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# Effects of dietary inclusion of sun-dried or roasted stranded fish on egg-type pullet growth and egg laying of hens

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## ABSTRACT

The objective of the study was to measure the effect of the substitution of imported super concentrate by different levels of locally produced fishmeal on pullet's growth and egg laying performance. Different types of stranded fish from the White Nile, Sudan, were collected during March and April 2017, ground and then sun-dried (A) or roasted (B). The experimental diets were iso-energetic and iso-nitrogenous to meet or exceed the requirements of pullets growing phases (starter, grower and developer) and laying. The dried or roasted fish (fishmeal) were used to replace the imported protein concentrates at three levels. The sun-dried fish (A) consisted of A1 with 1.5% locally sun-dried fishmeal (L.S.F) and 3.5% imported concentrate (I.C.), A2 with 3.5 % (L.S.F) and 1.5% (I.C) and A3 with 5 % (L.S.F) and 0% (I.C). Similarly, the roasted fish (B) consisted of B1 with 1.5 % locally roasted fishmeal (L.R.F) and 3.5% (I.C.), B2 with 3.5 % (L.R.F) and 1.5 % (I.C) and B3 with 5 % (L.R.F) and 0 % (I.C). The control diet contained 0% local fishmeal (C). A total of 210 one day-old (Hy-Line W-98) pullets were allotted to these seven treatments which were replicated three times with ten birds each. The results showed that at the end of the entire growing period, birds fed the sun-dried fishmeal (A) had the highest body weight, weight gain and feed consumption followed by birds fed on (B) diets. The birds fed on control diets (C) consumed numerically the least feed and had the lightest body weight. The highest body weight and weight gain values were recorded with A1 treatment. At the end of the starter period, the birds fed with B1, B2 and A3 had the lowest levels of blood cholesterol. The birds fed the control and B1 diets had the highest blood cholesterol. At the end of developer period, cholesterol, triglyceride, uric acid and calcium were not significantly affected by treatments. There were no significant differences between sun-dried and roasted fish in hen-day egg production during early weeks of production, however, hens fed the control diet produced less eggs compared with sun-dried treatments during the early production period. It is recommended to replace the super concentrate with 70% sun-dried fish.

## INTRODUCTION

The main objective of poultry production is to produce meat and eggs efficiently and economically by using cheaper and locally available feed ingredients, because feeds constitute higher percentage of the total cost (Panda and Mahapatra, 1989). Feed accounts about 60%-65% of the total cost of poultry production and protein costs 13% of the feed cost (Banerjee, 1992).

Protein quality is one of the most important factors in table eggs production. The high cost and demand of protein concentrate resources lead to uneconomic poultry diets. Many common feed ingredients such as imported concentrate are offered with high cost and urgent research attention is required for partial or complete replacement by alternatives (Agbede and Aletor, 2003).

In the Sudan, animal protein can be obtained from different sources, all of which eventually affect poultry feeding cost. For instance, the concentrates used in poultry feeding such as fishmeal and premixes are expensive and unaffordable for small poultry farmers. Moreover, protein of cereal grains and most other plant protein meals failed to supply the complete amino acids needs of poultry, due to a shortage of methionine and/or lysine (Beski *et al.,* 2015).

Fishmeal is a high protein feedstuff often included in poultry diets. It is usually marketed at 65% crude protein, but the crude protein content can vary from 57 to 77%, depending on the species of fish used (Miles *et al.*, 2011). Fishmeal is added to poultry diets as a source of highly digestible animal protein to improve feed consumption and consequently growth and egg production (Solangi *et al.,* 2002). A well-balanced protein, such as that found in fishmeal, is considered to be of high nutritional value for the birds.

In the Sudan, poultry industry depends on imported super concentrates as animal protein source, Although, there are huge amount of local stranded fish into rice cultivation area in the White Nile river, which could be processed as local fishmeal and used as an alternative feedstuff.

The objective of the current study was to investigate the effects of dietary replacement of super concentrate by sun-dried or roasted stranded fish on egg-type pullet growing and laying performance.

# MATERIALS AND METHODS

## Experimental birds, design and feed preparation

This study was carried out during March and April 2017 at the Extension and Rural Development Center, Faculty of Animal Production, University of Gezira, Almanagil, Gezira State, Sudan.

A total of 210 Hy-line W 98 one- day-old chicks were brought from a commercial hatchery to investigate the effects of inclusion of stranded fishes (local fishmeal) on pullet growth and egg laying performance. The birds were housed in an open-sided deep litter house situated on east –west direction, with the long axis facing north and south wind. The house was divided into 21 pens. Each pen contained 10 chicks, and provided with one metallic tubular feeder and one plastic drinker.

The chicks were exposed to 23 hours light and 1 hour dark in the first week. The light hours were reduced gradually by two hours weekly to 12 hours light by the end of the sixth week of age. The 12 hours light were kept constant because it is equivalent to the longest day length during the summer in the Sudan.

At the $18^{th}$ and $19^{th}$ week of age the day length was 14 and 16 hours, respectively. The light hours during the laying period were kept constant (16 hours). Each pen was supplied with incandescent bulb lamp of 60 watts. They were hanged at one meter height. Those lambs were used for chicks brooding during the first two weeks by hanging them at 30 cm height.

Different types of disposed and spoiled fish were collected from El-dueim town, White Nile state, Sudan, where rice is cultivated. This area is characterized by annual flooding of the White Nile during the autumn and large numbers of fish are left during the dry season. The birds were fed on diets in the mash form. For the sun-drying treatment, the fish were collected, minced using the electric beef meat mincer and subjected to solar radiation for 72 hours. For the roasting treatment, the fish were collected, ground and roasted by manual turning in a gas fire using a locally designed drum for 15 minutes.

The samples of treated fish were weighed and stored in plastic bags to avoid moisture, pests and microbiological contamination. The experimental diets were formulated iso-energetic and iso-nitrogenous to meet or exceed the requirements of pullets growing phases (starter, grower, and developer) and laying (NRC, 1994). The sun-dried and roasted fish (local fishmeal) were used to replace the imported protein concentrates at three levels. The sun-dried fish (A) consisted of A1 with 1.5% locally sun-dried fishmeal (L.S.F) and 3.5% imported concentrate (I.C.), A2 with 3.5 % (L.S.F) and 1.5% (I.C) and A3 with 5 % (L.S.F) and 0% (I.C). Similarly, the roasted fish (B) consisted of B1 with 1.5 % locally roasted fishmeal (L.R.F) and 3.5% (I.C.), B2 with 3.5 % (L.R.F) and 1.5 % (I.C) and B3 with 5 % (L.R.F) and 0 % (I.C). The control diet contained 0% locally fishmeal (C). The birds were allocated to the seven treatments (A1, A2, A3, B1, B2, B3, and C).

The treatments were replicated three times with ten birds each in a completely randomized design. The composition of the experimental diets is presented in Tables 1, 2 and 3. The same adopted protocol of diet formulation during each growth period was applied to formulate the standard laying rations. All birds had free access to feed and water (*ad libitum*).

Table 1. Composition of experimental diets for pullets during the starter period (0-6 wks).

| Ingredients | Treatments (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried (A) | | | Roasted (B) | | | Control (C) |
| | 5 | 3.5 | 1.5 | 5 | 3.5 | 1.5 | 0 |
| Sorghum | 54.28 | 53.0 | 53.8 | 53.8 | 53.8 | 53.8 | 54.28 |
| GC | 18 | 19 | 19 | 19 | 19 | 19 | 18 |
| Wheat bran | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Fish meal | 5 | 3.5 | 1.5 | 5 | 3.5 | 1.5 | 0 |
| Concentrate | 0 | 1.5 | 3.5 | 0 | 1.5 | 3.5 | 5 |
| Di Ca P | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 | 0.72 |
| Limestone | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Na Cl | 0.3 | 0.3 | 0.3 | 00.3 | 0.3 | 3.5 | 0.3 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Methionine | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 |
| Anti-Toxin | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 |
| Premix[1] | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Calculated analysis | | | | | | | |
| ME[2] (Kcal/kg) | 3092.2 | 3072.5 | 3073 | 3084.3 | 3079.5 | 3073.2 | 3072.2 |
| Protein (%) | 20.4 | 20.04 | 20.01 | 20.80 | 20.50 | 20.20 | 20.00 |
| Analyzed | | | | | | | |
| ME (Kcal/kg) | 2888 | 2833 | 2873 | 2931 | 2978 | 3021 | 2725 |
| Protein (%) | 21.0 | 21.7 | 21.1 | 21.6 | 21.9 | 21.3 | 19.8 |

[1]Vitamin - mineral premix provided the following per kilogram of diet: Vitamin A (retinyle acetate), 10,000 IU; cholecalciferol, 2,500 IU; "-tocopheryl acetate, 60 mg; mendione sodium bisulfite complex, 15 mg; thiamine hydrochloride, 2 mg; riboflavine, 8 gm; pyridoxine hydrochloride, 4 mg; cyanocobalamin, 0.04 mg; pantothenic acid, 15 mg; nicotinic acid, 40 gm; folic acid, 1.5 mg; biotin, 0.2 mg; choline chloride, 200 mg; iron, 50 mg; manganese, 50 mg; copper, 10 mg; zinc, 50 mg; calcium, 352 mg; iodine, 1.46 mg; cobalt, 0.5 mg; selenium, 0.2 mg.

[2]Values and metabolizable energy calculated according to Lodhi *et al.* (1976).

GC= Groundnut cake, Di Ca P= Di-calcium phosph,, Na Cl= Sodium chloride.

Table 2. Composition of experimental diets for pullets during the grower period (7-12 wks).

| Ingredients | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried (A) | | | Roasted (B) | | | Control (C) |
| | 5% | 3.5% | 1.5% | 5% | 3.5% | 1.5% | |
| Sorghum | 58.28 | 58.28 | 56.28 | 59.28 | 58.28 | 58.28 | 58.28 |
| GC | 13 | 13 | 15 | 13 | 13 | 14 | 13 |
| Wheat bran | 20 | 20 | 20 | 19 | 20 | 19 | 20 |
| Fish meal | 5 | 3.5 | 1.5 | 5 | 3.5 | 1.5 | 5 |
| Concentrate | 0 | 1.5 | 3.5 | 0 | 1.5 | 3.5 | 0 |
| Di Ca P | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Limestone | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Na Cl | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Methionine | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.45 | 0.45 |
| Anti-Toxin | 0.125 | 0.125 | 0.125 | 0.125 | 0.125 | 0.125 | 0.125 |
| Premix[1] | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Grit | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Calculated analysis | | | | | | | |
| ME[2](kcal/kg) | 3090 | 3079 | 3073 | 3084 | 3070 | 3073 | 3090 |
| Protein | 18 | 18 | 18 | 18 | 18 | 18 | 18 |
| Analyzed | | | | | | | |
| ME[2] (kcal/kg) | 3000 | 2839 | 2824 | 3067 | 2954 | 3047 | 2928 |
| Protein | 19.3 | 19.5 | 19.7 | 19.6 | 19.8 | 19.2 | 19 |

GC= Groundnut cake, Di Ca P= Di-calcium phosph,, Na Cl= Sodium chloride

Table 3. Composition of experimental diets for pullets during the developer period (13-18 wks).

| Ingredients | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried (A) | | | Roasted (B) | | | Control |
| | 5% | 3.5% | 1.5% | 5% | 3.5% | 1.5% | (C) |
| Sorghum | 60.32 | 60 | 59.32 | 60 | 59.32 | 58.32 | 60.32 |
| GC | 8.0 | 8.32 | 10 | 8.32 | 9.0 | 10 | 8.0 |
| Wheat bran | 20 | 20 | 19 | 20 | 20 | 20 | 20 |
| Fish meal | 5 | 3.5 | 1.5 | 5 | 3.5 | 1.5 | 5 |
| Concentrate | 0 | 1.5 | 3.5 | 0 | 1.5 | 3.5 | 0 |
| Di Ca P | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Limestone | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Na Cl | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Methionine | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 | 0.045 |
| Anti-Toxin | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 |
| Premix[1] | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Grit | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| Calculated analysis | | | | | | | |
| ME[2] (kcal/kg) | 2996 | 2989 | 2977 | 2994 | 2985 | 2973 | 2895 |
| Protein | 16.82 | 16.70 | 16.85 | 17.04 | 16.96 | 16.89 | 16.61 |
| Analyzed | | | | | | | |
| ME[2] (kcal/kg) | 2781 | 2748 | 2811 | 2796 | 2996 | 2999 | 2972 |
| Protein | 16.90 | 17.01 | 16.98 | 17.08 | 17.22 | 17.00 | 16.54 |

GC= Groundnut cake, Di Ca P= Di-calcium phosph,, Na Cl= Sodium chloride

**Parameters measured**

Body weight of each bird was recorded on the first day of age and at the end of each growth period (starter, grower and developer). The average weight gain and feed consumption were recorded weekly and at the end of each growth period. Feed conversion ratio (FCR) was calculated weekly and at the end of each growth period. All parameters were recorded for the entire growing period.

Two birds were randomly selected from each replicate (six birds for each treatment) for blood sampling. Blood samples were collected to assess the total protein, cholesterol, triglycerides, uric acid, calcium and phosphorus at the end of each growth period (starter and developer).

Hen-day egg production was accorded throughout the production period. Three periods of production were selected as early egg production.

**Laboratory analysis**

The chemical analysis of treated fish was carried out at the Institute of Animal Science Laboratory, Central Laboratory, Berlin University of Humboldt, according to (AOAC, 2005).

Blood samples were obtained *via* wing-vein using 0 -5ml insulin syringe and drawn into vacuumed capillary tubes. After coagulation, blood samples were centrifuged for 10 minutes (Hettich EBA 20 – Germany) at 2000 rpm at room temperature, and then serum was collected and stored at −20°C for analysis. Blood cholesterol, triglycerides, total protein, uric acid, calcium and phosphorus levels were determined spectrophotometrically using commercial kits (BioSystems S. A. Costa Brava 30, Barcelona, Spain). Samples were prepared and analyzed according to manufacturer's specifications.

**Statistical analysis**

Data were subjected to the analysis of variance procedure using the SPSS (2001) software. Means were separated using Duncan’s Multiple Range Test.

## RESULTS AND DISCUSSION

Table 4 shows the proximate analysis of sun-dried, roasted fish and imported concentrate. The proximate analysis was similar in the two treated fish samples. The sun-dried and roasted fish recorded higher values of protein, fat and metabolizable energy compared with the imported concentrate.

Table 4. Proximate analysis (%) of sun-dried and roasted fish and imported concentrate (on DM basis)

| Treatments | Crude protein | Fat | Crude fiber | Ash | NFE | ME*(Kcal/kg) |
|---|---|---|---|---|---|---|
| Roasted | 51.58 | 11.64 | 0.89 | 32.54 | 3.86 | 2441 |
| Sun- dried | 51.34 | 11.64 | 0.95 | 32.13 | 3.9 | 2438 |
| Imported concentrate | 35.00 | 2.00 | 4.5 | ND | ND | 2000 |

*ME calculated according to the equation of Lodhi *et al.* (1976).
ND=Not determined

Table 5 shows significant differences ($p \leq 0.05$) among treatments in feed consumption during the growing period (0-18 weeks). The highest feed consumption was obtained by birds fed with A3 diets followed by A1 and B1 diets. A similar pattern was observed for the results of the body weight and weight gain. Sun-dried fish at level A1 recorded the highest body weight and weight gain.

Table 5. Effects of different levels of sun-dried and roasted fish on pullets' performance during the growing period (0-18 weeks).

| Para-meters | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried fish | | | Roasted fish | | | Control |
| | A1 1.5% | A2 3.5% | A3 5% | B1 1.5% | B2 3.5% | B3 5% | C |
| FC | 6924 $^{b}$ | 6541 $^{d}$ | 7247 $^{a}$ | 7000 $^{b}$ | 6748 $^{c}$ | 6672 $^{cd}$ | 6611 $^{cd}$ |
| BW | 1291 $^{a}$ | 1281 $^{b}$ | 1267 $^{d}$ | 1280 $^{bc}$ | 1271 $^{cd}$ | 1249 $^{e}$ | 1254 $^{e}$ |
| WG | 1256 $^{a}$ | 1247 $^{b}$ | 1230 $^{d}$ | 1243 $^{bc}$ | 1235 $^{cd}$ | 1212 $^{e}$ | 1216 $^{e}$ |
| FCR | 5.84$^{d}$ | 5.25$^{a}$ | 5.88$^{d}$ | 5.63$^{c}$ | 5.47$^{bc}$ | 5.50$^{bc}$ | 5.44$^{b}$ |

Means in the same row followed by the same letters are not significantly different according to Duncan's Multiple Range Test.
FC =Feed consumption (g/bird), BW = Body weight (g),WG = Weight gain (g),
FCR = Feed conversion ratio (g:g)

Body weight, weight gain and feed conversion ratio (FCR) of the birds fed on A2 diets were significantly ($p \leq 0.05$) higher than the control. The best FCR was attained by birds fed A2 diets.

Sun-dried fish at level A3 impaired the body weight, weight gain and FCR. The values of feed consumption, body weight and weight gain were decreased as the level of roasted fish increased. This result may be attributed to the high temperature during roasting. Based on unsaturated fatty acids content in fish oil, the lipid peroxidation will be inevitable during heat processing because they are sensitive to high temperature (Cleland *et al.*, 2006). This oxidation negatively affected the broiler performance, because of increased the turnover of gastrointestinal epithelial cell, proliferation of hepatic cells, and decreased the immunoglobulin in intestinal tissues (Dibner *et al.*, 1996).

Body weight and weight gain of sun-dried fish at A1 and A2 levels were significantly higher than roasted fish at levels B2 and B3. The sun-dried fishmeal was less susceptible to protein denaturation because they were not exposed to high heat like roasting. Gao *et al.* (2009) reported that the end point temperature of thermal denatured protein for fish ranged from 60°C to 80°C when sodium dodecyl sulfate polyacrylamide gel electrophoresis method was used. So, the results might be justified by the reason of protein denaturation which claimed to be the negative factor giving the poor performance results of roasting treatments. Overheating of non-fat dried milk, not only reduced lysine digestibility, but also methionine, phenylalanine, histidine, and cysteine (Savoie *et al.*, 1989).

Sarwar, (1997) revealed that overheating had significant deleterious effects on protein digestibility by (18%) of skim milk powder in rat diets. This led to the failure of growth at normal rates. Overheating reduced availability of protein either by a denaturing process or by reduction of the availability of essential amino acids (Papadopulos, 1989). Overheated fish protein concentrates are poorly digestible, some countries, such as Norway, developed a low-temperature fish meal production system for feeds for high-value commercial fish, such as salmon (Hughes and Rumsey, 1991).

During the starter period, levels of blood cholesterol, triglycerides, calcium, and phosphorus were significantly affected ($p \leq 0.05$) by treatments (Table 6). Uric acid and total protein were not significantly ($p > 0.05$) influenced by the experimental treatments. The birds fed with B2, B3 and A3 diets had the lowest levels of cholesterol, while birds fed on control and B1 diets had the highest blood cholesterol levels. The lowest values of triglycerides were observed with birds fed on A1 and A2 diets. These findings may be attributed to high levels of omega-3 fatty acids in fish oil which may reduce the concentrations of total lipid, triglycerides and cholesterol.

Table 6. Effects of different levels of sun-dried and roasted fish on some blood constituents of pullets at the end of the starter period.

| Parameters | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried fish | | | Roasted fish | | | Control |
| | A1 1.5% | A2 3.5% | A3 5% | B1 1.5% | B2 3.5% | B3 5% | C |
| Cholesterol (gm/dl) | 116.30[bc] | 114.50[bc] | 100.50[cd] | 124.83[ab] | 93.83[d] | 99.00[cd] | 136.00[a] |
| Triglyceride (gm/dl) | 102.17[b] | 102.67[b] | 147.83[a] | 120.30[ab] | 140.17[a] | 126.00[ab] | 119.17[ab] |
| Uric acid (mmol/L) | 2.10[a] | 1.83[a] | 2.20[a] | 2.38[a] | 1.80[a] | 2.10[a] | 2.72[a] |
| Total protein (g/dl) | 3.27[a] | 3.17[a] | 3.10[a] | 3.47[a] | 3.55[a] | 3.43[a] | 3.35[a] |
| Calcium (mg/dl) | 8.57[b] | 8.43[b] | 9.37[a] | 8.35[b] | 9.60[a] | 8.42[b] | 9.60[a] |
| Phosphorus (mg/dl) | 8.85[a] | 8.02[b] | 7.20[cd] | 7.28[cd] | 6.87[d] | 7.80[bc] | 6.88[d] |

Means in the same row followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

These results were in agreement with those of Harris *et al.* (1990) and Benson, (2009), who reported that omega-3 fatty acids reduced the concentrations of plasma cholesterol and triglyceride concentrations in humans through inhibition of triacylglycerol synthesis in the liver. The highest values of blood calcium were reported with A3, B2 and control.
Blood phosphorus in most birds fed fishmeal was significantly ($p \leq 0.05$) higher than the control. These results may be due to the existence of ground bones in fishmeal. Salih *et al* (2012) reported that phosphorus content in fish exposed to direct boiling and indirect boiling treatments were 3.49% and 3.06 %, respectively. They also, reported that the levels of phosphorus of all local fishmeal samples were higher by one and a half times when compared with imported concentrate. In addition, the sun-dried and roasted fish were made of different species of fish, so it may justify the discrepancies in calcium and phosphorus content values.

Table 7 shows that at the end of developer growth period (18 week of age), the dietary treatments had no significant effect on some blood constituents including cholesterol, triglycerides, uric acid and calcium. Most of the tested blood constituents were elevated in ascending pattern from growth period to the sequential one. Blood triglycerides were increased to reach high levels by the end of the growing period and that may be due to fat synthesis such as phospholipids to produce eggs. Keshavarz (1998) reported that the higher pullet liver weight at 18 weeks of age could be due to a greater rate of lipogenesis in this organ to supply the growing follicles with lipoproteins. The higher triglycerides concentration in improved high egg producing chicken is attributable to increased lipogenesis activities of the liver stimulated by the endogenous estrogens (North and Bell, 1990).

Table 7. Effects of different levels of sun-dried and roasted fish on some blood constituents at the end of developer period.

| Parameters | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried fish | | | Roasted fish | | | Control |
| | A1 1.5% | A2 3.5% | A3 5% | B1 1.5% | B2 3.5% | B3 5% | C |
| Cholesterol (gm/dl) | 155.50[a] | 174.00[a] | 202.50[a] | 159.17[a] | 164.17[a] | 155.50[a] | 159.50[a] |
| Triglyceride (gm/dl) | 644.83[a] | 909.33[a] | 940.50[a] | 701.50[a] | 784.00[a] | 605.83[a] | 511.67[a] |
| Uric acid (mmol/L) | 3.70[a] | 3.88[a] | 3.89[a] | 4.88[a] | 3.99[a] | 5.13[a] | 4.64[a] |
| Total protein (g/dl) | 6.41[b] | 6.96[ab] | 7.24[a] | 6.82[ab] | 6.74[ab] | 6.67[ab] | 6.55[ab] |
| Calcium (mg/dl) | 14.77[a] | 14.23[a] | 14.94[a] | 15.03[a] | 14.22[a] | 12.82[a] | 13.72[a] |
| Phosphorus (mg/dl) | 6.07[ab] | 7.06[ab] | 7.67[a] | 6.47[ab] | 5.59[b] | 6.81[ab] | 6.61[ab] |

Means in the same row followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

Blood uric acid levels were not high during the developer period. Uric acid in the plasma of birds is influenced by age, sex, plane of nutrition and reproductive status (Featherston, 1969). This could be an indication of amino acid utilization at early periods of growth (starter and grower), because the birds at this time need to build their lean body mass and frame size. Donsbough (2008) reported that the higher plasma uric acid is an indicator for amino acids utilization. However, at the end of the developer period, the uric acid decreased and it might be justified by the decline in the requirements of protein and the commencement of production period which needs more energy and less protein. The calcium blood content increased as the age of the bird increased to be ready of the onset of egg production.

There were no significant differences between sun-dried and roasted fish in hen-day egg production during the period of 21 to 23 weeks of age (Table 8). The best results of hen-day production were recorded with hens fed sun-dried fishmeal, whereas the lowest one was recorded with hens fed control diets. These results contradicted with that of Salih *et al.* (2012), who revealed that the hen-day egg production of layers fed diets including fishmeal was significantly lower than the control during 23 - 25 weeks of age. The contradiction among results may be due to the differences in the quality and adopted dietary levels of fishmeal. Although the period of production in the current study was not too long, the results obtained by local fishmeal were promising. The current study findings confirmed that good growing of pullets resulted in good egg laying performance. The local fishmeal scored good results during the growing period and consequently had higher egg production during the early laying period.

Table 8. Effects of different levels of sun-dried and roasted fish on early hen-day egg production.

| Parameters | Treatments | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sun-dried fish | | | Roasted fish | | | Control |
| | A1 1.5% | A2 3.5% | A3 5% | B1 1.5% | B2 3.5% | B3 5% | C |
| 21 (week of age) | 73.33[a] | 66.67[a] | 76.67[a] | 60.00[ab] | 56.67[ab] | 73.33[a] | 43.33[b] |
| 23 (week of age) | 70.00[ab] | 73.33[ab] | 86.67[a] | 80.00[a] | 73.33[ab] | 70.00[ab] | 66.67[b] |
| 25 (week of age) | 70.00[a] | 73.33[a] | 76.67[a] | 73.33[a] | 80.00[a] | 76.67[a] | 76.67[a] |

Means in the same row followed by the same letters are not significantly different according to Duncan's Multiple Range Test.

## CONCLUSION

Sun-dried fish at level A1 recorded the highest body weight and weight gain. Body weight, weight gain and FCR of the birds fed on A2 diets were significantly better than control. No significant differences were observed between sun-dried and roasted fish in hen-day egg production. Sun-dried at A1 and A2 levels had higher hen-day egg production than control. Based on the current study, the super concentrate could be replaced by up to 70% by sun-dried fish (A2) without adverse effects.

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