SINET: Ethiop. J. Sci., 32(1):75–80, 2009
 ISSN: 0379–2897

Short communication

THE EFFECT OF PARTIAL SUBSTITUTION OF PLANT PROTEIN BY FISHMEAL PREPARED OUT OF COOKED AND SUN DRIED FISH OFFAL ON FEED INTAKE AND CARCASS TRAITS OF RHODE ISLAND RED CHICKS

Asrat Tera, Tegene Neggese * and Aberra Melesse

Awassa College of Agriculture, PO Box 05, Awassa, Ethiopia. sgsdean@yahoo.com

ABSTRACT: Effects of cooked and sun dried fish offal, fishmeal, on intake, growth and carcass traits of Rhode Island Red (RIR) chicks was evaluated at Wolayta Soddo, southern Ethiopia. After 14 days of uniform brooding of unsexed day old RIR chicks, a feeding trial, with 6 dietary groups (T_1 to T_6), 5 replicates each and 10 chicks per replicate, was run for 11 weeks when daily group feed intakes were recorded. Results showed that chicks fed T_1 had significantly ($p \leq 0.01$) lowest (68.5g dry matter (DM) , 13.3g crude protein (CP), 0.54g calcium (Ca), 0.35g phosphorus (P) and 231kcal metabolizable energy (ME) head^{-1}) but those on T_6 had the highest daily intakes (77g DM, 14.8g CP, 1.81g Ca, 0.58g P and 243kcal ME head^{-1}). Slaughter weight was 1022g, 1234g, 1202g, 1295g, 1272g, and 1272g head^{-1} for T_1, T_2, T_3, T_4, T_5 and T_6, respectively. Commercial carcass weight (breast + thighs + drum sticks + wings + back) of the control (552g/head) was significantly ($p \leq 0.01$) lower than fishmeal groups (683g, 671g, 729g, 717g and 711g for T_2, T_3, T_4, T_5 and T_6, respectively). Difference in weights of drum sticks, thighs, wings and back separately were significantly ($p < 0.01$) higher for fishmeal groups. Breast weight of T_1 (160g) was significantly ($p < 0.01$) lower than T_2 (196g), T_3 (203g), T_4 (219g), T_5 (213) and T_6 (217g). Total edible carcass weight, including skin, liver and gizzard of T_1 was significantly lower (676g head^{-1}, $p \leq 0.01$) than the rest of the groups (837g, 807g, 874g, 860g and 850g head^{-1} for T_2, T_3, T_4, T_5 and T_6, respectively). Significantly ($p \leq 0.05$) lower Dressing % was obtained from T_1 (54.0%) than T_2 (55.3%), T_3 (55.7%), T_4 (56.2%), T_5 (56.5%) and T_6 (55.8%). Dressing percentage (on the basis of edible carcass) of T_1 (66.1%) was also significantly ($p \leq 0.05$) lower than T_2 (67.8%), T_3 (67.1%), T_4 (67.5%), T_5 (67.6%) and T_6 (66.8%). Males had significantly ($p < 0.01$) higher slaughter weight (1294g) and carcass weight (721g) than females (1138g and 633g, respectively), but they had similar breast weights and dressing %. It can thus be concluded that fishmeal inclusion in to diets of growing RIR chicken up to the levels of 16.6% of the DM of the diet did not affect health or carcass traits; however, best results were obtained at 9.96%.

Key words/phrases: Carcass traits, chicks, fishmeal, nutrient retention

INTRODUCTION

According to the Ethiopian Central Statistics Agency, CSA (2003) survey report, the country possesses over 42 million poultry, of which 95% is raised under free range scavenging system. The genetic potential of local chickens in terms of egg production and growth is very low. Their performance is further lowered mainly due to inadequate and inconsistent supply of quality feed (Alemu Yami and Tadelle Dessie, 1997). Cost of feed accounts for about 60–65% of the total cost of poultry production and protein shares about 13% of the total feed cost (Hassan *et al.*, 2003). The chronic shortage of supply of protein concentrates for poultry necessitates investigations of the potentials of some feed resources that are cheaper, locally available and have comparative nutritional value as the conventional protein sources. Hence, a feasible approach that seems worthy is to incorporate agricultural and aquatic by-products not directly consumed by man. These are valuable feed for poultry, reduce competition for food with humans and reduce feed cost and problem of waste disposal (Boushy and Vander, 1994). A notable feed ingredient with high nutrient content that deserves attention as livestock protein source available in the rift valley of Ethiopia is fishmeal. Because of the well-balanced amino acid profile, most fish meals are good sources of proteins (Donald and William, 2002) and contain ω -3 and ω -6 fatty acids that protect health & welfare and reduce dependence of animals on antibiotics and other drugs. The total landing from inland fresh water of Ethiopia in 1996/97 was 10400 tons (Dirk and Tesfaye Wudineh, 1998) part of which could be processed to fish meal. Whole fish is processed

* Author to whom all correspondence should be addressed, PO Box 336, fax 251 462-205421.

to fillets mostly myomere muscles, streaks or any 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. The levels of inclusion of locally prepared fishmeal into poultry ration need to be re-established as most of the original works done elsewhere are not recent. The current study was conducted to measure the effect of dietary levels of fish meal on health, feed intake and carcass traits of growing Rhode Island Red chicks.

MATERIALS AND METHODS

The study area

The feeding trial with Rhode Island Red chicks was conducted at Wolayta Soddo Poultry Husbandry centre located at approximately 400 km south west of the capital, Addis Ababa. Its altitude is 1884 m.a.s.l. Rainfall is bimodal and the annual rainfall ranges between 1000 and 1200 mm; temperature ranges between 22 and 24°C (FAO, 1984).

Formulations of the treatment rations

The proportions of feed ingredients used in these diets have been described by Asrat Tera et al. (2008) and readers are referred to this publication. The fishmeal used here was also prepared according to the procedure described by Asrat Tera et al. (2008). The control diet (T1) did not contain fish meal but to the test diets, T2, T3, T4, T5 and T6, fishmeal was included at rates of 3.32, 6.64, 9.96, 13.28 and 16.6% of the dm, 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 brown to deactivate trypsin inhibitor. The coarse feed ingredients were first ground and mixed with a special mixer fitted to a miller.

Management of the experimental chicks

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 2250 cm^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 to 21 hours of lighting. A batch of 400 day-old dual purpose 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 a total of 300 chicks were randomly selected and divided into 6 groups each with 50 chicks. Each group was further subdivided into 5 groups of 10 chicks each. These were randomly assigned to the six treatment rations in CRD with 5 replications. The actual experiment period lasted 11 weeks. The overall initial weight of the chicks was 114.6 ± 1.7g and the average initial weights of T1 (115g), T_2 (114g), T_3 (114g), T_4 (116g), T_5 (115g) and T_6 (115g) were similar. Male: female ratios of chicks were determined at end of the experimental period where T_1, T_2, T_3, T_4, T_5 and T_6 had 33:17, 33:17, 34:16, 33:17, 32:18 and 34:16 ratios, respectively and were similar across treatments.

Feed and water was 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 were pooled for each treatment ration. Samples of diets were also taken daily while the offers were weighed. Samples of refusals and offers were chemically analyzed. Mortality was calculated as the percentage of dead birds over the initial number of each replicate and the treatment ration.

Measurement of carcass characteristics

Carcass measurement was conducted according to Romans *et al.* (1977). At the end of the feeding trial three replicates from five, whose mean final body weights were closest to the mean body weight of the respective treatments, were selected and two chicks (one male + one female) from each of these replicates were taken. After starving them overnight (12 hours) they were weighed and killed by severing the jugular vein. Blood was collected and weighed. After bleeding, the body was scald in hot water for one minute and then the feathers were manually plucked. Feather weight was calculated by difference between body weight with and without feather. Carcass weight on commercial basis was calculated by subtracting weight of blood, feather, shank + claws, head, lungs, heart, liver, spleen, pancreas; digestive and uro-genital organs, abdominal fat and skin from the slaughter weight. Carcass weight was apportioned into back, two thighs, two drum sticks, two wings and a breast. Gizzard and skin are edible in most places in Ethiopia and were, therefore, included in the edible component. These were added to the carcass weight and another version of dressing percentage under Ethiopian content was also calculated.

Chemical analysis

The nutrient composition of feed ingredients, diets, feed refusals and carcasses were analyzed and energy values of feeds calculated in the laboratory of the National Veterinary Institute (NVI) at Debre Zeit. Dry matter, crude fiber (CF), mineral matter and ether extract (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 from nutrient contents using the formula: ME (kcal/kg DM) = 3951 + 54.4 Fat – 88.7 CF – 40.80 Ash (Wiseman, 1987).

Statistical analysis

Carcass characteristics were analyzed by two-way ANOVA using SAS software Version 6.12 (SAS, 1996). For further comparison of means of weight gain, intake and carcass traits, Tukey Hsd, Bonferroni and Duncan Multiple range tests (Duncan, 1955) were carried out, respectively. Differences between treatment groups were considered statistically significant at $p \leq 0.05$.

The specific ANOVA model was as follows:

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

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.

RESULTS AND DISCUSSION

Nutrient composition of diets

Mean daily nutrient and ME intakes of RIR chicks fed diets with different levels of fish meal diets is given in Table 1. Replacement of soybean and noug cake with various levels of fish meal resulted in significantly higher ($p \leq 0.01$) nutrient intakes. Except for crude protein intake (CPI) in T_4 which didn't differ significantly from the control diet, further mean comparison using Bonferroni test indicated that the daily crude protein intake (CPI) and metabolizable energy intake (MEI) were significantly ($p \leq 0.01$) higher for all fish meal groups than the control. Significantly lowest ($p \leq 0.01$) dry matter intake (DMI), CPI, organic matter intake (OMI) and MEI were recorded from the control diet but those with highest fish meal inclusion rate (T_6) had voracious appetite.

Table 1. Mean daily nutrient (g chick^{-1} d^{-1}) and ME (kcal/chick/d) intakes of RIR chicks fed diets with different levels of fish meal.

Parameters	Treatment diets						SEM
	T_1	T_2	T_3	T_4	T_5	T_6	
DM intake (DMI)	68.5^a	75.7b^c	74.9^b	74.4^b	75.4^b	77.0^c	0.325
CP intake (CPI)	13.3^a	14.3^b	14.8^c	13.6^a	14.3^b	14.8^c	0.069
OM intake (OMI)	63.9^b	69.1^a	68.3^a	68.0^a	68.0^a	68.4^a	0.292
ME intake (MEI)	231.0^c	213.0^a	230.0^c	220.0^b	234.0^c	243.0^d	0.983

Note: Means within a row with different superscript letters are significantly different ($p \leq 0.05$)

All fish meal groups had significantly higher ($p \leq 0.01$) DMI than the control, lowest intake was from the control and the highest from T_6, due to the combined effect of reduction in soybean and noug cake and simultaneous increase of wheat flour by-products and fish meal. 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).

The performance of chicks fed on treatment four had the lowest CPI compared to that of the other treatments containing higher proportion of fishmeal particularly that of T_6. The rest of the diets had significantly superior intakes ($p \leq 0.01$) than the control diet. The performance of chicks fed on T_3 and T_6 had significantly higher intakes than the rest of the fish meal groups. Chicks in treatment 4 had low DM, CP and OM intakes but improved production performance in all parameters. According to Isika *et al.* (2006), high mineral intake impairs nutrient digestibility and thus higher phosphorus intakes observed in T_4 and T_5 caused by high phosphorus contents of these diets as compared to other diets might be the possible explanation for the lower nutrient intakes in T_4 and T_5. On the other hand, the relatively higher CF intake in T_2 didn't impair intake of nutrients as well as utilization contradicting the expectation.

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 fish meal inclusion as opposed to the results obtained in the present study where the DMI, CPI, OMI and MEI were stimulated with fish meal levels. Similar results in feed intake were also reported by Karimi (2006) where chicks fed with 1.25 or 2.5% fish meal had higher average feed intake compared with chicks fed diets without fish meal. In disagreement 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.

Carcass characteristics

Data on carcass characteristics is presented in Table 2. Groups fed with rations containing fish meal were significantly superior ($p<0.05$) to the control group in the carcass parameters considered. The performance of chicks on the control diet had significantly ($p\leq0.01$) lower slaughter weight than the rest of the groups. However, slaughter weight among groups fed with rations containing fish meal was comparable, although chicks fed T_4 had higher slaughter weight. Slaughter weight was highly affected by sex where males were significantly ($p\leq0.01$) heavier than females. This is due to higher feed intake of males than females and also due to favoured fat deposition in females and adipose tissues is less dense than muscle tissues. It is also indicated that males grow more quickly and efficiently (Donald and William, 2002).

Under Ethiopian context total non edible organs (TNEO) includes feather, blood, head, shank + claws, oesophagus, crop, proventriculus, spleen, pancreas, kidney, heart, lung, small and large intestines with cecum, and abdominal fat. Diets with fish meal significantly ($p\leq0.05$) increased the weights of TNEO than the control. Chicks fed T_4 had higher weights of TNEO. Irrespective of treatment groups, TNEO were significantly affected by sex; males having statistically ($p\leq0.01$) higher mean weights of TNEO than females.

The gizzard, liver and skin under Ethiopian context are included in total edible offal (TEO). Thus the edible carcass portion was calculated by adding the gizzard, liver and skin to back, drumsticks, thighs, wings and breast. The edible carcass in general was highly affected by fish meal inclusion ($p\leq0.05$) compared to the control diet, with modest improvement with fish meal inclusion levels. The least edible carcass weight was observed from the control diet. Males were superior to females' in edible carcass weight.

Abdominal fat in the present work was affected neither by fish meal inclusion nor by sex, showing that the chicks were still growing and actively building muscle tissues and did not yet start to accumulate fat. Although high dietary energy levels are often blamed for excessive abdominal fat accumulation (Saleh *et al.*, 2004), this is however not true with the present experiment because chicks fed with T_6 had higher ME intakes but accumulated the lowest amount of abdominal fat among the groups fed with rations containing fish meal. In the present study, although statistically non significant, females had larger amounts of abdominal fat pad than males. It is a general fact that female birds are fatter than males (Scanes *et al.*, 2004) because female hormones stimulate fat deposition.

Table 2. Measurements of carcass characteristics of RIR chicks fed diets with different levels of fish meal.

Parameter(g)	Sex		Treatment diets						Root	Mean
	Male	Female	T_1	T_2	T_3	T_4	T_5	T_6	MSE	
Slaughter wt.	1294^a	1138^b	1022^b	1234^a	1202^a	1295^a	1272^a	1272^a	75.50	1216.0
Drumsticks	127^a	100^b	92^b	118^a	113^a	121^a	120^a	118^a	9.14	113.40
Thighs	134^a	111^b	93^b	124^a	122^a	132^a	128^a	134^a	9.95	122.30
Wing	98^a	85^b	79^c	89^b	88^b	99^a	96^a	98^a	6.25	91.40
Breast	202^a	201^a	160^c	196^b	203^{ab}	219^a	213^{ab}	217^{ab}	17.00	201.40
Back	160^a	137^b	128^b	156^a	146^a	159^a	158^a	145^a	13.00	148.70
Carcass weight	721^a	633^b	552^b	683^a	671^a	729^a	717^a	711^a	46.8	677
Total Edible part	867^a	771.3^b	676^b	837^a	807^a	874^a	860^a	850^a	56.7	817
Dressing % *	67.0^a	67.8^a	66.1^b	67.8^a	67.1^{ab}	67.5^{ab}	67.6^a	66.8^{ab}	1.33	67.2
Dressing %**	55.5^a	55.6^a	54^b	55.3^{ab}	55.7^a	56.2^a	56.5^a	55.8^a	1.3	55.6
Total NEO	386^a	331^b	303^b	367^a	352^a	379^a	372^a	377^a	21.7	358.5

Note: * Dressing % calculated by including skin, liver and gizzard to their respective slaughter weight;
** Dressing % calculated without skin, liver and gizzard;
Means within a row with different superscript letters are significantly different ($p\leq0.05$) for sex and also for treatment diets

The commercial carcass collectively referred to as carcass weight includes two wings, two thighs, two drumsticks, back, and breast. Carcass weight was significantly ($p \leq 0.01$) increased by fish meal inclusion in the diets. Control group had the lowest ($p \leq 0.01$) carcass weight, whereas the rest of the groups had significantly ($p \leq 0.01$) higher carcass weights. Chicks fed T_4 had higher carcass weight because they exhibited higher rates of growth and feed utilization. High carcass weight suggested more nutrient bioavailability for anabolic processes, perhaps more so, in protein synthesis than other diets. This was so indicative of complementary or associative effect of plant and fish protein sources. Accordingly, this finding agrees with those of Kassat and Baghel (1998) and Mandel *et al.* (1997) who observed higher carcass yields at 8% fish meal inclusion for broilers. Maigualema and Gernat (2003) also indicated that inclusion of tilapia by-product meal at different levels significantly influenced carcass yield.

Breast as part of commercial carcass was significantly ($p \leq 0.01$) improved by fish meal inclusion with heaviest breast being from T_4 although not statistically different from T_3, T_5 and T_6. Chicks on T_2 had smaller breast among fish meal groups whereas those on the control diet had the smallest ($p \leq 0.01$) breast. Sex had highly influenced carcass weight. Accordingly, males had heavier carcass ($p \leq 0.01$) than females. However, both sexes had similar breast size.

When the gizzard, liver and skin were considered as part of the carcass, it gave a higher dressing percentage than when it was calculated without them. Chicks maintained on T_2 and T_5 had significantly ($p \leq 0.05$) higher dressing % than on T_1. Differences between the remaining treatment diets were not significant and T_3, T_4 and T_6 were found in between. Sex in the present experiment had no observable effect on dressing percentage. In agreement with this, Negussie Dana (1999) reported comparable dressing percentage (63%) for RIR hens kept on choice feeding of energy or protein feeds under intensive and semi-intensive management conditions in the central highlands of Ethiopia; Munira *et al.* (2006) in their comparative study on carcass characteristics of different genetic groups of spent hens indicated similar dressing percentage (56%) of RIR hens regardless of diet; and Teketel Forsido (1986) also indicated a range of dressing % (51.5 to 57.8%) for different strains of local chicken in Ethiopia. Maigualema and Gernat (2003) found no significant differences in dressing % by using tilapia by-product meal as feed ingredient for broilers, which is not in agreement with the present work. The dressing % calculated without including liver, gizzard and skin as part of carcass in the present work does not agree with the figure (70%) reported by Scanes *et al.* (2004) and Maigualema and Gernat (2003) for broilers, probably due to differences in breed and types of chickens.

Treatment 4 was the best in most of the carcass parameters and level of fish meal could be considered as an optimum. Lopez *et al.* (1999) reported that chicken have accumulated omega 3 rich poly unsaturated fatty acids in their breast muscle to a greater extent than others by 8% inclusion of fish meal in their diets. This might have also taken place in the breast of the fish meal groups in this study. Such a carcass has useful health implications by protecting humans from heart disease and cancer.

Mortality

In the present study mortality was not observed by fish meal inclusion throughout the experimental period which disagrees with the finding of Ponce and Gernat (2002), and Maigualema and Gernat (2003) who have observed 1.74 to 2.43% and 5.35% mortality, respectively, in broilers when soybean meal was replaced with tilapia by-product meal. In line with the present work, Babu *et al.* (2005) observed no impact on health of hens fed fishmeal at 6% inclusion rate.

CONCLUSION

The study pointed out that cooked and sun dried fish offal, fish meal, can be incorporated up to 16.6% of the diets of growing RIR chicken without affecting health, feed intake and carcass traits; however best results were obtained at 9.96% inclusion level. 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.

ACKNOWLEDGEMENTS

The advice received from Dr Yosef T/Giorgis for most of the data analysis is greatly acknowledged.

REFERENCES

1. Agdebe, J.O. and Aletor, V.A. (1997). The performance, nutrient utilization and cost implications of feeding broiler finishers conventional or under-utilized resources. *Applied Tropical Agric.* **2**:57–62.
2. Alemu Yami and Taddele Dessie (1997). The Status of Poultry Research and Development in Ethiopia.

Debre Zeit Agricultural Research Centre. Poultry Research Bulletin Number 1. Alemaya University of Agriculture, pp. 17–41.

3. A.O.A.C. (1990). *Official Methods of Analysis,* 13th ed. Association of Official Analytical Chemists (A.O.A.C.). Arlington, Virginia, USA. pp 12–18.
4. Asrat Tera, Tegene Negesse, Aberra Melesse and Yosef T/Giorgis (2008). The effect of inclusion rate of cooked and sun dried fish offal meal on feed intake, growth and feed efficiency of Rhode Island Red chicks. *East African Journal of Sciences.* **2(2)**:111–118.
5. Babu, U.S., Wiesenfeld, P.L., Raybourne, R.B., Myers, M.J. and Gaines, D. (2005). Effect of dietary fish meal on cell-mediated immune response of laying hens. *International Journal of Poultry Science* **4(9)**:652–656.
6. Boushy, A.R.Y. EL and Vander, P.A.F.B. (1994). *A andbook of Poultry Feeds from Waste Processing and Use,* 2nd ed. Kluwer Academic Publishers. The Netherlands, p. 111.
7. CSA (2003). The 2001/2002 Ethiopian Agricultural Sample Enumeration Survey. Agricultural Census Results at country level. Part 2. Agricultural Census Commission, Central Statistics Authority (CSA), Federal Democratic Republic of Ethiopia. Addis Ababa. Ethiopia. p 233.
8. Dirk, R. and Tesfaye Wudineh (1998). Fisheries Management: A review of current status and working paper 26. Ministry of Agriculture. Addis Ababa. Ethiopia.
9. Donald, D.B. and William, D.W. (eds) (2002). *Commercial Chicken Meat and Egg Production,* 5th ed. Kluwer Academic Publishers. USA, pp. 224–226.
10. Duncan, D.B. (1955). Multiple range and multiple F-tests. *Biometrics* **11**:1–42.
11. FAO. (1984). Agroclimatology data for Africa. V.I. Countries North of the equator. FAO Plant production and protection series No 22. Rome.
12. Hassan, M.H., Ahmad, M.U. and Howlider, M.A.R. (2003). Replacement of fish meal by broiler offal in broiler diet. *International Journal of Poultry Science* **2(2):**159–163.
13. Isika, M.A., Eneji, C.A. and Agiang, E.A. (2006). Evaluation of sun and oven-dried broiler offal meal as replacement for fish meal in broiler and layer rations. *International Journal of Poultry Science* **5(7):**646–650.
14. Karimi, A. (2006). The effects of varying fish meal inclusion levels on performance of broiler chicks. *International Journal of Poultry Science* **5(3)**:255–258.
15. Kassat, M. and Baghel, R.P.S. (1998). Carcass traits of broilers influenced by fish meal protein and qualities of fish meal. *Indian Journal of Veterinary* **75(2)**:189–191.
16. Lopez, F.S., Baurcessl, M.D., Barroeta, A.C. and Grashorn, M.A. (1999). ω-3 enrichment of chicken meat using fish oil: alterative substitution with rape seed and linseed oils. *Poultry Science* **78(3):**365–363.
17. Maigualema, M.A. and Gernat, A.G. (2003). The effect of feeding elevated levels tilapia (*Oreochromus niloticusa*) byproduct meal on broiler performance and carcass characteristics. International Journal of Poultry Science 2(3): 195–199.
18. Mandell, I.B., Buchaman, S.J.G., Holub, B.J. and Campbell, C.P. (1997). Studies on feeding of different levels of fish meal protein along with groundnut cake on carcass traits of broilers. *Animal Science* **74(2):**172–174.
19. Munira, K.N., Uddin, M.J., Faruque, S., Parvez, M.S., Miah, M.Y. and Siddiqui, M.S.I. (2006). Comparative study on carcass characteristics of different genetic groups of spent hens in Bangladesh. *International Journal of Poultry Science* **5(2)**:178–180.
20. Negussie Dana (1999). Evaluation of the performance of local, Rhode Island Red and fayoumi breeds of chicken under different management regimes in the central highlands of Ethiopia. MSc. Thesis. Swedish University of Agricultural Sciences. Uppsala, p. 13.
21. Ponce, L.E and Gernat, A.G. (2002). The effect of using different levels of tilapia by product meal in broiler diets. *International Journal of Poultry Science* **8(7)**:1045–1049.
22. Romans, J.R., Jones, K.W., Costello, W.J., Carlson, C.W. and Ziegler, P.T. (1977). *The Meat We Eat.* Interstate Printers and Publishers, Inc. pp 200–212.
23. Saleh, E.A., Watkins, S.E., Waldroup, A.L and Waldroup, P.W. (2004). Effects of dietary nutrient density on performance and carcass quality of male broilers grown for further processing. *International Journal of Poultry Science* **3(1)**:1–10.
24. SAS (1996). Statistical Analysis System SAS/STAT®. Guide Version 6.12. SAS, Institute Inc. Raleigh, North California, USA.
25. Scanes, C.G., Brant, G. and Ensminger, M.E. (2004). *Poultry Science,* 4th ed. Pearson Prentice Hall. New Jersey, pp. 105–106
26. Teketel Forsido (1986). Studies on meat production potential of some local strains of chicken in Ethiopia. PhD Thesis. J.L. University of Giessen. Germany, p. 116.
27. William, R.F. (1984). I*ntroduction to Practice of Fishery Science*. Academic press London LTD. Great Britain, pp. 337–339.
28. Wiseman, J. (1987). *Feeding of Non-ruminant Livestock.* Butterworth and Co. Ltd; UK.

.