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Effects of Utilizing Disposed Fish of White Nile River on Performance of Layers', Gezira, Sudan

Research Article

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ABSTRACT

An experiment has been performed to utilize the wasted and disposed fish from White Nile River after simple heat treatments (Sun drying, roasting, direct boiling and indirect boiling) in layers' rations from 19 up to 40 weeks to replace the imported concentrate with the levels of 0, 1.5, 3.5 and 5% for all heat treatments. The crude protein of treated fish was 50.75, 52.50, 50.55 and 50.05% for sun drying, roasting, direct boiling and indirect boiling, respectively and for super concentrate 31.50%. Rations had been formulated according to NRC, 1994 recommendations. A total of 390 birds of Hy-line W-98 at 19 week of age were randomly distributed for groups, 5 group (6 replicate/13 birds). The performance of layers during the productive period (22 up to 40 weeks) showed significant differences ($P<0.05$) for feed intake, body weight gain, egg production and egg quality characteristics among treatment groups. The sun dried, roasted and supper concentrate respectively had the highest feed intake and body weight, while indirect boiling and boiling fish showed the lowest one. Sun dried 1.5%, roasted 1.5 and 3.5% levels and supper concentrates were the best egg production percentages and weights while the indirect boiling and direct boiling treatments were the lowest ones. There were no any significant differences among treatments for egg shell, weight, shell thickness and panel test. The study recommended the utilization of local wasted and disposal fish of White Nile River in substitution of imported concentrates in layers rations.

KEY WORDS disposed fish, egg characteristics, indirect boiling, layers, roasting.

INTRODUCTION

Poultry has seen the greatest increase in production in recent decades and this trend will likely continue. Both poultry eggs and meat are well positioned to meet demands for increased supply from our growing world population. The importance of poultry as a source of high quality protein in the form of meat and eggs had been established for a long time. The advance technology in management of poultry farms with specialized breeds and feed companies made eggs and poultry meat more widely available throughout the world than before. Recently, the wide fluctuation in ingredient costs has led to greater emphasis on poultry production economics. If wastes and neglected by-products from agriculture and food industry could be transferred into animal protein, this would solve a great problem, helping people of developing countries to avoid hunger and spare cereals and legumes for human consumption (Al-Harthi *et al*. 2009). The eggs production was increased as consumers become more educated about the nutritive value of the egg. Eggs are relatively inexpensive per unit of protein and energy contained in yolk and albumen, so eggs consumption

continues to increase in developing countries. The crude protein for fish meal in Sudan is 43.5% with 9.6% content of ether extract (Omer, 2000). The sun-drying time for (5 and 7 days) were similar in crude protein (50.77%) and ether extract (17.13%) (Elobied, 2003). Based on these observations, some studies have shown that poultry by-product meal cannot replace more than 50% of fish meal in fish diets (Fowlerm, 1991), but other studies have shown that with the recent improvement of the quality of poultry by-product meal it could replace 75% or 100% of fish meal without significant decrease in fish growth (Alexis *et al.* 1985). Objectives of the study to make use of the disposed fishes of the White River Nile in Sudan after a certain simple local treatments, i.e. (sun drying, roasting, direct boiling and indirect boiling) and to replace the imported concentrate for layers diets from 19 weeks (pre-production period) through the production period up to 40 weeks of age.

MATERIALS AND METHODS

Site of the study

The experiment had been carried out at Rural Development and Extension Center, Faculty of Animal Production, University of Gezira, El-Managil town Gezira State, Sudan, (14.25 N-32.99 E, 76 km. western Wad-Medani town) during the period from May 2013 to August 2013. The temperature at the Gezira State ranged between 20 ˚C to 47 ˚C; with relative humidity 45-80% while the raining level during autumn season (July, August, September and October) ranges between 110-120 mL (ARC, 2008).

Local disposed fish collection and preparations

More than 500 kg of disposed fish was brought from the White Nile River, Khor Abugassaba site 15 km north Eldueim town, central Sudan in April 2012. Usually after the flood season some fish are trapped at cultivated rice and irrigation canals. When the water run out, trapped fish are naturally died with some spoilage symptoms. Different fish types have been collected and identified which include: *Tilapia* spp. (Bulti), *Mormyrius niloticus* (Khshmelbanat), *Shilbe mystus* (Shellbaya), *Labeo nilotcus* (Debsa), *Synodontis nilotcus* (Gurgor) and *Protopterus aethiopicus* (Umkoru).

The whole quantity has been grinded by commercial mill then the raw grinded fish stored in a plastic bag to avoid moisture, microbial contamination and parasites (Tables 1 and 2). Then the raw ground fish was treated by heat as the flowing treatments:

Sun drying treatment (SDT)

A quantity of fish were treated by sun drying in which 125 kg of raw ground fish were exposed to direct sun radiation.

A screen-net was used to protect processing fish meal from all direct contact with animals and insects. The sun-treated fish were exposed to direct sun radiation for 72 hours. The sun-dried fish was weighed and stored in plastic bags to avoid moisture, microbial contamination and parasites and put in a clean and aerated room.

Roasting treatment (RT)

Approximately 125 kg of raw ground fish was treated by roasting in special local designed metal drum. The metal drum was exposed to moderate stove gas fire for 15 minutes with manual turned drum. The roasted product was weighed and stored in a plastic bags and put in a clean and aerated room.

Direct boiling treatment (DBT)

The direct boiling treatment depend on cooking about 125 kg of raw grinding fish on an alumium pots and gas stove. Tap water was boiled, after water start boiling gradually raw fish added, then the mixture boiled for 20 minutes on gas stove, then the mixture dried by air in the cage which been used for the first treatment then the direct boiling fish meal was weighed and stored in a plastic bags and put in a clean and aerated room.

Indirect boiling treatment (IBT)

Locally constructed pots were made of double wall aluminum, similar to waterpass aim. The heats from gas stove during the treatment was transmitted via water between wall of aluminum pots. The raw ground fish were placed inside the inner pots and tap water was poured in the space between the two bowls, that will transferred the heat indirectly to the raw ground fish, which subjected to the indirect boiling fish. The double bowl was covered. The treatments for ground raw fish depend on gas stove fire process till the water boiling point, then left for fifteen minutes. Then indirect boiling fish subjected to drying via screen-net cage. Then, the indirect boiling fish was weighed and stored in a plastic bag and put in a clean and aerated room.

Chemical analyses of the treated samples

Table 3 show the samples chemically analyzed according to AOAC (2005) at biochemistry lab, Faculty of Veterinary, University of Khartoum and Soba National Laboratory. Metabolizable energy (ME) value of the feed ingredients were calculated according to equation of Ellis (1981):

ME= 1.549 + 0.0102 CP + 0.0275 EE + 0.0148 NFE - 0.0034 CF

Where:

CP: crude protein.
EE: ether extracts.
NFE: nitrogen free extract.
CF: crude fibre.

Experimental birds

A total of 390 pullets of Hy-line W-98 at 19 weeks of age were used. The pullets were randomly distributed in 13 treatment groups, each replicated 3 times with 10 birds per replicate, to test the disposal White River Nile fish with supper concentrate.

Statistical analysis

Analysis of variance ANOVA, Steel and Torrie (1980) was performed on all data using the CRBD procedure of SPSS (2012). Differences between dietary treatments were tested using Duncan (1955).

Experimental rations

The diet was formulated according to Hy-line W-98 performance standards manual (Tables 1 and 2). The diets were used during the pre-productive period and the production period.

Table 1 Ingredients and calculated analysis of the experimental diets fed to laying hens during pre-production and production periods (19-40 weeks of age)*

Level of inclusion / Ingredients (%)	Sun dried DF[1]. 5%	Sun dried DF. 3.5%	Sun dried DF. 1.5%	Roasted DF. 5%	Roasted DF. 3.5%	Roasted DF. 1.5%	Supper concentrate 5% (control group)
Sorghum grain	54	54	54	54	54	54	54
Groundnut cake	12.01	12.01	12.01	12.01	12.01	12.01	12.01
Wheat bran	18	18	18	18	18	18	18
Local treated fish meal	5	3.5	1.5	5	3.5	1.5	0
Imported concentrates	0	1.5	3.5	0	1.5	3.5	5
Dicalcium phosphate	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Limestone	10	10	10	10	10	10	10
Salt (NaCl)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Lysine-HCl	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DL-methionine	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Antitoxins	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Premix[2]	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100	100
Calculated analysis							
ME (kcal/kg)	2823.26	2829.72	2834.57	2823.25	2829.72	2834.57	2818
Protein (%)	16.88	17.20	17.44	16.917	17.28	17.56	16.64

* Diets formulated according to Hy-line W-98 Performance Standards Manual.
[1] Disposed fish.
[2] Supplied per kilogram of diet: vitamin A (retinyl acetate+retinyl palmitate): 6050 µg; vitamin D_3: 55 µg; vitamin E (α-tocopheryl acetate): 22.05 µg; vitamin K_3: 2 mg; vitamin B_1: 5 mg; vitamin B_2: 6 mg; vitamin B_3: 60 mg; vitamin B_6: 4 mg; vitamin B_{12}: 0.02 mg; Pantothenic acid: 10.0 mg; Folic acid: 6 mg; Biotin: 0.15 mg and Ethoxyquin: 0.625 mg.

Table 2 Ingredients and calculated analysis of the experimental diets fed to laying hens during pre-production and production periods (19-40 weeks of age)*

Level of inclusion / Ingredients (%)	Direct boiling DF[1]. 5%	Direct boiling DF. 3.5%	Direct boiling DF. 1.5%	Indirect boiling DF. 5%	Indirect boiling DF. 3.5%	Indirect boiling DF. 1.5%
Sorghum grain	54	54	54	54	53.97	54
Groundnut cake	12.01	12.01	12.01	12.01	12.04	12.01
Wheat bran	18	18	18	18	18	18
Local fish meal	5	3.5	1.5	5	3.5	1.5
Imported concentrates	3.5	1.5	0	3.5	1.5	0
Dicalcium phosphate	0.25	0.25	0.25	0.25	0.25	0.25
Lime stone	10	10	10	10	10	10
Salt (NaCl)	0.3	0.3	0.3	0.3	0.3	0.3
Lysine-HCl	0.1	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.04	0.04	0.04	0.04	0.04	0.04
Antitoxins	0.2	0.2	0.2	0.2	0.2	0.2
Premix[2]	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100
Calculated analysis						
ME (kcal/kg)	2823.25	2829.72	2834.57	2823.26	2829.70	2830
Protein (%)	16.89	17.22	17.40	16.88	17.18	17.44

* Diets formulated according to Hy-line W-98 Performance Standards Manual.
[1] Disposed fish.
[2] Supplied per kilogram of diet: vitamin A (retinyl acetate+retinyl palmitate): 6050 µg; vitamin D_3: 55 µg; vitamin E (α-tocopheryl acetate): 22.05 µg; vitamin K_3: 2 mg; vitamin B_1: 5 mg; vitamin B_2: 6 mg; vitamin B_3: 60 mg; vitamin B_6: 4 mg; vitamin B_{12}: 0.02 mg; Pantothenic acid: 10.0 mg; Folic acid: 6 mg; Biotin: 0.15 mg and Ethoxyquin: 0.625 mg.

Table 3 Proximate analyses of the ingredients used in feed formulation

Proximate analyses / Ingredients	*ME (kcal/kg)	CP (%)	EE (%)	CF (%)	Ash (%)	NFE (%)	Ca (g/kg)	P (g/kg)
Sun-dried fish	2395.55	50.75	9.20	4.06	30.45	6.04	49.10	29.62
Roasted fish	2418.61	52.50	8.32	5.05	29.85	6.22	48.81	30.54
Direct boiled fish	2370.62	50.55	9.43	6.12	32.95	4.56	48.84	29.37
Indirect boiled fish	2360.24	50.05	8.60	4.65	30.05	5.61	53.59	33.79
Imported Concentrates	2088.66	31.50	3.30	13.88	22.60	6.50	14.25	7.75
Sorghum	2306.82	13.26	2.63	8.41	19.25	56.45	0.44	0.26
Groundnut cake	2516.45	43.75	4.57	15.03	11.88	24.77	0.55	0.64
Wheat bran	2023.92	14.00	4.83	23.98	5.05	52.14	0.32	7.75

ME: metabolizable energy; CP: crude protein; EE: ether extracts; CF: crude fibre and NFE: nitrogen free extract.
* Calculated metabolizable energy according to equation of Ellis (1981).

RESULTS AND DISCUSSION

Chemical analyses of treated disposed fish samples

Table 1 shows chemical analyses of the treated disposed fish samples and feed ingredients used in the experiments. Metabolizable energy was calculated using Ellis (1981) equation ME MJ/kg (0.004184 kcal/kg= 1.549 + 0.012 CP + 0.0275 EE + 0.0148 NFE - 0.0034 CF). The crude protein content of treated disposed fish for sun-dried, roasting, direct and indirect boiled samples of treated disposed fish were very high (50.75, 52.50, 50.55 and 50.05%, respectively) compared to super concentrate (34.41%). Ether extract content of treated disposed fish samples scored < 8% compared to imported super concentrate-control (3.3%). The crude fibre of treated disposed fish samples scored < 4.06% and super concentrate was 13.88%. The nitrogen free extract value was scored < 4.56%, which was less than value of super concentrate (25.81%). All treated disposed fish ash content, calcium and phosphorus was high than imported supper concentrated. Calculated ME values for testing treated disposed fish scored < 9.876 MJ/kg with low value for imported super concentrate (9.294 MJ/kg) compared to all treated disposed fish. The chemical composition of treated disposed fish and the feed stuffs used were shown in Table 1. All of the treated disposal fish samples were a good source of protein and its protein content was very close to many previous studies (Omer Dar-elgalal, 2012; Salih *et al.* 2012).

Feed intake (g/bird/week)

Tables 4a, 4b and 4c show a significant differences (P<0.05) in the feed intake of treated disposed fish and control during the pre-production period. Mutayoba *et al.* (2003) found out that, the feed intake during 19th to 21th weeks were less than the present study, also the present study results of feed intake was higher than Chowdhury *et al.* (2005). Additionally Shim *et al.* (2013) reported that feed intake were 87.96 to 90.96 g/bird/day during the period (19-21 week), which was higher than the present study results.

Body weight

Table 5 show the growth performance of pre-layers body weight during the pre-production period showed the same variation of progress in body weight during the growing period with a little increase in weight gain. The present results of body weight were less than Al-Harthi *et al.* (2009) who found the body weight at the 20th week were (1303.8 to 1342.83 g/bird).

Body weight (g/bird/2 weeks)

Table 5 showed the body weight of the treated disposed fish concentrate compared to the control, which shown a significant difference (P<0.05) among the different treatments when compared with each other. Generally, the treatments of sun-dried fish (1.5%) was showed high body weight, followed by roasted fish (1.5 and 3.5%), control and roasted fish (5%), sun-dried fish (3.5 and 5%), while the different level of direct boiled fish and indirect boiled fish were showed lower body weight compared to other treatments. The body weight was affected significantly (P>0.05) as treated disposed fish substituted with supper concentrate. However, the best body weights achieved with the experiment were less than standards manual performance. The results in the present study were similar to Rao *et al.* (2011), while were less than the results found by Sirirat *et al.* (2013).

Egg production (% egg/week)

Data for table egg production (%) were summarized in Tables 6a and 6b. The average of weekly egg production (%) was showed significant different (P<0.05) among the treatment groups of treated disposed fish concentrate and supper concentrate.

The sun-dried fish (1.5%) showed the best egg production (%) throughout the production period followed by roasting fish (1.5 and 3.5%) and the control, especially during the 27th to 40th weeks. The results in the present study results were less than egg production (%) for Dickey *et al.* (2012), while the present results were similar to Rao *et al.* (2011) and higher than Novak *et al.* (2006).

Table 4a Means of weekly feed intake and weight gain during pre-production period (19-21 weeks)

Treatments	Feed intake/week (g/b/w)			Body weight/week (g)		
	19th	20th	21th	19th	20th	21th
Sun-dried fish 1.5%	641.67^{ab}	672.33^{abc}	674.68^{de}	1292.12^{a}	1294.13^{a}	1295.09^{a}
Sun-dried fish 3.5%	574.16^{cde}	600.68^{cde}	671.00^{de}	1229.17^{e}	1229.35^{e}	1232.11^{e}
Sun-dried fish 5%	648.00^{ab}	671.35^{abc}	694.02^{bcde}	1206.02^{f}	1207.12^{f}	1211.35^{f}
Roasted fish 1.5%	644.17^{ab}	688.66^{ab}	660.18^{e}	1281.11^{ab}	1282.85^{ab}	1284.35^{ab}
Roasted fish 3.5%	654.00^{a}	715.00^{a}	681.50^{cde}	1277.39^{b}	1280.70^{b}	1282.89^{b}
Roasted fish 5%	641.83^{ab}	676.00^{ab}	623.82^{e}	1263.73^{c}	1262.81^{c}	1261.20^{c}
Direct boiled fish 1.5%	566.66^{cde}	627^{bcde}	684.31^{bcde}	1170.54^{g}	1181.95^{g}	1183.57^{g}
Direct boiled fish 3.5%	537.68^{de}	587.33^{de}	737.00^{bcd}	1179.1^{g}	1179.94^{g}	1182.71^{g}
Direct boiled fish 5%	530.33^{e}	572.34^{e}	686.98^{bcde}	1163.50^{g}	1164.95^{g}	1163.64^{g}
Indirect boiled fish 1.5%	600.00^{bc}	598.71^{cde}	758.32^{b}	1163.61^{gh}	1169.23^{gh}	1167.71^{gh}
Indirect boiled fish 3.5%	585.01^{cd}	643.66^{abcde}	753.00^{bc}	1150.16^{i}	1154.19^{i}	1158.49^{i}
Indirect boiled fish 5%	615.66^{abc}	695.01^{ab}	848.64^{a}	1165.92^{gh}	1171.7^{gh}	1176.83^{gh}
Control 5% concentrates	667.00^{a}	650.00^{abcd}	753.00^{bc}	1234.64^{cd}	1234.95^{cd}	1250.86^{cd}
SEM	4.58	6.30	6.25	4.6	4.7	5.17

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4b Means of weekly feed intake (g/bird/day) during the production period from 22-30 weeks

Age in weeks / Treatments	22th	23th	24th	25th	26th	27th	28th	29th	30th
Sun-drying fish 1.5%	86.038^{a}	88.34^{a}	89.61^{b}	90.23^{bc}	90.70^{abc}	92.20^{a}	92.71^{a}	92.78^{a}	92.74^{a}
Sun-drying fish 3.5%	82.47^{d}	84.79^{d}	87.80^{d}	88.16^{e}	90.67^{abc}	92.24^{a}	92.67^{a}	92.75^{a}	92.71^{a}
Sun-drying fish 5%	81.02^{e}	83.32^{e}	86.32^{e}	86.71^{f}	89.22^{cd}	90.74^{bc}	91.22^{bc}	91.30^{bc}	91.26^{bc}
Roasting fish 1.5%	85.37^{b}	87.69^{b}	90.70^{a}	91.11^{a}	91.87^{a}	92.23^{a}	92.71^{a}	92.79^{a}	92.77^{a}
Roasting fish 3 5%	84.98^{b}	87.31^{b}	90.27^{a}	90.69^{ab}	91.55^{ab}	91.27^{abc}	91.76^{abc}	91.85^{abc}	91.81^{abc}
Roasting fish 5%	83.59^{c}	85.86^{c}	88.89^{c}	89.31^{d}	91.17^{ab}	90.63^{c}	91.14^{c}	91.21^{c}	91.17^{c}
Direct boiling fish 1.5%	79.95^{f}	82.21^{f}	84.60^{g}	85.02^{gh}	86.20^{e}	87.23^{e}	87.75^{e}	87.81^{e}	87.77^{e}
Direct boiling fish 3.5%	79.56^{fg}	81.82^{fg}	84.15^{gh}	84.60^{hi}	85.74^{e}	87.39^{e}	87.54^{e}	87.62^{e}	87.58^{e}
Direct boiling fish 5%	78.26^{h}	80.53^{h}	83.56^{h}	83.89^{i}	86.04^{e}	87.20^{e}	87.71^{e}	87.79^{e}	87.75^{e}
Indirect boiling fish 1.5%	78.15^{h}	80.46^{h}	84.70^{g}	85.28^{gh}	87.76^{d}	89.25^{d}	89.75^{d}	89.84^{d}	89.83^{d}
Indirect boiling fish 3.5%	79.07^{g}	81.31^{h}	84.81^{g}	85.27^{gh}	87.80^{d}	89.27^{d}	89.78^{d}	89.91^{d}	90.21^{d}
Indirect boiling fish 5%	79.18^{g}	81.50^{g}	85.56^{f}	85.60^{g}	88.05^{d}	89.61^{d}	90.05^{d}	90.13^{d}	90.91^{d}
Control 5% concentrates	83.95^{c}	86.19^{c}	89.22^{bc}	89.61^{cd}	90.13^{bc}	91.60^{ab}	92.16^{ab}	92.21^{ab}	92.17^{ab}
Manual standard	92	92	95	96	97	97	98	98	98
SEM	0.141	0.141	0.230	0.231	0.475	0.309	0.309	0.309	0.309

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4c Means of weekly feed intake (g/bird/day) during the production period from 31-40 weeks

Age in weeks / Treatments	31th	32th	33th	34th	35th	36th	37th	38th	39th	40th
Sun-drying fish 1.5%	93.74^{a}	95.75^{a}	97.19^{a}	97.94^{a}	98.00^{a}	98.38^{a}	98.46^{a}	98.54^{a}	99.24^{a}	100.23^{a}
Sun-drying fish 3.5%	93.71^{a}	95.72^{a}	97.21^{a}	97.89^{a}	97.97^{a}	98.34^{a}	98.43^{a}	98.51^{a}	99.21^{a}	100.24^{a}
Sun-drying fish 5%	92.25^{b}	93.67^{cd}	95.18^{cd}	95.89^{cd}	95.96^{bc}	96.31^{b}	96.40^{bc}	96.48^{bc}	97.18^{bc}	98.16^{bc}
Roasting fish 1.5%	93.65^{a}	95.78^{a}	97.26^{a}	97.97^{a}	98.03^{a}	98.40^{a}	98.49^{a}	98.56^{a}	99.27^{a}	100.26^{a}
Roasting fish 3.5%	92.81^{abc}	94.84^{ab}	96.29^{ab}	97.00^{ab}	97.69^{ab}	97.44^{a}	97.53^{ab}	97.61^{ab}	98.31^{ab}	99.30^{ab}
Roasting fish 5%	92.17^{b}	94.17^{bc}	95.67^{bc}	96.79^{bc}	97.31^{a}	97.67^{a}	97.76^{a}	97.84^{a}	98.54^{a}	99.53^{a}
Direct boiling fish 1.5%	88.79^{d}	90.77^{e}	92.28^{e}	92.96^{e}	93.77^{e}	94.01^{c}	94.16^{e}	94.18^{e}	94.88^{e}	95.87^{e}
Direct boiling fish 3.5%	88.58^{d}	90.57^{e}	92.08^{e}	92.80^{e}	93.41^{e}	93.92^{c}	94.0^{e}	94.09^{e}	94.79^{e}	95.78^{e}
Direct boiling fish 5%	88.19^{d}	90.54^{e}	91.86^{e}	92.98^{e}	94.24^{de}	94.01^{c}	94.72^{de}	94.80^{de}	95.50^{de}	96.49^{de}
Indirect boiling fish 1.5%	90.65^{c}	92.84^{d}	94.31^{d}	95.05^{d}	95.07^{cd}	95.43^{b}	95.54^{cd}	95.60^{cd}	96.31^{cd}	97.29^{cd}
Indirect boiling fish 3.5%	90.81^{c}	91.81^{d}	93.34^{d}	94.01^{d}	94.97^{cd}	95.44^{b}	95.43^{cd}	95.64^{cd}	96.29^{cd}	97.59^{cd}
Indirect boiling fish 5%	91.09^{c}	93.10^{d}	94.83^{cd}	95.54^{d}	95.59^{c}	96.10^{b}	96.19^{c}	96.27^{c}	96.97^{c}	97.96^{c}
Control 5% concentrates	92.83^{ab}	94.83^{ab}	96.33^{ab}	97.02^{ab}	97.09^{ab}	97.46^{a}	97.55^{ab}	97.63^{ab}	98.32^{ab}	99.33^{ab}
Manual standard	98	98	98	99	99	99	99	99	99	99
SEM	0.306	0.323	0.316	0.334	0.409	0.355	0.384	0.384	0.384	0.384

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 5 Means of Body weight (g/bird/2weeks) during the whole production period

Treatments \ Age in weeks	22th	24th	26th	28th	30th	32th	34th	36th	38th	40th
Sun-drying fish 1.5%	1296.01^{a}	1301.91^{a}	1310.07^{a}	1321.22^{a}	1330.34^{a}	1339.11^{a}	1350.74^{a}	1361.18^{a}	1370.62^{a}	1382.02^{a}
Sun-drying fish 3.5%	1234.35^{d}	1240.41^{d}	1248.30^{d}	1257.54^{d}	1268.30^{d}	1278.58^{d}	1289.61^{d}	1297.57^{d}	1308.09^{d}	1316.37^{d}
Sun-drying fish 5%	1209.42^{e}	1215.62^{e}	1223.81^{e}	1234.28^{e}	1242.75^{e}	1253.33^{e}	1265.27^{e}	1275.13^{e}	1283.51^{e}	1294.79^{e}
Roasting fish 1.5%	1284.66^{b}	1290.04^{b}	1298.27^{b}	1305.00^{b}	1319.51^{b}	1328.49^{b}	1338.58^{b}	1349.04^{b}	1358.45^{b}	1367.91^{b}
Roasting fish 3.5%	1278.49^{b}	1284.78^{b}	1292.95^{b}	1303.76^{b}	1312.08^{b}	1321.83^{b}	1332.00^{b}	1342.94^{b}	1353.67^{b}	1362.00^{b}
Roasting fish 5%	1253.59^{c}	1259.67^{c}	1268.63^{c}	1275.63^{c}	1286.19^{c}	1295.95^{c}	1307.67^{c}	1317.01^{c}	1326.55^{c}	1337.55
Direct boiling fish 1.5%	1190.17^{f}	1196.09^{f}	1204.25^{fg}	1215.05^{g}	1224.09^{g}	1236.91^{g}	1245.01^{g}	1256.24^{g}	1268.68^{g}	1276.34^{g}
Direct boiling fish 3.5%	1183.84^{fg}	1189.84^{f}	1197.31^{g}	1208.85^{g}	1216.34^{g}	1225.74^{g}	1237.29^{g}	1248.89^{g}	1252.40^{g}	1267.33^{g}
Direct boiling fish 5%	1161.19^{h}	1167.25^{i}	1174.33^{i}	1188.27^{h}	1195.49^{h}	1206.88^{h}	1216.55^{h}	1225.29^{h}	1237.92^{h}	1246.24^{h}
Indirect boiling fish1.5%	1165.58^{h}	1176.98^{g}	1189.11^{h}	1210.42^{g}	1222.16^{g}	1231.66^{g}	1239.75^{g}	1245.67^{g}	1259.00^{g}	1267.76^{g}
Indirect boiling fish3.5%	1160.23^{h}	1175.07^{g}	1182.94^{h}	1207.94^{g}	1218.88^{g}	1229.43^{g}	1236.98^{g}	1248.73^{g}	1255.33^{g}	1271.52^{g}
Indirect boiling fish 5%	1177.45^{g}	1192.94^{f}	1206.38^{f}	1224.53^{f}	1235.42^{f}	1247.82^{f}	1255.69^{f}	1264.37^{f}	1276.54^{f}	1285.48^{f}
Control 5% concentrates	1259.41^{c}	1265.38^{c}	1270.54^{c}	1285.31^{c}	1292.87^{c}	1304.12^{c}	1315.65^{c}	1324.74^{c}	1337.78^{c}	1345.07^{c}
SEM	2.440	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435	2.435

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 6a Means of daily egg production (%) during 22-30 weeks

Treatments	Daily egg production at different age (%)								
	22th	23th	24th	25th	26th	27th	28th	29th	30th
Sun-dried fish 1.5%	59.21^{a}	62.28^{a}	65.91^{a}	70.77^{a}	73.70^{a}	77.01^{a}	80.81^{a}	85.34^{a}	89.21^{a}
Sun-dried fish 3.5%	56.75^{de}	60.06^{cde}	63.69^{cd}	68.46^{cde}	70.75^{de}	74.54^{de}	78.68^{bc}	83.25^{cd}	86.75^{cd}
Sun-dried fish 5%	56.12^{ef}	59.43^{ef}	62.45^{de}	67.48^{def}	70.43^{de}	73.50^{fg}	77.74^{cd}	82.17^{de}	85.79^{de}
Roasting fish 1.5%	58.68^{ab}	62.08^{a}	65.68^{ab}	70.15^{ab}	72.69^{ab}	76.48^{ab}	80.54^{a}	85.15^{ab}	88.92^{a}
Roasting fish 3.5%	58.43^{abc}	61.49^{ab}	65.43^{ab}	69.90^{abc}	72.80^{ab}	76.25^{abc}	80.36^{a}	84.65^{ab}	88.43^{ab}
Roasting fish 5%	57.48^{cd}	60.55^{bcd}	64.51^{bc}	69.04^{bcd}	71.13^{cd}	75.28^{cd}	79.75^{ab}	83.98^{bc}	87.48^{bc}
Direct boiled fish 1.5%	55.48^{fg}	58.62^{f}	61.91^{e}	56.88^{g}	67.91^{f}	71.76^{h}	75.51^{e}	83.84^{f}	83.85^{f}
Direct boiled fish 3.5%	54.74^{gh}	58.45^{f}	59.75^{f}	63.67^{h}	66.11^{g}	69.60^{i}	73.73^{f}	78.33^{g}	81.80^{g}
Direct boiled fish 5%	54.29^{h}	56.89^{g}	58.58^{f}	62.51^{h}	64.63^{h}	68.36^{j}	72.73^{f}	77.36^{g}	80.89^{g}
Indirect boiled fish 1.5%	55.45^{fg}	58.51^{f}	62.28^{e}	66.25^{fg}	69.51^{e}	72.71^{gh}	77.05^{d}	81.71^{e}	85.24^{e}
Indirect boiled fish 3.5%	56.16^{ef}	59.53^{def}	63.10^{de}	66.93^{efg}	70.55^{de}	73.97^{ef}	78.06^{cd}	82.60^{de}	86..15^{cde}
Indirect boiled fish 5%	55.79^{efg}	59.12^{ef}	63.03^{de}	67.25^{efg}	70.03^{de}	73.46^{fg}	77.59^{cd}	82.25^{de}	85.70^{de}
Control 5%	57.66^{bcd}	60.73^{bc}	64.100^{ab}	68.13^{de}	72.03^{bc}	75.46^{bcd}	79.59^{ab}	84.46^{abc}	87.33^{bc}
SEM	0.336	0.336	0.404	0.500	0.399	0.335	0.409	0.437	0.437

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 6b Means of daily egg production during 31-40 weeks

Treatments	Daily egg production at different age (%)									
	31th	32th	33th	34th	35th	36th	37th	38th	39th	40th
Sun-dried fish 1.5%	91.41^{a}	91.41^{a}	90.95^{a}	90.48^{a}	90.54^{a}	89.21^{a}	88.28^{a}	88.45^{a}	86.46^{a}	86.19^{a}
Sun-dried fish 3.5%	89.28^{cd}	89.32^{c}	88.48^{cd}	88.52^{cd}	88.08^{cd}	86.75^{cd}	86.15^{cd}	86.13^{de}	84.35^{cd}	83.72^{cd}
Sun-dried fish 5%	88.32^{de}	87.72^{c}	87.85^{de}	86.51^{de}	86.79^{ef}	85.79^{de}	85.19^{de}	85.50^{ef}	83.37^{de}	83.10^{de}
Roasting fish 1.5%	90.80^{ab}	90.23^{ab}	90.13^{ab}	90.07^{ab}	89.60^{ab}	88.60^{ab}	87.97^{a}	87.97^{ab}	86.28^{ab}	85.59^{ab}
Roasting fish 3.5%	90.65^{ab}	90.57^{ab}	89.40^{ab}	90.10^{ab}	89.70^{ab}	88.45^{ab}	87.85^{ab}	87.50^{abc}	86.07^{ab}	85.43^{ab}
Roasting fish 5%	90.08^{bc}	89.68^{b}	90.95^{a}	89.18^{bc}	88.78^{bc}	87.78^{bc}	86.88^{bc}	86.84^{bc}	85.15^{bc}	84.76^{bc}
Direct boiled fish 1.5%	86.04^{g}	85.96^{d}	85.58^{f}	85.44^{f}	84.84^{g}	84.18^{f}	83.24^{f}	83.22^{g}	81.76^{f}	81.16^{f}
Direct boiled fish 3.5%	84.43^{h}	84.08^{e}	83.53^{g}	83.40^{g}	83.13^{h}	82.13^{g}	81.20^{g}	81.51^{h}	79.71^{g}	79.11^{g}
Direct boiled fish 5%	83.15^{i}	82.84^{f}	82.48^{h}	8230^{h}	81.96^{i}	80.89^{h}	79.96^{h}	79.96^{i}	78.26^{h}	77.86^{h}
Indirect boiled fish 1.5%	87.11^{f}	88.74^{d}	86.85^{e}	86.71^{e}	86.11^{f}	85.45^{e}	84.51^{e}	84.49^{f}	82.69^{ef}	82.43^{e}
Indirect boiled fish 3.5%	88.57^{de}	88.19^{c}	87.66^{de}	87.52^{de}	87.26^{de}	86.59^{de}	85.32^{de}	85.30^{ef}	83.84^{de}	83.24^{de}
Indirect boiled fish 5%	88.31^{e}	87.96^{c}	87.39^{de}	87.26^{e}	87.33^{de}	86.33^{de}	85.39^{de}	85.04^{f}	83.57^{de}	82.97^{de}
Control 5%	90.10^{bc}	89.93^{b}	89.73^{b}	89.59^{ab}	88.95^{bc}	87.87^{b}	87.33^{ab}	87.04^{abc}	85.58^{ab}	84.64^{bc}
SEM	0.327	0.315	0.343	0.343	0.374	0.384	0.342	0.342	0.375	0.363

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Feed conversion ratio (FCR)

The effects of the experimental treatments on FCR are illustrated in Tables 7a and 7b. The results showed a significant difference (P>0.05) among the treatments during the experimental periods. It appears that the feed conversion value was high at the begging of the production period then gradually decreased till it become relatively stable at 31th weeks of the production period up to week 40, that, the feed conversion ratio was affected significantly (P<0.05) by as treated disposed fish change and control. The feed conversion ratio (g feed/g egg) for all treatments that including control agree with the results of (Sittiya and Yamauchi, 2014), while, the ratio of feed conversion ratio was high than the results of (Bryant *et al.* 2007). The results of the present study were less than (Perez-Bonilla *et al.* 2012) who found the means of feed conversion ratio were (1.89 to 2.05 g/g) during 24 to 59 weeks of age, also the results found by (Bonekamp *et al.* 2010).

Egg weight

The results of egg weights were illustrated in Tables 8a and 8b, which showed a significant differences (P<0.05) among the treatments during the experimental periods. Egg weight of layers chickens fed roasted fish (5%) have the highest egg weight during all the experimental period followed by roasted fish (3.5 and 1.5%), while the lowest egg weight was found at treatment of direct boiled fish (5%).

The results of the present results were high than that reported by (Rao *et al.* 2011) who found the means of egg weight for layers chickens at age of (21, 24, 29 and 32 to 36weeks) were (46, 52, 53.2 and 53.5 g/egg/day) respectively, while the present results were low than (Neijat *et al.* 2011). Also Perez-Bonilla *et al.* (2012) who found the means of egg weight were (63.1 to 64.1 g) during 24 to 59 weeks of age, while the present study results of egg weight were similar to (Park and Ryu, 2011). Egg weight was significantly (P<0.05) affected due to the different treated disposed fish. Generally the treatments of sun-dried fish and roasted fish levels and control have the best performance production which indicates the positive ability of treatment especially sun-dried fish and roasted fish compared to control as a source of protein to support layer production.

Panel test

Table 9 shows the panel test for test acceptability, colour, and smell. The panel which runs only for (5%) replicate to showed the effects of concentrations for different treated disposed fish concentrate and control to avoid the interaction effect on the level at (1.5 and 3.5%).

The panel test runs for all treated disposed fish and control for only (5%) replicate for accurate test for treated disposed fish concentrate or supper concentrate without interaction between the mixture of treated disposed fish and control.

Table 7a Means of feed conversion ratio (g feed/g egg) during production period of 24-32 weeks

Treatments	Age in weeks							
	24th	25th	26th	27th	28th	29th	30th	31th
Sun-drying fish 1.5%	3.26	2.97	2.91	2.81	2.65	2.63	2.46	2.41
Sun-drying fish 3.5%	3.36	3.10	3.05	2.90	2.79	2.68	2.48	2.38
Sun-drying fish 5%	3.43	3.15	3.06	2.99	2.82	2.65	2.53	2.43
Roasting fish 1.5%	3.28	3.07	2.99	2.82	2.73	2.54	2.37	2.35
Roasting fish 3.5%	3.24	3.05	2.97	2.79	2.62	2.60	2.41	2.39
Roasting fish 5%	3.18	2.92	2.92	2.73	2.62	2.50	2.35	2.31
Direct boiling fish 1.5%	3.47	3.62	3.06	2.88	2.80	2.47	2.44	2.34
Direct boiling fish 3.5%	3.53	3.23	3.14	3.04	2.84	2.67	2.63	2.48
Direct boiling fish 5%	3.69	3.41	3.31	3.22	3.12	2.92	2.67	2.57
Indirect boiling fish 1.5%	3.28	3.08	2.96	2.90	2.74	2.57	2.41	2.37
Indirect boiling fish 3.5%	3.22	3.01	2.94	2.80	2.68	2.52	2.39	2.32
Indirect boiling fish 5%	3.33	3.03	3.01	2.90	2.71	2.53	2.43	2.33
Control 5% concentrates	3.48	3.18	2.98	2.84	2.75	2.61	2.48	2.37

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Table 7b Means of feed conversion ratio (g feed/g egg) during production period 32-40 weeks

Treatments	Age in weeks								
	32th	33th	34th	35th	36th	37th	38th	39th	40th
Sun-drying fish 1.5%	2.45	2.43	2.42	2.40	2.43	2.44	2.42	2.48	2.54
Sun-drying fish 3.5%	2.44	2.53	2.46	2.44	2.49	2.50	2.50	2.57	2.60
Sun-drying fish 5%	2.48	2.42	2.45	2.41	2.44	2.43	2.41	2.46	2.49
Roasting fish 1.5%	2.44	2.43	2.43	2.42	2.45	2.47	2.47	2.54	2.58
Roasting fish 3.5%	2.43	2.46	2.40	2.38	2.41	2.41	2.42	2.48	2.51
Roasting fish 5%	2.32	2.31	2.36	2.35	2.36	2.36	2.35	2.41	2.44
Direct boiling fish 1.5%	2.47	2.44	2.43	2.43	2.45	2.49	2.49	2.55	2.58
Direct boiling fish 3.5%	2.52	2.60	2.59	2.59	2.63	2.66	2.65	2.73	2.79
Direct boiling fish 5%	2.72	2.68	2.69	2.71	2.71	2.77	2.77	2.85	2.88
Indirect boiling fish 1.5%	2.42	2.50	2.50	2.49	2.52	2.55	2.55	2.62	2.65
Indirect boiling fish 3.5%	2.40	2.41	2.39	2.38	2.40	2.44	2.48	2.50	2.54
Indirect boiling fish 5%	2.42	2.45	2.43	2.39	2.43	2.44	2.45	2.51	2.54
Control 5% concentrates	2.42	2.44	2.43	2.40	2.43	2.43	2.43	2.48	2.51

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

Table 8a Means of weekly egg weight (g) during production period from 24-31 weeks

Treatments	Age in weeks							
	24th	25th	26th	27th	28th	29th	30th	31th
Sun-drying fish 1.5%	52.50^{bcd}	54.00^{ab}	53.33^{b}	53.77^{b}	54.60^{ab}	52.00^{a}	53.17^{bcde}	53.69^{abc}
Sun-drying fish 3.5%	51.67^{cde}	25.36^{b}	53.00^{b}	53.80^{b}	53.10^{abc}	52.33^{a}	54.20^{abcd}	55.53^{ab}
Sun-drying fish 5%	50.80^{def}	51.47^{bc}	52.17^{bc}	52.03^{c}	52.47^{bc}	52.77^{a}	53.03^{cde}	54.23^{abc}
Roasting fish 1.5%	53.00^{abc}	53.23^{b}	53.33^{b}	53.90^{ab}	53.13^{abc}	54.00^{a}	55.53^{ab}	55.28^{ab}
Roasting fish 3.5%	53.67^{ab}	53.66^{ab}	53.33^{b}	54.03^{ab}	55.00^{a}	52.66^{a}	54.20^{abcd}	54.04^{abc}
Roasting fish 5%	54.57^{a}	55.9^{a}	55.33^{a}	55.47^{a}	54.90^{a}	54.66^{a}	55.87^{a}	55.93^{a}
Direct boiling fish 1.5%	49.66^{fj}	52.00^{bc}	52.33^{bc}	53.20^{bc}	52.33^{c}	53.33^{a}	54.16^{abcd}	55.52^{ab}
Direct boiling fish 3.5%	50.33^{efj}	51.83^{bc}	52.00^{bc}	51.97^{c}	52.61^{bc}	52.73^{a}	51.20^{e}	53.27^{abc}
Direct boiling fish 5%	48.67^{j}	49.66^{c}	50.66^{c}	49.90^{d}	48.70^{d}	49.00^{b}	51.20^{de}	52.03^{c}
Indirect boiling fish 1.5%	52.17^{bcde}	52.67^{ab}	53.66^{b}	53.33^{bc}	53.54^{abc}	53.86^{a}	55.10^{abc}	55.40^{ab}
Indirect boiling fish 3.5%	52.67^{bcd}	53.33^{b}	53.33^{b}	54.33^{ab}	54.17^{abc}	54.46^{a}	55.00^{abc}	55.72^{ab}
Indirect boiling fish 5%	51.33^{cdef}	53.00^{b}	52.66^{b}	53.00^{bc}	54.00^{abc}	54.53^{a}	55.00^{abc}	55.87^{a}
Control 5% concentrates	50.33^{efj}	52.17^{bc}	52.83^{b}	53.87^{ab}	53.10^{abc}	52.67^{a}	53.66^{abcd}	54.87^{ab}
SEM	0.17	0.22	0.16	0.14	0.18	0.26	0.20	0.21

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 8b Means of weekly egg weight (g) during production period from 32-40 weeks

Treatments	Age in weeks								
	32th	33th	34th	35th	36th	37th	38th	39th	40th
Sun-drying fish 1.5%	53.92^{b}	55.30^{abc}	56.33^{ab}	56.83^{ab}	57.09^{ab}	57.55^{ab}	58.03^{ab}	58.24^{bc}	57.71^{bcd}
Sun-drying fish 3.5%	55.45^{ab}	54.66^{bc}	56.53^{ab}	57.40^{ab}	57.43^{ab}	57.63^{ab}	57.65^{ab}	57.67^{cd}	58.03^{bcd}
Sun-drying fish 5%	54.31^{b}	56.43^{ab}	57.03^{ab}	57.90^{a}	58.08^{ab}	58.76^{a}	59.10^{a}	59.77^{ab}	59.66^{ab}
Roasting fish 1.5%	54.83^{b}	55.87^{ab}	56.46^{ab}	57.07^{ab}	57.09^{ab}	57.12^{ab}	57.14^{ab}	57.16^{cd}	57.23^{cd}
Roasting fish 3.5%	54.29^{b}	55.10^{bc}	56.50^{ab}	57.56^{ab}	57.59^{ab}	58.06^{a}	58.09^{a}	58.11^{bc}	58.46^{abc}
Roasting fish 5%	57.00^{a}	57.47^{a}	58.06^{a}	58.67^{a}	59.52^{a}	60.01^{a}	60.40^{a}	60.43^{a}	60.63^{a}
Direct boiling fish 1.5%	53.83^{b}	55.73^{abc}	56.46^{ab}	57.30^{ab}	57.33^{ab}	57.35^{ab}	57.37^{ab}	57.39^{cd}	57.72^{bcd}
Direct boiling fish 3.5%	53.77^{b}	53.52^{cd}	54.13^{cd}	54.73^{cd}	54.76^{cd}	54.78^{cd}	54.80^{cd}	54.82^{ef}	54.59^{e}
Direct boiling fish 5%	50.68^{c}	52.35^{d}	52.93^{d}	53.53^{d}	53.95^{d}	53.97^{d}	53.99^{d}	54.01^{f}	54.28^{e}
Indirect boiling fish 1.5%	54.56^{b}	54.70^{bc}	55.30^{bc}	55.90^{bc}	55.93^{bc}	55.95^{bc}	55.97^{bc}	55.99^{de}	56.06^{de}
Indirect boiling fish 3.5%	55.21^{b}	56.34^{ab}	57.13^{ab}	57.73^{ab}	57.76^{ab}	57.78^{ab}	57.08^{ab}	57.82^{bcd}	58.09^{bcd}
Indirect boiling fish 5%	55.20^{b}	55.71^{abc}	56.73^{ab}	57.66^{ab}	57.69^{ab}	58.27^{a}	58.29^{a}	58.31^{bc}	58.54^{abc}
Control 5% concentrates	54.80^{b}	55.55^{abc}	56.17^{ab}	57.33^{ab}	57.42^{ab}	57.98^{ab}	58.11^{a}	58.44^{bc}	58.81^{abc}
SEM	0.15	0.19	0.17	0.16	0.16	0.16	0.16	0.17	0.21

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 9 Egg quality panel test (%)

Panel test degree	Sun-drying fish	Roasted fish	Direct boiled fish	Indirect boiled fish	Control
Acceptability					
4-Very good	42	36	44	38	40
3-Good	50	54	42	46	54
2-Acceptable	8	10	12	16	6
1-Not acceptable	-	-	2	0	0
Totals	100	100	100	100	100
Smell					
4-Good smell	50	48	54	42	56
3-Normal smell	46	42	42	48	42
2-Little fishy smell	4	10	4	8	2
1-Fishy smell	0	0	0	2	0
Totals	100	100	100	100	100
Egg yolk color					
4-Extremely desirable	0	0	0	0	0
3-Moderate desirable	8	6	10	6	8
2-Slightly undesirable	36	42	38	28	34
1-Extremely undesirable	56	52	52	66	58
Totals	100	100	100	100	100

The panel test declared that all treated disposed fish and control were similarity among all treatment level if the trace difference been ignored at acceptability, smell and colour.

CONCLUSION

The results of this study showed that the disposed fish in the Sudan can be converted to useful conventional fish meal for poultry rations by simple means of heat processing.

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