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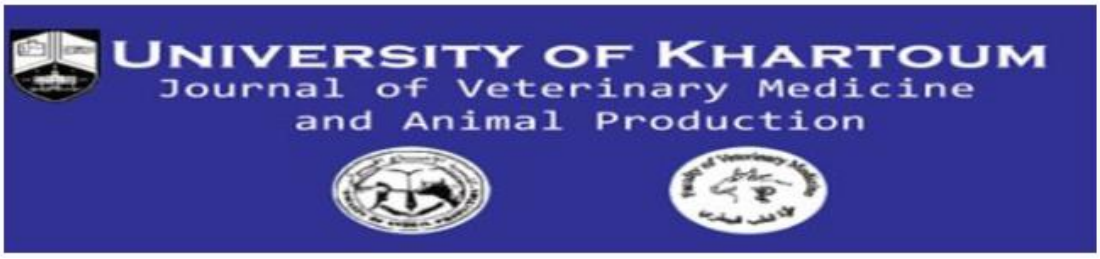

The effect of feeding treated fish meal by different methods of heat sterilization on broiler performance

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Abstract

The present experiment was conducted to investigate the possibility of using local sun-dried fishmeal in broiler diets and examine the effect of different methods of heat sterilization on microorganisms content of fishmeal. Serial dilutions for pour-plate were used for counting the number of bacterial colonies. Chemical analysis revealed that D.M., C.P., E.E., C.F., ash, Ca, P, Mg, lysine and methionine of sun-dried fishmeal were 96.13, 35.0, 10.84, 0.0, 45.31, 8.0, 2.22, 0.51, 4.82 and 1.52%, respectively. Four experimental diets were formulated to meet NRC (1994) recommendations. The sun-dried fishmeal (A) was sterilized by autoclaving at 121°C for 20 minutes to give type B fishmeal, oven heating at 80°C for 25 minutes to give type C fishmeal and oven heating at 75°C for 25 minutes to give type D fishmeal. Diet A is a control containing 5% super-concentrate; Diet B, C and D were contained 10% sterilized fishmeal. The experimental diets were fed to 160 unsexed one-day old broiler chicks (Hybro). Body weight gain, feed intake, feed conversion ratio and protein efficiency ratio were recorded weekly. Evaluation for bacterial count and isolation of salmonella for the different diets were investigated. At dilution 10^{-1}, 10^{-2}, 10^{-3} and 10^{-4} autoclaving at 121 °C for 20 minutes was more effective in reducing number of bacterial colonies compared to the other heat treatments which revealed no significant ($P \geq 0.05$) differences. Body weight gain, FCR and PER were negatively ($P \leq 0.01$) influenced by the dietary treatments. Birds fed the control diet showed better performance than those subjected to any of the fishmeal under test. The experimental diets did not significantly ($P \geq 0.05$) affect dressing out percentage and sensory attributes. In conclusion the results of the current study indicated that fishmeal caused a significant depression in feed intake, body weight gain and feed efficiency. Autoclaving at 121°C for 20 minutes had significantly ($P \leq 0.05$) reduced number of colonies compared to the other heat treatments.

Keywords: Fishmeal, Sterilization, Broiler Performance, Carcass, Salmonella.

الملخص العربى

تم اجراء هذه التجربة لتقييم امكانية استخدام مسحوق السمك المجفف بالشمس في تغذية الدجاج اللاحم، اضافة لدراسة تأثير طرق التعقيم الحراري المختلفة على المحتوى الميكروبي لمسحوق السمك. وقد تم استخدام التخفيفات التسلسلية لحساب عدد المستعمرات البكتيرية. اوضح التحليل الكيميائي ان مسحوق السمك المجفف بالشمس يحتوي على 96.13% مادة جافة، 35.0% بروتين خام، 10.84% دهن، 0.0% الياف خام، 45.31% رماد، 8.0% كالسيوم، 2.22% فسفور، 0.51% مغنسيوم، 4.82% لايسين و1.52% ميثيونين. تم تركيب اربعة اعلاف تجريبية حسب توصيات (NRC, 1994). تعرض مسحوق السمك المجفف بالشمس لثلاث طرق تعقيم، تمثلت في التعقيم عن طريق الاوتوكلاف على درجة حرارة 121م لمدة 20 دقيقة لتعطي مسحوق السمك B. ايضاً تم استخدام الفرن عند درجة حرارة 80م لمدة 25 دقيقة لتعطي مسحوق السمك C. كذلك تم استخدام الفرن عند درجة حرارة 75م لمدة 25 دقيقة لتعطي مسحوق السمك D. وبذلك فإن العلف التجريبي A يمثل العلف الضابط ويحتوي على 5% مركز فيما تحتوي الاعلاف التجريبية C, B وD على مسحوق السمك C, B وD على الترتيب. تم استخدام هذه الاعلاف في تغذية 160 كتكوت لاحم بعمر يوم واحد من سلالة الهابيرو غير المجنسة. خلال هذه التجربة تم تسجيل الزيادة في وزن الجسم، العلف المستهلك، معدل التحويل الغذائي ومعدل كفاءة البروتين اسبوعياً. كذلك تم تقييم البكتيريا وعزل السالمونيلا في الاعلاف التجريبية المختلفة. اوضحت النتائج ان التعقيم عن طريق الاوتوكلاف كان الاكثر كفاءة في تقليل المستعمرات البكتيرية وذلك عند التخفيفات 10^{-1}، 10^{-2}، 10^{-3} و10^{-4}. وقد تأثر الوزن المكتسب، معدل التحويل الغذائي ومعدل كفاءة البروتين سلبياً باستخدام مسحوق السمك بانواعه المختلفة. وقد اظهرت الطيور التي تم تغذيتها على العلف الضابط اداءاً افضل مقارنة بتلك التي تم تغذيتها على مسحوق السمك. من جهة اخرى فلم تكن للاغذية التجريبية اي اثر على معدل التصافي والخصائص الحسية. يستخلص من هذه الدراسة ان مسحوق السمك قد تسبب في انخفاض كبير في العلف المستهلك، الوزن المكتسب ومعدل كفاءة العلف.

Introduction

Until the late sixties, the per capita consumption of poultry meat and eggs in Sudan was low. For poultry meat it was less than one kilogram, however it has increased to about one kilogram in the last 10 years. Generally feed accounts for about 70% of the poultry production cost. Due to low quality of feed in many developing countries, poultry production is suffering from considerable losses due to high mortality and poor feed conversion ratio. Animal by-products such as fishmeal considered as good source of protein, essential amino acids and minerals.

Halloran (1979) reported that Norwegian herring meal had 70% crude protein, 9.8% fat, 0.3% crude fiber, 11.2% ash and 8.8% moisture. On the other hand, Balogun *et al.* (1986) showed that fishmeal produced from tuna wastes had 54% protein, 26% ash, 5.52% lipid, 4.48% fiber, 7.75% calcium and 4.60% calcium. In a study conducted by Maigualema and Gernat (2003), crude protein from tilapia by-product meal (TBM) was replaced for soybean meal crude protein at 0, 25, 50, 75, and 100% in broiler feed. Those authors found that chicks fed 0, 25 and 50% TBM had significantly ($P \leq 0.01$) higher body weights, feed intake, improved feed conversion and carcass weights compared to the other treatments. Moreover, Karimi (2006) showed that the body weight of broilers at 32 and 42day, daily gain during 0-42day and feed intake during 11-20day, 21-32day and 0-42day significantly increased with fishmeal inclusion. On the other hand, Morris *et al.* (1970) found that the percentage of salmonella contamination in fishmeal is progressively reduced through the various sequence of processing. Between July 1990 and April 1991, 31% of 130, 10g samples of fishmeal in the Netherlands were found to be contaminated with salmonella (Veldman *et al.*, 1995). So the objectives of the present study were to investigate the effect of different methods of heat sterilization on nutritive value and micro-organisms content of sundried fishmeal. In addition broilers performance, carcass composition and meat quality as influenced by sundried fishmeal were considered.

Materials and methods

Discarded fish and fish byproducts were obtained from the Nuba Lake. The obtained materials were subjected to sun-drying and grinding. The sundried fishmeal (FM) was proximately analyzed according to the methods of the Association of Official Analytical Chemists (AOAC, 1990) as shown in Table 1. The sundried fishmeal was sterilized by three conventional methods at Food Research Center-Food Microbiology Laboratory, Shambat, Khartoum. These methods were autoclaving at 121°C for 20 minutes to give fishmeal B, an oven drying at 80°C for 25 minutes to give fishmeal C and an oven drying at 80°C for 25 minutes to give fishmeal D.

Samples from different sterilized fishmeal were evaluated for chemical composition according to (AOAC, 1990). Serial dilutions (10-1-10-7) were prepared for pour plate method of counting bacteria (Harrigan and McCance, 1976). Isolation of salmonella for the different fishmeal was done by selective enrichment according to Harrigan and McCance (1976).

Table 1: Chemical composition of sundried fishmeal

Nutrient	Percent
Dry matter D.M	**96.13**
Ether extract E.E.	**10.84**
Crude protein C.P.	**35.00**
Crude fiber C.F.	**0.00**
Ash	**45.31**
Nitrogen free extract N.F.E.	**4.98**
ME kcal/kg	**2278**
Ca	**8.00**
P	**2.22**
Mg	**0.51**
Lysine	**4.82**
Methionine	**3.00**
Mycotoxin binder	**0.20**
Lysine	**1.11**
Methionine	**0.72**

Values are means of duplicate samples assayed.
ME calculated according to (Lodhi *ei al*., 1976).
Lysine and methionine determined by Provimi B.V. The Netherlands

Four experimental diets (Table 2) were formulated in this study. Diet A is a control containing 5% super-concentrate. Diets B, C and D contained 10% sterilized fishmeal B, C and D, respectively. All experimental diets were approximately isocaloric and isonitrogenous and met nutrient specifications recommended by National Research Council (NRC, 1994).

One hundred and sixty unsexed one-day old, broiler chicks (Hybro) were purchased from a commercial hatchery. The mean initial live body weight was 32.5 g. The chicks were randomized into the 4 dietary treatments, each consisting of 4 replicates with 10 birds each. Weekly feed intake, live body weight, body weight gain, feed conversion ratio (FCR) and protein efficiency ratio (PER) were recorded.

Broilers were kept in an open- sided poultry house, east to west oriented house. The feeding trial was extended for 6 weeks. The house was constructed of iron post pillars, reinforced bricks (half a meter height) and wire netting sides. Each pen was littered with wood shavings and supplied with one feeder and one drinker. Feed and water were supplied ad libitum while light duration was continuous throughout the experimental period. The birds were vaccinated against Gumboro disease.

At the end of the experiment, birds were fasted overnight. Three birds were randomly selected from each pen, weighed and manually slaughtered. Then the weight of hot dressed carcass, intestine, heart, liver and abdominal fat were recorded. The carcasses were stored in air chilling refrigerator for 24 hours at 4°C, and then weighed again to obtain the dressed weight on cold basis. Dressing out percentage on hot and cold basis was calculated by expressing dressed weight to the live weight. Right halves of the carcasses were dissected into meat and bone for meat bone ratio determination. The left halves were stored at -20°C for 24 hours. Then sensory panel tests were conducted to determine the effect of fish meals on selected sensory attributes (Stone *et al.*, 1974).

A completely randomized design was used to test the effect of different dietary treatments. Data were statistically analyzed by the general linear model (GLM) procedure of SAS (SAS Institute, 2003). Duncan's multiple range test (Steel and Torrie, 1980) was used to separate the treatments means with significant difference

Results and discussion

The effect of different fish meals on overall growth performance of broiler chickens is given in Table 3. Overall feed intake, body weight gain, FCR and PER were significantly ($P \leq 0.05$) influenced by dietary treatments. Birds fed dietary autoclaved fishmeal (B) showed significantly ($P \leq 0.05$) the lowest feed

intake versus control. On the other hand, significantly (P≤0.05) poorest body weight gain, FCR and PER were shown by the birds fed dietary oven heated fishmeal (D). However, those fed diet B and C revealed similar (P≥0.05) body weight gain and FCR. The reduction in feed intake associated with the inclusion of different fishmeal may be due to poor feed palatability. This finding agreed with Rose and Michie (1984) and Hulan et al. (1989) who found reductions in body weight and feed consumption and observed unpalatability of large amount of red fishmeal. However, Karimi (2006) found significant improvement of daily gain and feed intake of broilers supplemented with fishmeal through (0-42d). The pronounced reduction in weight gain could be due to low feed intake. This finding is in agreement with Proudfoot *et al.* (1971) who reported a decrease in body weight and poorer feed efficiency when larger amounts of fishmeal were fed to broiler chickens.

Table 2: Composition of broilers experimental diets

	Experimental diets			
Ingredients, %	Control (A)	10% fishmeal (B)	10%fishel(C)	10% fishmeal (D)
Sorghum	57.0	57.0	56.0	57.0
Groundnut cake	17.0	16.5	17.5	16.0
Sesame cake	13.9	12.0	12.0	12.0
Wheat bran	4.0	1.0	1.0	1.5
Super concentrates*	5.00	0.0	0.0	0.0
Fishmeal	0.0	10.0	10.0	10.0
Oyster shell	0.8	0.8	0.8	0.8
NaCl	0.3	0.3	0.3	0.3
Vegetable oil	2.0	2.0	2.0	2.0
Lysine	0.0	0.2	0.2	0.2
Methionine	0.0	0.2	0.2	0.2
Calculated analysis				
ME (kcal/kg)	3163	3162	3158	3167
CP%	23.0	22.8	22.7	22.8
Crude fiber%	4.9	4.2	4.2	4.2
Ether extract%	4.6	7.2	7.4	7.3
Ca%	1.3	1.4	1.5	1.5
Total phosphorous%	0.8	0.7	0.6	0.6
Lysine%	1.2	1.2	1.2	1.2
Methionine%	0.5	0.5	0.5	0.5
Calculated analysis				
DM%	93.5	94.9	94.8	95.1
Ash%	10.6	15.4	13.5	18.0
CP%	27.7	24.5	25.1	25.3
Crude fiber%	4.8	4.1	4.1	4.2
Ether extract%	1.9	5.4	5.4	6.0
Ca%	1.5	1.4	1.5	1.5
Total phosphorous%	0.8	0.6	0.6	0.6

SE: Standard error of means

The poor growth could also be attributed to oil oxidation as shown by Hussein and Kratzer (1982) that feeding heat- abused fats or oil depressed animal growth or to the justification of Lin et al. (1989) that the oxidation products of fishmeal may react with proteins and/or amino acids in the diet and impair their biological values. Likewise, the growth performance in current study is in concurrence with Opstvedt (1973) who postulated that when chicks were fed large amounts of fish lipids or fishmeal containing high residual oil contents, chicks' requirements for vitamin E may increased, resulting in poor performance. Carcass and non carcass characteristics as affected by dietary treatments are summarized in Table 4. There was no significant (P≥0.05) difference in carcass parameters and internal organs between the different treatments except for meat bone ratio, gizzard weight and abdominal fat weight. Birds given diet D showed the highest relative weight of gizzard compared to those fed diet A and C.

Table 3: The effect of different fish meals on overall performance of broiler chickens

Parameter	Experimental diets				± SEM
	Control (A)	10% fish meal B (B)	10% fishmeal C (C)	10% fishmeal D (D)	
Feed intake (g/bird)	2497 ^{a}+36.0	1422 ^{c} +43.3	1754 ^{bc} +22.4	1830 ^{b} +45.6	114
Body weight gain (g/bird)	1280 ^{a}+11.1	713 ^{b} +9.4	678 ^{b}+11.9	606 ^{c}+16.3	15
FCR (g feed /g Bwt gain)	1.95 ^{b}+0.02	2.00 ^{b}+0.04	2.58 ^{ab}+0.05	3.06 ^{a}+0.04	0.22
PER (Bwt gain/protein consumed)	1.86 ^{ab}+0.08	2.06 ^{a}+0.09	1.56 ^{bc}+0.09	1.35 ^{c}+0.11	0.11
Mortality%	4	5	4	4	49.2

Values are means of 4 replicates per treatment (10 bird\replicate).
$^{a\ b\ c}$ Means not sharing common superscript letters are significantly (P≤0.05) different.
SEM: Standard error of the means from ANOVA d.f 12.

Abdominal fat for birds fed the control diet was significantly (P≤0.05) higher compared to the other groups. There was no significant (P≥0.05) difference between the different treatments on dressing percentage. This result is in line with the findings of Merkely *et al.* (1980) who observed significant effect of nutrition on carcass characteristics. (1980). On the other hand, the insignificant differences of relative weight of heart and liver among the different treatments coincided with the finding of Crawley *et al.* (1980) that the heart and liver were increase in size as the age progress to 8 weeks but they remained constant as percentage of live body weight.

The results of sensory evaluation are shown in Table 5. The results indicated that neither tenderness, falvour, colour nor juiciness of breast, drumstick and thigh are significantly (P≥0.05) affected by the dietary treatments.

Table 4: The effect of different fish meals on carcass and non carcass characteristics of broiler chickens

Parameter	Experimental diets				± SEM
	Control (A)	Control (B)	10% fishmeal (B)	10% fishmeal (C)	
Dressing % on hot base	77.98±1.6	68.63±2.4	67.74±1.3	72.04 ±2.9	2.6
Dressing % on cold base	77.85±1.7	67.64±1.4	67.17±1.1	71.59±19.4	3.2
Meat bone ratio	3.61^{a}±0.81	2.51^{ab}±0.44	2.32^{b}±0.78	2.49^{ab}±0.67	0.2
Relative wt of Abdominal fat (ratio)	1.3^{a}±81	0.0^{b}±0.0	0.0^{b}±0.0	0.0^{b}±0.0	0.04
Relative wt of intestines (ratio)	6.5±1.2	7.0±2.1	7.5±1.4	8.5±1.0	1.7
Relative wt of gizzard (ratio)	2.8^{b}±1.4	3.8^{ab}±0.8	3.3^{b}±1.1	4.8^{a}±1.6	1.2
Relative wt of liver (ratio)	3.3±0.8	3.5±0.9	2.8±1.1	3.0±1.0	1.5
Relative wt of heart (ratio)	0.5±1.3	1.0±0.9	1.0±0.8	0.9±1.0	0.6

Values are means of 4 replicates per treatment.
^{ab}Means ± SD with different superscripts in the same row are significantly different (P≤ 0.05).
SEM: Standard error of the means from ANOVA d.f 12

Table 5: The effect of different heat treatments on bacterial contamination in sun-dried fish meal

Dilution	Sundried fishmeal (FM)				± SEM
	Untreated FM	Autoclaved FM (120°C for 20 min.)	Oven-heated FM (80°C for 20 min.)	Oven-heated FM (75°C for 20 min.)	
10^{-1}	245^{a}±1.1	135^{b}±1.3	256^{a}±1.2	264^{a}±1.5	23.7
10^{-2}	158^{a}±1.3	68^{c}±1.2	94^{b}±0.8	99^{b}±1.2	5.5
10^{-3}	76^{a}±0.8	23^{c}±0.3	48^{b}±0.6	47^{b}±0.4	5.7
10^{-4}	22^{a}±0.7	9^{b}±0.1	20^{a}±0.2	20^{a}±0.4	1.6
10^{-5}	19^{a}±1.1	7^{b}±1.1	4^{b}±1.2	6^{b}±1.1	0.8
10^{-6}	3.0±1.0	3.0±0.8	2.0±0.9	2.0 ±1.0	0.8
10^{-7}	2.0^{a}±0.7	1.0^{b}±0.9	1.0^{b}±0.7	1.0^{b}±0.5	0.2
Total bacterial count (cell/g)	$7.6x10^{4}$	$2.3x10^{4}$	$4.8x10^{4}$	$4.7x10^{4}$	
Salmonella	+	+	+	+	

Values are means of duplicates samples assayed.

^{abc} Means ± SD with different superscripts in the same row are significantly different (P≤ 0.05).

SEM: Standard error of the means from ANOVA d.f 4.

The effect of different fish meals on total bacterial and salmonella count is summarized in Table 6. At dilutions 10-1, 10-2, 10-3 and 10-4, heat treatment significantly (P≤0.01) affected number of bacterial colonies. Autoclaving at 121°C for 20 minutes significantly (P≤0.05) reduced number of colonies compared to the other heat treatments. At dilution 10-5 and 10-7 heat treatments were similar in their effectiveness and significantly (P≤0.05) reduced number of colonies. However, at dilution 10-6 different heat treatments revealed no significant (P≥0.05) effect on number of colonies. On the other hand and with the aid of salmonella enrichment medium, results obtained indicated that untreated fishmeal contained higher number of salmonella colonies compared to the heat-treated fish meal. Direct microscopic examination confirmed the incidence of salmonella in fish meals under test. The results in the present study showed that the heat treatments reduced salmonella number in fishmeal. This finding is agreed with that of Rasmussen et al. (1964) who reported that heat treatment reduced salmonella in animal by-products. Heat treatment A was more effective in reducing salmonella and total count bacteria, this coincided with several workers (Carlson and Snoeyenobs, 1970) who investigated the phenomenon of spontaneous reduction in salmonella and concluded that microbial multiplication or reduction is related to water activity of substrate.

Table 6: Sensory evaluation of breast, drumstick and thigh as affected by treated fish meals

	Experimental diets				
Parameter	Control (A)	Control (A)	10% fishmeal (B)	10% fishmeal (C)	± SEM
Breast					
Tenderness	7.0	7.1	6.9	6.6	0.4
Flavuor	5.3	6.1	5.0	5.9	0.6
Colour	6.4	6.1	6.9	6.5	0.4
Juiciness	5.8	5.9	5.6	6.3	0.3
Drumstick					
Tenderness	6.3	6.1	5.9	6.1	0.6
Flavuor	5.8	6.0	5.8	6.3	0.3
Colour	6.5	6.8	6.8	6.8	0.3
Juiciness	5.8	6.0	5.8	6.0	0.5
Thigh					
Tenderness	6.3	6.3	6.4	6.4	0.5
Flavuor	5.9	5.8	5.8	5.9	0.3
Colour	6.3	6.3	5.8	6.3	0.3
Juiciness	6.6	6.6	6.8	6.5	0.3

Values are means of 8 replicates per treatment.

SEM: Standard error of the means from ANOVA d.f 28.

Conclusion

The combined results of the present study showed that the inclusion of fishmeal in poultry diets caused a significant reduction in feed intake, body weight gain and feed efficiency. Autoclaving at 121°C for 20 minutes had significantly (P≤0.05)

reduced number of colonies compared to the other heat treatments.

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