United States Department of the Interior
Fish and Wildlife Service

Fishery Leaflet 159

Chicago 54, Ill. December 1945

Condensed Fish Press Water and Fish Liver Meal in Chick Rations[1,2]

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(Received for publication, September 25, 1944)

NUMEROUS workers have investigated the supplementary effect of small amounts of animal protein feeds in diets containing vegetable proteins. Berry, Carrick, Roberts, and Hauge (1943) pointed out that the proteins of soybean oil meal were of excellent quality, but that rations containing soybean oil meal as a sole protein supplement were deficient in certain vitamins which were adequately supplied by additions of small amounts of animal protein feeds. This work has been confirmed by Hammond and Titus (1944), who mention the necessity of supplementing a diet containing soybean oil meal as the sole protein supplement with adequate vitamins and minerals. The same workers, however, state that "sardine fish meal is of outstanding value as a protein supplement to soybean meal." Whether sardine meal is of value purely as a protein supplement (chiefly as a contributor of methionine) or partly as a vitamin supplement (choline and other vitamins) has not been clearly proved. The relationship of the interchangeable supplementary action between choline and methionine in a chick ration consisting largely of corn and soybean oil meal was discussed by Marvel, Carrick, Roberts, and Hauge (1944).

EXPERIMENTAL

Five trials were conducted to ascertain the value of fish press water and fish liver meal as supplements to simplified rations composed largely of ground yellow corn and soybean oil meal. These experiments were conducted with Barred Plymouth Rock chicks for a period of either six or eight weeks. The day-old chicks were sexed according to a method described by Quinn and Knox (1939) and were sorted into lots on the basis of weight. Only one sex was used in a trial, except in trial 4 where 20 male and 20 female chicks were started in each lot. The chicks of trial 4 were kept on wire-floored electrically-heated brooder tables, while the chicks of the remaining trials were grown in metal electrically-heated batteries. Water and the all-mash rations were given *ad libitum*. At four weeks, each lot of trials 1, 2, and 3 was reduced to 25 by keeping the median weight chick and twelve chicks on each side of the median weight chick.

Trial 1 was started in March, trial 2 in May, trial 3 in June, trial 4 in September, and trial 5 in January. Individual biweekly weights were taken for each experiment.

The crystalline vitamins* were dissolved in ethanol and/or water and dried on ground yellow corn, and then incorpo-

[1] Journal Paper Number 190, of the Purdue University Agricultural Experiment Station.

[2] This investigation was supported in part by a grant from The Borden Company.

* The choline chloride used in these experiments was generously furnished by the Lederle Laboratories, Pearl River, New York.

Note: Reprinted from Poultry Science, vol. XXIV, no. 3, May 1945.

rated in the ration as a dry premix. The rations were mixed in amounts of either 4,000 or 6,000 grams.

Condensed fish press water is a by-product of the fish processing industry. The body fluids are pressed from fish, some of the fat is removed, and the resulting press water is condensed to contain approximately 50 percent solid matter, 29 percent protein, and 7 percent fat. Henceforth, in this paper, condensed fish press water will be referred to as "fish press water." One sample of fish press water was used in trials 1, 2, 3, and for the first four weeks of trial 4. A second sample was used during the last four weeks of trial 4 and for tiral 5.

TABLE 1.—*Comparison of fish press water with crystalline vitamins (females)*

Ingredient	Lot 1	Lot 2	Lot 3
Ground yellow corn	55.5	55.5	55.5
Soybean oil meal	34.5	32.5	30.5
Alfalfa leaf meal	5	5	5
400-D oil	0.5	0.5	0.5
Salt mixture[1]	0.5	0.5	0.5
Steamed bone meal	2	2	2
Ground limestone	1	1	1
Riboflavin concentrate[2]	0.5	0.5	0.5
Choline[3]	+		
Nicotinic Acid[4]	+		
Calcium pantothenate[5]	+		
Whey solubles	0.5	0.5	0.5
Fish press water		2	4
Total	100	100	100
Percentage protein	20.62	20.38	19.94
Av. wt. 6 weeks (grams)[6]	321	474	463
Standard deviation	57.4	66.4	43.6
Coefficient of variation	17.9	14.0	9.4
Grams feed per gram of gain	2.50	2.10	2.10
Number chicks at 6 weeks	25	25	25

[1] 95 grams iodized salt, 5 grams $MnSO_4$.
[2] 280 micrograms riboflavin per gram.
[3] 150 mg. choline chloride per 100 grams feed.
[4] 30 mg. nicotinic acid per 100 grams feed.
[5] 1.95 mg. calcium pantothenate per 100 grams feed.
[6] Least significant difference: 5% level, 30; 1% level, 40.

The fish liver meal used in trial 5 contained approximately 50 percent of dried fish livers and 50 percent of soybean oil meal.

Trial 1. This trial consisted of three lots, with 35 chicks started per lot. The composition of the rations with the results is shown in Table 1. Lot 1, containing no animal protein supplement except for the small amount in 0.5 percent of whey solubles, was supplemented with nicotinic acid, pantothenic acid, choline, and riboflavin. A highly significant increase in growth was obtained when either two or four percent of fish press water was used in lots 2 and 3. Riboflavin was added to lots 2 and 3 because of the uncertainty of the amount of riboflavin in fish press water. The tremendous increase in growth when 2 or 4 percent of fish press water was used indicated that the level of fish press water used contained an adequate amount of nicotinic acid, pantothenic acid, and choline for satisfactory chick growth, plus one or more factors not present in lot 1.

Trial 2. Five lots of 35 male chicks were started per lot. The composition of the rations with the results is given in Table 2. Since fish press water increased growth very markedly over lot 1 in trial 1, two percent of gelatin was added in lot 4 to ascertain whether the increased growth might not have been due to the high glycine and lysine content of the gelatinous fish press water. The results of lot 4 did not confirm the supposition inasmuch as additions of gelatin did not give growth comparable to that of fish press water or animal liver meal. The growth response with one percent of fish press water (lot 5) was significantly poorer than with two percent of fish press water (lot 6). In lot 7, when the riboflavin concentrate which supplied approximately 140 micrograms of riboflavin per 100 grams of feed was omitted, a highly significant decrease in growth resulted. Lot 8 with three percent

TABLE 2.—*Comparison of fish press water with liver meal (males)*

Ingredient	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
Ground yellow corn	60	60	60	60.5	57.5
Soybean oil meal	28	29	28	28	30.5
Alfalfa leaf meal	5	5	5	5	5
400-D oil	0.5	0.5	0.5	0.5	0.5
Salt mixture[1]	0.5	0.5	0.5	0.5	0.5
Steamed bone meal	2	1.5	1.5	1.5	2
Ground limestone	1	1.5	1.5	1.5	1
Riboflavin concentrate[2]	0.5	0.5	0.5		
Gelatin	2				
Choline[3]	+				
Nicotinic acid[4]	+				
Calcium pantothenate[5]	+				
Whey solubles	0.5	0.5	0.5	0.5	
Fish press water		1	2	2	
Liver meal					3
Total	100	100	100	100	100
Percentage protein	21.03	19.93	19.78	19.82	21.12
Av. wt. 6 weeks (grams)[6]	359	398	484	436	494
Standard deviation	38.7	59.7	61.0	58.9	12.3
Coefficient of variation	10.8	15.0	12.6	13.5	2.5
Grams feed per gram of gain	2.82	2.70	2.77	2.46	2.46
Number chicks at 6 weeks	24	25	25	25	20

[1,2,3,4,5] See Table 1.
[6] Least significant difference: 5% level, 37; 1% level, 49.

TABLE 3.—*Supplementary value of fish press water fractions and vitamins (males)*

Ingredient	Lot 9	Lot 10	Lot 11	Lot 12	Lot 13	Lot 14	Lot 15	Lot 16
Ground yellow corn	54	54	54.5	50.5	54	50	49.2	50
Soybean oil meal	34	34	34.5	34.5	36	36	36	36
Alfalfa leaf meal	5	5	5	5	5	5	5	5
400-D oil	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt mixture[1]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Steamed bone meal	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Ground limestone	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Whey solubles	0.5	1	0.5	0.5	0.5	0.5	0.5	0.5
Riboflavin concentrate[2]	0.5		0.5	0.5	0.5	0.5	0.5	0.5
Fish press water	2	2	1	1				
Gelatin				4		4	4	4
Choline[3]				+	+	+	+	+
Nicotinic acid[4]				+	+	+	+	+
Calcium Pantothenate[5]				+	+	+	+	+
Pyridoxin[6]				+	+	+	+	+
Alcohol ppt. of fish press water							0.8	
Water extract of fish press water								+
Total	100	100	100	100	100	100	100	100
Percentage protein	21.85	21.93	21.82	25.04	22.15	23.7	23.37	23.37
Av. Wt. 6 weeks (grams)[7]	506	525	491	527	413	400	440	511
Standard deviation	58.7	46.9	69.4	59.3	61.7	66.3	55.1	43.7
Coefficient of variation	11.6	8.9	14.1	11.2	14.9	16.6	12.5	8.6
Grams feed per gram of gain	2.40	2.39	2.51	2.40	2.60	2.73	2.60	2.52
Number chicks at 6 weeks	25	25	24	24	25	25	25	25

[1,2,3,4,5] See Table 1.
[6] 400 micrograms pyridoxin per 100 grams feed.
[7] Least significant difference: 5% level, 34; 1% level, 44.

of animal liver meal grew as well as lot 6 with two percent of fish press water plus riboflavin.

Trial 3. Eight lots of 38 male chicks were started per lot. The composition of the rations with the results is shown in Table 3. Lot 9 contained two percent of fish press water with a riboflavin supplement, and 0.5 percent of whey solubles. In lot 10, the whey solubles was increased to one percent, the riboflavin supplement was omitted, and the level of fish press water remained the same. Growth in lots 9 and 10 was practically the same, indicating that the deficiency of riboflavin which occurred when the riboflavin concentrate was omitted in lot 7 was readily corrected by increasing the whey solubles from 0.5 to one percent (lot 10). One percent of fish press water (lot 11) supported practically the same growth as did two percent (lot 9). In the previous trial on a slightly different ration, two percent of fish press water was superior to one percent. The supplementary value of only one percent of fish press water is clearly shown by comparing lot 12 with 13 and 14. That the four percent of gelatin in lot 12 is of no value is shown by comparing lots 13 and 14, where there was no growth difference with or without gelatin.

Lots 15 and 16 involved two fractions of fish press water. The fish press water was mixed with ethanol to precipitate a considerable portion of the protein which was removed by filtration. A small amount of protein remained in the filtrate. In lot 15, an amount of the alcohol precipitate

TABLE 4.—*Supplementary value of fish press water to a corn and soybean oil meal ration (males and females)*

Ingredient	Lot 17	Lot 18	Lot 19	Lot 20
Ground yellow corn	55	58.5	52	48
Soybean oil meal	34	35	29	27
400-D oil	0.5	0.5	0.5	0.5
Salt mixture[1]	0.5	0.5	0.5	0.5
Steamed bone meal	1.5	1.5	1.5	
Ground limestone	1	1.5	1	1
Whey solubles	0.5	0.5	0.5	
Riboflavin[2]	+	+	+	
Alfalfa leaf meal	5		5	3
Fish press water	2	2	2	
Domestic casein			5	
Liver meal			3	
Wheat bran				5
Wheat middlings				5
Meat and bone scraps				5
Dried skimmilk				5
Total	100	100	100	100
Percentage protein	21.94	21.71	25.61	22.76
Av. wt. 6 weeks (grams)[3]	506	511	517	496
Av. wt. 8 weeks (grams)[3,4]	766	797	799	737
Standard deviation[5]	113.0	143.5	157.2	142.7
Coefficient of variation[5]	14.8	18.0	19.7	19.4
Grams feed per gram gain[5]	2.42	2.50	2.46	2.82
Number chicks at 8 weeks	40	37	37	38

[1] See Table 1.
[2] 200 micrograms synthetic riboflavin per 100 grams feed.
[3] Weights reported are average female weights plus average male wts., with the resulting sum divided by two.
[4] Least significant difference: 5% level, 63; 1% level, 84.
[5] Eight week weights.

TABLE 5.—*Comparison of different protein levels with fish press water and different levels of fish press water with fish liver meal (females)*

Ingredient	Lot 21	Lot 22	Lot 23	Lot 24	Lot 25	Lot 26	Lot 27	Lot 28
Ground yellow corn	58	64	69.5	58	59	59	58	61.2
Soybean oil meal	36	30	24.5	36	36	36	36	32.5
400-D oil	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Salt mixture[1]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Steamed bone meal	1.5	1.8	2	1.5	1.5	1.5	1.5	1
Ground limestone	1.5	1.2	1	1.5	1.5	1.5	1.5	1.3
Riboflavin[2]	+	+	+	+	+	+	+	+
Fish press water	2	2	2			1	1	
Fish liver meal				2	1		1	
Sardine meal								3
Total	100	100	100	100	100	100	100	100
Percentage protein	22.0	20.0	18.1	22.5	22.1	21.8	22.2	22.2
Av. wt. 6 weeks (grams)	464	429	410	458	437	408	460	413
Av. wt. 8 weeks (grams)[3]	732	703	676	728	711	677	728	661
Standard deviation[4]	121.6	110.0	119.3	118.5	176.5	123.6	87.5	141.9
Coefficient of variation[4]	16.6	15.6	17.6	16.3	24.8	18.3	12.0	21.5
Grams feed per gram gain[4]	2.68	2.63	2.83	2.68	2.60	2.82	2.74	2.81
Number chicks at 8 weeks	47	43	44	44	45	44	43	45

[1] See Table 1.
[2] See Table 4.
[3] Least significant difference: 5% level, 54; 1% level, 71.
[4] Eight week weights.

of fish press water equivalent to the amount in three percent of fish press water was used. The increase in growth from this protein fraction was significant, but not highly significant. An amount of the water extract of fish press water equivalent to that amount in three percent of fish press water was used in lot 16, with a highly significant increase in growth over lot 14 with no fish press water, and over lot 15, containing the alcohol precipitated protein fraction of fish press water. The results of lots 15 and 16 indicate that the water soluble fraction is responsible for most of the growth-promoting properties of fish press water.

Trial 4. Forty chicks were started in each lot, with the sexes approximately equally divided. All chicks were kept throughout the experiment. The rations and the results are given in Table 4. Since the two percent fish press water level had given good growth, it seemed desirable to ascertain the value of alfalfa leaf meal in the ration. Lot 18, with the alfalfa leaf meal omitted, supported the same growth as did lot 17, which contained five percent of alfalfa leaf meal. In lot 19, five percent of domestic casein, three percent of liver meal, and two percent of fish press water were included in an attempt to secure better growth than that supported by fish press water alone. No significant growth increase resulted. Lot 20 was a positive control ration containing dried skimmilk, meat and bone scraps, alfalfa leaf meal, wheat bran, and wheat middlings as supplements. The poorer growth supported by this ration at eight weeks compared to lots 18 and 19 approached significance.

Trial 5. Females were used in this experiment, with 49 chicks started in each lot. The composition of the rations with the results is shown in Table 5. Lots 21, 22, and 23 contained decreasing amounts of soybean oil meal and, therefore, three different levels of protein. As the protein

level decreased from 22 percent, the growth also decreased, but only the difference between the 22 percent level (lot 21) and the 18 percent level (lot 23) was significant. It appeared that the most satisfactory protein level for rapid growth on this type of ration was between 20 and 22 percent.

Lot 24 contained two percent of fish liver meal, composed of one-half dried fish livers and one-half soybean oil meal. The two percent fish liver meal (lot 24) supported growth equal to two percent of fish press water (lot 21). Even when the fish liver meal was reduced to a one percent level (lot 25), the growth remained approximately the same. The use of one percent of fish press water (lot 26), resulted in a significant retardation of growth when compared to two percent of fish press water (lot 21). When a combination of one percent of fish press water and one percent of fish liver meal was used (lot 27), growth was equal to, but no better than, either two percent of fish press water or two percent of fish liver meal. Apparently the addition of one percent of fish press water did not supply quantitative or qualitative factors not already present in lot 25. Sardine meal (lot 28) was used to compare with fish press water and fish liver meal. The growth supported by three percent of sardine meal was significantly poorer than that from two percent of fish press water or two percent of fish liver meal.

DISCUSSION

Fish press water, fish liver meal, and animal liver meal appear to be three of the most satisfactory supplements to a corn and soybean oil meal ration, especially when the supplements are compared at very low levels. Two percent of fish press water or two percent of fish liver meal seemed to supply all factors except riboflavin, vitamin D, and minerals needed to supplement a ration composed of ground yellow corn as a source of energy and soybean oil meal as a protein supplement. When two percent of fish press water was used the deficiency of riboflavin could be corrected by the addition of one percent of whey solubles.

The unusual potency of fish press water and fish liver meal may be more fully appreciated when it is realized that the moisture content of the fish press water used in these experiments was slightly over 50 percent, and that the fish liver meal used contained 50 percent of soybean oil meal.

Three percent of liver meal appeared to supply sufficient riboflavin, in addition to the factors supplied by fish press water or fish liver meal. Further investigation may show that two percent of fish liver meal may also contain enough riboflavin to supplement a corn and soybean oil meal ration. This factor was not tested in the one trial involving fish liver meal.

The data suggest that fish press water and fish liver meal supply the same qualitative factors, since similar results were obtained when either product was fed in an adequate quantity. Since the filtrate fraction of the fish press water proved more effective than the precipitate in promoting growth, it is likely that the important factors necessary for supplementing this type of ration were vitamins rather than amino acids.

Further work will be necessary to determine the variability of the fish products, since only two samples of the fish press water and one sample of the fish liver meal were involved in these trials.

Since fish press water has a very fishy odor, there existed a possibility of a fishy flavor being transmitted to the meat of the chicken. Thirty nine-week old chickens which had received a ration containing

two percent of fish press water were dressed, halved, and distributed to families for palatability tests. Dressed chickens grown from control lots were also included. Several methods of cooking were used. Only one person reported a slight fishy flavor, and this was not confirmed in the opposite half of the same chicken. Therefore, it seemed that no flavor transmission occurred from the fish press water to the chicken meat.

SUMMARY

1. Two percent of fish press water or two percent of fish liver meal contained an adequate amount of nicotinic acid, pantothenic acid, and choline or its equivalent to supplement a corn and soy bean oil meal ration.

2. Two percent of fish press water with one percent of whey solubles supplied a sufficient amount of riboflavin for satisfactory growth.

3. Three percent of liver meal adequately supplemented a ration containing corn, soybean oil meal, alfalfa leal meal, 400-D oil, and minerals.

4. Fish press water was separated into two fractions. An alcohol precipitate containing most of the protein had little supplementary action, while the water extract containing only a small percentage of protein had most of the supplementary value of whole fish press water.

5. Alfalfa leaf meal was not necessary for rapid growth in the corn and soybean oil meal ration containing two percent of fish press water and a riboflavin supplement.

6. Five percent of domestic casein and three percent of liver meal did not further supplement a corn and soybean oil meal ration containing fish press water and whey solubles.

7. When riboflavin was added, one percent of fish liver meal effectively supplemented the ration and was as effective as two percent of fish press water.

8. Three percent of sardine meal was inferior to two percent of fish press water or two percent of fish liver meal.

9. In the type of rations used, between 20 and 22 percent of protein was necessary for maximum growth.

10. The use of fish press water did not adversely affect the flavor of the cooked chicken.

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