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TEXAS AGRICULTURAL EXPERIMENT STATION

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COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 476 AUGUST, 1933

DIVISION OF POULTRY HUSBANDRY

Feeding for Efficient Growth and Prevention of Slipped Tendons in Chickens

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**In cooperation with U. S. Department of Agriculture.
‡In cooperation with Texas Extension Service.
†As of July 1, 1933.

The data presented in this Bulletin show that, even in rations having a satisfactory mineral balance, another factor, or food material, is necessary in the ration if slipped tendons are to be prevented. These studies show that wheat gray shorts and rice bran contain appreciable amounts of this preventative material and that oat groats and possibly cottonseed meal and whole-pressed peanut screenings may contain lesser amounts of it.

Approximately 14% of the chicks developed slipped tendons when fed a ration composed of yellow corn meal 73 7-8%, dehydrated alfalfa leaf meal 5%, dried buttermilk 18%, ground oyster shell 1%, bone meal 1%, salt 1%, and fortified cod-liver oil 1-8%, but when 20% of wheat gray shorts replaced a like amount of yellow corn meal in the basal ration none of the chicks developed slipped tendons. The ration with the wheat gray shorts produced greater gains with lower feed requirements than the ration without the wheat gray shorts.

The number of chicks developing slipped tendons was less, the gains were greater, and gains were made with less feed when 5% or 10% of rice bran or 10% or 20% of ground oat groats replaced an equal amount of yellow corn meal in the above ration than when these feeds were not used.

The gains in live weight were greater and the feed requirements were less when 6% of meat and bone scrap or cottonseed meal replaced an equal amount of dried buttermilk in the ration composed of 73 7-8% yellow corn meal, 5% dehydrated alfalfa leaf meal, 18% dried buttermilk, 1% oyster shell, 1% bone meal, 1% salt, and 1-8% fortified cod-liver oil. When 6% whole-pressed peanut screenings replaced 6% of the dried buttermilk, and 10% of wheat gray shorts and 5% of rice bran replaced corresponding amounts of yellow corn meal in the above ration the gains were better than those obtained with the original ration, and they were made with less feed.

A ration composed of yellow corn meal 44 7-8%, dehydrated alfalfa leaf meal 5%, dried buttermilk 6%, cottonseed meal 6%, meat and bone scrap 6%, wheat gray shorts 20%, rice bran 10%, oyster shell 1%, salt 1%, and fortified cod-liver oil 1-8% is recommended for growing chicks in battery brooders. The chicks fed this ration in these experiments made rapid gains with low feed requirements, and very few slipped tendons occurred. The rice bran may be replaced by yellow corn meal. Whole-pressed peanut screenings is not recommended in this ration.

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BULLETIN NO. 476 AUGUST, 1933

FEEDING FOR EFFICIENT GROWTH AND PREVENTION OF SLIPPED TENDONS IN CHICKENS

R. M. SHERWOOD AND J. R. COUCH

Poultrymen are experiencing financial losses in growing chicks due to unsatisfactory rations. Three common causes for these losses are poor gains, costly gains as measured by the units of feed necessary to produce a unit of gain in live weight, and the unmarketable quality of birds due to slipped tendons. The condition known as slipped tendons occurs from the fourth to the seventh week in the growth period of battery-brooded chicks. The symptoms of this condition in the advanced stages are: the hocks are swollen with a bluish-green color, caused apparently by small hemorrhages in the underlying tissue; the tendons slip out of place to either side, and the use of one or both legs is partially or wholly lost. Whether the chick will be unmarketable depends upon the severity of the deformity. It was first reported by Titus and Ginn (4) and later by Titus (3) that if sufficient quantities of rice bran were used in chick rations which contained satisfactory minerals the losses due to slipped tendons would be very slight. Hunter (1) found that slipped tendons was influenced by the amount of bone meal in the ration, and also that with reasonably satisfactory mineral levels oat feed prevented this disorder. Sherwood (2) showed that the percentage of slipped tendons was influenced by the amount of bone meal and oyster shell fed.

The object of the study herein reported was to ascertain the effect of various carbonaceous and protein feeds upon the rate and economy of gains in live weight, and upon the prevention of slipped tendons. This study was concerned chiefly with six feeds; three of them—wheat gray shorts, rice bran, and ground oat groats—were used to replace part of the yellow corn meal in the basal ration, and the other three—meat and bone scrap, cottonseed meal, and whole-pressed peanut screenings—were used to replace part of the dried buttermilk. Thirty-two experiments using twenty rations, with different combinations of these feeds as supplements to the basal ration were studied.

METHOD OF PROCEDURE

The chicks used in these studies were Single Comb White Leghorns of like breeding. The birds were fed in battery brooders; all lots were kept under as nearly uniform conditions as possible. The number of chicks on the different experiments using these rations was not large, but in every case the experiments were repeated and the total number of chicks on each ration was large enough to give significant results. The experimental feeding periods lasted ten weeks. The chicks were weighed individually at the beginning and at the close of the experiments and at intervals of two weeks during the experiments. They were weighed early in the forenoon after feed had been withheld since six o'clock of the preceding after-

noon. In figuring weighted average gains all pullet weights were raised to the cockerel weights.

The feed was weighed to the chicks daily. They were fed all they would consume. Tap water was before them at all times.

Samples of all feeds used in these experiments except ground oat groats were analyzed in the Division of Chemistry. These analyses are given in Table 1.

The percentage of the different feeds used in the rations is given in

Table 1. Percentage composition of feeds*

	Protein	Fat	Crude Fiber	Nitrogen-free extract	Water	Ash	P_2O_5	CaO
Yellow corn meal	9.78	3.78	1.64	73.27	10.26	1.27	.71	.02
Dehydrated alfalfa leaf meal	23.27	4.37	12.92	38.74	6.61	14.09	.60	3.18
Dried buttermilk	45.34	9.41	0	30.08	7.98	7.19	1.98	2.16
Wheat gray shorts	18.52	5.49	6.11	56.27	9.20	4.41	2.29	.17
Rice bran	11.83	12.24	16.08	38.97	7.26	13.62	2.30	.54
50% Protein meat and bone scrap	50.25	9.47	2.08	1.54	5.14	31.52	12.52	15.79
43% Protein cottonseed meal	46.43	7.41	8.49	25.27	6.60	5.80	2.72	.27
30% Protein whole-pressed peanut screenings	29.91	10.95	10.32	34.99	7.54	6.29	.66	.20
Oyster shell	0	0	0	0	0	100.00	.14	53.44
Bone meal	24.23	3.01	.71	3.63	6.91	61.51	25.65	33.64
Salt	0	0	0	0	0	100.00	0	0
Fortified cod-liver oil	0	100.00	0	0	0	0	0	0

*Analysis made under the supervision of Dr. Fraps, State Chemist.

Table 2. The chemical composition of the rations as computed from Table 1 and 2 is given in Table 3.

EXPERIMENTAL RESULTS

Wheat Gray Shorts Compared with Yellow Corn Meal

In this work both 10% and 20% of wheat gray shorts replaced corresponding amounts of yellow corn meal in the basal ration. The results of three experiments on this feed as given in Table 4 show that the replacement of 10% of the yellow corn meal by 10% of wheat gray shorts caused no significant gain in live weight; the average weighted gain for the three experiments was only 21.3 grams in favor of the shorts. However, along with this slightly better gain there was a lower cost of gain, as measured by units of feed necessary to produce a unit of gain in live weight; the difference amounted to 20 pounds of feed in the production of 100 pounds of gain in live weight. The percentage of chicks developing slipped tendons is a more important consideration than gains. There were no slipped tendons in the chicks receiving 10% of wheat gray shorts as compared with 13.8% with those not receiving this feed.

With the chicks receiving the ration in which 20% of wheat gray shorts replaced 20% of yellow corn meal in the basal ration the results were more pronounced than in the ration with only 10% of wheat gray shorts replacing 10% of yellow corn meal. In this case, as pointed out in Table 4, chicks fed 20% of wheat gray shorts gained 73.5 grams, or nearly

Table 2. Percentage of ingredients in rations

Feeds	Ration numbers																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Yellow corn meal	73⅞	63⅞	53⅞	68⅞	63⅞	63⅞	53⅞	74⅞	74⅞	73⅞	73⅞	58⅞	58⅞	59⅞	58⅞	59⅞	58⅞	44⅞	43⅞	59⅞
Dehydrated alfalfa leaf meal	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Dried buttermilk	18	18	18	18	18	18	18	12	6	12	6	18	12	12	12	6	6	6	6	6
Wheat gray shorts	0	10	20	0	0	0	0	0	0	0	0	10	10	10	10	10	10	20	20	10
Rice bran	0	0	0	5	10	0	0	0	0	0	0	5	5	5	5	5	5	10	10	5
Ground oat groats	0	0	0	0	0	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0
50% Protein meat and bone scrap	0	0	0	0	0	0	0	6	12	0	0	0	0	6	0	6	0	6	0	6
43% Protein cottonseed meal	0	0	0	0	0	0	0	0	0	6	12	0	0	0	6	6	6	6	6	0
30% Protein whole-pressed peanut screenings	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	6	0	6	6
Ground oyster shell	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Bone meal	1	1	1	1	1	1	1	0	0	1	1	1	1	0	1	0	1	0	1	0
Salt	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fortified cod-liver oil	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛	⅛

9%, more than those not receiving it. One hundred pounds of gain in live weight was produced with 28 pounds less feed with the ration con-

Table 3. Percentage Composition of Rations as calculated for analyses of feeds

Ration numbers	Protein	Fat	Crude Fiber	Nitrogen-free extract	Water	Ash	P_2O_5	CaO
1	16.79	4.86	1.87	61.51	9.42	5.55	1.17	1.43
2	17.67	5.03	2.31	59.81	9.31	5.87	1.33	1.45
3	18.54	5.20	2.76	58.12	9.20	6.18	1.49	1.46
4	16.89	5.28	2.59	59.80	9.27	6.17	1.25	1.46
5	16.99	5.71	3.31	58.08	9.12	6.79	1.33	1.49
8	16.94	4.87	2.00	60.50	9.28	6.41	1.55	1.91
9	17.23	4.88	2.12	58.79	9.11	7.87	2.18	2.73
10	16.86	4.74	2.37	61.23	9.33	5.47	1.22	1.32
11	16.92	4.62	2.88	60.94	9.25	5.39	1.26	1.21
12	17.77	5.45	3.03	58.11	9.16	6.48	1.41	1.47
13	16.84	5.55	3.65	58.40	9.13	6.43	1.33	1.36
14	17.92	5.47	3.17	57.08	9.02	7.34	1.79	1.42
15	17.84	5.33	3.54	57.81	9.08	6.40	1.45	1.36
16	17.98	5.35	3.68	56.79	8.94	7.26	1.83	1.84
17	16.91	5.43	4.16	58.10	9.05	6.35	1.37	1.24
18	18.96	5.94	4.85	53.38	8.68	8.19	2.07	1.88
19	17.89	6.02	5.33	54.69	8.79	7.28	1.61	1.28
20	16.99	5.56	3.79	57.38	8.99	7.29	1.86	1.84

taining the 20% of wheat gray shorts than with the ration without this feed.

Table 4. Value of varying amounts of wheat gray shorts for chicks

	No wheat gray shorts Ration 1	10% Wheat gray shorts Ration 2	20% Wheat gray shorts Ration 3
Average weighted gain in live weight in grams			
Experiment 1	855.6	658.0	931.3
Experiment 2	944.4	904.2	997.4
Experiment 3	715.2	816.9	806.9
Units of feed to produce a unit of gain			
Experiment 1	4.00	4.03	3.71
Experiment 2	3.80	3.76	3.66
Experiment 3	3.82	3.23	3.40
Percentage of chicks developing slipped tendons			
Experiment 1	15.8	0	0
Experiment 2	12.5	0	0
Experiment 3	13.0	0	0
Average of three experiments			
Total number of chicks on ration	63	63	63
Average weighted gain in live weight in grams	838.4	859.7	911.9
Units of feed to produce a unit of gain	3.87	3.67	3.59
Percentage of chicks developing slipped tendons	13.8	0	0

None of the chicks on the ration in which the 20% of wheat gray shorts was substituted for yellow corn meal developed slipped tendons, while, as noted before, with the basal ration without this substitution 13.8% of the chicks developed this trouble. In this study both 10% and 20% of wheat gray shorts were used. These amounts of wheat gray shorts were arbitrary; later studies will be made on other amounts of wheat gray shorts with the phosphoric acid and lime content of the ration held constant.

The greater and more economical gains made by the chicks fed wheat shorts and especially the prevention of slipped tendons when this feed is

used certainly recommend it as an ingredient in chick rations, and particularly for chicks raised in battery brooders.

Rice Bran Compared with Yellow Corn Meal

In this study three experiments were conducted in which 5% and 10% of rice bran were used to replace 5% and 10% of yellow corn meal in the basal ration. The data of these experiments, as shown in Table 5, point out that the use of either of these amounts of rice bran produce more rapid gains than the original ration. The gain in live weight was greater from the larger amount of rice bran by 52 grams, or about 6% over the basal ration; however, the units of feed to produce a unit of gain was in favor of the smaller amount of rice bran. One hundred pounds of live weight was produced with 25 to 33 pounds less feed when rice bran was fed than

Table 5. Value of varying amounts of rice bran for chicks

	No Rice bran Ration 1	5% rice bran Ration 4	10% rice bran Ration 5
Average weighted gain in live weight in grams			
Experiment 1	855.6	931.3	912.3
Experiment 2	944.4	938.2	981.6
Experiment 3	715.2	752.0	777.3
Units of feed to produce a unit of gain			
Experiment 1	4.00	3.72	3.79
Experiment 2	3.80	3.51	3.71
Experiment 3	3.82	3.38	3.35
Percentage of chicks developing slipped tendons			
Experiment 1	15.8	0	8.3
Experiment 2	12.5	5.6	0
Experiment 3	13.0	0	0
Average of three experiments			
Total number of chicks on ration	63	63	63
Average weighted gain in live weight in grams	838.4	873.8	890.4
Units of feed to produce a unit of gain	3.87	3.54	3.62
Percentage of chicks developing slipped tendons	13.8	1.9	2.8

when it was omitted. In both cases, the amount of slipped tendons in the chicks receiving the rice bran was reduced almost to a minimum.

These experimental results support the recommendation of 5% to 10% of rice bran in chick rations in place of an equal quantity of yellow corn meal when good quality rice bran is available at a reasonable price.

Ground Oat Groats Compared with Yellow Corn Meal

Two experiments were conducted studying the replacement of both 10% and 20% of yellow corn meal with an equal amount of ground oat groats in the basal ration. The data as presented in Table 6 show no advantage in gain in weight by the use of the 10% of ground oat groats. They do show a reduction of units of feed to produce a unit of gain in live weight and in the prcentage of chicks which developed slipped tendons. The use of 20% of ground oat groats to replace 20% of yellow corn meal gave greater gains in both experiments than the ration without this replacement and with about the same feed efficiency as the ration containing 10% of ground oat groats. The mixture containing 20% of ground oat

groats in place of yellow corn meal produced few slipped tendons; however, it was not as satisfactory in this respect as the rations containing wheat gray shorts or rice bran.

The results of these experiments would not justify the use of ground oat groats at the present price of this feed. In accordance with the results of Hunter (1) who found that oat feed was of value in preventing slipped tendons, it is very possible that ground whole oats may be very valuable and economical for chick feeding; experimentation is being continued along this line.

Table 6. Value of varying amounts of ground oat groats for chicks

	No ground oat groats Ration 1	10% ground oat groats Ration 6	20% ground oat groats Ration 7
Average weighted gain in live weight in grams			
Experiment 1	855.6	854.0	904.6
Experiment 2	944.4	940.7	986.4
Units of feed to produce a unit of gain			
Experiment 1	4.00	3.86	3.71
Experiment 2	3.80	3.43	3.62
Percentage of chicks developing slipped tendons			
Experiment 1	15.8	0	5.3
Experiment 2	12.5	5.3	5.9
Average of three experiments			
Total number of chicks on ration	37	37	37
Average weighted gain in live weight in grams	900.0	897.4	945.5
Units of feed to produce a unit of gain	3.90	3.65	3.67
Percentage of chicks developing slipped tendons	14.2	2.7	5.6

Meat and Bone Scrap Compared with Dried Buttermilk, Cottonseed Meal and Whole-Pressed Peanut Screenings

Two experiments were conducted in which 6% and 12% of meat and bone scrap were used to replace equal amounts of dried buttermilk in the basal ration. In order to lower the phosphoric acid content of the meat and bone scrap rations, bone meal was omitted when meat and bone scrap

Table 7. Value of varying amounts of meat and bone scrap compared with dried buttermilk for chicks

	18% Dried buttermilk, no meat and bone scrap Ration 1	12% dried buttermilk, 6% meat and bone scrap Ration 8	6% dried buttermilk, 12% meat and bone scrap Ration 9
Average weighted gain in live weight in grams			
Experiment 1	855.6	835.2	679.2
Experiment 2	944.4	800.2	781.6
Units of feed to produce a unit of gain			
Experiment 1	4.00	4.07	4.23
Experiment 2	3.80	4.19	4.07
Percentage of chicks developing slipped tendons			
Experiment 1	15.7	21.1	84.2
Experiment 2	12.5	16.7	83.3
Average of three experiments			
Total number of chicks on ration	37	37	37
Average weighted gain in live weight in grams	900.0	817.7	730.4
Units of feed to produce a unit of gain	3.90	4.13	4.15
Percentage of chicks developing slipped tendons	14.2	18.9	83.8

was fed, and one pound of yellow corn meal was added to make the mixture up to 100 pounds.

The results, as shown in Table 7, point out that the gain in live weight and feed efficiency were decreased when the meat and bone scrap was used to replace part of the dried buttermilk in the basal ration. The number of slipped tendons was disastrously high with the chicks fed the ration containing 12% of meat and bone scrap. It must be remembered that the basal ration contained no wheat gray shorts or rice bran. With other combinations of feeds more satisfactory results were secured for meat and bone scrap. The results given in Tables 8 and 9 show that fewer chicks developed slipped tendons when fed a ration containing 6% of meat and bone scrap, together with wheat gray shorts and rice bran (ration 14, Table 8) than in the case of ration 8, Table 9, which contains meat and bone scrap but no wheat gray shorts or rice bran.

Table 8. Value of meat and bone scrap compared with whole-pressed peanut screenings for chicks

	12% Dried 12% dried buttermilk, 6% meat and bone scrap Ration 14	12% Dried buttermilk, 6% whole-pressed peanut screenings Ration 13	6% Dried buttermilk, 6% cotton-seed meal, 6% meat and bone scrap Ration 18	6% Dried buttermilk, 6% cotton seed meal, 6% whole-pressed peanut screenings Ration 19
Average weighted gain in live weight in grams				
Experiment 1	939.8	992.6	783.9	700.0
Experiment 2	854.4	910.0	814.6	726.4
Experiment 3	880.2	850.9	783.2	681.2
Units of feed to produce a unit of gain				
Experiment 1	4.03	3.75	3.85	3.94
Experiment 2	3.45	3.42	3.41	3.91
Experiment 3	3.39	3.36	3.78	3.92
Percentage of chicks developing slipped tendons				
Experiment 1	6.7	0	0	0
Experiment 2	4.3	0	6.3	0
Experiment 3	0	0	0	0
Average of three experiments				
Total number of chicks on ration	72	72	51	51
Average weighted gain in live weight in grams	891.5	917.8	793.9	702.5
Units of feed to produce a unit of gain	3.62	3.51	3.68	3.92
Percentage of chicks which developed slipped tendons	3.7	0	2.1	0

There is little difference between the gains made on rations containing 6% of meat and bone scrap or 6% of whole-pressed peanut screenings when they contain 12% of dried buttermilk, 5% of rice bran, and 10% of wheat gray shorts. These data are shown under rations 14 and 13 of Table 8. The data presented in this table show that when 6% of dried buttermilk in the ration is replaced by 6% of cottonseed meal, leaving only 6% of dried buttermilk in the ration, the results for whole-pressed peanut screenings are not satisfactory. The average gain for ration 18, Table 8, is 793.9 as compared with 702.5 for ration 19. Ration 19 contained 6% whole-pressed peanut screenings and only 6% dried buttermilk.

Four experiments were run in triplicate testing cottonseed meal as compared with meat and bone scrap when replacing dried buttermilk in the ration. Table 9 shows that when no whole-pressed peanut screenings was used in the ration the gains were as rapid with the cottonseed meal as with the meat and bone scrap. The loss from slipped tendons was less

Table 9. Value of meat and bone scrap compared with cottonseed meal for chicks

	12% Dried buttermilk, 6% meat and bone scrap	12% Dried buttermilk, 6% cotton-seed meal	6% Dried buttermilk, 6% whole-peanut screenings, 6% meat and bone scrap with wheat shorts and rice bran	6% Dried Buttermilk, 6% whole-pressed peanut screenings, 6% cotton seed meal with wheat shorts and rice bran
	Ration 8	Ration 10	Ration 20	Ration 17
Average weighted gain in live weight in grams				
Experiment 1	835.2	927.8	754.9	736.7
Experiment 2	800.2	875.5	790.6	698.5
Experiment 3	740.7	723.2	772.1	662.6
Units of feed to produce a unit of gain				
Experiment 1	4.07	3.80	3.73	3.70
Experiment 2	4.19	4.00	4.08	4.03
Experiment 3	3.78	3.80	3.51	3.72
Percentage of chicks developing slipped tendons				
Experiment 1	21.1	5.6	6.3	0
Experiment 2	16.7	11.1	0	0
Experiment 3	66.7	4.8	0	0
Average of three experiments				
Total number of chicks on ration	58	58	51	51
Average weighted gain in live weight in grams	792.0	842.2	772.5	699.3
Units of feed to produce a unit of gain	4.01	3.87	3.77	3.82
Percentage of chicks developing slipped tendons	34.8	7.2	2.1	0

Table 10. Value of varying amounts of cottonseed meal compared with dried buttermilk for chicks

	18% Dried buttermilk, no cotton-seed meal	12% Dried buttermilk, 6% cotton-seed meal	6% Dried buttermilk, 12% cotton-seed meal
	Ration 1	Ration 10	Ration 11
Average weighted gain in live weight in grams			
Experiment 1	855.6	927.8	817.9
Experiment 2	944.4	875.5	981.7
Units of feed to produce a unit of gain			
Experiment 1	4.00	3.80	4.10
Experiment 2	3.80	4.00	3.85
Percentage of chicks developing slipped tendons			
Experiment 1	15.8	5.6	5.3
Experiment 2	12.5	11.1	11.1
Average of three experiments			
Total number of chicks on ration	37	37	37
Average weighted gain in live weight in grams	900.0	901.7	899.8
Units of feed to produce a unit of gain	3.90	3.90	3.98
Percentage of chicks developing slipped tendons	14.2	8.4	8.2

with the chicks fed cottonseed meal (ration 10) than with those fed meat and bone scrap (ration 8). In the case of rations containing only 6% of dried buttermilk and 6% of whole-pressed peanut screenings the gains were in favor of the meat and bone scrap as compared with cottonseed meal. These data are shown in Table 9, ration 20 as compared with ration 17. These last mentioned rations contained wheat gray shorts and rice bran; therefore few of the chicks developed slipped tendons.

Cottonseed Meal Compared with Dried Buttermilk and Whole-Pressed Peanut Screenings

The data presented in Table 10 are somewhat conflicting and inconclusive. In one experiment the chicks receiving 6% of cottonseed meal made better gains than did those receiving no cottonseed meal, but the lot receiving 12% of cottonseed meal made poorer gains than those receiving none. In the other experiment the lot receiving 6% of cottonseed meal made the poorest gains and the lot receiving 12% of cottonseed meal made better gains than the lot receiving none. There was no difference in units of feed required to produce a unit of gain on these different rations. There was a slight advantage in favor of the cottonseed meal in that it tended to prevent slipped tendons.

The comparison of the value of cottonseed meal with meat and bone scrap has been discussed above under the heading, "Meat and Bone Scrap as Compared with Dried Buttermilk, Cottonseed Meal and Whole-Pressed Peanut Screenings."

From Table 11, ration 15 as compared with ration 13 it is seen that when

Table 11. Value of cottonseed meal compared with whole-pressed peanut screenings for chicks

	12% Dried buttermilk, 6% cotton-seed meal	12% Dried buttermilk, 6% whole-pressed peanut screenings	6% Dried buttermilk, 6% meat and bone scrap, 6% cotton-seed meal	6% Dried buttermilk, 6% meat and bone scrap, 6% whole-pressed peanut screenings
	Ration 15	Ration 13	Ration 16	Ration 20
Average weighted gain in live weight in grams				
Experiment 1	791.7	800.9	867.2	754.9
Experiment 2	811.1	779.7	772.5	790.6
Experiment 3	797.4	738.4	738.4	772.1
Units of feed to produce a unit of gain				
Experiment 1	3.57	3.37	3.56	3.73
Experiment 2	3.50	3.68	3.72	4.08
Experiment 3	3.46	3.53	3.56	3.51
Percentage of chicks developing slipped tendons				
Experiment 1	7.1	0	0	0
Experiment 2	0	0	0	0
Experiment 3	0	0	0	0
Average of three experiments				
Total number of chicks on ration	51	51	51	51
Average weighted gain in live weight in grams	800.1	773.0	792.7	772.5
Units of feed to produce a unit of gain	3.51	3.53	3.61	3.77
Percentage of chicks developing slipped tendons	2.4	0	0	2.1

12% of dried buttermilk is included in the ration with no meat and bone scrap, 6% of cottonseed meal gave about the same gains as 6% of whole-pressed peanut screenings. It is shown in ration 16 as compared with ration 20 of Table 11 that the chicks getting 6% of dried buttermilk, 6% of meat and bone scrap, and 6% of cottonseed meal made larger gains than those receiving the same ration except that 6% of whole-pressed peanut screenings replaced the 6% of cottonseed meal. These rations contained wheat gray shorts and rice bran; therefore, there was no difference in the percentage of chicks developing slipped tendons.

Whole-Pressed Peanut Screenings Compared with Dried Buttermilk, Cottonseed Meal and Meat and Bone Scrap

The results of the experiments, as presented in Table 12, show that the substitution of 6% of whole-pressed peanut screenings for 6% of dried buttermilk (ration 13), caused the chicks to make over 9% greater gains than in the ration containing the 18% of dried buttermilk (ration 12).

It has been pointed out under the headings, "Meat and Bone Scrap Compared with Dried Buttermilk, Cottonseed Meal and Whole-Pressed Peanut Screenings," and "Cottonseed Meal Compared with Dried Buttermilk, and Whole-Pressed Peanut Screenings," that poor gains result from the substitution of only 6% of whole-pressed peanut screenings for 6% of dried buttermilk in rations containing 6% of meat and bone scrap or 6% of cottonseed meal with 12% of dried buttermilk. In other words,

Table 12. Value of whole-pressed peanut screenings compared with dried buttermilk for chicks

	18% Dried buttermilk, no whole-pressed peanut screenings Ration 12	12% Dried buttermilk, 6% whole-pressed peanut screenings Ration 13
Average weighted gain in live weight in grams		
Experiment 1	918.6	992.6
Experiment 2	801.0	910.0
Experiment 3	800.8	850.9
Units of feed to produce a unit of gain		
Experiment 1	3.67	3.81
Experiment 2	4.49	3.42
Experiment 3	3.36	3.36
Percentage of chicks developing slipped tendons		
Experiment 1	0	0
Experiment 2	0	0
Experiment 3	3.8	0
Average of three experiments		
Total number of chicks on ration	72	72
Average weighted gain in live weight in grams	840.1	917.8
Units of feed to produce a unit of gain	3.51	5.53
Percentage of chicks developing slipped tendons	1.3	0

a ration containing 6% of whole-pressed peanut screenings and 12% of dried buttermilk gave greater gains with as low a feed requirement per unit of gain as the ration containing 18% of dried buttermilk and no whole-pressed peanut screenings. However, a ration containing the same amount of whole-pressed peanut screenings (6%) and only 6% of

dried buttermilk together with 6% of either meat and bone scrap or cottonseed meal gave poor gains as compared with the rations containing 6% of each of dried buttermilk, meat and bone scrap, and cottonseed meal.

The cause of the poorer results with whole-pressed peanut screenings when fed with 6% of dried buttermilk as compared with 12% of dried buttermilk has not yet been determined. Experimental work is being continued to learn if possible the cause of these poor gains.

GENERAL DISCUSSION

Slipped tendons appears to be a disorder brought about as the result of two or more nutritional factors. One factor is the lack of mineral balance in rations. Excessive amounts of phosphoric acid or insufficient amounts of lime cause a large percentage of the chicks to develop slipped tendons, as noted in Bulletin 462 of this Station. This bulletin pointed out that as the phosphoric acid content of the ration increased, the amount of this disorder increased, and as the per cent of lime in the ration became larger, the number of chicks developing this disorder decreased.

Ration 1, Table 7, of this present Bulletin, contained 1.17% phosphoric acid and 14.2% of the chicks receiving this ration developed slipped tendons. Ration 8 contained 1.55% phosphoric acid, and 18.9% of the chicks which received it developed this trouble as compared with ration 9, which contained 2.18% phosphoric acid and produced 83.8% of slipped tendons in the chicks.

A second factor which prevents slipped tendons is present in appreciable amounts in wheat gray shorts, rice bran, and probably in lesser amounts in oat groats, and possibly cottonseed meal and whole-pressed peanut screenings. It may be a substance which when added to rations similar to ration 1 of this study will prevent slipped tendons. With ration 1, Tables 4 and 5, the percentage of slipped tendons is 13.8, while in the same ration, except that 10% and 20% of wheat gray shorts replace equal amounts of corn meal (rations 2 and 3, Table 4) this trouble is prevented. As a result of feeding rations 4 and 5, Table 5, in which 5% and 10% of rice bran replaced like amounts of yellow corn meal, only 1.9% and 2.8% of the chicks respectively developed slipped tendons.

The data in Table 6 indicate that probably oat groats do not contain as much of this second factor for preventing slipped tendons as do wheat gray shorts or rice bran. The percentage of this trouble runs as high as 5.6% with the oat groats, as compared with no slipped tendons with wheat gray shorts, Table 4, and only 2.8% for rice bran, Table 5.

It appears from the data of Table 10 that cottonseed meal may contain limited quantities of the factor which prevents slipped tendons. The first experiment given in Table 10 shows more evidence of this point, while the second experiment shows very little evidence of the presence of this factor.

The causes of all of the differences in gains in live weight resulting from the use of the different feeds studied have not been determined. In one case, ration 9, it is suggested that excess of minerals caused the un-

satisfactory results. In other cases the ratio of lime to phosphoric acid may influence the results. The supplementary action of the amino acids may also influence the efficiency of these rations. It is shown definitely that the introduction of certain amounts of any of the six feeds studied into the basal ration, composed of a very limited number of feeds, gave decidedly better results on gains in weight. The efficiency of the feeds was in most cases proportional to the gain in live weight. In other words, large gains were in most cases produced with low feed requirements.

CONCLUSIONS

The use of 10% and 20% of wheat gray shorts to replace corresponding amounts of yellow corn meal in a ration composed of yellow corn meal 73 7-8%, dehydrated alfalfa leaf meal 5%, dried buttermilk 18%, oyster shell 1%, bone meal 1%, salt 1%, fortified cod-liver oil 1-8% increased the gains in live weight, produced gains with less feed per unit of gain, and prevented slipped tendons.

The replacement of 5% and 10% of yellow corn meal by corresponding amounts of rice bran in the same ration increased the gains in live weight, lowered the feed requirements per unit of gain, and lowered the percentage of chicks that developed slipped tendons.

When 10% and 20% of ground oat groats replaced corresponding amounts of yellow corn meal in the above ration the chicks did not make enough greater gains to offset the higher cost of this feed. This feed apparently reduced the percentage of chicks that developed slipped tendons.

Rations similar to the one mentioned above except that 6% of meat and bone scrap, cottonseed meal, or whole-pressed peanut screenings replaced an equal amount of dried buttermilk gave more rapid gains than did rations containing 18% of dried buttermilk and no meat and bone scrap, cottonseed meal, or whole-pressed peanut screenings. The use of these feeds reduced the cost of the rations.

Six per cent of whole-pressed peanut screenings did not give good results in rations containing only 6% of dried buttermilk.

A ration containing 6% of meat and bone scrap, 6% of cottonseed meal, and 6% of dried buttermilk together with 20% of wheat gray shorts, 10% of rice bran, 44 7-8% yellow corn meal, 5% dehydrated alfalfa leaf meal, 1% ground oyster shell, 1% salt, and 1-8% fortified cod-liver oil gave greater gains at lower costs than when the ration contained 18% of dried buttermilk and no meat and bone scrap or cottonseed meal. This ration is recommended for raising chicks in battery brooders. The rice bran may be replaced by an equal amount of yellow corn meal.

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