FAILURE OF FEATHER PIGMENTATION IN BRONZE POULTS DUE TO LYSINE DEFICIENCY

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ONE FIGURE

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Turkey growers who raise bronze poults in complete confinement are frequently disturbed by the appearance of an unusual extent of white coloring in the primary and secondary wing feathers. The tail feathers may also be affected. The abnormal pigmentation is most apparent during the first 4 or 5 weeks, and gradually disappears as the birds become older, even though the diet and conditions of management remain the same (Carrick, '45).

Funk and Kempster ('40) observed a white feather development in bronze poults when 10% cottonseed meal or 10% corn gluten meal was used in the ration. Feather pigmentation was normal when soybean meal was similarly used in the ration. They also recorded that the abnormality diminished as maturity approached, and they postulated that the pigmentation failure was due to "a deficiency of some constituent which was required for rapid growth but was released for pigmentation when the growth rate diminished." These authors also suggested that "manganesed calcium" used in some of the rations may have been a causative factor. Roberts ('45) noted that white plumage developed in bronze poults when 20% soybean meal in the ration was replaced with ground corn.

A series of reports from the Oklahoma Experiment Station (summarized by Ewing, '43) indicated that low fiber rations caused a similar loss of pigment in bronze poults. However, it might be noted that the source of fiber used in these studies was alfalfa stem meal which may have contributed many factors in addition to fiber.

Excessive white feather formation has also been reported in growing chickens (McConachie, Graham, and Branion, '35; and Poley, '38) but in these reports it is not clear that the causative factor was the same as in the cases involving poults. Groody and Groody ('42) reported that pantothenic acid deficiency caused less feather pigmentation in chicks.

The object of this investigation was to study the possible causes of the loss of pigment from the feathers of poults, and to determine how this syndrome can be prevented.

EXPERIMENTAL

Standard bred bronze poults, hatched from the Borden Experimental Farm flock, were used in this study. The day-old poults were placed in electrically heated, wire floored, battery brooders. Throughout the test they received the designated diets and fresh tap water ad libitum. The first test was designed to study the effect of varying fiber and calcium content, and of the use of corn gluten meal upon the incidence of the white feather syndrome. The diets and a summary of the observations are shown in table 1. The feather pigmentation was judged on an arbitrary scale when 0 indicated normal color, 1 indicated slightly abnormal extent of white color on the feathers of a few poults in the group, 2 indicated all poults with slight degrees of pigmentation failure, 3 indicated moderate to severe loss of pigment, and 4 indicated very severe loss of pigment with extremely wide white bands on both wings and also on the tail feathers. Figure 1 shows the normal bronze pattern of the poults on diet 4213 and the abnormal white wing feathers of poults on diet 4215.

The data of Almquist ('45) and of Block and Bolling ('45) on the composition of soybean protein and of corn gluten

protein indicated large differences in the content of glycine and lysine. In the second test, crystalline glycine [1] and crude lactalbumin, respectively, were added to the corn gluten meal diet, no. 4215, in such quantities as to raise the intake

TABLE 1

Observations on corn gluten meal, fiber content, and calcium content as possible causes of pigmentation failure in bronze turkey poults.

INGREDIENTS	DIET					
	4213	4214	4215	4216	4217	4218
	%	%	%	%	%	%
Yellow corn meal	20.4	20.4	20.4	22.9	25.4	17.9
Pulverized oats	10.0	10.0	10.0	5.0	...	10.0
Rolled oats	...	...	...	5.0	10.0	...
Ground wheat	...	...	...	10.0	20.0	...
Standard middlings	10.0	10.0	10.0	5.0	...	10.0
Wheat bran	10.0	10.0	10.0	5.0	...	10.0
Alfalfa meal	7.5	7.5	7.5	3.75	...	7.5
Alfalfa leaf meal	...	...	...	1.25	2.5	...
Meat and bone scrap	12.5	12.5	12.5	12.5	12.5	12.5
Sardine meal	2.5	2.5	2.5	2.5	2.5	2.5
Soybean meal	20.0	10.0	...	20.0	20.0	20.0
Corn gluten meal	...	10.0	20.0	...	...	...
Flaydry [1]	2.0	2.0	2.0	2.0	2.0	2.0
Ladpro 100 D [2]	1.6	1.6	1.6	1.6	1.6	1.6
Ground limestone	2.5	2.5	2.5	2.5	2.5	5.0
Salt with I_2 and Mn	1.0	1.0	1.0	1.0	1.0	1.0
Calculated % Fiber	6.78	6.46	6.14	5.02	3.26	6.73
Calculated % Protein	24.8	25.0	25.2	24.5	24.2	24.6
Calculated % Lysine	1.23	1.02	0.81	1.18	1.13	1.22
No. poults	35	35	35	35	34	34
Av. wt. of poults at 6 weeks (gm)	466	589	605	665	631	464
Achroma score	0	1.5	3	0	0	0

[1] Poultry feed supplement containing whey solubles, used to supply B-complex vitamins.

[2] Poultry feed supplement containing fish solubles and fish liver and glandular meal, standardized to contain 100 A.O.A.C. units of vitamin D per gm.

of these amino acids to the levels which would be supplied if soybean meal had replaced the corn gluten meal. The preventive values of crystalline d-lysine monohydrochloride [2] and

[1] Dow.

[2] Merck.

of calcium pantothenate were also tested in conjunction with the high corn gluten meal diet. Two levels of ground limestone were also used in this series to determine any effect of varying the calcium content of the ration. Table 2 summarizes the diets and observations.

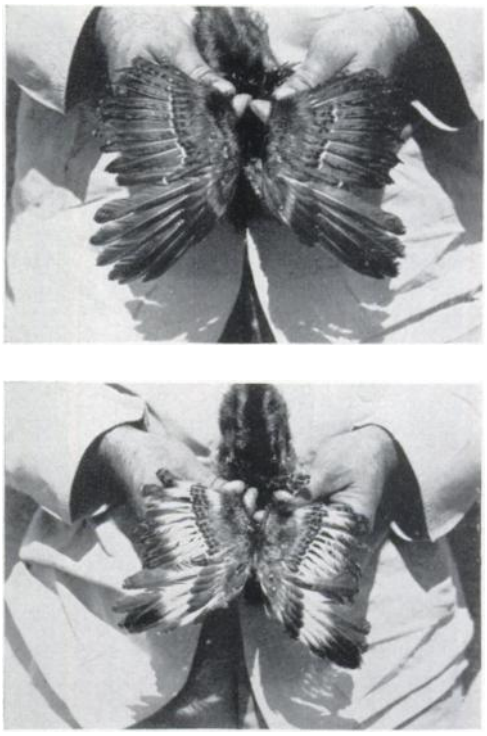

Fig. 1 The upper poult was raised on diet 4213 and shows the normal bronze pattern. The lower poult was raised on diet 4215 and shows the abnormal white wing feathers.

Table 3 summarizes a test in which the effectiveness of crystalline d-lysine (Block) was compared with soybean meal, yeast, and casein as food sources of lysine. Several modifications of the lysine deficient ration were produced by varying the protein sources used. The basal mixture had the following composition: Yellow corn meal 26.3, pulverized oats 10.0, standard middlings 10.0, wheat bran 10.0, dehydrated al-

falfa meal 5.0, Flaydry [3] 2.0, Ladpro 100 D [4] 1.6, ground limestone 2.5, and salt with added iodine and manganese 1.0. To this basal mixture were added the variables of interest indicated in table 3. Diet 4406 contained the least lysine of any diet used in this study.

TABLE 2

Effect of certain supplements added to the corn gluten meal diet which causes feather pigmentation failure.

PEN	SUPPLEMENT TO DIET 4215	CONTENT OF			NO. OF POULTS	AV. WT. AT AGE IN WKS.	ACHROMA SCORE
		Protein	Lysine	Ground Limestone			
		%	%	%		gm	
4269	Glycine, 1.25%	26.1	0.80	2.5	8	377 (5)	4
4270	Lactalbumin, 10.5%	27.3	1.18	2.5	8	396 (5)	0
4271	None	25.2	0.81	2.5	8	355 (5)	3.5
4354	None	25.2	0.81	2.5	6	182 (4)	4
4355	Calcium pantothenate 10 mg/lb	25.2	0.81	2.5	6	240 (4)	4
4356	Lysine, 1.8 gm/lb	25.6	1.20	2.5	6	340 (4)	0
4357	None	24.6	0.79	5.0	6	227 (4)	3
4358	Lysine, 1.8 gm/lb	25.0	1.19	5.0	6	296 (4)	0

The preventive value of fish solubles and of fish meal were investigated, and this test is summarized in table 4. It was considered desirable to study these materials because of their general acceptance and wide use in commercial poultry feeds. Almquist ('45) gives the lysine content of fish solubles as 4.9% of the crude protein, and of fish meal as 5.7% of the crude protein.

DISCUSSION

From the data presented in table 1, it seems obvious that the only cause of the white feather syndrome was the use of corn gluten meal. Among the differences in amino acid composition of soybean meal, which did not produce the syn-

[3] Poultry feed supplement containing whey solubles, used to supply B-complex vitamins.

[4] Poultry feed supplement containing fish solubles and fish liver and glandular meal, standardized to contain 100 A.O.A.C. units of vitamin D per gram.

drome, and of corn gluten meal, which did produce the syndrome, was that of the lysine content. Throughout the course of the tests outlined in this report, the use of protein sources which were good carriers of lysine prevented the pigmentation failure. Whenever proteins of low lysine content were substituted, the white feather syndrome was observed. The use

TABLE 3

Effect of varying the source of protein on the incidence of the white feather syndrome.

INGREDIENTS	DIET								
	4398	4399	4400	4401	4402	4403	4404	4405	4406
	%	%	%	%	%	%	%	%	%
Basal mixture [1]	68.4	68.4	68.4	76.7	68.4	68.4	68.4	68.4	68.0
Meat and bone scrap	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	6.5
Sardine meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	..
Cottonseed meal	16.6	..	..	..	..	..	..	..	8.5
Soybean meal	..	16.6	..	..	..	..	..	..	..
Dried brewer's yeast	..	..	16.6	..	..	..	..	..	..
Casein [2]	..	..	..	8.3	..	..	..	..	..
Linseed meal	..	..	..	..	16.6	..	..	..	8.5
Corn gluten meal	..	..	..	..	..	16.6	16.6	16.6	8.5
Lysine, crystalline [3]	..	..	..	..	..	..	1.8[3]	3.6[3]	..
Protein % (calculated)	24.1	24.0	24.9	25.0	23.0	24.3	24.7	25.1	22.4
Lysine % (calculated)	0.92	1.14	1.20	1.24	0.88	0.79	1.18	1.58	0.69
No. of poults	12	12	12	12	12	12	13	13	13
Av. wt. at 5 weeks	317	404	328	357	265	227	394	348	253
Achroma score	1	0	0	0	0	1	1	0	3

[1] See text for composition of basal mixture.

[2] Difference made up with the yellow corn meal.

[3] Lysine additions are expressed as grams per pound. The lysine used was Block's d-lysine. 2 HCl.

of crystalline lysine was as effective in preventing the syndrome as were any natural sources of lysine. It therefore seems obvious that under the conditions of this study, lysine deficiency was the cause of the pigmentation failure. Of course, it must be recognized that not all cases of pigmentation failure are necessarily due to a lysine deficiency. This syndrome is only an indication and as such may have numerous causes.

TABLE 4

Study of fish solubles and fish meal and their effect upon incidence of the depigmentation.

INGREDIENTS	DIET										
	4440	4441	4442	4443	4444	4445	4446	4472	4473	4474	4475
	%	%	%	%	%	%	%	%	%	%	%
Yellow corn meal	..	..	..	56.50	55.50	54.50	52.50	25.90	25.89	25.91	25.90
Ground barley	20.40	18.40	16.40	..	..	..	..	..	..	..	..
Pulverized oats	10.00	10.00	10.00	..	..	..	..	10.00	10.00	10.00	10.00
Standard middlings	10.00	10.00	10.00	..	..	..	..	10.00	10.00	10.00	10.00
Wheat bran	10.00	10.00	10.00	..	..	..	..	10.00	10.00	10.00	10.00
Alfalfa meal	7.50	7.50	7.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Meat and bone scrap	12.50	12.50	12.50	..	..	..	..	10.00	10.00	10.00	10.00
Sardine meal	2.50	2.50	2.50	..	..	..	..	2.50	5.00	7.50	10.00
Condensed fish solubles	..	2.00	4.00	..	..	2.00	4.00	..	..	..	..
Glycine	..	..	..	..	1.00	..	..	..	..	..	..
Soybean meal	..	..	..	34.50	34.50	34.50	34.50	..	..	..	..
Corn gluten meal	20.00	20.00	20.00	..	..	..	..	6.50	5.67	4.83	4.00
Cottonseed meal	..	..	..	..	..	..	..	6.50	5.67	4.83	4.00
Linseed meal	..	..	..	..	..	..	..	6.50	5.67	4.83	4.00
Flaydry	2.00	2.00	2.00	..	..	..	..	2.00	2.00	2.00	2.00
Ladpro 100 D	1.60	1.60	1.60	..	..	..	..	1.60	1.60	1.60	1.60
400 D fish oil	..	..	..	0.50	0.50	0.50	0.50	..	..	..	..
Ground limestone	2.50	2.50	2.50	1.00	1.00	1.00	1.00	2.50	2.50	2.50	2.50
Steamed bone meal	..	..	..	2.00	2.00	2.00	2.00	..	..	..	..
Salt with I_2 and Mn	1.00	1.00	1.00	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00
Additional vitamins	..	..	..		(See footnote [1]			..	..	..	..
Protein % (calculated)	25.7	26.3	26.9	20.5	21.4	21.1	21.7	23.2	23.7	24.2	24.7
Lysine % (calculated)	0.81	0.85	0.89	1.04	1.04	1.08	1.12	0.82	0.89	0.95	1.02
No. of poults	10	10	10	10	10	9	9	7	7	7	7
Average weight at 5 weeks	355	384	387	298	295	420	393	220	340	336	350
Achroma score	4	3.5	3.5	2	2	1	0	3	3	2	1

[1] To diets 4443 to 4446, inclusive, the following crystalline vitamins were added per pound: 1.2 mg riboflavin, 68.0 mg nicotinic acid, and 3.4 gm choline chloride.

A reasonable rate of growth is required to bring out the abnormality. If growth is below a critical limit, the lysine requirements are apparently reduced to the point where sufficient lysine is available for pigmentation.

Lysine is also seen to be a growth factor. This confirms the conclusion that the syndrome described is actually a deficiency. In all but a few cases the addition of either a natural source of lysine or of crystalline lysine did stimulate growth as well as prevent the pigmentation failure.

There are a few discrepancies in the growth rate which are not fully explained. The growth on diet 4213 was relatively poor (table 1). However, the average weight shown is influenced considerably by an unusual number of very small poults. If these were eliminated, the average weight of the birds on diet 4213 would be fully up to the highest weights obtained with other diets in this trial.

Calculations of the lysine content of the various rations are based upon data of Almquist ('45) and Block and Bolling ('45). With a few exceptions, chiefly those summarized in table 3, the incidence of the white feather syndrome varied inversely with the lysine content of the ration. Diets which contained 1.1% to 1.2% of lysine seemed to meet the poults' requirements for growth and pigmentation. These figures are above the recommended nutrient allowances for chickens (Cravens et al., '44). It seems apparent that the turkey poult requires considerably more lysine than does the chick. Similar differences have been noted in vitamin requirements.

When poults were placed on a lysine deficient diet, the white feather syndrome became apparent at about 2 weeks of age. The abnormal condition reached a maximum at about 5 weeks of age, and then gradually receded. Even when the poults were kept on diet 4215, the normal bronze pigmentation had nearly completely replaced the white by the time the poults were 10 weeks of age. This is somewhat more rapid disappearance of the syndrome than was noted by Funk and Kempster ('40).

As would be predicted from the lysine content, fish solubles and fish meal showed little protective value. Unless higher than usual levels of these ingredients are used, they are not especially effective in preventing the white feather syndrome. They do, however, show a growth stimulating value which may be due to other factors. Variations in the fiber or calcium content of the ration, and additions of glycine and calcium pantothenate, had no apparent influence on the incidence of the white feather syndrome.

Some of the poults on these diets also developed a curled feather condition similar to the symptoms of vitamin B_{10} deficiency described by Briggs, Luckey, Elvehjem and Hart ('44). This condition did not parallel the pigmentation failure, and may have indicated another deficiency in the rations used.

SUMMARY

A feather pigmentation failure was observed in bronze poults raised in confinement on diets containing a high percentage of certain vegetable protein concentrates. The syndrome was prevented by adding crystalline lysine to the diet, or by substituting protein concentrates high in lysine. The data indicates that the diet must contain approximately 1.1 – 1.2% of lysine for normal feather pigmentation and to permit optimum growth of poults.

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