
RESEARCH BULLETIN 97

# The Utilization of Food Elements by Growing Chicks

## IV. Meat Meal and Fish Meal Compared with Meat Meal, Fish Meal, and Soybean Meal as Protein Concentrates

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

LINCOLN, NEBRASKA
FEBRUARY, 1938

COLLEGE OF AGRICULTURE UNIVERSITY OF NEBRASKA
AGRICULTURAL EXPERIMENT STATION
RESEARCH BULLETIN 97

# The Utilization of Food Elements by Growing Chicks

## IV. Meat Meal and Fish Meal Compared with Meat Meal, Fish Meal, and Soybean Meal as Protein Concentrates

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

LINCOLN, NEBRASKA
FEBRUARY, 1938

## SUMMARY

1. Two groups of 15 newly hatched chicks were fed rations differing in the composition of the protein concentrates. One lot received ration 2MFX, in which the concentrate was a mixture of meat meal and fish meal. In ration 3MFSX one-third of the meat and fish meals was replaced by soybean meal. The protein levels of the concentrates and of the rations as fed, were identical.

2. The composition of the chicks at the end of the feeding trial was determined, and the composition of the gains calculated.

3. The gain in live weight per gram of nitrogen or dry matter fed was practically identical in the two lots.

4. The retention of nitrogen by the chicks of the two lots was not significantly different.

5. The variation within lots was as great as that between lots; hence the slight variations in the retention of calcium and phosphorus were not judged significant.

# The Utilization of Food Elements by Growing Chicks

## IV. Meat Meal and Fish Meal Compared with Meat Meal, Fish Meal, and Soybean Meal as Protein Concentrates

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

The past few years have seen a great increase in the production of soybeans in this country. The reason for this is found largely in the increased use of soybeans in animal feeding as well as in the manufacture of edible products such as oleomargarine and lard substitutes and in the expanding requirements of industry for basic materials, notably in the manufacture of paints, enamels, and plastics. The soybean has been a staple in the human diet in the Orient for centuries. Its use as an animal food has been studied at many of the experiment stations by means of feeding trials with domestic animals as well as laboratory animals. Its use in rat work is widespread.

Philips and Hauge (1), Tomhave and Mumford (2), and Miller and Bearse (3) studied the value of soybean meal as a protein supplement for laying hens. Kennard, Holder, and White (4) found a mixture of soybean meal and corn meal only slightly inferior to corn meal and buttermilk for fattening cockerels. The value of soybean meal in the ration of growing chicks was investigated by Philips, Carr, and Kennard (5), Tomhave and Mumford (6), and Carver, St. John, Miller, and Bearse (7). In general it is believed that soybean meal can replace a portion of the animal protein in a growing ration. The effect of heat in the preparation of soybean meal was studied by Wilgus, Norris, and Heuser (8), who found raw meals inferior in protein efficiency to the well-cooked meals.

In work at this station (9) it has been shown that a protein concentrate derived from animal sources is better than one mixed from vegetable sources and (10) that a mixture of animal proteins promotes slightly better growth than a single animal protein concentrate in the ration of growing chicks. In view of the absence of specific work on the effect of supplanting a portion of the meat and fish meals with soybean meal, an experiment was planned wherein the variable consisted of introducing soybean meal into the concentrate.

### PREPARATION OF THE RATIONS

In the preparation of the rations used in this experiment the base was the same as that used in earlier work in this series (9). In this test the experimental variable planned was that of the protein concentrate. In one instance a mixture of meat meal and fish meal was used, and in the other a mixture of meat meal, fish meal, and soybean meal was fed. This work extends the findings with regard to animal and vegetable protein concentrates for growing chicks, and also permits conclusions to be drawn with respect to the feasibility of substituting soybean meal for a portion of the meat and fish meal of the concentrate. The soybean meal used was produced by the expeller process.

The rations were mixed as in previous work; that is, a quantity of the base was mixed and divided into two portions. To 85 pounds of one portion was added a mixture of five pounds each of meat meal, fish meal, and soybean meal, and designated as ration 3MFSX. In order to have a second concentrate with the same protein content, one was made up of a mixture of 6.42 pounds each of meat meal and fish meal, together with 1.93 pounds of starch. Fifteen pounds of this concentrate were mixed with 85 pounds of the base and designated as ration 2-MFX. The rations were mixed as follows:

| Ingredients | 2 MFX | 3 MFSX |
|---|---|---|
| | *Lbs.* | *Lbs.* |
| Yellow corn meal | 32 | 32 |
| Shorts | 20 | 20 |
| Bran | 10 | 10 |
| Pulverized oats | 10 | 10 |
| Alfalfa meal | 10 | 10 |
| Meat meal | 6.42 | 5 |
| Fish meal | 6.42 | 5 |
| Soybean meal | 0 | 5 |
| Corn starch | 1.92 | 0 |
| Pulverized calcium carbonate | 2.24 | 2 |
| Sodium chloride | 1 | 1 |

The protein concentrate of each ration contained 58 per cent protein and the finished rations were found to have 19.8 per cent. Each ration was pelleted with a 5/32-inch die. The protein concentrate in each ration contained 44 per cent of the total protein of the ration, the other 56 per cent obviously coming from the base. The variable is thus seen to lie in the substitution of soybean meal for one-third of the meat and fish meals. The composition of the rations is given in Table 1.

TABLE 1.—*Analyses of the rations.*

| Ration | Water | Ash | Nitrogen | Calcium | Phosphorus |
|---|---|---|---|---|---|
| | *P.ct.* | *P.ct.* | *P.ct.* | *P.ct.* | *P.ct.* |
| 2-MFX | 9.5 | 7.6 | 3.17 | 1.55 | 0.74 |
| 3-MFSX | 9.5 | 7.0 | 3.17 | 1.34 | 0.74 |

| Ration | Crude fat | Crude fiber | Protein | N-free extract | Ratio Ca:P |
|---|---|---|---|---|---|
| | *P.ct.* | *P.ct.* | *P.ct.* | *P.ct.* | |
| 2-MFX | 3.8 | 8.5 | 19.8 | 50.8 | 2.10 |
| 3-MFSX | 4.0 | 8.5 | 19.8 | 51.2 | 1.81 |

## EXPERIMENTAL FEEDING

The chicks used in this experiment were chosen from a group of 51 which were hatched from a setting of 100 eggs, each weighing 56±1 grams. Thirty chicks were selected which weighed between 35 and 39 grams, and these were divided into two lots of 15 each. The average initial weight was 37 grams in each lot. No chicks were lost from these lots during a feeding trial of 42 days which began October 23. No changes were made in the technique of handling and feeding these chicks from that described in recent papers of this series (9, 10). Feeding equal amounts to all chicks daily was continued, so that the matter of a variable intake did not enter into the experimental error. Cod-liver oil was fed individually by burette at a level of 0.6 per cent of the ration. The chicks were weighed individually at intervals which coincided most closely with the consumption of 150 grams of air-dry feed by each chick. From these weights the rates of gain on successive increments of dry matter and the rates of gain at period weights were calculated. The results of such calculations are given in Table 2.

TABLE 2.—*Rates of gain of chicks.*

| | | | | | | |
|---|---|---|---|---|---|---|
| RATES OF GAIN ON SUCCESSIVE INCREMENTS OF DRY MATTER | | | | | | |
| Age of chicks, days | 17 | 24 | 31 | 35 | 39 | 42 |
| Dry matter increment (*g.*) | 136 | 126 | 158 | 123 | 149 | 122 |
| LOT 2 MFX | | | | | | |
| 9 males, rate of gain (*p.ct.*) | 54 | 53 | 46 | 49 | 48 | 39 |
| 6 females, rate of gain (*p.ct.*) | 52 | 51 | 42 | 45 | 44 | 41 |
| LOT 3 MFSX | | | | | | |
| 5 males, rate of gain (*p.ct.*) | 51 | 48 | 45 | 46 | 44 | 42 |
| 10 females, rate of gain (*p.ct.*) | 54 | 45 | 45 | 46 | 46 | 39 |
| RATES OF GAIN OF CHICKS, CALCULATED AT ATTAINED WEIGHT ON GAIN OVER INITIAL WEIGHT | | | | | | |
| Total dry matter fed (*g.*) | 136 | 262 | 420 | 543 | 692 | 814 |
| LOT 2 MFX | | | | | | |
| 9 males, rate of gain (*p.ct.*) | 54 | 53 | 51 | 50 | 49 | 48[1] |
| 6 females, rate of gain (*p.ct.*) | 52 | 51 | 48 | 47 | 46 | 45[1] |
| LOT 3 MFSX | | | | | | |
| 5 males, rate of gain (*p.ct.*) | 51 | 50 | 48 | 48 | 47 | 46[1] |
| 10 females, rate of gain (*p.ct.*) | 54 | 50 | 48 | 47 | 47 | 46[1] |

[1] 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.

At the end of the feeding period the chicks were killed by ether anesthesia after feed had been withheld for 16 hours. After chilling sufficiently to prevent loss of blood the intestinal tract was emptied of its contents. Nitrogen was determined on the contents of the proventriculus and gizzard; thus the nitrogen found could be subtracted from the abount fed since it represents unused nitrogen in the body at death. This correction involves but 0.1 per cent of the nitrogen fed and could be ignored without noticeable effect on the accuracy of the final results. The sex and net weight of each chick were noted at this time. From the net weights of the chicks in the two lots the mean net weights were calculated, together with their standard errors. These data are given in Table 3, and show that no marked difference existed between lots. When these differences were tested for significance by the method of weighted squares of means, a value for

'F' of 2.76 was found. The five per cent point of 'F' on the basis of Table 4 is 2.98; thus there was no significant difference apparent in the primary analysis of the net body weights. The standard deviation was 15.23, so that with a mean net weight of 398 grams the coefficient of variation is 3.8 per cent. In this experiment the chance distribution of males and females led to unequal numbers of the sexes in both lots, which increased the standard deviation and consequently the coefficient of variation.

TABLE 3.—*Mean net weights*[1] *at slaughter and their standard errors.*

| Lot | Males | Females | Males and females (unweighted mean) |
|---|---|---|---|
| | *g.* | *g.* | *g.* |
| 2-MFX | 410.67±5.08 | 390.00±6.22 | 400.33±4.01 |
| 3-MFSX | 398.00±6.80 | 394.50±4.82 | 396.25±4.17 |

[1] The net weight of the chick after removal of the 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 | 1,918.47 | 639.49 | .... |
| Error | 26 | 6,030.50 | 231.94 | 15.23 |
| Total | 29 | 7,948.97 | 274.10 | .... |

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

| Item | Ration 2-MFX Male | Ration 2-MFX Female | Ration 3-MFSX Male | Ration 3-MFSX Female |
|---|---|---|---|---|
| Number of chicks | 9 | 6 | 5 | 10 |
| Net weight (*g.*) | 411 | 390 | 398 | 394 |
| Gain in weight (*g.*) | 375 | 354 | 361 | 357 |
| Dry matter fed (*g.*) | 814 | 814 | 814 | 814 |
| Rate of gain (*p.ct*) | 46.1 | 43.5 | 44.4 | 43.9 |
| Gain per g. nitrogen fed (*g.*) | 13.1 | 12.4 | 12.7 | 12.5 |
| Nitrogen in chicks (*p.ct.*) | 3.17 | 3.17 | 3.19 | 3.16 |
| Calcium in chicks (*p.ct.*) | 0.96 | 0.95 | 0.94 | 0.87 |
| Phosphorus in chicks (*p.ct.*) | 0.65 | 0.64 | 0.64 | 0.60 |
| Ratio, Ca:P in chicks | 1.48 | 1.48 | 1.47 | 1.45 |
| Nitrogen in gain (*p.ct.*) | 3.22 | 3.23 | 3.26 | 3.21 |
| Calcium in gain (*p.ct.*) | 1.01 | 1.00 | 0.99 | 0.92 |
| Phosphorus in gain (*p.ct.*) | 0.68 | 0.68 | 0.67 | 0.64 |
| Ratio, Ca:P in gain | 1.49 | 1.47 | 1.48 | 1.44 |
| Ether extract (*p.ct.*) | 6.3 | 7.1 | 5.4 | 7.2 |
| Nitrogen intake (*g.*) | 28.51 | 28.51 | 28.51 | 28.51 |
| Nitrogen in gain (*g.*) | 12.07 | 11.43 | 11.77 | 11.49 |
| **Nitrogen retained** (*p.ct.*) | **42.3** | **40.1** | **41.3** | **40.3** |
| Calcium intake (*g.*) | 13.96 | 13.96 | 12.08 | 12.08 |
| Calcium in gain (*g.*) | 3.79 | 3.54 | 3.58 | 3.29 |
| **Calcium retained** (*p.ct.*) | **27.2** | **25.4** | **29.6** | **27.3** |
| Phosphorus intake (*g.*) | 6.66 | 6.66 | 6.66 | 6.66 |
| Phosphorus in gain (*g.*) | 2.56 | 2.39 | 2.44 | 2.27 |
| **Phosphorus retained** (*p.ct.*) | **38.4** | **36.0** | **36.6** | **34.2** |

## CONCLUSIONS

1. The rate of gain (gain in weight divided by the weight of dry matter fed) was not materially altered by substituting soybean meal for one-third of the meat meal and fish meal of the protein concentrate of the ration of growing chicks. The gain of newly hatched chicks fed for six weeks amounted to 44 per cent of the dry matter fed.

2. The mean net weight of the chicks fed the mixture of meat meal, fish meal, and soybean meal was not significantly different from that of the lot fed a mixture of meat meal and fish meal as the protein concentrate of the ration.

3. In each of the two lots about 41 per cent of the nitrogen fed was retained in the gain.

4. Slightly less of the calcium was retained by the 2-MFX lot, but this lot retained slightly more of the phosphorus fed. The lower retention of calcium could be attributed to the slightly higher content of calcium in the feed. However, differences were as great within lots as between lots, so the differences were not significant.

5. With the base used, a mixture of meat meal, fish meal, and soybean meal can satisfactorily replace a mixture of meat meal and fish meal as the protein concentrate.

## LITERATURE CITED

1. PHILIPS, A. G. AND HAUGE, S. M.
1925. Ind. Agr. Exp. Sta. Bul. 293.

2. TOMHAVE, A. E. AND MUMFORD, C. W.
1936. Del. Agr. Exp. Sta. Bul. 197.

3. MILLER, M. W. AND BEARSE, G. E.
1937. Wash. Agr. Exp. Sta. Bul. 347.

4. KENNARD, D. C., HOLDER, R. C., AND WHITE, P. S.
1922. Amer. Jour. Physiol. 59:298-309.

5. PHILIPS, A. G., CARR, R. H., AND KENNARD, D. C.
1920. Jour. Agr. Res. 18:391-98.

6. TOMHAVE, A. E. AND MUMFORD, C. W.
1933. Del. Agr. Exp. Sta. Bul. 183.

7. CARVER, J. S., ST. JOHN, J. L., MILLER, M. W., AND BEARSE, G. E.
1935. Wash. Agr. Exp. Sta. Bul. 321.

8. WILGUS, H. S., NORRIS, L. C., AND HEUSER, G. F.
1936. Jour. Ind. and Eng. Chem. 28:586-88.

9. ACKERSON, C. W., BLISH, M. J., AND MUSSEHL, F. E.
1937. Nebr. Agr. Exp. Sta. Res. Bul. 90.

10. ACKERSON, C. W., BLISH, M. J., AND MUSSEHL, F. E.
1937. Nebr. Agr. Exp. Sta. Res. Bul. 94.

[2½M]