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Short communication

EFFECT OF RATE OF INCLUSION OF FISHMEAL PREPARED BY COOKING AND SUN DRYING OF FISH OFFAL ON FEED INTAKE AND NUTRIENT RETENTION OF GROWING RHODE ISLAND RED CHICKS

Asrat Tera [1], Tegene Negesse [2,*] and Abera Melesse [2]

[1] Wolaita Soddo ATVET College, PO Box 120, Wolaita Sodo, Ethiopia
[2] Hawassa College of Agriculture, Hawassa University, PO Box 05
Hawassa, Ethiopia. E-mail: sgsdean@yahoo.com

ABSTRACT: Effect of cooked and sun dried fish offal on intake and nutrient retention of growing Rhode Island Red (RIR) chicks in southern Ethiopia was evaluated. Unsexed day old RIR chicks were uniformly brooded, vaccinated against Gumboro and Newcastle diseases. At the age of 14 days, 10 chicks were assigned to each of the 5 replicates of the 6 dietary groups, fed for 11 weeks and daily group feed intakes were recorded. The control diet (T_1) consisted of Maize (34.1%), wheat short+bran (21.0%), limestone (1.20%), salt (0.5%), premix (0.1%), lysine (0.05%), methioinine (0.05%), roasted soybean (27.0%) and noug cake (16.0%); the rest of the diets contained all ingredients in the control plus fishmeal at rates of 3.32% (T_2), 6.64% (T_3), 9.96% (T_4), 13.28% (T_5), and 16.6% (T_6) of the diet and had 19.76, 18.89, 19.82, 18.44, 18.96 and 19.20% CP, respectively. At the beginning of the feeding trial, 13 chicks representing initial body weight of those in the trial were stunned by dislocation of the neck. At the end, one male and one female chick from each of the 3 replicates of each of the 6 treatment groups were systematically selected, tagged, fasted for 12 hours, weighed, and stunned by dislocation of the neck. All carcasses were kept intact in deep freezer at -20°C and then cut into small pieces in freezing condition, minced and dried in an oven at 65°C for 80 hours, ground, homogenized and chemically analyzed. Chicks fed T_1 had significantly ($p \leq 0.001$) lowest (68.5g DM, 13.3g CP, 0.54g Ca, 0.35g P and 231kcal ME head^{-1}) but those on T_6 had the highest daily nutrient intakes (77 g DM, 14.8 g CP, 1.81 g Ca, 0.58 g P and 243 kcal ME head^{-1}). T_1 (2.28) of all and T_4 (2.65) among fishmeal groups viz T_2 (3.01), T_3 (2.92), T_5 (2.86) and T_6 (2.85) had the lowest ($p<0.001$) CP retention (CPR). Males had significantly ($p<0.001$) higher CPR (2.9 g head^{-1}d^{-1}) than female (2.62 g head^{-1}d^{-1}). Energy retention of T_1, T_2, T_3, T_4, T_5, T_6 were 21.6, 28.7, 29.1, 27.0, 25.9 and 28.1 kcal head^{-1}d^{-1}, respectively, with significant differences ($p<0.01$) only between T_1 and fishmeal groups. Sex had no influence on energy retention. Based on the results of the present study fishmeal can be incorporated up to 16.6% of the diet of RIR chicks, however, best results of protein retention was obtained at 3.32%, and of energy retention at 6.64%.

Key words/phrases: Chicks, fishmeal, nutrient retention

INTRODUCTION

According to CSA (2007) Ethiopia possesses over 34.2 million poultry. Their performance is lowered mainly due to inadequate and inconsistent supply of feeds that can provide sufficient amount of energy, protein, vitamins and minerals (Alemu Yami and Tadelle Dessie, 1997). There is chronic shortage of supply of protein concentrates for poultry (Tegene Negesse, 1992) that necessitates investigations of the potentials of some feed resources that are cheaper, locally available and have comparative nutritional value as the conventional protein sources. Incorporating agricultural and aquatic by-products not directly consumed by man reduces competition of poultry for food with humans, feed cost and problem of waste management.

A notable feed ingredient with high nutrient density and availability in the rift valley of Ethiopia that deserves attention as livestock protein source is fish meal. Because of the well-balanced amino acid profile, most fish meals are good sources of proteins (Donald and William, 2002) and contain omega -3 and -6 fatty acids that protect health and welfare and reduce dependence of chicks on antibiotics and other drugs. The total annual landing from inland fresh water of Ethiopia is over 10,000 tons (LFDP, 1997), from which about 5,700 tons of offal (1900 tons of DM) could be produced (personal communication) which could be processed to fish meal. Whole fish is processed to fillets mostly myomere muscles, streaks or any

* Author to whom all correspondence should be addressed.

of the convenient packages; the balance is usually waste, of no industrial or other uses at present and are available throughout the year, and can be used as animal feed either in fresh or processed form (William, 1984; Ponce and Gernat, 2002).

Although a substantial amount of work has been reported using fish meal in animal diet elsewhere, much less has been studied on the nutritive value of locally made fish meal in Ethiopia. In the current study the effect of dietary levels of fish meal on feed intake and nutrient retention of growing Rhode Island Red chicks was evaluated.

Abbreviations: Ca, calcium; CF, crude fiber; CP, crude protein; DM, dry matter; EE, ether extract; ME, metabolisable energy; N, nitrogen; OM, organic matter; P, phosphorus; RIR, Rhode Island Red

MATERIALS AND METHODS

The study area

The feeding trial with Rhode Island Red (RIR) chicks was conducted at Wolaita Soddo Poultry Husbandry Centre located at approximately 400 km south west of the capital, Addis Ababa and lies between 6.72–6.99°N and 37.61–37.88°E. Its altitude is 1884 m. a. s. l. Rainfall is bimodal and the annual mean rainfall ranges between 1201 and 1600 mm; and temperature between 15.1 and 20°C.

Composition of the diets

The ingredients used in diets (Table 1) were maize, fishmeal, roasted soybean, noug cake, wheat bran, limestone, salt, vitamin-mineral premix, lysine and methionine and diets had similar crude protein and energy values. The fishmeal used here was prepared according to the procedure described by Asrat Tera (2007). The control diet (T_1) did not contain fishmeal but to the test diets, T_2, T_3, T_4, T_5 and T_6, fishmeal was included at rates of 3.32, 6.64, 9.96, 13.28 and 16.6% of the diets, respectively, to replace 7.6, 15.3, 22.9, 30.5 and 38.2% of the CP of the control diet.

Soybean was roasted for 5 minutes until the beans were brown to deactivate trypsin inhibitor. The coarse feed ingredients were first ground and mixed using a special mixer fitted to a mill.

Chicks and their management

Chick houses were thoroughly cleaned, disinfected with formalin (37%), closed for 14 days and then aerated for 5 days. Chicks were reared at floor space of 0.5m x 0.45 m (0.225 m^2/bird). Wood shavings were used as litter at a depth of 5 cm. The birds were exposed to continuous artificial light during the adaptation period but later on for only 21 hours. A batch of day-old RIR chicks was purchased and uniformly brooded for two weeks. They were vaccinated against New castle and infectious bursal diseases (Gumboro) on the 7th and 12th days, respectively. At the age of 14 days, they were weighed and 10 chicks were randomly assigned to each of the 5 replicates of the 6 dietary treatments. The overall initial weight of the chicks was 114.6±1.7 g and the average initial weights of T_1 (115 g), T_2 (114 g), T_3 (114 g), T_4 (116 g), T_5 (115 g) and T_6 (115 g) were similar. Male: female ratios of chicks 33:17 (T_1), 33:17 (T_2), 34:16 (T_3), 33:17 (T_4), 32:18 (T_5) and 34:16 (T_6) determined at end of the experimental period were similar across treatments.

Table 1. The proportion of feed ingredients (% as fed basis) and nutrient content and energy value of the experimental diets.

Ingredients (%)	Treatments					
	T_1	T_2	T_3	T_4	T_5	T_6
Maize	34.10	34.10	34.10	34.10	34.10	34.10
Wheat bran + short	21.00	24.00	27.16	29.74	33.72	37.90
Soybeans, roasted	27.00	20.88	15.20	10.30	5.00	1.50
Noug cake	16.00	15.80	15.00	14.00	12.00	8.00
Fishmeal, cooked and dried	0.00	3.32	6.64	9.96	13.28	16.60
Lime stone	1.20	1.20	1.20	1.20	1.20	1.20
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vit/ Min premix	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.05	0.05	0.05	0.05	0.05	0.05
Methionine	0.05	0.05	0.05	0.05	0.05	0.05
Composition						
Dry matter (%)	92.17	91.81	91.86	91.65	91.45	91.45
Ash (% of DM)	6.92	8.69	8.93	8.69	9.94	11.17
Crude fiber(% DM)	10.27	13.72	10.53	11.99	10.06	9.07
Crude protein(% DM)	19.76	18.89	19.82	18.44	18.96	19.20
Nitrogen free extract(% DM)	52.32	50.72	53.19	53.20	52.89	51.92
Fat(% DM)	10.65	7.96	7.50	7.66	8.13	8.62
Calcium(% DM)	0.85	1.30	1.45	1.45	1.89	2.36
Phosphorus(% DM)	0.52	0.63	0.61	0.83	0.85	0.76
Energy (kcal ME/kg DM)	3335	2813	3061	2950	3095	3160

Feed and water were provided *ad-libitum* to each replicate. Refusals were collected and weighed in the morning before the daily ration was offered. Samples of refusals were taken daily from each replicate and pooled per treatment. Samples of diets were also taken daily while the offers were weighed and pooled for each treatment.

Whole body analysis for nutrient retention

Nutrient retention was measured through comparative slaughter technique according to Tegene Negesse *et al.* (2001). At the beginning of the feeding trial 13 chicks were randomly selected from chicks of same age to represent the initial weight and chemical composition of the carcass of the chicks used for the feeding trial. They were then weighed (109±1.5 g), killed by dislocation of the neck, put in a plastic bag and kept in a deep freezer at –20°C until chemical analysis. At the end of the feeding trial (92 days), three out of five replicates per treatment were systematically selected and one male and one female chick from each replicate were randomly picked up and tagged. They were starved for 12 hours, weighed, killed by dislocating the neck, put in plastic bags and kept in a deep freezer at -20°C.

The whole body of each chick was then cut into small pieces with hand grinder and special scissors in its frozen state and kept back in the deep freezer. It was then minced three times with a meat mincer for effective homogenization and again kept back in the deep freezer. After thawing the minced and homogenized carcass about 10 g was taken from each for immediate DM determination at 105°C and dried to constant weight. The rest of the minced mass was weighed and dried in an oven at 65°C for about 80 hours, after determining the partial DM content it was ground using local hand mortar and homogenized with a juicer. The partially dried samples were chemically analyzed.

The nutrient contents (on DM basis) multiplied by the respective DM weights in the total carcass gave the amount of each nutrient in the whole body. The amount of each nutrient retained during the trial period was calculated as a difference between final and initial amounts of a nutrient in a carcass.

Chemical analysis

The nutrient composition of feed ingredients, diets, feed refusals and carcasses were analyzed in the laboratory of the National Veterinary Institute (NVI) at Debre Zeit. Dry matter, CF; mineral matter and EE were determined according to AOAC (1990). Nitrogen was determined by kjeldhal procedure and CP was calculated by multiplying N content by 6.25. Calcium was determined by atomic absorption spectrometer and phosphorus by spectrophotometer after dry ashing. Energy value (ME) of feeds was calculated using the formula: ME (kcal/kg DM) = 3951 + 54.4 EE – 88.7 CF - 40.80 ash (Wiseman, 1987). Gross energy (GE) retained in carcasses was calculated using the formula: GE (kJ) = 23.6 CP retained (g) + 39.3 EE retained (g) (ARC, 1994).

Statistical analysis

The data collected in this study was subjected to the analysis of variance (ANOVA) using the following model:

$$Y_{ijk} = \mu + A_i + S_j/A_i + e_{ijk}$$

where,

Y_{ijk} = individual values of the dependent variable;
μ = grand mean of the response variable;
A_i = the effect of the i^{th} feed (A) on the dependant variable (i= 1, 2, 3, 4, 5, 6);
S_j/A_i = the effect of the j^{th} replicate trial under the i^{th} feeding group (j= 1, 2, 3, 4, 5);
e_{ijk} = random variation in the response of individual chick.

The effect of the six feeds on DM and nutrient intakes of the chicks was analyzed using single factor ANOVA. Replicates within each feeding group were considered as a nested factor within feed to account for variation in response of chicks assigned under different replicates of the same feeds. Nutrient retention was analyzed by two-way ANOVA using SAS software Version 6.12 (SAS, 1996).

For further comparison of means Bonferroni and Duncan Multiple range tests (Duncan, 1955) were carried out for intake and nutrient retention, respectively. Differences between treatment groups were considered significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

Chemical composition of diets

The chemical composition of the treatment diets used in the feeding trial is presented in Table 1. All the diets contained similar dry matter content. However the fat as well as ME contents of T1 showed slight increase than the rest of the diets due to full fat soybeans used as major protein source. The ME values in the rest of the treatment diets are almost similar. The CP contents of the diets varied between 18.44 to 19.76% which is higher than the minimum CP requirement (18%) suggested by Eekeren *et al.* (1997) for growing chicks but was with in the range recommended (20% and 18.5%) by Scanes *et al.* (2004) for grower and finisher broilers, respectively. Treatment 2 contained slightly higher percentage of CF than the rest of the diets due to higher amount of noug cake; however, the chicks fed on this diet had voracious appetite which may be related to combined effect of noug cake and limited amount of fishmeal inclusion. The ash, calcium and phosphorus contents linearly increased with fishmeal inclusion levels and were with in the recommended range for broilers (Scanes *et al.*, 2004).

Nutrients and energy intakes

Table 2 shows the mean daily intakes of dry matter (DMI), crude protein (CPI), organic matter (OMI) and energy (MEI) of RIR chicks fed different levels of fishmeal. Replacement of soybean and noug cake with various levels of fishmeal resulted in significantly higher ($p \leq 0.001$) nutrient intakes. Except for CPI in T_4 which didn't differ significantly from the control diet, the daily CPI was significantly ($p \leq 0.001$) higher for all fishmeal groups than the control. The lowest ($p \leq 0.001$) DMI, CPI, OMI and MEI were recorded from the control diet but the chicks with highest fishmeal inclusion rate (T_6) had voracious appetite.

When the level of fish meal increased from 3.32%(T_2) to 13.28%(T_5), the DMI didn't vary significantly. The DMI in the present experiment seems to be affected not by energy but protein intake. The depressed appetite in the control diet could probably be due to possible amino acid imbalance in the plant proteins (Agdebe and Aletor, 1997).

Chicks in T_6 had significantly highest CPI, MEI and CaI of all the treatment groups. T_1 had significantly lowest ($p \leq 0.001$) DMI, OMI, CaI and PI of all the treatment groups. Between T_2, T_3, T_4 and T_5 there was no difference in DMI and OMI but T_3 had higher CPI than T_2, T_4 and T_5. T_3 and T_6 had significantly higher CPI than the rest of the fishmeal groups and control. T_4 had the lowest CPI among the fishmeal groups but was similar to the control diet. CaI increased linearly with the inclusion level of fishmeal and differences were significant between treatment diets. PI generally increased with fishmeal inclusion rate, the highest PI was recorded from T_5 and lowest from T_1. According to Isika *et al.*, (2006), high mineral intake impairs nutrient digestibility and thus higher P intakes observed in T_4 and T_5 caused by high P contents of these diets as compared to other diets might have reduced nutrient intakes in T_4 and T_5.

The present result is in agreement with the work of Ponce and Gernat (2002) who found significant increase in feed intake of broilers when tilapia by-product meal was added up to 6% of the diet, however, feed intake was depressed at higher levels of fishmeal inclusion as opposed to the results obtained in the present study where the DMI, CPI, OMI and MEI were stimulated with fishmeal levels. Similar results in feed intake were also reported by Karimi (2006) where chicks fed 1.25 or 2.5% fishmeal had higher average feed intake compared with chicks fed diets without fishmeal. Contrary to the present finding, Maigualema and Gernat (2003) found no significant differences in feed intake as protein from tilapia by-product meal substituted soybean meal protein.

Table 2. Mean nutrient and metabolisable energy intakes, and nutrients and energy retentions of Rhode Island Red chicks fed diets with different levels of fishmeal.

Parameters	Treatment diets						
	T_1	T_2	T_3	T_4	T_5	T_6	SEM
Intake							
Dry matter (g head^{-1}d^{-1})	68.5^a	75.7^{bc}	74.9^b	74.4^b	75.4^b	77.0^c	0.325
Crude protein (g head^{-1}d^{-1})	13.3^a	14.3^b	14.8^c	13.6^a	14.3^b	14.8^c	0.069
Organic matter (g head^{-1}d^{-1})	63.9^a	69.1^b	68.3^b	68.0^b	68.0^b	68.4^b	0.292
Calcium (g head^{-1}d^{-1})	0.54^a	0.99^b	1.07^c	1.07^c	1.41^d	1.81^e	0.01
Phosphorus (g head^{-1}d^{-1})	0.35^a	0.48^c	0.46^b	0.62^e	0.64^f	0.58^d	0.003
Energy (kcal ME head^{-1}d^{-1})	231^c	213^a	230^c	220^b	234^c	243^d	0.983
Retention							MSE
Crude protein (g head^{-1} d^{-1})	2.28^c	3.01^a	2.92^a	2.65^b	2.86^{ab}	2.85^{ab}	0.20
Calcium (g head^{-1} d^{-1})	0.11^c	0.16^{ab}	0.13^{bc}	0.15^{ab}	0.18^a	0.18^a	0.02
Phosphorus (g head^{-1} d^{-1})	0.03^b	0.04^a	0.04^a	0.04^a	0.04^a	0.04^a	0.01
Energy (kcal head^{-1}d^{-1})	21.6^b	28.7^a	29.1^a	27.0^a	25.9^a	28.1^a	3.30

Means within a raw with different superscript letters are significantly different ($p < 0.05$)

Nutrients and energy retention

Table 2 shows the effect of dietary levels of fishmeal on daily retention of CP (CPR), Ca (CaR), P (PR) and energy (ER) of RIR chicken. Fishmeal inclusion resulted in a highly significant ($p<0.001$) difference in daily CPR, CaR, PR and ER between the control group and fishmeal groups. Among the fishmeal groups, difference in CPR between T_2, T_3, T_5 and T_6 and between T_4, T_5 and T_6 were not significant. T_2 and T_3 had 21% and 20% efficiency of utilization of protein, respectively, and were not significantly different from T_5 and T_6, but varied significantly from that of T_4. Difference in CPR between T_4, T_5 and T_6 were not significant, but they were higher than T_1 and lower than T_2 and T_3. The chicks in T_1 deposited the lowest ($p<0.001$) protein with 17% efficiency of utilization. The CPR for chicks maintained on T_2 and T_5 were equal, but it was relatively higher for T_2 than T_5 with 20% efficiency of utilization and differences were not significant, may be due to individual biological variations of the chicks. These groups thus utilized most protein. The CPR in chicks fed on T_4, with 20% CP utilization didn't follow similar pattern as in growth performance parameters of the same breed reported earlier (Asrat Tera *et al*, 2008). However, it may be attributed to their lower CPR, as it is always positively correlated with CP-intake (Fasuyi and Aletor, 2005). The efficiency of utilization of protein (19%) of chicks fed T_6 was the lowest among the fishmeal groups, may be due to poor protein digestibility caused by high mineral intake. In their study for nitrogen retention with broilers through digestibility trial using fishmeal (68% CP) as control diet, Fasuyi and Aletor (2005) found a daily CPR of 14.6 g which is much higher than the present finding probably due to breed differences as broilers have fast gains. Although diets were close to each other in their nitrogen content, they varied greatly in their CPR and utilization. The higher CPR in fishmeal groups might be due to possibly higher contents of sulphur containing amino acids of fishmeal which play a decisive role in nitrogen utilization of chicks (Agdebe and Aletor, 1997). When the daily protein retention (CPR) was fitted into exponential function for the daily crude protein intake (CPI) of the chicks, the equation $CPR = -0.0874\ (CPI)^2 + 2.5711\ CPI - 16.06$, ($R^2=0.25$) was obtained. According to this equation the maximum CPR was 2.849 g $head^{-1}d^{-1}$ and was observed at about 14.7 g CPI $head^{-1}d^{-1}$ with 20% efficiency of utilization and then it tended to decline. Male chicken retained significantly ($p<0.001$) more protein (2.90 $head^{-1}d^{-1}$) than females (2.62 $head^{-1}d^{-1}$) due to higher CP intake.

Fishmeal inclusion resulted in significant difference ($p<0.01$) in daily energy retention, (Table 2) among treatments. Although chicks maintained on the control diet had consumed considerable amounts of energy which is statistically comparable with some of the fishmeal groups (T_3 and T_5), fishmeal inclusion resulted in significantly ($p<0.01$) higher energy retention in T_2 than in T_1. Although not significant among fish meal groups, highest amount of energy retention was in T_3 followed by T_2, T_6, T_4 and T_5 and the lowest by T_1. Higher efficiencies of utilization of dietary energy were obtained from chickens fed on T_2 (13.3) and T_3 (12.6%), followed by those in T_4 (12.5%), T_5 (11.8%), T_6 (11.5%) and T_1 (9.4%). When the daily energy retention (ER) was fitted into exponential function for the daily energy intake (EI) of the chicks, the equation $ER = -0.0051\ (EI)^2 + 2.3425\ EI - 241.11$, ($R^2 = 0.45$) was obtained. According to this equation the maximum energy retention (27.9 kcal $head^{-1}d^{-1}$) in the present trial was observed at ME intake of 230.1 kcal $head^{-1}d^{-1}$ with the corresponding efficiency of utilization of only 10%. Sex had no significant influence on energy retention.

Fishmeal inclusion in the present study resulted in highly significant differences ($p<0.001$) in Ca and P retentions compared to the control. Thus, the lowest ($p<0.001$) retention was observed from the control diet while the rest of the groups had higher depositions. Differences in PR among fishmeal groups were not significant although intakes for this mineral were significantly different. As a result, the PR didn't correlate with intake. However, the observed insignificant variation may be due to antagonism or competition between Ca and P as a result of higher Ca:P ratios in the diets (Perry *et al.*, 2004).

The control group had lowest CaR which is statistically comparable with those in T_3. Chicks on T_2 consumed lowest amount of Ca among the fishmeal groups but CaR of the group was not significantly different from the fishmeal groups, and thus it has higher efficiency of utilization (16%). Differences in CaR between T_2, T_3 and T_4, and thus between T_2 and T_6 were not statistically significant. However, fishmeal groups except T_3, had significantly higher ($p<0.05$) retention compared to the control group probably due to higher intake of the mineral. Intake for Ca was the highest, but utilization the lowest (9.6%) for T_6. Highest CaR was observed in chicks maintained on T_5 although not significantly different from that of T_6. Chicks on T_6 had consumed nearly 3.5 times more Ca than those on the control, though the retention was not proportional to intake. Male chicks deposited significantly ($p<0.01$) more Ca and P than females which could partly be related to intake and probably also to physiological differences.

CONCLUSION

The study pointed out that cooked and sun dried fish offal, fishmeal, can be incorporated up to 16.6% of the diets of growing RIR chicken without affecting health, feed intake and nutrient retentions; however best results of protein retention was obtained at 3.32%, and of energy retention at 6.64%. Thus the meal is a satisfactory and cheap animal protein that can partly replace expensive plant protein sources such as soybean and oil seed cakes.

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