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Effect of Feeding Various Levels of Feather Meal as a Replacement of Fish Meal on the Growth of Broiler

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Abstract – **The present study was carried out in a feeding trial of 42 days, 120 broiler chicks were reared at experimental station were divided into four groups, A, B, C and D for feeding iso-nitrogenous and iso-caloric mash rations, having 0, 33, 67 and 100 % feather meal as replacement of fish meal. The average final live body weight of groups A, B, C and D was 2221.1, 2205, 2196.05 and 2187.15 grams per bird, respectively. The difference of live body weight between the groups was non-significant (P<0.05). Results of feed and water consumption showed similar pattern. Average feed consumed was 3687, 3706, 3728 and 3744 grams per boiler for group A, B, C and D, respectively. Water consumption recorded per boiler was 9270, 9289, 9300 and 9316 ml of group A, B, C and D. The differences in average carcass weight and giblets weight were also non-significant (P<0.05). Carcass weight of group A 1332 grams was heaviest followed by B, C and D, weighing 1322, 1314 and 1300 grams per broiler, respectively. There was no effect of feather meal feeding on broiler mortality. The average per broiler feeding cost of group A, B, C and D was Rs. 162.22, Rs. 159.35, Rs. 156.57 and Rs. 153.50, respectively. After marketing, net profit of Rs. 23.98, Rs. 26.14, Rs. 28.02 and Rs.30.20 per broiler was earned for group A, B, C and D, respectively. Broiler fed with 100% feather meal as replacement of fish meal proved to be most economically raised, without any negative effect on their performance.**

Keywords – **Iron, FCR, RBC, Meal, Economic and Poultry.**

I. INTRODUCTION

The role of poultry industry in Pakistan and the importance of broiler meat are very well known now days. Local poultry production last year was layers 47.00 million (M), broilers 37.25 M, breeding stock 652.72 M, day old chicks 718 M, eggs 13813 million and meat production was 907 thousand tons (Farooq, 2013). It indicated an increasing trend in the poultry production over the preceding year. Poultry sector generates employment (direct/indirect) and income for 1.5 M people. Its contribution in agriculture is 5.76% and livestock is 10.40%. Poultry meat contributes 26.80% of total meat production in the country. Poultry sector has shown a robust growth at the rate of 7-8% annually which reflects its inherent potential (Farooq, 2013). A 100 g edible portion of broiler meat is contained 74.6 g moisture, 12.1 g proteins, 11.1 g lipid, 1.0 g minerals and 158-175mg cholesterol. To overcome this gape, poultry industry can play its role by providing the best source of palatable, nutritious and high quality animal protein in a comparatively short duration, at an appropriate and affordable cost, because broiler meat is a high source of nutrients and is easily and completely digested. It also a good source of protein and vitamins (Khan *et al*., 2009; Nabi *et al*., 2012; Sahito, 2012; Sahito, 2013). Quality feed ingredients should have optimum level of protein and energy for the better growth of broilers. There are two sources of feed proteins i.e. proteins of animal origin and proteins of plant origin. Plant proteins are usually low in lysine and methionine and their biological value is lower (Ahmad *et al.,* 2006). In a broiler ration, fish meal, poultry by-product meal, meat and bone meal are predominantly the principal sources of animal protein. Among these, fish meal is widely used item since long. Fish meal is not only used in poultry feed composition but also in ruminant feeding, aquaculture feeding and also used as a fertilizer. This creates a big gap between supply and demand resulting in boosting its price and allowing makers to adulterate it with other ingredients like fish bone, sand, stone, soil and sawdust, which affects the overall quality of the feed (Karimi, 2006). Feather is the major poultry by-product that has less use in the animal farming practices and is having a better energy value and crude protein, when compared with others (Ravindra *et al.,* 2002, 2005; Wang and Parsons 1998).

Feathers are highly consumable by-product of chicken. Protein present in feathers is in the form of Keratin. Unlike other Keratin sources like wool, hairs, hooves and fingernails etc., feathers have longer surface area which makes it highly absorbable as compared with others. Feathers are hydrolyzed by the help of steam and heat into high protein and cystine rich meal that is 75 % digestible and have other main amino acids like glycine, serine, threonine, agrinine, isoleucine, leucine, phenylalamine and valine are also present in feather meal. Feather meal is good source of protein and can be used to replace significant portions of other protein sources in feeding mono-gastrics. The amino acid profile of feather meal is similar to fish meal (Sarmwatanakul and Bamrongtum, 2000). Feather meal can be effectively used as a cheap protein source in poultry ration (Macalpine and Payne, 1977). On the other hand disposal of feathers from local

poultry shops and poultry processing plants are considered as a major environmental threat. Cost of wastes disposal compels that these feathers should be recycled or reused (El-Boushy *et al.,* 2007). Therefore, successful use of cheaper protein source as substitute of costly fish meal may reduce the production cost of balanced poultry feed and at the same time it will reduce dependence on fish meal. For this reason, it is very important to find out the possibilities of using alternate sources of low cost proteins to substitute expensive fish meal. The present study was therefore, designed to investigate the influence of various levels of feather meal as replacement of fish meal on the growth of broilers in our conditions.

II. Materials and Methods

The experiment was conducted at Poultry Experiment Station, Department of Poultry Husbandry, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam. 120, 'day-old' Hubbard chicks were purchased from Hyderabad and brought to Experiment Station during month of October to November 2013. Chicks were initially weighed and on the basis of equal mean weight divided into four groups, A= kept as control with the treatment 0% feather meal, 100% fish meal, B= 33% feather meal, 67% fish meal, C= 67% feather meal, 33% fish meal and D= 100% feather meal, 0% fish meal, respectively having 30 chicks in each group. In the 42 days experimental feeding trial following treatment of Feather meal/Fish meal ratio was maintained in the ration. Total eight feeding rations were formulated having four different replacement levels of feather meal feed, for starter phase (day one to day 21) and finisher phase (day 22 to day 42). The eight feed samples of starter and finisher phase, having different levels of feather and fish meal, were examined at the post-graduate laboratory, department of Animal Nutrition, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam. Determination of Dry matter, crude protein, oil, fiber and ash was carried out according to standard analytical methods described by the AOAC (2000).

The feed sample of 5 grams W_1, was placed in an oven at 105 °C and was dried to a constant weight. The moisture content of the sample was lost during drying, W_2. After cooling remaining dry matter, W_3 was calculated by the following formula:

$$\text{Dry Matter } \% = \frac{W_1 - W_2}{\text{Sample weight}} \times 100$$

Nitrogen of protein in the samples was determined by Kjeldhal method. The grams 2 of oven dried sample (W_2) was taken in a long necked Kjeldhal flask, 3.5 grams of a catalyst mixture, 0.2 gram copper sulphate ($CuSO_4$) and 2 grams potassium sulphate (K_2SO_4) and 35 ml of concentrated sulphuric acid (H_2SO_4) as an oxidizing agent. The samples were boiled in a digestion rack, initially at a low temperature and then with vigorous boiling till the content became clear. After cooling the contents of the flask, mixed with few drops of distilled water in a 100 ml volumetric flask. A 5ml of this solution was transferred to the Markham still apparatus. The ammonia so liberated was collected in a flask containing 5 ml of 2% boric acid solution having two drops of methyl red (indicator). The distillate was titrated against 0.1 N H_2SO_4 to light pink color end point. Nitrogen and crude protein was calculated by following formula:

$$\text{N } \% = \frac{R - Bx \text{ Standard acid } 1.4}{\text{Sample weight}}$$

$$\text{Crude Protein } \% = \frac{R - B \times W \times 1.4 \times D \times F}{\text{Sample}}$$

Note: R= reading, B= blank, N= normality of standard H_2SO_4, D= dilution, F= N factor 6.25

Oven dried sample of 5 grams was taken in an extraction thimble it was plugged with absorbent cotton. The sample was extracted with petroleum ether at 60 °C Soxhlet apparatus by fixing the condensation rate at 3-4 drops per second. The process was continued for about 10 hours. Ether (oil) was evaporated by placing it in an oven at 105 °C till the extract attained a constant weight (W_2). Percentage of the ether extract was calculated with the following formula:

$$\text{Oil } (\%) = \frac{\text{Weight of ether extract}}{\text{Sample weight}} \times 100$$

Oven dried sample, 5 grams was made fat free. The residue was shifted an 800 ml beaker. The sample was boiled in 200 ml 1.25% H_2SO_4 solution for 30 minutes. The contents were filtered and residue was washed with distilled water. Residue was transferred to a beaker and digested with 200 ml 1.25% sodium hydroxide (NaOH) solution for 30 minutes. The contents were filtered and washed with distilled water. The residue was dried to a constant weight. The weight of dried residue was recorded. The dried residue was then ignited in a muffle furnace at 600 °C for 30 minutes till white/ grey ash was obtained. Loss in weight during ignition was considered as crude fiber and its percentage was calculated by the following formula:

$$\% \text{ crude fiber} = \frac{\text{Loss in weight on ignition}}{\text{Sample weight}} \times (100 - \text{moisture } \% - \text{oil } \%)$$

Feed sample of 5 grams was taken in crucible. It was ignited on an oxidizing flame of a burner till no smoke was evolved. The crucible was placed in a muffle furnace and heated at 600 °C till white/ grey ash was obtained. The crucible was cooled in a desiccator and weight of ash was recorded. The ash percentage was calculated by following formula:

$$\% \text{ Ash (as fed)} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100$$

Nitrogen Free Extract (NFE) was worked out by difference according to the formula: NFE % = 100 – (% moisture + % CP + % oil + % CF + ash).

Chemical composition of fish meal: CP % (48.00), Energy (ME Kcal/kg) (2800), Oil % (18.00), Crude Fiber % (6.00), Ash % (15.00), Calcium % (6.00), Phosphorus % (3.65), Lysine % (3.50), Methionine % (1.5) and Cystine % (0.60).

Chemical composition of feather meal: CP % (52.00), Energy (ME Kcal/kg) (3000), Oil % (12.00), Crude Fiber % (9.00), Ash % (8.00), Calcium % (2.00), Phosphorus % (1.00), Lysine % (1.26), Methionine % (0.6) and Cystine % (1.70).

Ingredients and Feed composition (on dry matter basis)

Ingredients %	Starter ration				Finisher ration			
	A	B	C	D	A	B	C	D
Fish meal	3.5	2.34	1.15	0	3	2	0.98	0
Feather meal	0	1.2	2.44	3.64	0	1.03	2.09	3.15
Corn gluten meal	6.785	6.725	6.69	6.5	6.73	6.73	6.7	6.5
Canola meal	6	6	6	6	8	8	8	8
Soyabean meal	18	18	18	18	9	9	9	9
Wheat bran	2.5	2.5	2.5	2.5	3.5	3.5	3.5	3.5
Rice polishing	4	4	4	4	5	5	5	5
Molasses	4.25	4.25	4.25	4.25	2.25	2.25	2.25	2.25
Maize	35	35	35	35	36.75	36.62	36.43	36.25
Rice tips	10	10	10	10	11	11	11	11
Wheat	8.2	8.2	8.2	8.2	13	13	13	13
Common salt	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Di calcium phosphate	0.65	0.65	0.65	0.65	0.55	0.65	0.65	0.75
Limestone	0.15	0.15	0.15	0.15	0.25	0.25	0.25	0.35
Lysine-SO4	0.35	0.35	0.35	0.35	0.35	0.35	0.5	0.65
DL-methionine	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
L-threonine	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Premix	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Phytase enzyme	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Total	100	100	100	100	100	100	100	100
Chemical composition	**Starter ration**				**Finisher ration**			
CP %	22.00	22.00	22.00	22.00	19.00	19.00	19.00	19.00
Energy (ME Kcal/kg)	2600	2600	2600	2600	2950	2950	2950	2950

*Feather meal is replaced with fish meal on protein equivalent basis.

Floor housing system was provided, in which one square foot space was given to each chick. Poultry house was entirely cleaned, washed with fresh water. Entire shed was also coated with limestone and allowed to dry for 24 hours and disinfectant was used one day before arrival of flock. Wooden dust was used as litter. Locally purchased wooden dust was brought to the farm and was dried under sunlight for 12 hours and checked for any foreign object present in it to maintain litter quality. Four inches deep layer of litter was provided for each group of broiler. Limestone was mixed with litter to check any sort of infection. Litter turning was practiced on regular basis, to keep it dry and minimize gas production in the shed.

Artificial electric brooders were run two days before arrival of chicks. One brooder was provided to each group. During first week, brooding temperature was maintained at 95^0F and 5^0F was reduced each subsequent week till 70^0F, as house temperature. During brooding, electric brooders were placed in the center of each partition fitted with three 100 watt electric bulbs in each. One thermometer was placed at the height of 6 inches near brooder to maintain brooding temperature. 60% humidity was maintained in the shed throughout the study period. Lighting was provided by using 200 watt bulbs, fitted with roof at the height of 8 feet. For emergency use rechargeable lights were placed at the shed. Light was provided round the clock during experiment. All the feed ingredients were purchased from Hyderabad market and brought to experimental station. Fish meal and feather meal was provided by H.S feeds Hyderabad on demand. Mash feed was prepared at farm by manual mixing of ingredients. A large polythene sheet was spread on the floor and weight wise ingredients were added and mixed one by one to form evenly distributed mash feed separately for each group.

The feed was given to all experimental chicks according to their treatments. Feed and water was provided *ad libitum.* A certain quantity of feed was offered to broilers of each group early in the morning and later in the evening daily and refusal of each time was collected and weighed to record feed consumption of chicks. Similarly, water was provided *ad libitum* replaced twice a daily with fresh water and refusal was collected to calculate water intake of the day. Chicks were vaccinated against contagious diseases on following schedule.

Days	Vaccines	Route
7^{th}	Newcastle disease + Infectious Bronchitis.	Eye Drop
10^{th}	Infectious Bursal Disease.	Drinking Water
14^{th}	Hydro Pericardium Syndrome.	Sub Cutaneous Injection
21^{nd}	Infectious Bursal Disease.	Drinking Water
28^{th}	Newcastle disease.	Drinking Water

After arrival of day old chicks at Poultry Experimental Station, individual chick was weighed by using electric weighing scale. At the end of each week, five chicks from each group were randomly selected for weight record till last week. Weight gain of each group was calculated and recorded.

Feed was provided to the chicks twice daily and refusal of feed was collected from feeders of each group, weighed and finally consumed feed was recorded daily. For this practice, the following formula was used:

Feed intake (grams/bird/day) =

$$\frac{\text{Total feed offered} - \text{Total feed refused}}{\text{No. of chicks}}$$

Water was provided *ad libitum* and per bird consumption was recorded by following formula:

Water intake (ml/b/d) =

$$\frac{\text{Total water offered} - \text{Total water refused}}{\text{No. of chicks}}$$

Feed conversion ratio of each group was calculated by following formula:

$$\text{FCR} = \frac{\text{Feed consumed}}{\text{Weight gained}}$$

Mortality percentage was calculated by the following formula:

Mortality (%) =

$$\frac{\text{No. of broiler died}}{\text{No. of chicks at start of experiment}} \times 100$$

Everyday expenditure on various items was recorded on daily basis of each group separately and at the end cost of per broiler and total income was calculated separately for each group. Net profit was calculated by subtracting total cost from total income.

On completion of experimental period of 42 days, 5 broilers from each group were weight and slaughtered. After dressing, carcass weight was recorded and its dressing percentage was calculated by following formula:

Carcass weight = Body weight (g) – Weight of non edible parts (g)

Dressing percentage was recorded by using following formula:

$$\text{Dressing Percentage} = \frac{\text{Carcass weight}\,(g)}{\text{Live weight}\,(g)} \times 100$$

The liver, heart and gizzard were separated from slaughtered broilers of each group and their weight was calculated by using electric balance and recorded for each group separately. The collected data were tabulated and analyzed by using statistical program, SPSS 2007, for windows.

III. Results

The study was conducted to investigate the effect of feeding different levels of feather meal as a replacement of fish meal on the growth of broilers. The results on parameters, initial and final body weight, feed and water consumption, carcass weight, weight of giblets, mortality and economics are presented and explicated.

The results of feed consumption showed highest per broiler feed intake 3744 g was recorded in group D (fed with 100% feather meal), followed by 3728 g in group C (broilers fed with 67% feather meal and 33% fish meal). While in group B, (broilers fed with 33% feather meal and 67% fish meal) average feed intake was 3706 g and in control group (broilers fed with 0% feather meal and 100% fish meal), 3687 g feed intake per broiler was recorded. The difference in average feed consumption was found non-significant. The average final body weight, 2212.1 g in group A broilers fed with control ration were higher than group B 2205 g, C 2196.05 g, and D 2187.15 g/b. Statistically difference among the groups was observed non-significant. Results for water consumed showed same pattern as of feed intake. Average water intake of group D 9316 ml was recorded higher than 9300 ml in group C, 9289 ml in group B and 9270 ml/b in control group. The data of average water consumption of different groups showed non-significant difference whereas, average growth of broilers of different groups showed similar pattern.

Group wise result showed that FCR of control group, 1.699 was better than 1.711 of group B, 1.730 of group C and 1.745 of group D. Average carcass weight 1332 g in control group, was higher than 1322 g of group B, 1314 g of group C and 1300 g/b of group D. The difference recorded was found non-significant. The dressing percentage of group A, B, C and D was recorded 60.21 %, 59.95 %, 59.83 % and 59.43 %, respectively. Maximum average weight of liver was found in group A, 51.350 g, while in group B it was 50.75 g, group C was 50.65 g and 50.41 g/b in group D. This result showed non-significant difference between the groups. Average heart weight of liver in group A 8.40 g was heavier than group B 8.30 g, group C 8.30 g and 8.20 g/b of group D. Maximum average weight of gizzard 42.12 g was found in group A, while 41.72 g in group B, 41.15 g in group C and 40.93 g/b in group D. There was no any morality in group A, B, C and D and percentage mortality remained nil in each group. There was no visual specific symptom of any disease / syndrome. The result showed that there is no effect of feather meal feeding on mortality of broilers (table- 1).

Table 1: Different studies on different groups kept during, 2013

Groups	A	B	C	D
Initial Body weight (g)	42.10	42.00	42.05	42.15
Feed Consumed (g)	3687	3706	3728	3744
Final Body weight (g)	2212.1	2205	2196.05	2187.15
Carcass weight	1332	1322	1314	1300
Water consumed (ml)	9270	9289	9300	9316
Average Growth (g)	2170	2163	2154	2145
FCR	1.699	1.711	1.730	1.745
Dressing Percentage	60.21	59.95	59.83	59.43

Weight of liver (g)	51.35	50.75	50.65	50.41
Weight of heart (g)	8.40	8.30	8.30	8.20
Weight of gizzard (g)	42.21	41.72	41.15	40.93

Economics: Cost of feed of control group was Rs. 44 per kg, group B Rs. 43 per kg, group C Rs. 42 per kg and group D was Rs. 41 per kg .Average per broiler fed cost for group A, B, C and D was Rs. 162.22, Rs 159.35, Rs. 156.57 and Rs. 153.55, respectively. Total production cost per broiler was Rs. 212.22, Rs. 209.35, Rs. 206.57 and Rs. 203.50 for group A, B, C and D, respectively. After marketing, per broiler income of group A, B, C and D was Rs. 236.21, Rs. 235.5, Rs. 234.6 and Rs 233.71 with the profit of Rs. 23.98, Rs. 26.14, Rs. 28.02 and Rs. 30.20 per boiler, respectively. The broilers feed with 100% feather meal in ration proved to be most economical (table- 2).

Table 2: Economics of broilers (Rs/b)

S. No.	Economic Parameters	Groups A	B	C	D
1	Cost of DOC	32	32	32	32
2	Cost of feed	162.22	159.35	156.57	153.50
3	Miscellaneous Expenses	18	18	18	18
4	Total Expenditure	212.22	209.35	206.57	203.50
5	Income from sale of broilers	231.21	230.50	229.60	228.71
6	Income from sale of empty feed bags and litter	05	05	05	05
7	Total Income (5+6)	236.21	235.50	234.60	233.17
8	Net Profit (7-5)	23.98	26.14	28.02	30.20

Note: Electricity, water and rent expenses are exclusive.

IV. Discussion

Broilers have high demand of crude protein and energy for their body maintenance and growth, therefore feed ingredients rich in protein and energy have high demand. Only the feed cost is up to 70% of total expenses of broiler production. In order to increase the profit margin, feeding expense should be minimized. Among different available protein source ingredients, animal protein sources contain better CP and energy value as well. High demand of some conventionally used animal protein source ingredients increased its rate and consequently resulted in increased feed prices. A simple way to counter it is to, identify such abundantly used ingredient and replace it. Feather meal is among the most protein rich by-products. Some nutritionists have concern on its digestibility, because keratinous protein of feather is in form of disulphide bond that is why now-a-days feathers are processed under different conditions to increase its digestibility. On the other hand its use is increasing day by day due to the availability of reasonably good amino acids at cheap price. Although it lacks few of the essential amino acids like lysine, methionine and leucine but it carries extremely high contents of amino acids like cystine, threonine, agrinine and serine. Boiler feed supplemented with lysine and methionine produce good growth. Inclusion of feather meal in broiler chickens diet usually did not exceed 3% due to the low digestibility of its protein (Eissler and Firman, 1996). However, inclusion of 5-8% feather meal was reported (Xavier *et al.,* 2011; Mandubuike *et al.,* 2009; and Holanda *et al.,* 2009).

As far as the effect of feather meal on final live body weight is concern, feather meal substitution with fish meal at different levels, showed non-significant difference. Highest average final live body weight was recorded in control group with 2212.1 g, followed by broilers of group B fed with 33% feather meal 2205 g, group C having 67% feather meal 2196.05 g and group D having 100% feather meal as replacement of fish meal 2187.15 g/b. Statistically the difference in weight was found non-significant. This difference might be due to amino acids imbalance of feather meal and resulted in relatively low performance of broilers. The inherent deficiencies of methionine, lysine and tryptopham might be additional responsible factors for low biological value of feather meal. However, high level of cystine in feather meal could have compensated for low methionine level. Amino acids supplementation in feed further improved broiler performance. The final body weights obtained in this study are comparable with Ochetim (1993), Ahaotu and Ekenyem (2009), Holanda *et al.,* (2009) and Mandubuike *et al.,* (2009). Tsang *et al.,* (1963) incorporated hydrolyzed poultry feather (feather meal) with soyabean meal at different levels and their data regarding final weight showed no difference in weight gain when 8% feather meal were incorporated. Wang *et al.,* (1990) reported that 20, 40 and 60% of fish meal substituted by feather meal showed non-significant difference in final live body weight. Ochetim (1993) recommended use of 3% of feather meal in broiler feed without any significant difference in live body weight. Similar result was reported by Mandubuike *et al.,* (2009), while substituting feather meal with fish meal at starter phase and Ahaotu and Ekenyem (2009) for finisher. Mandubuike *et al.,* (2009) suggested use of 5% feather meal in starter feed. While Ahaotu and Ekenyem (2009) recommended 7.5% of feather meal an optimal level as a replacement of fish meal in finisher ration without any negative effect on live body weight. Holanda *et al.,* (2009) suggested inclusion of up to 8% feather meal in feed of

broiler without any significant decrease in weight. Previous findings and recent experiment result about the use of feather meal a replacement of fish meal on the final live body weight showed similar pattern. The energy content of feather meal is more than fish meal and in rapidly growing broiler energy becomes one of the limiting nutrients, that's why the weight of broilers was not affected by feather meal feeding.

Feed consumption of control group, 3687 g/b was recorded lowest but non-significantly different from other groups. On the other hand highest feed intake was recorded in D group 3744 g, followed by group C 3728 g and group B 3706 g/b. These results are similar to Wang *et al.,* (1990) and Caires *et al.,* (2010). Mandubuike *et al.,* (2009) also reported highest feed consumption in control group followed by 2.5, 5, 7.5 and 10% fish meal in feed, replaced by feather meal in their starter phase trial and reported up to 7.5% feather meal in feed as replacement of fish meal did not affect feed consumption of broilers. Similar result for finisher phase was reported by Ahaotu and Ekenyem (2009), they recommended 5% feather meal in broiler feed and while Ochitum (1993) reported non-significant difference in total feed consumption of broilers up to 3% feather meal in ration. On the hand Jackson *et al.,* (1971) recommended 10% inclusion of feather meal in broiler feed with optimum utilization of feed. Effect of feather meal on feed consumption of current study is in-line with Nakhash (2008) who suggested 5% feather meal in broiler ration. Broilers can adjust their feed intake over a considerable range of energy and protein level in order to meet their daily energy needs. Broiler fed with feather meal increases their feed intake for their body maintenance. Moran Jr. (1994) reported that the deficiency in methionine reduce weight gain, feed efficiency and stimulate feed intake when this deficiency is not hard. This might be the reason for increased feed consumption of group D broilers. Results regarding water consumption showed maximum intake in group D with 9316 ml and minimum intake in group A with 9270 ml, followed by B with 9289 ml and C with 9300 ml/b. Statistically this difference recorded was non-significant among different groups. It showed that feather meal inclusion in ration have no negative effect on water consumption of broilers. Feeding of feather meal as replacement of fish meal did not significantly affect body weight, feed intake and FCR. This study is in agreement of previous studies of Ochitum (1993). Feather meal at different levels of inclusion in the experimental diets had no detrimental effect on live performance parameters in this study.

Carcass weight of different groups showed the same pattern. Feather meal at different levels of inclusion had non-significant effect on carcass yield. Carcass weight of 100% feather meal fed bird 1300 g was recorded lowest than group C 1314 g, group B 1322 g and group A 1332 g/b. Isika *et al.,* (2006) also reported non-significant difference in carcass weight of feather meal feeding up to 3% of total ration. Wang *et al.,* (1990) suggested 5% feather meal in broiler ration without any negative effect on carcass yield. Similar results are reported by Nakhash (2008), who recommended 5% feather meal in broiler diets without any adverse effect on carcass performance. Ochitum (1993) also reported non-significant difference in carcass yield and dressing percentage while conducting a trial of feather meal feeding on broilers. Since there was no difference in dressing percentage between different groups, the observed differences in carcass yields is due to differences in average final live body weights of different treatments.

The data for weight of giblets in current study at different feather meal feeding levels showed non-significant difference. These findings regarding weight of giblets were similar to previous researchers, Wang *et al.,* (1990), Isika *et al.,* (2006) and Nakhash (2008). They reported no significant difference in weight of giblets of broilers while feeding feather meal. It was proved that feather meal does not have any negative effect on giblets growth because no abnormality was seen in the weight of liver, heart and gizzard of feather meal fed broilers. No mortality at all was observed during experiment. Effect of feather meal on mortality of broiler was nil, similar finding was reported by Xavier *et al.,* (2011). This proved that feather meal do not have any effect on livability of chicks.

Economical aspect of feather meal feeding was discussed by various scientists. In recent study group D broiler fed with 100% feather meal feeding proved to be cheapest and control group was costly among all. Similar results were reported by Ahaotu and Ekenyem (2009) and Mandubuike *et al.,* (2009). They reported significant difference in cost of feed production with or without feather meal inclusion. The recent study result regarding economic impact of feather meal feeding on broiler production is similar to Caires *et al.,* (2010) they concluded that inclusion of 5% feather meal in broiler feed is cost effective. Nakhash (2008) studies also confirm that inclusion feather meal reduce the relative cost per unit weight gain.

Even when broiler feed contain recommended level of protein, satisfactory growth also requires sufficient quantities and proper balance of all the essential amino acids. In the absence of essential amino acids (EAA) low growth can be seen. Overall, amino acids content of fish meal is usually of good quality but its protein content is less than feather meal. Other than lysine, sulfur amino acids methionine and cystine, are limiting in feed for poultry. The requirement of these amino acids is usually considered as requirements for methionine+cystine as they compensate each others. In the final results, imbalance of feather meal amino acid was compensated due to presence of high protein contents like cystine, threonine, agrinine, etc and its low inclusion in feed did not significantly affect broiler performance. Feather meal fed broilers were cost effective. It was concluded from present study that substitution of fish meal by feather meal in broiler feed did not compromise live performance, carcass yield or mortality and allowed feed cost reduction. Keeping in view the results of the present study, the author suggest that feather meal can replace fish meal in feed by 100 % without any negative influence on the performance of broilers.

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AUTHOR'S PROFILE

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We bow our heads to Allah, the most beneficent and the most merciful, who blessed us good health, very kind parents, talented teachers, colleagues and a conductive environment that ultimately resulted in accomplishment of one of the prime goals of our lives. I wish to express my deep sense of gratitude and sincere appreciation to my researchers who kept on encouraging me and provided valuable suggestions. Dr. Hakim Ali Sahito as a corresponding and co-author got BSc. MSc. Ph.D. and Post Doctorate from SAU, Tandojam and working as Assistant Professor, Department of Zoology, Faculty of Natural Science, SALU, Khairpur has published more than 56 research papers up to 2014 on different aspects.