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HAWAII AGRICULTURAL EXPERIMENT STATION, UNIVERSITY OF HAWAII

1862-1962

LAND-GRANT COLLEGES

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Honolulu, Hawaii

An Evaluation of Albacore Bone and Fish Meals As Protein Supplements In Chick Starter Rations

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Unlike farmers in many mainland areas, farmers in the state of Hawaii do not engage in the production of crops for use in formulated poultry and animal feeds. This fact, coupled with the distance to the nearest feed-producing area, has made Hawaii dependent on imported feeds and feedstuffs. For this reason, an intensive study has been, and is being, made to evaluate the nutritive potential of locally produced by-products. Locally available sources of protein have been of particular interest since protein is generally the most expensive major ingredient in poultry rations.

The Hawaii tuna-packing industry, in the course of its operations, produces a number of by-products of value as protein supplements in poultry feeds. Tuna meal and tuna fish solubles are two such by-products which are commonly used in the manufacture of poultry feeds in Hawaii. In recent years an increasing percentage of by-products is being derived from albacore (*Thunnus germo*), a species of tuna currently imported from Japan. Bone meal is a by-product peculiar to this species, being high in calcium and phosphorus. The purpose of this study, therefore, was to evaluate albacore bone and fish meals as potential protein and mineral supplements in chick starter rations.

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EXPERIMENTAL PROCEDURES

Chicks. Two hundred and sixty day-old chicks of a commercial broiler strain were divided into 26 pens, each pen containing 5 male and 5 female chicks. Duplicate pens were assigned at random to each of 13 treatments. The experimental chicks were housed in wire-floor, electrically-heated battery brooders until they were 6 weeks of age. At that time they were vaccinated for fowl pox and transferred to outdoor wire-floor developer pens where they remained until the termination of the experiment at 9 weeks of age.

Feed, water, and artificial light were continuously available to the chicks for the first 6 weeks of the experiment, while feed, water, and natural daylight were available during the last 3 weeks. Individual body weights and group feed consumption were recorded weekly. At the end of the study the sex of the chicks was checked according to secondary sex characters and any sexing discrepancies noted.

Feed conversion was calculated as the ratio of grams of feed consumed per gram of gain in body weight. The growth data were analyzed by means of the analysis of variance (Snedecor, 1956) and tests of significance by means of a multiple range test (Kramer, 1956).

Feed. The experimental rations used are shown in table 1. To insure uniformity of the constant ingredients a premix of the following composition was prepared: ground corn, 600 lbs.; soybean oil meal, 50 lbs.; iodized salt, 5 lbs.; and a vitamin and mineral mix, 5 lbs. This premix served as the base for all experimental rations. Graded levels (5, 10, 15, and 20 percent) of each of 3 fish by-products were added to 66 lbs. of this premix. Sufficient additional corn and soybean oil meal were then added to yield a final calculated protein level of approximately 21 percent.

Fish products. The fish bone meal used was derived from the back and head bones of *Thunnus germo* (albacore). Figure 1 is a schematic flow-chart showing the derivation of the various fish by-products. The back bones are removed from the fish in the manufacturing process, further cooked, dried and ground. The head, together with "cook" juices and viscera, undergo enzymatic digestion to yield fish solubles. After digestion, head bones, together with some adhering fish solubles, are removed from the digestion mixture. These bones are combined with the cooked back bones, dried, and then ground. The final product includes, in addition, some residual fish meal which is present in the dryer.

TABLE 1. Experimental rations

Ingredients[1]	1	2	3	4	5	6	7	8	9	10	11	12	13
Premix[2]	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0
Corn	—	1.25	2.7	2.3	2.0	3.25	6.5	10.0	13.25	2.75	5.8	8.75	11.75
Soybean meal	31	26.25	21.3	16.7	12.0	23.5	16.0	8.25	0.75	24.0	16.7	9.5	2.25
Tuna bone meal	—	5.0	10.0	15.0	20.0	—	—	—	—	—	—	—	—
Albacore meal no solubles	—	—	—	—	—	5	10	15	20	—	—	—	—
Albacore meal plus solubles	—	—	—	—	—	—	—	—	—	5	10	15	20
Defluorinated phosphate	3.0	1.5	—	—	—	2.25	1.5	0.75	—	2.25	1.5	0.75	—
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
%Protein (calculated)	20.94	21.00	21.00	20.99	20.95	20.98	21.02	20.98	21.01	21.02	21.00	21.01	21.01
Calories/lb. feed	886	918	952	967	982	926	966	1007	1047	923	962	1000	1039

[1] Unit of measure is pounds.

[2] Premix was prepared as follows: corn, 600 lbs; soybean oilmeal, 50 lbs; iodized salt, 5.0 lbs; vitamin premix, 5.0 lbs. The vitamin premix was designed to provide in mg. per lb. of finished ration the following: pyridoxine, 8; biotin, 0.3; folic acid, 2; i inositol, 50; para amino benzoic acid, 4; ascorbic acid, 10; procaine penicillin, 2.25; menadione, 5; vitamin B_{12}, 0.008; riboflavin, 4; thiamin, 12; niacin, 32; pantothenic acid, 8; choline chloride, 500; vitamin A, 8000 I.U.; vitamin D, 1200 I.C.U.; vitamin E, 6 I.U. Minerals, mg/lb. finished feed: manganese, 27.2; zinc, 20.4; iron, 9.07; copper, 1.13; iodine, 0.56; and cobalt, 0.22.

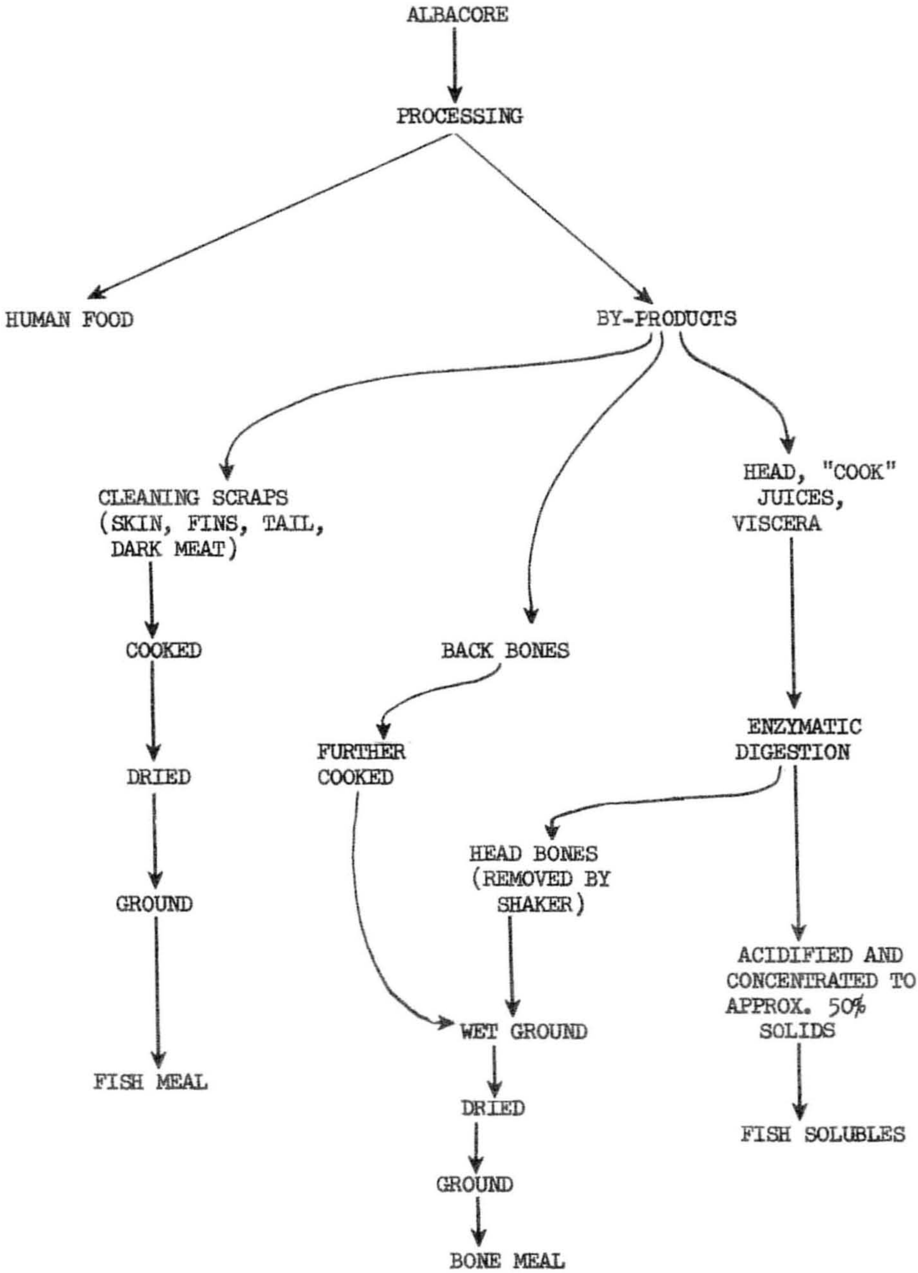

FIGURE 1. Flow chart of fish by-products manufacture.

The fish bone meal used in this study was estimated to have the following percentage composition:[1] protein, 39.88; moisture, 8.1; calcium, 15.61; phosphorus, 6.24; fiber, 2.0; and total ash, 44.0. The fish bone meal used during the last 3 weeks of the experiment came from a different batch than the bone meal used the first 6 weeks, but the estimated difference in composition was negligible. In the formulation of the experimental rations defluorinated phosphate (34 percent Ca, 17 percent P) was replaced by the calculated levels in the fish products, i.e., 15.61 percent of calcium and 6.24 percent of phosphorus in the fish bone meal. Thus, in groups receiving 5 percent of fish bone meal in the ration, the defluorinated phosphate supplement was reduced by 50 percent. In groups receiving 10 percent or more of the bone meal the phosphorus supplement was completely eliminated.

Two different types of albacore meal were used. "Whole albacore meal" contained, by weight, approximately 10 percent of dried fish solubles. The protein and moisture content were found by analysis to be 58.56 and 10.8 percent, respectively. The "albacore meal" without solubles was found to contain 61.32 percent of protein and 6.5 percent of moisture. Since no information was available as to the calcium and phosphorus content of these fish meals the values of 5.11 percent and 3.28 percent (Nopco, 1960), respectively, were used.

Bone ash. Since the fish products being tested were replacing a considerable amount of the phosphorus supplement it seemed desirable to determine their effectiveness as sources of calcium and phosphorus. Therefore, bone ash was determined on one-half of the chicks receiving each treatment when the chicks were 3 weeks of age, and in the other half when the chicks were 4 weeks of age. In order that the chicks could be continued on experiment the bone ash was determined in the fresh toes after the method described by Evans and St. John (1944), and Campbell, Migicovsky, and Emslie (1945). In this method the middle toe was removed at the third joint and the first phalanx was coated with collodion to minimize bleeding. The toes from each individual group were weighed in a covered crucible and ashed at 850° C. for 1 hour. The percent ash was then calculated as the percentage of the fresh toe weight.

RESULTS AND DISCUSSION

Body weight. The mean body weights and feed conversions of the chicks fed graded levels of fish bone meal, albacore meal, and whole albacore meal are summarized in table 2. At 6 weeks of age only the groups receiving

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[1] The fish by-products used in this study and the analyses of these materials were generously supplied by Mr. Scott McLeod of the Hawaiian Tuna Packers, Inc., Honolulu.

TABLE 2. Mean body weights and feed conversions of broiler chicks fed graded levels of several fish by-products

Treatment	Mean Body Weights				Feed Conversion
	6 weeks	9 weeks			
	Both sexes	Both sexes	Males	Females	Both sexes
	gm.	lbs.	lbs.	lbs.	
Control	813	3.24	3.77	2.87	2.66
+ 5% fish bone meal	831	3.20	3.46	2.94	2.63
+ 10% fish bone meal	863	3.37	3.70	2.88	2.48
+ 15% fish bone meal	803	3.33	3.53	3.10	2.55
+ 20% fish bone meal	754	3.00	3.42	2.66	2.72
+ 5% albacore meal	818[1]	3.22[1]	3.42[1]	3.03[1]	2.76
+ 10% albacore meal	801	3.17	3.45	2.89	2.61
+ 15% albacore meal	828	3.18	3.56	2.76	2.42
+ 20% albacore meal	721	2.90	3.25*	2.56*	2.39
+ 5% whole albacore meal	822	3.24	3.59	2.98	2.61
+ 10% whole albacore meal	844	3.39	3.71	3.00	2.44
+ 15% whole albacore meal	809	3.08	3.39*	2.80	2.49
+ 20% whole albacore meal	746[1]	2.98	3.41*	2.51*	2.55

[1] These values represent only 1 replicate, since the other pens were without water for an indefinite period during the 5th week.

*Significantly lower than the control, P = 0.05.

the 20 percent concentration of the fish products failed to gain at a rate comparable to the control group. The same general trend continued to 9 weeks of age. Chicks receiving 20 percent of the fish products weighed 0.24–0.34 pounds less than the control chicks at 9 weeks.

A statistical analysis of the 9-week growth data by sex showed that only the 15 and 20 percent levels of whole albacore meal and the 20 percent level of albacore meal resulted in significantly poorer growth in the males when compared with the control group. In the case of the females, only the groups receiving 20 percent of albacore and the whole albacore meals gained significantly less than the control chicks.

These results are in general agreement with previous unpublished data obtained at this station, which showed that tuna meal, up to about 10 percent of the diet, was a satisfactory protein supplement for chick starter rations.

Fish bone meal, substituted in this experiment for soybean oil meal on approximately a pound-for-pound basis, appeared to be at least equal to albacore and whole albacore meals as a protein supplement. In addition, fish bone meal appeared to be as good as soybean oil meal up to about 15 percent of the diet.

Feed efficiency. The efficiency of feed utilization of most groups fed the fish products was generally better than that of the control group (table 2). Only the groups receiving 20 percent of fish bone meal and 5 percent of albacore meal had a poorer feed conversion than the control group. The fact that one of the pens receiving the 5 percent albacore treatment was accidentally allowed to go without water for an indefinite period of time probably contributed to the poorer feed conversion for this group.

Bone ash. The 3- and 4-week toe ash data (table 3) are in good agreement except for a few scattered points. It appears from these data that there was a general trend toward increasing bone ash with increasing increments of the fish products. This would indicate that either the calculated calcium and phosphorus was underestimated, or that the calcium and phosphorus compounds present in these fish meals were more available to the chick than the defluorinated phosphate supplement included in the basal diet.

These data also show that 10 percent of the fish bone meal provided all the supplemental calcium and phosphorus required in the ration. The albacore and whole albacore meals have a slightly lower value as a source of calcium and phosphorus, although 10 percent of each of these materials replaced half of the defluorinated phosphate in their respective diets.

This information suggests that the mineral content (especially calcium and phosphorus) of available fish products should be considered in calculating the nutritive value of starter rations. Such a consideration may well result in lowered feed costs by replacing part or all of expensive imported phosphorus supplements.

TABLE 3. Mean 3- and 4-week toe ash of broiler chicks fed graded levels of fish by-products

Treatment	Toe Ash		
	3-week %	4-week %	Mean %
Control	4.68	4.78	4.73
+ 5% bone meal	4.88	4.91	4.90
+ 10% bone meal	4.93	5.03	4.98
+ 15% bone meal	5.11	5.22	5.17
+ 20% bone meal	4.43[1]	5.22	4.83
+ 5% albacore	4.69	4.81	4.75
+ 10% albacore	4.92	5.44	5.18
+ 15% albacore	5.06	5.02	5.04
+ 20% albacore	5.13	5.12	5.13
+ 5% whole albacore	4.60	4.78	4.69
+ 10% whole albacore	5.00	4.82	4.91
+ 15% whole albacore	4.86	5.33	5.10
+ 20% whole albacore	4.95	5.29	5.12

[1]This value does not follow the general trend and may be due to experimental error.

SUMMARY

Fifteen percent of fish bone meal, substituted for almost 15 percènt soybean oil meal in a chick starter ration, proved as satisfactory for chick growth as either albacore meal or whole albacore meal. At the 10 percent level the growth of the chicks fed the 3 fish products was not significantly different from that of chicks fed the control diet. Higher levels of the fish products tended to depress chick growth.

The efficiency of feed utilization was generally improved at all levels of fish products except at the 20 percent level of fish bone meal. The calcium and phosphorus in all fish products tested were readily available to the chick as evidenced by bone ash values equal to or exceeding those of the control group. Ten percent of fish bone meal satisfactorily replaced all of the defluorinated phosphate in the feed, while 10 percent of either albacore meal or whole albacore meal successfully replaced one-half of the phosphorus supplement.

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