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# Protein requirements of chickens at various stages of growth and development II., Bulletin, no. 335

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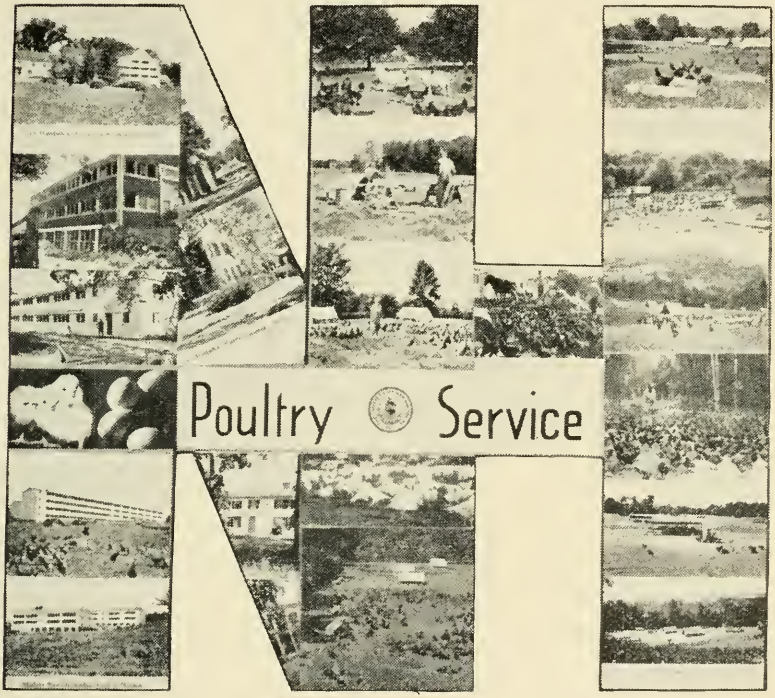


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# PROTEIN REQUIREMENTS OF CHICKENS AT VARIOUS STAGES OF GROWTH AND DEVELOPMENT* II

**A. E. Tepper, R. C. Durgin,[1] T. B. Charles, S. R. Shimer and H. A. Davis**

PREVIOUS work on this problem has been reported in Station Bulletin 312, covering the results of investigations in the period April, 1935 to August, 1938. Work reported in this bulletin was conducted from April, 1939 to August, 1940.

In the earlier studies of protein requirements of chicks described in Bulletin 312, chicks were raised to 70 weeks of age with meat scraps, dried skimmilk and fish meal as the protein sources in their rations. Results showed that increase of protein up to 18 or 20 per cent in the ration improved growth in the first 12-week period of age. Per cent of protein fed had no apparent relationship to body weight, while there was a definite relation between total feed consumed and body weight. Birds receiving the protein mixture and fish meal supplements were heavier at twelve weeks of age than were the meat scrap or dried skimmilk fed groups. Birds receiving lower protein feeds (range 15 to 19 per cent) were more efficient in use of feed in the 12 to 23 week age period. Birds receiving fish meal as their only animal protein, laid better than other birds, had a lower feed cost per dozen eggs, and were earliest in sexual maturity. The per cent of protein fed had no significant relation to size of eggs, or age of laying first egg. Fish meal in the ration did not produce any discernible flavor or odor in meat or eggs.

## EXPERIMENTAL METHODS

The previous work described in Bulletin 312 was conducted with all birds grown and maintained in batteries and laying cages throughout the experimental period. It was deemed wise to change this method to growth and maintenance of birds in floor pens to allow a comparison of the two methods of management as they may be influenced by percentage and type of protein fed the birds. This report is prepared in a form similar to that of Bulletin 312 for direct comparison.

April 6, 1939 twelve groups of 60 New Hampshire day-old chicks were started under electric brooders on floor pens and raised to 16 weeks of age. At six weeks of age all groups were reduced in number by approximately one half. At twenty-three weeks of age, each group was further reduced to fifteen females and two males each and continued as a breeding unit for future fertility and hatchability studies through a period terminating at 70 weeks of age. The weights reported after six weeks of age apply to females only.

*A cooperative project between the Poultry Husbandry and Agricultural and Biological Chemistry departments.

[1]Resigned, December 31, 1940.

The groups were fed various protein carrying rations as outlined below:

Groups 1, 2, and 3: basal ration plus meat scraps to make 15, 17, and 19 per cent protein content, respectively. Groups 4, 5, and 6: basal ration plus white fish meal, vacuum processed, to make 15, 17, and 19 per cent protein content, respectively. Groups 7, 8, and 9: basal ration plus dried skimmilk to make 15, 17, and 19 per cent protein content, respectively. Groups 10, 11, and 12: basal ration plus a combination of the three animal protein products in equal protein-carrying amounts to make 15, 17, and 19 per cent protein content, respectively.

The basal ration was composed of 200 pounds yellow corn meal, 100 pounds wheat bran, 100 pounds white flour middlings, 100 pounds ground heavy oats, 25 pounds alfalfa leaf meal, 15 pounds oyster shell flour, 5 pounds salt and 3 pounds biologically tested sardine oil. All groups were fed this ration plus the specified animal proteins in an all-mash form throughout the experiments.

All groups were weighed weekly throughout the first twenty-three week period using a random selection of 10-25 birds as a unit and calculating a simple average weight figure to apply to the group. Following the twenty-third week of age these weights were calculated every other week. Feed consumption records were determined weekly by groups throughout the experimental period.

## PROTEIN CONCENTRATES USED

The concentrates used consisted of meat scraps, vacuum-processed white fish meal, and dried skimmilk. The reader is referred to the previously mentioned publication for more complete details concerning their manufacture. Analyses of protein and mineral content of these concentrates and mixed rations are given in Table 1.

TABLE 1. CALCIUM, PHOSPHORUS, ASH AND PROTEIN CONTENT OF MIXED RATIONS AND PROTEIN SUPPLEMENTS

| Complete ration | Ash (per cent) | Calcium (per cent) | Phosphorus (per cent) | Ca:P | Protein (per cent) |
|---|---|---|---|---|---|
| 15% Meat scrap | 9.533 | 2.145 | .900 | 2.38:1 | ..... |
| 17% Meat scrap | 11.179 | 2.709 | 1.171 | 2.31:1 | ..... |
| 19% Meat scrap | 12.999 | 3.334 | 1.470 | 2.27:1 | ..... |
| 15% Fish meal | 9.077 | 1.970 | .824 | 2.39:1 | ..... |
| 17% Fish meal | 10.263 | 2.359 | 1.019 | 2.31:1 | ..... |
| 19% Fish meal | 11.562 | 2.786 | 1.232 | 2.26:1 | ..... |
| 15% Dried skimmilk | 8.804 | 1.721 | .743 | 2.31:1 | ..... |
| 17% Dried skimmilk | 9.856 | 1.896 | .876 | 2.16:1 | ..... |
| 19% Dried skimmilk | 11.175 | 2.115 | 1.043 | 2.03:1 | ..... |
| 15% Mixture | 9.161 | 1.962 | .828 | 2.37:1 | ..... |
| 17% Mixture | 10.323 | 2.314 | 1.009 | 2.29:1 | ..... |
| 19% Mixture | 11.483 | 2.665 | 1.192 | 2.23:1 | ..... |
| Meat scraps | 30.64 | 10.52 | 5.04 | 2.08:1 | 56.34 |
| Fish meal | 25.62 | 8.42 | 4.20 | 2.0 :1 | 62.22 |
| Dried skimmilk | 8.37 | 1.39 | 1.06 | 1.3 :1 | 34.76 |
| Basal ration | 7.83 | 1.56 | .62 | 2.5 :1 | 12.70 |

Records were maintained to measure the possible influence of protein source on the prevention of gizzard lesion.

## DISCUSSION

### STARTING PERIOD (0-12 WEEKS)

This experimental procedure, as previously noted, has been limited to a comparative study of three animal protein concentrates: namely, meat scraps, fish meal and dried skimmilk. Table 2 presents by stated weekly periods the weight records for the twelve groups of birds studied. With little exception, as the protein content of each ration increased, the growth rate of birds increased. These results are in harmony with previous reports to the effect that 18 to 20 per cent protein in the ration during the first twelve week period produces the greatest gains in weight.

To summarize by groups according to type of animal protein concentrate used, it will be noted that the mixed protein fed groups led with an average weight at twelve weeks of age of 2.733 pounds. Relatively slight differences between groups are apparent, however, except for the meat scrap groups having the lowest average weight of 2.470 pounds at 12 weeks of age.

Table 3 presents a summary of the recorded feed consumption levels by stated periods for all groups. It is noted that the widest difference in consumption level of feed over the entire twelve week period occurred between Groups 11 and 1, 10.250 pounds and 8.778 pounds respectively. All other groups were intermediate between these figures.

From the standpoint of efficiency in the utilization of feed according to pounds of feed required to produce one pound of gain over the initial twelve week period the reader is referred to Table 4. It will be noted that Group 8 (17% dried skimmilk) was most efficient,

TABLE 2A. SUMMARY OF WEIGHT RECORDS IN POUNDS PER BIRD BY STATED WEEKLY PERIODS FOR MEAT SCRAP GROUPS

| Age | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| 1 day | .0925 | .0928 | .0927 |
| 4 weeks | .4180 | .4850 | .4670 |
| 8 weeks | 1.330 | 1.312 | 1.392 |
| 12 weeks | 2.300 | 2.600 | 2.500 |
| 16 weeks | 3.225 | 3.375 | 3.500 |
| 19 weeks | 3.625 | 3.900 | 3.950 |
| 23 weeks | 4.325 | 4.500 | 4.400 |
| 27 weeks | 4.900 | 5.050 | 5.200 |
| 31 weeks | 5.300 | 5.425 | 5.200 |
| 35 weeks | 5.400 | 5.400 | 5.150 |
| 39 weeks | 5.500 | 5.450 | 5.200 |
| 43 weeks | 5.450 | 5.350 | 5.350 |
| 47 weeks | 5.900 | 5.800 | 5.600 |
| 51 weeks | 5.750 | 5.750 | 6.050 |
| 55 weeks | 5.750 | 5.800 | 5.500 |
| 59 weeks | 5.400 | 5.650 | 5.500 |
| 63 weeks | 5.250 | 5.250 | 5.700 |
| 67 weeks | 5.400 | 5.400 | 5.500 |
| 70 weeks | 5.364 | 5.364 | 5.455 |

with 3.365 pounds of feed required. Group 3, (19% meat scrap) was least efficient, requiring 4.017 pounds. Combining the three groups on each animal protein source we find the milk groups most efficient, with 3.702 pounds of feed required to produce one pound of gain. The fish, mixed protein and meat scrap groups follow in the order named with 3.726 pounds, 3.791 pounds and 3.897 pounds, respectively. The variations between groups are too small to be considered significant.

Table 5 presents a summary of mortality records for all groups, throughout the 23-week period. In no group was the mortality greater than five per cent and in all the pens the major causes of death were reported by the Poultry Pathology Laboratory as coccidiosis, accident and gizzard erosion.

## GROWING PERIOD (13-23 WEEKS)

Similar feed and management procedures were continued for the 13 to 23 week age period as during the initial twelve week period. Referring again to Table 2, it will be noted that Group 12 leads all others with an average weight of 4.825 pounds for females at 23 weeks of age. Group 4 was lowest in weight with 4.225 pounds per bird, average. Combining groups according to type of animal protein fed we find the mixed protein groups have maintained their lead with an average weight at 23 weeks of 4.567 pounds per bird. The milk, meat and fish groups follow in the order named.

Very slight differences are noted in Table 3 recording the total feed consumed during this period. Table 4 shows the 15 per cent dried skimmilk group to be most efficient in the utilizaton of feed with 8.382 pounds required per pound of gain. The least efficient was Group 6 (19% fish meal) with 11.120 pounds of feed required.

Birds that received meat scrap were most efficient in feed utilization with a requirement of 8.891 pounds of feed. The milk, mixed

TABLE 2B. SUMMARY OF WEIGHT RECORDS IN POUNDS PER BIRD BY STATED WEEKLY PERIODS FOR FISH MEAL GROUPS

| | Group 4 | Group 5 | Group 6 |
|---|---|---|---|
| 1 day | .0915 | .0903 | .0910 |
| 4 weeks | .4500 | .5350 | .5410 |
| 8 weeks | 1.308 | 1.518 | 1.640 |
| 12 weeks | 2.525 | 2.675 | 2.825 |
| 16 weeks | 3.275 | 3.525 | 3.375 |
| 19 weeks | 3.775 | 4.000 | 4.000 |
| 23 weeks | 4.225 | 4.500 | 4.375 |
| 27 weeks | 5.075 | 5.000 | 5.100 |
| 31 weeks | 5.000 | 5.250 | 5.350 |
| 35 weeks | 5.000 | 5.100 | 5.350 |
| 39 weeks | 5.510 | 5.550 | 5.350 |
| 43 weeks | 5.300 | 5.500 | 5.500 |
| 47 weeks | 5.500 | 5.600 | 5.700 |
| 51 weeks | 5.700 | 5.450 | 5.500 |
| 55 weeks | 5.800 | 5.550 | 5.000 |
| 59 weeks | 5.500 | 5.500 | 5.350 |
| 63 weeks | 5.400 | 5.250 | 5.400 |
| 67 weeks | 5.350 | 5.400 | 5.400 |
| 70 weeks | 5.208 | 5.231 | 5.423 |

protein and fish meal fed groups followed in the order named, with the latter requiring 10.299 pounds of feed.

All groups had started production previous to 24 weeks of age. Table 6 indicates the days in production for each group. Since the test terminated on the same day for all groups, those showing the most days in production were the first to start. Group 9 (19% dried skimmilk) started production before all others. This occurrence is just the reverse of that mentioned in Station Bulletin 312—the dried skimmilk fed groups "were somewhat slower in sexual maturity than were the other groups. Other than this, protein percentage of ration or kind of protein did not significantly influence date of sexual maturity." The results this year using floor management rather than cage management are in harmony with the last statement but without exception for the milk groups.

## PRODUCTION PERIOD (24-70 WEEKS)

As previously mentioned, at the start of the twenty-four week period all groups were reduced in number to 15 females each. Records of feed, weight and production were maintained for comparative studies.

All groups reached standard body weight or better by 50 weeks of age but throughout the production period the weights varied considerably. (See Table 2.) During the later period of production body weights per bird in all groups were reduced but in no group did the average fall below 5 pounds.

The total feed consumption per bird during this period, as shown in Table 3, varied from 91.2 pounds to 94.19 pounds. Generally, these figures are considered quite uniform and with but little preference between groups. There appears to be little relationship between the protein content of the ration and the total feed consumed. The

TABLE 2C. SUMMARY OF WEIGHT RECORDS IN POUNDS PER BIRD BY STATED WEEKLY PERIODS FOR DRIED SKIMMILK GROUPS

| | Group 7 | Group 8 | Group 9 |
|---|---|---|---|
| 1 day | .0907 | .0890 | .0912 |
| 4 weeks | .4280 | .4815 | .5130 |
| 8 weeks | 1.381 | 1.624 | 1.490 |
| 12 weeks | 2.450 | 2.825 | 2.625 |
| 16 weeks | 3.350 | 3.450 | 3.450 |
| 19 weeks | 3.825 | 4.150 | 3.950 |
| 23 weeks | 4.400 | 4.650 | 4.275 |
| 27 weeks | 4.900 | 4.900 | 4.700 |
| 31 weeks | 5.150 | 5.100 | 5.250 |
| 35 weeks | 5.200 | 5.200 | 5.150 |
| 39 weeks | 5.250 | 5.300 | 5.050 |
| 43 weeks | 5.400 | 5.350 | 5.200 |
| 47 weeks | 5.700 | 5.800 | 5.350 |
| 51 weeks | 5.700 | 5.700 | 5.450 |
| 55 weeks | 5.450 | 5.500 | 5.350 |
| 59 weeks | 5.300 | 5.350 | 5.300 |
| 63 weeks | 5.350 | 5.000 | 5.200 |
| 67 weeks | 5.150 | 5.300 | 5.250 |
| 70 weeks | 5.125 | 5.000 | 5.166 |

milk groups showed the lowest total feed consumed, 277.198 pounds, whereas the fish meal groups had the greatest total consumption, 282.553 pounds.

In a consideration of laying house mortality Table 5 indicates the mixed protein groups to have suffered least, followed by the fish meal, meat scrap and dried skimmilk fed groups, respectively. The range by groups was quite wide being from 5.8 per cent in Group 10 to 33.3 per cent in Groups 2 and 7.

Table 6 presents a cost comparison of feed consumption and egg production per bird for all groups.

As reported in Bulletin 312 there is a direct relationship between production and type of animal protein supplement. However, with birds managed in floor pens the relationship is not the same as when birds are in cages. We find, according to Table 6, that the mixed protein fed groups were most efficient in utilization of feed required to produce one dozen eggs with a figure of 7.33 pounds. The meat scrap groups were least efficient requiring 8.73 pounds of feed while the dried skimmilk and fish meal fed birds were intermediate with 7.86 and 8.41 pounds, respectively. Under cage management the dried skimmilk fed birds were relatively inefficient but under floor pen management they were the second most efficient in utilization of feed.

The rate of production was found to be in the same order as that of feed efficiency with the mixed protein groups leading. These show an average production per bird of 151.38 eggs whereas the meat scrap groups averaged but 127.27 eggs per bird.

A comparison of feed cost per dozen eggs produced is also presented. As protein content of ration is increased just so is the cost of that ration. Generally speaking, as the content of animal protein in the ration was increased, the feed cost per dozen eggs produced

TABLE 2D. SUMMARY OF WEIGHT RECORDS IN POUNDS PER BIRD BY STATED WEEKLY PERIODS FOR PROTEIN MIXTURE GROUPS

| Age | Group 10 | Group 11 | Group 12 |
|---|---|---|---|
| 1 day | .0917 | .0922 | .0917 |
| 4 weeks | .4600 | .5055 | .5990 |
| 8 weeks | 1.330 | 1.576 | 1.674 |
| 12 weeks | 2.625 | 2.750 | 2.825 |
| 16 weeks | 3.000 | 3.425 | 3.725 |
| 19 weeks | 3.650 | 3.900 | 4.150 |
| 23 weeks | 4.350 | 4.525 | 4.825 |
| 27 weeks | 4.650 | 4.550 | 5.150 |
| 31 weeks | 5.450 | 5.250 | 5.450 |
| 35 weeks | 5.300 | 5.200 | 5.600 |
| 39 weeks | 5.200 | 5.200 | 5.500 |
| 43 weeks | 5.350 | 5.300 | 5.700 |
| 47 weeks | 5.700 | 5.500 | 6.000 |
| 51 weeks | 5.700 | 5.750 | 6.000 |
| 55 weeks | 5.600 | 5.250 | 6.000 |
| 59 weeks | 5.400 | 5.400 | 5.900 |
| 63 weeks | 5.050 | 5.150 | 5.450 |
| 67 weeks | 5.650 | 5.500 | 5.700 |
| 70 weeks | 5.357 | 5.321 | 5.393 |

also increased. The exceptions to this rule, however, are in the figures presented for the 19 per cent meat scrap and 17 per cent mixture groups.

Combining groups by type of animal protein source used, the mixed protein groups showed an average feed cost per dozen eggs produced of 15.25 cents. This was followed by the fish meal, meat scrap, and dried skimmilk groups with costs of 15.90, 16.36, and 20.94 cents, respectively.

Table 6 also confirms previously reported statements to the effect that the per cent of, or type of, animal protein concentrate fed had little or no effect on egg size.

## HATCHABILITY AND GIZZARD LESION STUDIES

From December 20, 1939, to April 10, 1940 nine settings of eggs were made from each of the twelve groups of experimental birds. Upon the completion of each hatch and compilation of hatching records on hatches 5, 6, 7, 8, and 9 all chicks were killed and examined for the presence and severity of gizzard lesions.

Table 7 presents the results of the hatchability test. The mixed protein, fish meal, meat scrap, and dried skimmilk fed groups were in the order named from high to low per cent hatch of fertile eggs. The spread from high to low groups was 6.7 per cent. No explanation is available for the relatively poor results secured from the dried skimmilk fed groups.

A determination of the riboflavin (Vitamin $B_2$ or G) content of the concentrates used by means of the microbiological assay of Snell and Strong* showed dried skimmilk to possess 18.1, fish 8.4 and meat scraps 5.8 micrograms per gram. A computation of the ribo-

TABLE 3. SUMMARY OF FEED CONSUMPTION RECORDS IN POUNDS PER CHICK FOR MEAT SCRAP AND FISH MEAL GROUPS

| Feed consumed | Group 1 | Group 2 | Group 3 | Group 4 | Group 5 | Group 6 |
|---|---|---|---|---|---|---|
| 0 -12 weeks — Total | 8.778 | 9.274 | 9.669 | 8.948 | 9.946 | 9.991 |
| 13-23 weeks — Total | 17.128 | 17.193 | 17.420 | 17.287 | 17.539 | 17.237 |
| Per week | 1.557 | 1.563 | 1.583 | 1.571 | 1.594 | 1.567 |
| 24-70 weeks — Total | 92.065 | 94.028 | 91.547 | 92.191 | 96.172 | 94.190 |
| Per week | 1.958 | 2.000 | 1.947 | 1.961 | 2.046 | 2.004 |

SUMMARY OF FEED CONSUMPTION RECORDS IN POUNDS PER CHICK FOR DRIED SKIMMILK AND PROTEIN MIXTURE GROUPS

| Feed consumed | Group 7 | Group 8 | Group 9 | Group 10 | Group 11 | Group 12 |
|---|---|---|---|---|---|---|
| 0 -12 weeks — Total | 9.120 | 9.208 | 9.822 | 9.548 | 10.250 | 10.247 |
| 13-23 weeks — Total | 16.345 | 16.377 | 17.173 | 17.776 | 17.038 | 17.556 |
| Per week | 1.485 | 1.488 | 1.561 | 1.616 | 1.548 | 1.596 |
| 24-70 weeks — Total | 92.132 | 91.786 | 93.280 | 92.759 | 93.336 | 91.200 |
| Per week | 1.960 | 1.952 | 1.984 | 1.973 | 1.985 | 1.940 |

*The analyses were run by T. G. Culton and H. R. Bird, of the University of Maryland, Agr'l. Experiment Station.

TABLE 4. POUNDS OF FEED REQUIRED TO PRODUCE ONE POUND OF GAIN—ALL GROUPS

| Period | 15% Meat Scrap | 17% Meat Scrap | 19% Meat Scrap | 15% Fish Meal | 17% Fish Meal | 19% Fish Meal | 15% Dried Milk | 17% Dried Milk | 19% Dried Milk | 15% Mix-ture | 17% Mix-ture | 19% Mix-ture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 -12 weeks | 3.975 | 3.699 | 4.017 | 3.677 | 3.847 | 3.654 | 3.866 | 3.365 | 3.876 | 3.769 | 3.856 | 3.749 |
| 13-23 weeks | 8.458 | 9.048 | 9.168 | 10.168 | 9.610 | 11.120 | 8.382 | 8.973 | 10.407 | 10.304 | 9.598 | 8.778 |

TABLE 5. SUMMARY OF MORTALITY IN PER CENT—ALL GROUPS

| | Group | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 0 -23 weeks inclusive | 3.3 | 3.3 | 0.0 | 5.0 | 1.6 | 0.0 | 1.6 | 1.6 | 1.6 | 1.6 | 5.0 | 0.0 |
| 24-70 weeks inclusive | 17.6 | 33.3 | 23.5 | 17.6 | 11.7 | 11.7 | 33.3 | 11.7 | 23.5 | 5.8 | 11.7 | 11.7 |

flavin content of the various diets used indicated all milk groups to be well above the minimum requirements.

The differences in hatchability between the mixed protein, fish meal and meat scrap groups are too small to be considered significant.

All chicks procured in the last five hatches were killed and their gizzards were examined for the presence and severity of gizzard lesions. It is noted in Table 8 that the greater the content of meat scraps or mixed proteins in the diet, the greater were the number of normal gizzards observed. The reverse condition was true with regard to the dried skimmilk diets*. Since meat scraps contain cartilage, and Bird, et al (1936) have reported this to possess the anti-gizzard erosion factor, the results procured seem to substantiate this report.

Since it is quite conceivable that fish meal would also contain a considerable portion of cartilage a question may be raised concerning its "protective" value. However, Almquist (1937) has reported the gizzard factor to be unstable to heat. The heat treatment of the fish meal as used was 120° at a 26" to 27" vacuum over a period of several hours. This may have been sufficient to destroy partially the effectiveness of the gizzard factor, if present. On the other hand,

TABLE 6. A COST COMPARISON OF FEED CONSUMPTION AND EGG PRODUCTION PER BIRD FOR ALL GROUPS

| Group | Ave. prod. per bird (eggs) | Prod. per bird doz. | Ave. egg size oz. per doz. | Days in production | Ave. feed consumed per bird (lbs.) | Lbs. feed per doz. eggs | Cost per lb. of feed ¢ | Feed cost per doz. eggs ¢ |
|---|---|---|---|---|---|---|---|---|
| 15% Meat | 121.99 | 10.16 | 25.18 | 331 | 92.06 | 9.06 | 1.82 | 16.48 |
| 17% Meat | 124.64 | 10.38 | 24.32 | 328 | 94.03 | 9.05 | 1.87 | 16.92 |
| 19% Meat | 135.18 | 11.26 | 24.40 | 330 | 91.55 | 8.13 | 1.93 | 15.69 |
| Average | 127.27 | 10.60 | 24.63 | 330 | 92.55 | 8.73 | 1.87 | 16.36 |
| 15% Fish | 140.08 | 11.67 | 23.89 | 340 | 92.19 | 7.89 | 1.82 | 14.35 |
| 17% Fish | 136.56 | 11.38 | 24.74 | 341 | 96.17 | 8.45 | 1.88 | 15.88 |
| 19% Fish | 126.14 | 10.51 | 24.16 | 349 | 94.19 | 8.96 | 1.95 | 17.47 |
| Average | 134.50 | 11.20 | 24.26 | 343 | 94.18 | 8.41 | 1.88 | 15.90 |
| 15% Milk | 138.49 | 11.54 | 24.64 | 335 | 92.13 | 7.98 | 2.23 | 17.79 |
| 17% Milk | 149.79 | 12.48 | 24.54 | 341 | 91.79 | 7.35 | 2.66 | 19.55 |
| 19% Milk | 135.26 | 11.27 | 24.45 | 351 | 93.28 | 8.27 | 3.08 | 25.47 |
| Average | 141.18 | 11.76 | 24.54 | 342 | 92.40 | 7.86 | 2.66 | 20.94 |
| 15% Mixture | 147.09 | 12.25 | 24.86 | 332 | 92.76 | 7.57 | 1.93 | 14.61 |
| 17% Mixture | 164.28 | 13.69 | 24.08 | 336 | 93.34 | 6.82 | 2.08 | 14.18 |
| 19% Mixture | 142.75 | 11.89 | 24.72 | 341 | 91.20 | 7.67 | 2.21 | 16.95 |
| Average | 151.38 | 12.61 | 24.55 | 336 | 92.43 | 7.33 | 2.07 | 15.25 |

*More recent unpublished data from this station indicates dried skimmilk in combination with the protein basal diet as fed to breeding birds gives somewhat better gizzard scores in their resulting progeny than those fed the fish meal diet. The birds used on this test were the same (one year older) as used on the project herein reported.

the meat scraps used in this test are prepared by cooking at 260° F. for a period of 3 to 6 hours followed by passage through a continuous process worm press wherein a temperature of 400° F. is created. It would seem, therefore, that if temperature were a factor the meat scraps would be less "protective" than the fish meal. This is contrary to the results obtained and hence the fish meal as used, it is believed, was of lower initial "protective" value.

The results procured lend support to the statement of Tepper (1941) that "It is possible to reduce the severity of gizzard lesions in the day-old chicks by an adjustment of the diet fed to breeding birds."

TABLE 7. SUMMARY OF HATCHABILITY RECORDS—ALL GROUPS

| Group | No. Eggs Set | Per cent Fertile | No. Chicks | Total Eggs % Hatch | Fertile Eggs % Hatch |
|---|---|---|---|---|---|
| 15% Meat | 217 | 95.8 | 173 | 79.7 | 83.1 |
| 17% Meat | 150 | 97.3 | 114 | 76.0 | 78.0 |
| 19% Meat | 210 | 98.5 | 179 | 85.2 | 86.4 |
| Total-Average | 577 | 97.2 | 466 | 80.7 | 83.0 |
| 15% Fish | 204 | 84.3 | 158 | 77.4 | 91.8 |
| 17% Fish | 196 | 95.9 | 156 | 79.5 | 82.9 |
| 19% Fish | 211 | 95.2 | 162 | 76.7 | 80.5 |
| Total-Average | 611 | 91.8 | 476 | 77.9 | 84.8 |
| 15% Milk | 229 | 90.3 | 146 | 63.7 | 70.5 |
| 17% Milk | 222 | 94.5 | 161 | 72.5 | 76.6 |
| 19% Milk | 229 | 93.0 | 187 | 81.6 | 87.7 |
| Total-Average | 680 | 92.6 | 494 | 72.6 | 78.4 |
| 15% Mixture | 229 | 93.0 | 187 | 81.6 | 87.7 |
| 17% Mixture | 240 | 96.2 | 192 | 80.0 | 83.1 |
| 19% Mixture | 243 | 77.3 | 159 | 65.4 | 84.5 |
| Total-Average | 712 | 88.7 | 538 | 75.5 | 85.1 |

TABLE 8. OBSERVATIONS OF GIZZARD LESION SEVERITY IN PROGENY OF SPECIFIED PROTEIN FED GROUPS

| | Per cent of total observations | | | | | |
|---|---|---|---|---|---|---|
| Protein | Normal | Slight hemorrhage | Severe hemorrhage | Slight erosion and hemorrhage | Severe erosion and hemorrhage | Total |
| 15% Meat scrap | 7.9 | 64.8 | 12.5 | 13.6 | 1.1 | 89 |
| 17% Meat scrap | 9.6 | 60.2 | 27.7 | 2.4 | | 82 |
| 19% Meat scrap | 20.3 | 57.5 | 17.7 | 3.5 | .9 | 115 |
| Average | 12.6 | 60.8 | 19.3 | 6.5 | .7 | |
| 15% Fish meal | 7.3 | 28.8 | 36.7 | 16.9 | 10.0 | 101 |
| 17% Fish meal | 6.9 | 51.5 | 28.7 | 12.9 | | 101 |
| 19% Fish meal | 6.7 | 63.5 | 20.2 | 8.6 | .9 | 104 |
| Average | 7.0 | 47.9 | 28.5 | 12.8 | 3.6 | |
| 15% Dried skimmilk | 12.5 | 66.7 | 16.7 | 4.2 | | 96 |
| 17% Dried skimmilk | 7.6 | 50.6 | 30.4 | 11.4 | | 79 |
| 19% Dried skimmilk | 6.7 | 35.9 | 21.3 | 24.7 | 11.2 | 89 |
| Average | 8.9 | 51.1 | 22.8 | 13.4 | 3.7 | |
| 15% Mixture | 1.9 | 49.5 | 28.6 | 14.3 | 5.7 | 105 |
| 17% Mixture | 8.4 | 70.5 | 17.9 | 3.1 | | 95 |
| 19% Mixture | 19.0 | 61.0 | 19.0 | 1.0 | | 100 |
| Average | 9.8 | 60.3 | 21.8 | 6.1 | 1.9 | |

## SUMMARY AND CONCLUSIONS

1. Evidence is presented herein to substantiate many major conclusions drawn in Station Bulletin 312. The fact is demonstrated, however, that the protein requirements of cage managed birds as reported in this bulletin are somewhat different than for floor managed birds, especially in the use of dried skimmilk. This concentrate gave better results when fed to floor managed birds than when fed to cage managed birds.

2. Protein levels of approximately 19 per cent produced the greatest gains in weight during the initial twelve week brooding period of this experimental study.

3. The results reported appear to justify the conclusions that for floor managed birds a mixture of the three animal protein sources in the ration is more desirable from the standpoint of growth, efficiency of feed utilization, production and hatchability of eggs than is the use of but one animal protein concentrate.

4. The per cent of or type of animal protein concentrate fed has but little influence on the date of sexual maturity or on egg size.

5. Evidence is presented to indicate that the type and amount of animal protein concentrate fed to breeding birds has an influence in the control of gizzard lesions in their resulting progeny.

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