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EVALUATION OF DIFFERENTLY PROCESSED MAGGOT (*MUSCA DOMESTICA*) MEAL AS A REPLACEMENT FOR FISHMEAL IN BROILER DIETS

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Abstract

The high cost of imported fishmeal as animal protein source is one of the limiting factors in raising broiler chickens particularly in Nigeria. Maggots are housefly larvae that are rich in protein which could be used as alternative to fishmeal in broiler production. This study assessed differently processed Maggot Meal (MM) as replacement for fishmeal in broilers diet in a completely randomized design. A total of 144 day old Arbor Acre broilers were randomly divided into 4 treatments. Each treatment (of 36 birds) was replicated thrice of 12 birds per replicate. Maggots were produced using blood and wheat offal as substrates in ratio 4:1 using either mango or intestinal offal as flies attractant. The maggots matured within 5days and harvested. The maggots were processed by sun-drying, oven drying and roasting. Four experimental diets were formulated for the study. A corn-soybean meal based diet that contained imported fishmeal was denoted as control. Sun dried MM, oven dried MM and roasted MM replaced imported fishmeal wholly denoting T1, T2 and T3, respectively. Data were collected on maggot yield, growth performance, nutrient digestibility and serum enzymes of experimental birds. Data collected were analyzed using One-Way Analysis of Variance. The results showed that the maggots yield from the substrates and intestinal offal as fly attractant produced more maggots than using mango as flies attractant. The highest crude protein (CP) was observed in roasted MM (43.75%). Broiler chickens fed roasted MM had final body weight comparable ($P > 0.050$) to the control. Broiler chickens fed roasted maggot meal had the highest ($P = 0.011$) CP digestibility (70.68%). Serum aspartate aminotransferase (AST) was significantly ($P = 0.002$) elevated for broiler chickens fed sun dried and oven dried maggot meals. In conclusion, processing maggots by roasting was the best for enhanced crude protein digestibility without any deleterious effect on serum enzymes.

Keywords: animal protein, high cost, fishmeal, maggot meal, nutritional profile, substrate, differently processed

INTRODUCTION

The growth of the livestock industry is been threatened by persistent feed ingredients shortage. In the event of global feed crisis, the only pragmatic approach to solving the escalating prices of feed ingredients is the use of alternatives to the conventional feedstuffs that can partly or wholly replace them without compromise on the health status and performance of the animals.

Fishmeal and soybean meal are important sources of high-quality protein in poultry feeds, concerns about their costs and adulteration has motivated the search for viable alternatives. Replacing soya bean and fishmeal with alternative protein source such as shrimps, snails, insects (including their larvae such as maggots) in poultry diets is a practice that is gaining momentum (Selaledi *et al.*, 2021). Maggots are larvae of housefly (order Diptera), with a very short life span and can be produced in large biomass from materials regarded as waste make it a viable option to explore. The nutritional quality of maggot meal has been reported as a quality protein source. The production system of maggot serves dual purpose of providing a nutrient rich feed resource as well as waste management.

The proximate analysis of dehydrated housefly larvae showed that it contained 60% crude protein and 20% crude fat, the amino acid content of proteins being similar to that of fishmeal (Inaoka *et al.*, 1999). Awoniyi *et al.* (2003) reported that housefly larvae meal contained 92.6% dry matter, 55.1% crude protein, 20.7% crude fat, 10.4% ash and 6.3% cellulose. Previous studies have shown that housefly larvae, in the fresh and meal form, can be substituted for fishmeal in broiler diets; this replacement resulting in optimal productive performance, without any harmful impact on broilers health (Fasakin *et al.*, 2003).

The quality of protein from maggots could be influenced by the processing methods for turning maggots into maggot meal. The necessity to determine the effective processing method(s) that could sufficiently retain the native protein of the maggots for its maximum utilization in broiler production is critical. This study therefore aimed to asses the differently processed maggot meals on maggot yield, growth performance and serum enzymes of broiler chickens.

MATERIALS AND METHODS

Site of the Experiment

The experiment was conducted at Broiler Unit, Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria. Ogbomoso lies on the longitude 4015' East of the Greenwich Meridian and latitude 80 08' North of the equator. The altitude is between 300 and 600 m above the sea level while the mean annual rainfall of 1247 mm and mean temperature of about 27 °C (Google Earth Map, 2022).

Sources of the Substrates Materials

The blood used in the maggot production was collected from Amo Byng Chicken Processing Plant, Akinyele Local Government Area, Ibadan, Oyo State, Nigeria. Intestinal offal was part of the blood mixture collected from the Processing Plant. Wheat offal was obtained from a reputable commercial feedmill. Mangoes were collected from mango trees within the university campus.

Culturing of Maggots

Blood mixture (obtained from chicken processing plant) and wheat offal were used as substrates at 4:1. Intestinal offal and mango were used as fly attractants separately. The maggots matured within 5 days and harvested.

Harvesting Technique

The maggots for each of the fly attractant were harvested using floating method as described by Sogbesan *et al.* (2006). The blood with matured maggot was mixed with hot water and the floated larvae were collected with a sieve after which they were washed in clean water. The harvested maggots were partitioned into three portions and processed differently namely sun-drying, oven drying and roasting. The differently processed maggot meals were then milled to form three differently processed (MM).

Processing of Maggots into Meal

Maggots were sun dried as described by Makinde (2015). Precisely, the maggots were spread on iron sheet for drying using direct sunlight for 2 days. Roasting of the maggots was done as described by Nzemujo (2010). The maggots were spread on iron sheet placed 15 cm above hot charcoal, at 70 °C for 30 minutes. Oven drying of the maggots was carried out as described by Hwangbo *et al.* (2009). Maggots were dried in an electric oven regulated at 50 °C for 40 minutes.

Density of the Processed Maggot Meals

The density of processed maggot was done to determine the weight per volume of each processed maggot meal using the technique of "Archimedes Principle". The maggot density was done by estimating the volume of weighed maggots (aided by attaching a mass of stone) and the volume of water displaced.

Formulation of Experimental Diets

Four experimental diets were formulated for study. Differently processed maggot meals wholly replaced imported fishmeal as the sole animal protein source. Diet that contained imported fishmeal (72% CP) was denoted as control. Diet that contained sun dried maggot meal was in T1. Diet that contained oven dried maggot meal was denoted as T2. Finally, diet that contained roasted maggot meal was denoted as T3.

Experimental Birds and Management

A total number of 144 days old Arbor Acre broiler chicks were randomly divided into four (4) treatments of 36 birds in a treatment group. Each treatment was replicated thrice. There were 12 birds per replicate. All necessary vaccination, medication and other routine management were observed throughout the study. The duration of the experiment was 6 weeks. The experiment was laid out in a completely randomized design.

Data Collection

Growth Performance

Initial Body Weight (IBW) was the body weight of the day old chicks measured on arrival from hatchery. Subsequently, body weights of experimental broilers were taken weekly. Final Body Weight (FBW) was determined at 21st and 42nd day of the study for starters and finishers, respectively. The weight gain was determined as the difference between the IBW and FBW of the experimental birds. The average daily gain (ADG) was determined by dividing weight gain by the number of birds in each replicate. Feed intake was estimated as difference between the feed supplied to the birds and feed remnant. Average daily intake (ADI) was calculated by dividing the feed intake by the numbers of birds and number of days in each growth phase. Feed conversion ratio (FCR) was estimated by dividing ADI by ADG.

Nutrient Digestibility

Nutrient digestibility trial was carried out at the 35th day of the study. Six birds from each treatment were randomly selected for the trial. The birds were housed in individual battery cage cells for total faecal collection. An allowance of 70% of their daily feed intake was used for the trial. It was a five day trial. A pre-adjustment period of 2 days was observed while faecal collection was done for the last three days. The faecal samples collected were oven-dried to a constant weight, bulked and representative samples collected for proximate analysis.

Serum Enzymes

Six blood samples for each treatment were collected on the 40th day of the study. Blood samples were drawn from the jugular vein around the neck of the broiler chickens using a 5 ml Syringe collected in bottles without anticoagulant. Blood samples collected were analyzed for serum enzymes: alanine

I: *Ingredients composition of broiler starter diets*

Ingredients	Control	T1 (Sundried MM)	T2 (Oven dried MM)	T3 (Roasted MM)
Maize	58.00	58.00	58.00	58.00
Soybean meal	32.00	32.00	32.00	32.00
Wheat offal	2.00	2.00	2.00	2.00
Fishmeal (72%CP)	4.50	0.00	0.00	0.00
Maggot meal	0.00	4.50	4.50	4.50
Bone meal	2.25	2.25	2.25	2.25
Limestone	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
Lysine	0.05	0.05	0.05	0.05
Methionine	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
		Calculated Analysis		
Energy (KcalME/kg)+	2917.68	3040.80	3042.99	3038.91
Crude protein (%)	22.29	21.88	21.76	21.91
Ether extract (%)	2.64	3.44	3.44	2.91
Crude fibre (%)	3.44	3.41	3.57	3.57
Calcium (%)	1.14	1.03	1.03	1.04
Phosphorus (%)	0.66	0.59	0.82	0.59
Methionine (%)	0.58	0.50	0.50	0.50
Lysine (%)	1.31	1.11	1.10	1.10

*A kilogram of diet contained the following vitamins and trace minerals- 12500 IU Vitamin A, 2500 IU Vitamin D3, 40 mg Vitamin E, 2 mg Vitamin K3, 3 mg Vitamin B1, 5.5 mg Vitamin B2, 55 mg Niacin, 11.5 mg Calcium Pantothenate, 5 mg Vitamin B6, 0.025 mg Vitamin B12, 500 mg Choline chloride, 1 mg Folic acid, 0.08 mg Biotin, 120 mg Manganese, 100 mg Iron, 80 mg Zinc, 8.5 mg Copper, 1.5 mg Iodine, 0.3 mg Cobalt, 0.12 mg Selenium, 0.12 mg Antioxidant.
Av.P = Available phosphorus
Metabolisable energy was calculated using Pauzengua (1985) equation
+ME = 37X %CP + 81 X %EE + 35.5 X %NFE
(Proximate composition of sun dried, oven dried and roasted maggot meal was used in the calculation)

aminotransferase (ALT) using IFCC (1986), aspartate aminotransferase (AST) using IFCC (1986), alkaline phosphatase (ALP) using Reitman and Frankel (1957). Total protein and albumin were analyzed using Tietz (1995) and Doumas *et al.* (1971), respectively. The difference between total protein and albumin was recorded as the globulin.

Proximate Analysis

The proximate analysis of maggot meals, experimental diets and faecal samples were done in the procedure of AOAC (2000).

Statistical Analysis

Data collected were subjected to One-Way Analysis of Variance using SAS (1999). Significant means were separated using Duncan's option of the same statistical package. A 5% level of probability was considered significant. Furthermore, data collected for maggots yield based on the two fly attractants was analyzed by T-test.

RESULTS AND DISCUSSION

The effect of processing methods on maggots yield as influenced by the types of fly attractant used is presented in Tab. III. The maggots produced from the substrates (blood with wheat offal) and intestine offal as fly attractant yielded more quantity of maggots (P = 0.0021) than those produced from the same substrate using mango as fly attractant. The highest maggots yield (57.50%) was observed from maggots processed by oven dried maggots while the lowest yield (51%) was from those that were sun-dried. The yield and density of differently processed maggot meals is presented in Tab. IV. Maggots dried by roasting ($0.80\,g\,cm^{-3}$) had numerically higher density than other maggot meals ($0.71\,g\,cm^{-3}$ for sun dried MM and $0.67 g\,cm^{-3}$ for oven dried MM).

II: *Ingredients composition of broiler finisher diets*

Ingredients	Control	T1 (Sundried MM)	T2 (Oven dried MM)	T3 (Roasted MM)
Maize	47.00	47.00	47.00	47.00
Soybean meal	25.50	25.50	25.50	25.50
Wheat offal	20.00	20.00	20.00	20.00
Fishmeal (72%)	4.00	0.00	0.00	0.00
Maggot meal	0.00	4.00	4.00	4.00
Bone meal	2.25	2.25	2.25	2.25
Limestone	0.50	0.50	0.50	0.50
Salt	0.25	0.25	0.25	0.25
Lysine	0.05	0.05	0.05	0.05
Methionine	0.20	0.20	0.20	0.20
Premix*	0.25	0.25	0.25	0.25
Total	100	100	100	100
Determined Analysis**				
Energy (KcalME/kg)+	2790.88	2807.18	2809.21	2805.50
Crude protein (%)**	20.70	17.20	21.35	20.35
Ether extract (%)**	2.81	3.52	3.52	3.05
Crude fibre (%) **	4.80	1.90	3.00	2.40
Calcium (%)	1.11	1.02	1.02	1.02
Phosphorus (%)	0.62	0.55	0.76	0.55
Methionine (%)	0.54	0.62	0.47	0.47
Lysine (%)	1.11	1.93	1.93	0.93

*see Tab. I
Av.P = Available phosphorus+ see Tab. I

III: *Production yield of maggot meals based on fly attractant type*

Parameters	Mango	Intestinal offal	P > t	t-value
Yield (%)	$20.0^{b} \pm 0.58$	$24.60^{a} \pm 0.31$	0.0021	-7.042

IV: *Yield and density of differently processed maggot meals*

Parameters	Sun dried maggot meal	Oven dried maggot meal	Roasted maggot meal	P-value	SEM
Yield (%)	51.00	57.50	53.34	0.0685	4.74
Density (g/cm^3)	0.71	0.67	0.80	-	-

V: *Proximate composition of differently processed maggot meals (%)*

Parameters	Sun dried maggot meal	Oven dried maggot meal	Roasted maggot meal
Crude protein	39.15	42.70	43.75
Ash	5.00	4.20	5.90
Ether extract	6.00	6.60	6.11
Crude fibre	4.40	4.90	5.30
Nitrogen free extract	37.55	33.91	31.32
Dry matter	92.10	92.31	92.38

This indicated that roasted maggot meal was more compact together than other processing methods which may suggest very rich nutrients meal. Oven dried maggot meal had non- significantly (P = 0.0685) higher maggot yield than other processed maggot meals.

The proximate composition of differently processed maggot meals used in the study is presented in Tab. V. Roasted maggot meal had the highest crude protein (43.75%) while the lowest crude protein (39.15%) was observed in sun dried maggot meal. The crude protein of oven dried maggot meal (42.70%) was relatively close to roasted meal (43.75%) The dry matter content of the differently processed maggot meals ranged from 92.10% to 92.38% indicating that the maggots were effectively dried.

The 39.15% CP of sun dried maggot meal obtained in the present study was consistent with the observation of Atteh and Ologbenla (1993) who reported 39.15% CP for sun dried maggot meal. However, Aniebo *et al.* (2009) and Fasakin *et al.* (2003) reported higher CP of 47.1% and 43.3% for sun dried maggot meals respectively. The 42.7% CP for oven dried maggot meal in this study was similar with 42.3% CP in the oven dried maggot meal reported by Aniebo and Owen (2010). Fasakin *et al.* (2003) reported a slightly higher CP of 46.7% for oven dried maggot meal. The highest CP (43.75%) content observed for roasted maggot meal suggested that appropriate drying method for the maggots is crucial for the nutritional content of the maggots meal. The variation in the CP content of the differently processed maggot meals may be attributed to effects of processing methods, particularly in relation to the intensity and duration of exposure to heat. Tang *et al.* (2012) reported that depending on the intensity of heat treatment, the nutritive value of proteins may be affected differently. Furthermore, it could then inferred that roasting of maggot meal at 70 °C for 30 minutes was more advantageous than oven drying of maggots at 50 °C done for 40 minutes in the present study. Roasting of maggots at higher temperature (70 °C) and for shorter period of time (30 minutes) was more advantageous than oven drying of maggots at 50 °C done for 40 minutes in the present study. Processing methods had significant influence on physico-chemical properties of food containing protein. Oxidation of protein do occur during feed processing such as heat, comminuting and grinding which introduced oxygen molecules and mix oxidants with susceptible food components (Korhonen *et al.*, 1998). The substrates used in the culturing of maggots also influence the protein content of the maggot meal. Odesanya *et al.* (2011) reported that maggot meal (produced from poultry droppings, rotten mangoes and animal offal as fly attractant) had higher CP (48%) and the nutritive values inherent in the meal from this substrate compares favourably with other protein source. Ukwanoko and Olalekan (2015) reported that maggot meal produced from poultry dropping without any fly attractant had a lower CP of 39.58%. Fasakin *et al.* (2003) reported that variations in crude protein of maggot meal may be related to the quality of poultry droppings used to produce the maggots.

The growth performance of broiler starter and finishers fed the differently processed maggot meal as a replacement for imported fishmeal is presented in Tabs. 6 and 7, respectively. Diets did not significantly influence the growth performance of broiler starter and finishers. However, broiler starters fed control diet had the heaviest FBW (551.26 g/bird, P = 0.095) and ADG (23.95 g/bird, P = 0.096) while the lowest FBW (467.37 g/bird) and ADG (19.97 g/bird/day) were observed in those fed sun dried maggot meal diet. The FBW of starters fed roasted maggot meal (499.30 g/bird) was very close to those in the control (551.26 g/bird). Finisher broilers fed control diet had the highest (P = 0.063)

FBW (1396.47 g/bird) which was very close to those fed roasted maggot meal (FBW 1335.29 g/bird). Furthermore, broiler finishers fed sun dried MM had the lowest FBW. The final body weights of broilers fed control diet and those fed roasted maggot meal were comparable at both growth phases. This could be due to superior protein quality of roasted maggot meal in the present study compared to other processing methods. Reports showed that feeding oven dried maggot meal to broilers achieved similar growth performance as observed in the present study. Teguia *et al.* (2002) reported that there was no significant difference between the control group and broiler chickens fed oven dried maggot meal, although 10% substitution level of maggot meal for fishmeal was used for the study. However, Fasakin *et al.* (2003) reported that fish (Clarias gariepinus) fed oven dried maggot had improved final body weight and weight gain while those fed sun dried maggot meal (27% CP in the diet) had lowest weight gain. The variation in the response of the fish in the study of Fasakin *et al.* (2003) and the present study might be associated to the methods used in the processing of the maggot into maggot meal.

The nutrient digestibility of broiler chickens fed differently processed maggot meals is presented in Tab VIII. Broiler chickens fed roasted maggot meal had the highest (P = 0.011) CP digestibility (70.68%) and ether extract digestibility (88.88%). Broiler chickens fed sun dried maggot meal had the lowest crude protein digestibility (49.96). In addition, chickens fed oven dried maggot meal had higher CP digestibility than those fed sun dried maggot meal Broiler chickens fed control diet had the highest (P = 0.0001) crude fibre (83.39%) digestibility. Furthermore, broilers fed control diet (83.39%) and those fed roasted maggot meal (80.48%) had comparable crude fibre (CF) digestibility. Meanwhile those fed sun dried maggot meals had the lowest crude fibre digestibility (57.38%).

The maximal CP digestibility (70.68%) observed in broiler chickens fed roasted maggot meal indicated that roasted maggot meals were nutritionally superior to both oven dried and sun dried maggot meals. The CP digestibility of broiler chickens fed oven dried maggot meal was also better than those fed sun dried maggot meal. The maximum CP digestibility (60.13%) was noticed in chickens fed oven dried maggots meal. However, Hwangbo *et al.* (2009) reported CP digestibility of 98.8% for broilers fed oven dried maggot meal. Diet composition may be the probable reason for the variation. The optimum ether extract digestibility that was observed in broilers fed roasted maggot meal was consistent with the findings of Kushwaha (2013) who documented the highest ether extract digestibility for broiler fed 5% roasted maggot meal. Furthermore, the nutrient digestibilities for CP, CF and ether extract of broilers fed roasted maggot meal and those fed control diet were comparable. It is an indication that roasted maggot meal may contain similar levels of essential nutrients as imported fishmeal particularly in regards to essential amino acids required by broilers for maximum growth.

The serum enzymes and proteins of broiler chickens fed differently processed maggot meals is presented in Tab. IX. Serum aspartate aminotransferase (AST) showed significantly (P = 0.002) elevated activity for broiler chickens fed sun dried (39.86 IU/L) and oven dried (41.35 IU/L) maggot meals than for those with roasted maggot meal (18.11 IU/L). Chickens fed control and roasted maggot meal had similar AST activities. Serum

VI: *Growth performance of broiler chickens fed differently processed maggot meals from the 1st to 21st day of the study (g/bird)*

Parameters	T1 control	T2 SMM	T3 OMM	T4 RMM	P-value	SEM
Initial BW	48.26	48.06	48.42	49.10	0.565	0.53
Final BW	551.26	467.37	495.94	499.30	0.095	20.16
ADG (g/bird)	23.95	19.97	21.31	21.44	0.096	0.96
ADI (g/bird)	44.05	38.40	40.02	40.39	0.484	2.54
FCR	1.84	1.92	1.89	1.89	0.970	0.12

BW = Body weight, ADG = Average Daily Gain, ADI = Average Daily Intake, FCR =Feed Conversion Ratio

VII: *Growth performance of broiler chickens fed differently processed maggot meals from the 22nd to 42nd day of the study (g/bird)*

Parameters	T1 control	T2 SMM	T3 OMM	T4 RMM	P-value	SEM
Initial BW	551.26	467.37	495.94	499.30	0.095	20.16
Final BW	1396.47	1159.29	1185.97	1335.29	0.063	59.95
Weight gain (g/bird/day)	40.25	32.95	32.86	39.81	0.159	2.74
Feed intake (g/bird/day)	129.53	127.64	116.20	119.03	0.229	4.86
FCR	3.23	3.91	3.54	3.08	0.170	0.25

BW = Body weight, ADG = Average Daily Gain, ADI = Average Daily Intake, FCR =Feed Conversion Ratio

VIII: *Nutrient digestibility of broiler chickens fed differently processed maggot meal as a replacement for fishmeal*

Parameters	T1 control	T2 SMM	T3 OMM	T4 RMM	P-value	SEM
Dry matter	63.77	63.61	67.07	72.44	0.398	3.91
Crude protein	67.62[a]	46.96[b]	60.13[a]	70.68[a]	0.011	3.87
Crude fibre	83.39[a]	57.38[b]	79.01[a]	80.48[a]	< 0.0001	2.28
Ether extract	70.66[b]	73.77[b]	72.84[b]	88.88[a]	0.011	3.09
Ash	44.54	56.33	47.72	63.43	0.175	5.86
NFE	57.75	72.56	69.00	61.80	0.148	4.38

[ab] Means along the same row with different superscripts are significantly different ($P < 0.05$)

IX: *Serum enzymes and plasma protein of broilers chickens fed differently processed maggot meal*

Parameters	T1 control	T2 SMM	T3 OMM	T4 RMM	P-value	SEM
AST (IU/L)	26.09[b]	39.86[a]	41.35[a]	18.11[c]	0.002	4.24
ALT (IU/L)	6.75	7.20	7.07	6.20	0.916	1.09
ALP (IU/L)	3.37	3.53	2.44	3.23	0.457	0.25
Total protein (g/dl)	2.63	2.72	2.18	2.34	0.523	0.28
Albumin (g/dl)	1.83[a]	1.75[a]	1.43[b]	1.58[ab]	0.048	0.10
Globulin (g/dl)	0.80	0.98	0.75	0.77	0.914	0.25

[ab] Means along the same row with different superscripts are significantly different ($P < 0.05$)

alanine aminotransferase (ALT) and alkaline phosphatase (ALP) of broilers fed with differently processed maggot meals showed no significant differences.

Elevated concentration of serum aspartate aminotransferase in broiler chickens fed sun dried and oven dried maggot meals could suggest that there were deleterious effect on liver of chickens in the two dietary treatment groups. Kulkarni *et al.* (2018) reported that is predominant in skeletal, cardiac muscle and erythrocytes. Clinically, relevant elevations of AST are usually reflective of liver disease, especially with respect to ALT elevations, isolated elevation of AST should be assumed to reflect liver disease until proven otherwise. AST and ALT are enzymes present in hepatocytes and released into blood stream in response to hepatocyte injury or death (hepatitis). In acute hepatitis the level of these enzymes are increased sometimes 10 or even 100. Elevation in either of these enzymes is the most common abnormality seen on liver blood test profiles and myocardial infraction (myositis) (Newsome *et al.*, 2017).

CONCLUSION

It is concluded that production of maggots using substrate such as blood and wheat bran has proved efficient as a good protein supplement for replacement of imported fishmeal in broiler diets. Processing of maggots by roasting produced the highest crude protein content in the maggot meal. Feeding roasted maggot meal to broiler chickens had comparable final body weight. Elevated serum aspartate aminotransferase was noticed in chickens fed sun dried and oven dried maggot meals leading to deleterious effect on the hepatocytes. It is therefore recommended that roasted maggot meal should be developed as suitable alternative protein source for broiler production.

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