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INFLUENCE OF DIETARY BENISEED (*Sesamum indicum*) OIL ON GROWTH PERFORMANCE, CARCASS TRAITS AND INTESTINAL HISTOMORPHOLOGY OF BROILER CHICKENS UNDER HEAT STRESS

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ABSTRACT
This experiment was conducted to investigate the effect of incorporating different levels of sesame seed oil (SSO) in diets on performance, carcass characteristics and intestinal histomorphology of broiler chickens under heat stress condition. Two hundred day one-day-old ROSS 308 broiler chicks were randomly allotted into 5 dietary treatments, 4 replicates groups of 10 chicks each and were provided diets with SSO: 0, 20, 40, 60, or 80 gkg^{-1} replacing part of maize on equi-energy basis for a 42-day feeding trial. From 28 to 42 days of age, all broilers were challenged by a heat stress of 29±1 °C for 10 h per day. Results showed that body weight gain was similar ($p>0.05$) among the treatment groups, feed intake reduced ($p<0.05$) and feed conversion ratio improved ($p<0.05$) in broiler chickens fed SSO diets compared with control group at 22 to 42 days. Nitrogen, Fat and Fibre were best retained at 20 gkg^{-1} SSO diet. Breast muscle was heaviest at 0 gkg^{-1}SSO and least at 60 gkg^{-1} SSO. SSO did not have a significant effect on the small intestinal profile examined. Therefore, 60 gkg^{-1} SSO can alleviate the effect of heat stress through improved feed conversion ratio and reduced feed intake.

Keywords: Heat stress, broiler, carcass, sesame oil, performance, intestinal morphology

INTRODUCTION
Heat stress has been a major factor limiting adequate poultry productivity in hot climatic environment (Lin *et al.*, 2006). Many research workers have found decline in growth, feed conversion efficiency, carcass yield as well as increased mortality in poultry birds due to the effects of high ambient temperatures which results to heat stress (Younis, 2007; Quinteiro-Filho *et al.*, 2010). Increase in water intake and decrease in feed intake of poultry under hot climate was reported by Gous and Morris (2005); Sohail *et al*. (2012). Zhang *et al*. (2017) also reported a shorter villus height and lower villus height to crypt depth ratio in heat stressed broilers. However, the effects of environmental seasonality and the inadequacy of facilities to ensure appropriate temperature ranges expose the broilers to heat, thus, impairing their genetic productivity and as such, there are significant economic losses to the poultry sector (Mujahid *et al.*, 2005).

Different methods have been used to mitigate the adverse effects of heat stress on the performance of broiler chickens which include adjustment of physical facilities such as fixing of fans and sprinklers (Turner *et al*., 1992; Wolfenson *et al*., 2001; Ikegushi and Xin, 2001) but installing this equipment will add to the cost of production on the farm. The use of high dietary fat is a nutritional strategy that can also be employed. There is considerable evidence that a higher dietary fat content contributes to improved heat tolerance in broiler chickens (Daghir, 1995; Ghazalah *et al.*, 2008; Rahman *et al.*, 2002). Zulkifli *et al.* (2003) reported enhanced growth performance and improved heat tolerance in broiler chickens fed diets containing high level of palm oil.

The current study investigated the effect of dietary levels of sesame oil on growth performance and carcass traits in broiler chickens under heat stressed condition. Fats have a lower specific dynamic effect than carbohydrates thus help the birds cope better with heat stress (Daghir, 2009) by losing less energy. Digestibility of dietary fats is affected by the fatty acid profiles, and several studies have shown better utilization of unsaturated fats leading to a higher metabolizable energy than saturated fats (Celebi and Utlu, 2004). Sesame seed oil is an example of such oil rich in unsaturated fat (linolenic acid). There is paucity of information on the use of SSO in mitigating heat stress in broiler chickens.

MATERIALS AND METHODS

Source of Sesame seeds and Oil Extraction

Sesame seed (160 kg) was purchased at a local market in Okene, Kogi State., Nigeria. The seeds were toasted, milled and oil was extracted using sesame hydraulic oil press machine locally fabricated at the Department of Agricultural and Biosystem Engineering, University of Ilorin, Ilorin, Nigeria. The sample was further extracted with solvent (petroleum ether).

Diets, Chicks and Management

One hundred and sixty day old broilers (Ross-308, unsexed) were divided into five groups of 32 chicks each, which were randomly assigned to the dietary treatment. Each treatment had 4 replicates cage units of 8 chicks. Chicks were weighed by cage. Routine management and vaccination were followed. Feed and water were provided *ad libitum* throughout the experiment.

Heat Challenge

Heat stress was induced from day 28 to day 42, all chicks were exposed to ambient temperature of 29 °C±1°C for 10 h daily (8- 18 h) and average relative humidity of 70%; these parameters were measured with a room thermometer and hydrometer. Five (5) isocaloric and isonitrogenous diets each for starter (23% CP and 12.3 MJ/Kg) and finisher (20% CP and 12.0 MJ/Kg) broilers were formulated as shown in Tables 1 and 2. There were five graded levels of sesame oil inclusion (i.e. 0, 20, 40, 60 and 80 gkg^{-1}). The dietary oil was substituted for carbohydrate sources on an equi-energy basis, i.e. for a known inclusion level of oil e.g. 4%, the total energy yield of the 4% was subtracted from the total energy yield of maize in the control diet, thus the left over energy will then be supplied by maize, the quantity of maize included in the diet was then calculated and the diet was balanced by adjusting the quantity of other ingredients.

Table 1: Ingredients and composition of the experimental diets for broilers

Ingredient	SSO(gkg^{-1})									
	Starter diet (1-21days)					Finisher diet (22- 42 days)				
	0	20	40	60	80	0	20	40	60	80
Maize	513	461	410	359	307	500	448	397	345	294
Sesame seed oil	-	20.0	40.0	60.0	80.0	-	20.0	40.0	60.0	80.0
Wheat offal	70	70	70	79	90	185	185	185	190	197
Soyabean meal	190	200	210	213	220	156	166	176	176	180
Groundnut cake	168	168	168	170	174	110	110	110	120	130
Fishmeal	20	20	20	20	20	10	10	10	10	10
Oyster shell	10	10	10	10	10	10	10	10	10	10
Bone meal	20	20	20	20	20	20.0	20.0	20.0	20.0	20.0
Methionine	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Lysine	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
*Vitamin/min premix	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Salt	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Sand	-	22	43	60	70	-	22	43	60	70
Nutrient content										
ME MJ/kg	12.24	12.35	12.47	12.60	12.80	11.81	11.92	12.04	12.18	12.39
Crude protein	231.2	230.0	230.1	231.3	229.0	201.3	201.1	200.9	201.6	204.6
ME/CP	126.58	127.80	129.12	130.95	131.83	140.24	141.65	143.18	144.35	144.84
Crude fibre	37.2	36.8	36.4	36.4	37.0	41.2	41.1	40.7	40.6	40.9
Ether extract	40.6	59.9	77.1	96.7	114.5	39.0	57.9	75.2	95.8	114.4
Lysine	1.37	1.38	1.40	1.4	1.43	1.19	1.20	1.21	1.22	1.22
Methionine	0.59	0.58	0.59	0.58	0.60	0.55	0.54	0.54	0.54	0.56
Calcium	1.29	1.30	1.30	1.3	1.44	1.23	1.23	1.23	1.23	1.38
Available phosphorus	0.57	0.58	0.58	0.58	0.58	0.55	0.55	0.55	0.55	0.62

* Vit. A,, 12,500 IU; Vit. D3, 2,500 IU; Tocopherols, 50.00mg; Vit. K3, 2.50mg; Folacin, 0.25mg; Vit B1 3.00mg; Vit B2 5,000 mg; Niacin, 40mg; Calcium Panthothenate, 10mg; Vit B6, 6.00mg; Vit B12, 0.25mg; Biotin, 0.08mg; Manganese, 100mg; Zinc, 45mg; Folic acid, 1.00mg; Iron, 50mg; Choline chloride, 300mg; Copper, 2.00mg; Iodine, 1.55 mg; Cobalt, 0.25 mg; Selenium, 0.01; Antioxidant, 200mg.

Table 2. Effect of dietary sesame seed oil on growth performance of broilers under heat stress (from day 28-42)

Criteria	SSO (gkg^{-1})					
	0	**20**	**40**	**60**	**80**	**SEM±**
Body weight gain, g per chick						
1 - 21 d	413.29	393.53	422.93	397.22	423.33	7.11
22 - 42 d	1090.94	1122.34	1122.50	1115.63	1095.93	11.38
Feed intake, g per chick						
1 - 21 d	1083.54	1067.39	1052.12	1069.79	1067.39	8.19
22 - 42 d	2543.75^{c}	2318.34^{b}	2286.66^{ab}	2342^{b}	2125.09^{a}	37.95
Feed/gain ratio, gg^{-1}						
1 - 21 d	1.68	1.72	1.57	1.71	1.59	0.53
22 - 42 d	2.33^{b}	2.07^{a}	2.04^{a}	2.09^{a}	1.94^{a}	0.39

SSO : Sesame seed oil

^{abc} means on the same rows having different superscripts were significantly different ($p<0.05$)

SEM = Standard error of mean

Performance

On daily basis, feed served to each replicate was weighed; the leftover was then weighed on the following day alongside wastages. The difference between the feed served and the leftover represents the feed intake per day. Feed intake per week was calculated by adding daily feed intake within the week (7 consecutive days). Birds of each replicate were placed in a bowl and weighed together with the aid of a digital weighing balance on a weekly basis. The difference between each successive weight gave the body weight gain. Feed conversion ratio (FCR) was calculated as the ratio of feed intake to body weight gain.

Carcass characteristics

At the end of the study (42^{nd} week), five birds per treatment were randomly selected, weighed, slaughtered and bled through the jugular vein. The birds were then defeathered, washed, eviscerated and the dressing percentage was determined. The carcass was cut into different parts and weighed accordingly. For each bird slaughtered and bled, each of the organ was weighed using a digital scale.

Nutrient Retention

At the end of the sixth week of the experiment, nutrient retention trial was conducted within duration of 72 h using the total collection method. Within this period, both the feed intake and faeces voided were collected and weighed. The faeces collected were first air dried and later oven dried with oven (10AF Quincy Bi-metal) at 80 ºC and reweighed. The dried samples were later analyzed at the Agric Laboratory, Kwara State University using the method of the Association of Official Analytical Chemist (AOAC, 1990).

Moisture content was estimated by drying in an oven at 100 - 105 °C to a constant weight. Crude protein determination was done by the Kjeldahl method. Crude fat content was determined using the continuous extraction in a Soxhlet apparatus (dimethyl ether was used as solvent). Crude fibre was determined by segmental hot digestion of the defatted sample with dilute acid and alkaline solutions.

Intestinal Histomophology

About 4 cm cut of the small intestine was taken at approximately mid way of the small intestine. This cut was then cut into two, the first was fixed immediately in 10% formalin while the second was cut open before it was fixed in 10% formalin. The tissue samples were then taken to the laboratory for tissue processing, morphometric readings and photomicrographs.

Histopathological assessment and morphometrical analyses (Crypt, villi and epithelial parameters) were done using TS View CX Image® Software, File version 6.2.4.3 and Motic Image 2000 (China).

Statistical analysis

Data collected were subjected to ANOVA using General Linear Model (GLM) module of SPSS19. For each parameter measured, significantly different means was separated by the use of the Duncan's Multiple Range procedure (SPSS19, IBM).

RESULTS AND DISCUSSION

Performance and Nutrient Retention

Body weight gain was not significantly different ($p>0.05$) among the group in the starter phase (1-21 day) and finisher phase (21-42 day) (Table 2). Feed intake did not differed significantly ($p<0.05$) within the group in the starter phase (1-21 day) while at finisher phase (21-42 day), 0% SSO was significantly high and 8% was significantly low. However, 4% was not significantly different ($p>0.05$) from 2%, 6% and 8% (Table 2). The feed conversion ratio in the starter phase (1-21 day) was not significantly ($p>0.05$) different from one another. In the finisher phase (21-42 day), 0% had a significantly lower feed conversion ratio while other SSO dietary treatments were not significantly ($p>0.05$) different from one another (Table 2).The retention of nitrogen, fat and fibre were significantly higher ($p<0.05$) in SSO diets. 0% SSO had a significantly lower retention of the three nutrients while 2% SSO had a significantly higher retention (Table 3).

Table 3. Effect of dietary sesame seed oil on nutrient retention of broilers under heat stress

	SSO (gkg^{-1})					
Digestibility (%)	0	20	40	60	80	SEM±
Nitrogen	69.79^{a}	75.68^{b}	72.70^{ab}	73.95^{b}	73.73^{b}	0.79
Fat	79.94^{a}	86.86^{c}	84.57^{b}	85.87^{bc}	85.70^{bc}	0.70
Fibre	42.14^{a}	45.16^{c}	42.61^{a}	43.83^{ab}	43.61^{ab}	0.80

SSO: Sesame seed oil

^{abc} means on the same rows having different superscripts were significantly different ($p<0.05$)

SEM = Standard error of mean

The result of feed intake of this experiment showed that heat stress had an effect on feed intake and this is in line with earlier findings of Mckee *et al.* (1997) that heat-exposed birds reduced their feed intakes in order to reduce the thermogenic effects associated with nutrient absorption, assimilation, and utilization. Contrary to the feed intake in the starter phase (1-21day) when the birds had not been subjected to heat stress, the feed intake at this stage was the same across the group which could be as a result of the fact that the birds were not under any stress and the feed was isocarloric and isonitrgenous. This is also in agreement with the previous findings of Pinchasov and Nir (1992) who reported that source of dietary fat had no effect on growth performance as long as the ratio of energy to protein (E:P) or energy to amino acids

and other nutrients were balanced. The heat stressed phase (22 - 42 day) differed significantly in all the performance parameters examined, although, the 0% SSO had the highest feed intake but the poorest feed conversion ratio was recorded in that group. Better feed conversion ratio of the oil included group agreed with earlier report of Mateos *et al*. (1982) that the addition of fat to the diet decreased the rate of feed passage and thus increased nutrient utilization.

Nitsan *et al*. (1997) also reported that diets without added fat had lower energetic efficiency (lower energy gain and higher energy losses) with respect to those with added fat. In addition, result of nutrient retention further explains the better feed conversion ratio of the SSO included groups in that the 0% recorded the least retention of the entire three nutrients which could translate to the poor feed conversion ratio. The birds own mechanisms to combat heat stress consume less amount of energy, reducing the energy available for growth. In the present study, inclusion of 8% SSO might have increased the available energy which improved the feed conversion ratio. This result thus suggests that the addition of SSO to the diet of heat stressed broiler caused a reduced feed intake but better feed conversion ratio of the birds. This is in line with earlier research of Zulkifli *et al.* (2003) that high fat diet alleviates the detrimental effects of heat on performance of broiler chickens.

Carcass Characteristics

The results of carcass evaluation are presented in Table 4. There was no significant difference ($p>0.05$) in the live weight, carcass weight as well as the dressing out percentage. Of the cut off parts examined, only breast muscle showed a significant difference ($p<0.05$) within the group in which the control (0% SSO) was significantly high, followed by 6% SSO while 2, 4 and 8% SSO did not differ from 0 and 6% SSO. Both thigh and wings were unaffected by SSO diets ($p>0.05$). Gizzard weight was significantly different ($p<0.05$) within the group, the result showed that the weight of the organ increased with increase in dietary oil inclusion (Table 4).

Although no significant difference was observed on the carcass yield as well as the cut-of parts, the gizzard weight increased as the oil inclusion level increased. This could be due to the fact that fibre (wheat) was used to balance the composition of the diets. The higher the oil inclusion levels, the higher the fibre content of the feed. Higher gizzard weight might be due to the increase of contraction of the organ in the process of reducing the fibre particle.

Table 4. Effect of dietary sesame seed oil on carcass characteristics of broilers under heat stress

	SSO (gkg^{-1})					
Parameters	**0**	**20**	**40**	**60**	**80**	**SEM±**
Live weight (g)	1675.00	1625.00	1625.00	1625.00	1550.00	22.48
Carcass weight (g)	1160.50	1162.00	1153.25	1127.25	1068.50	16.12
Dressing out percentage (%)	69.28	71.66	70.96	69.34	69.02	0.51
Thigh (%)[2]	31.34	30.38	29.67	30.35	31.09	0.38
Wings (%)[2]	11.35	10.99	10.85	11.11	10.86	0.15
Breast muscle (%)[2]	28.7^{b}	27.2^{ab}	26.6^{ab}	23.1^{a}	26.0^{ab}	0.36
Gizzard (%)[1]	1.67^{a}	1.63^{a}	1.77^{ab}	1.89^{b}	1.95^{b}	0.376
Head (%)[1]	2.91	2.97	2.62	2.74	2.94	0.91
Heart (%)[1]	0.39	0.40	0.43	0.43	0.42	0.14

SSO: Sesame seed oil; [1]Percentage computed as a ratio of live weight; [2]Percentage computed as a ratio of carcass weight. ^{abc} means on the same rows having different superscripts were significantly different ($p<0.05$), SEM = Standard error of mean

Intestinal Morphological Analysis

There was no significant effect (P>0.05) of dietary levels of SSO on crypt length, crypt width, villi length, villi width and epithelial height (Table 5).

Table 5. Effect of dietary sesame seed oil on intestinal histomorphology of broilers under heat stress

Parameters (µm)	SSO (gkg^{-1}) 0	20	40	60	80	SEM±
Crypt length	257.77	206.03	205.55	261.34	135.15	2.07
Crypt width	144.50	66.61	129.89	119.74	46.64	1.91
Villi length	1257.95	1367.78	1027.21	1505.32	1043.82	1.17
Villi width	146.67	191.33	261.44	272.23	111.19	2.77
Epithelial height	235.34	252.78	272.24	264.62	121.21	42.49

SSO : Sesame seed oil
SEM = Standard error of mean

CONCLUSION

It can be concluded that the addition of oil to the diet of heat stressed broiler caused a reduced feed intake but better feed conversion ratio of the birds and better nutrient retention.

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