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Effect of Replacing Blood Meal for Mealworm Larvae (*Tenebrio molitor*) Meal in Broiler Starter Diets on Growth Performance, Carcass Traits and Meat Sensory Test

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Abstract: The study was conducted to determine effects of replacing blood meal for mealworm larvae *Tenebrio Molitor* (TM) meal on growth performance, carcass traits and meat sensory test of broiler chickens. A total of 150day old broiler (Ross 308) chicks were allocated five dietary groups with three replicates pen (10birds/pen). Five starter were formulated with TM meal replacing at control (0) %, 25%, 50%, 75% and 100 % of blood meal and administered for a period (1-14days). A regular finisher and grower diets were offered to all groups during the 15–35 days of age. At the 35th day, 4 chickens per replicate were randomly selected and slaughtered to evaluate the carcass traits and meat sensory test. Replacement of blood meal for TM meal in broiler starter diets did not ($p>0.05$) influenced growth performance and carcass traits to all parameters measured. In contrast, replacing blood meal for TM meal significantly($P<0.05$) influenced meat tenderness to all diets containing TM meal compared to control diet. Diet containing TM meal significantly ($P<0.05$) affected colour of cooked meat at 50%, 75%, 100% replacement rate. Diets containing TM meal can reduce meat tenderness and also change colour of cooked meat.

Keywords: *Starter Diets, Tenebrio molitor Larvae Meals, Broilers, Carcass Traits, Meat Sensory.*

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I. INTRODUCTION

As population is growing pressure is increasing on natural resources. Chickens are common sources of meat worldwide, and the poultry production is constrained by increasing price of soya bean meal and fish meal, which are major protein source used in feed formulation. Poultry respond quickly when given access to balanced nutrition. In poultry, faster growth happens at first few days of life stages, in order to achieve that, poultry require well balance nutrition, particularly high protein, vitamin and minerals. For this purpose, more sustainable feed resources should be explored to guarantee future feed production for poultry in particular. Insects that are rich in protein, has been used to for common protein sources in poultry diets, thereby reducing environmental pollution and feed expense. (Khusro, Andrew, & Nicholas, 2012). Several studies have already highlighted the possibility of insects to become a common ingredient in animal feed (Biasato et al 2018, Bovera et al 2016, Sedgh-gooya et al 2020), due to the well-balanced amino acid protein source, lower ecological foot print and the some countries have studied insects as alternative sources of protein as animal feed have been has been identified such as house fly maggots (Kone et al. 2017) terminates (Dao et al. 2020) grasshoppers, silkworm caterpillars (Sheikh et al. 2018) earthworms and mealworm larvae (Moyo et al. 2020) *Imbrasia belina* worm feed on mopane leaves, have short breeding cycle, easy to processed and long shelf life. Mealworm *Tenebrio molitor* larvae (TM) have the potential as a sustainable future protein source for diets of production animals (poultry, fish, and pigs). *Tenebrio molitor* larvae contain high amounts of energy, protein and essential amino

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acids, fatty acids and micronutrients (e.g. copper, iron, zinc). Mealworm larvae can be produced in low value products including wheat bran, pearl millet bran and are able to convert agricultural waste into larval biomass which is high in protein, fat and minerals. TM larvae meal has been used in poultry and fish diets as alternative protein source (Elahi et al., 2020). Mealworm larvae meal has been reported to contain 47% to 55% crude protein. Recent studies have been focused on use of insect larvae as feed ingredients. birds have been found naturally eating insects in different life cycle (Elahi et al., 2020). There are few scientific reports on the performance of broiler chicks fed with mealworm larvae meal in starter diet. This study was conducted to evaluate effects of replacing TM meal on growth performance and carcass traits and meat sensory test of broilers chickens.

II. MATERIALS AND METHODS

➢ *Mealworm Harvesting*

Mealworm larvae were harvested at Matopos Research Institute, Livestock Nutrition Section, live mealworm larvae were killed by storing them in deep freezer at -24 degree Celsius for 24 hours and the roasted and dried. Then dry mealworm larvae were milled at 2mm sieve before mixing.

➢ *Experimental Birds and Housing*

The experimental procedure was viewed and approved by Department of Livestock Research and Specialist Services. A total of 150 one-day old broiler chicks (Ross 308) were randomly allocated to five treatments diets. Each treatment replicated three times of ten birds each with an average weight of 36.9g per bird. The broiler chicks were reared in 1 m^2 pens constructed in a standard broiler deep litter house. The stocking density was 10 birds/m^2. Each pen was individually heated by an infra red lamp. Lighting was provided on a 24-hour basis. Feed and water was provided *ad libitum* in tube feeders and water fonts respectively, the experiment lasted for 35 days.

➢ *Diets*

Five starter diets in mash form were formulated with TM meal replacing 0, 25, 50, 75 and 100 % of the blood meal on equi-protein basis. All the diets were iso-nitrogenous and iso-energetic (Table 1) and were formulated according to the recommendations of National Research Council (1994).

Table 1 Chemical Analysis of Formulated Broiler Starter Diets.

Crude protein	21.5	21.7	21.5	21.8	21.6
Fat	3.4	3.5	4.1	4.3	4.5
Crude fibre	5.1	5.4	5.2	5.1	5.2
ME (kcal/kg)	3021	3021	3021	3021	3021

NACI=Sodium chloride, ME= Metabolizable Energy

➢ *Growth Performance*

Weekly weights were taken every Friday, feed intake and refusals were recorded daily at 08:00am. Any mortality observed was recorded. Daily feed intake, feed conversion ratio, and average daily gain were calculated using documented data.

➢ *Slaughtering Procedure and Carcass Analysis*

At day35, four birds were randomly selected from each replicate weighed and fasted for 12hours before slaughtering. After stunning, decapitation and bleeding the carcass were plucked eviscerated. Hot water was used to remove feathers, then hot carcass was cleaned and opened to remove, heart, intestines, gizzard, liver and abdominal fat. All organs were expressed as a percentage of live weight.

➢ *Meat Sensory Study*

The meat sensory test properties were measured by a taste panel which consisted of 20 members. Panel members were briefly trained on how to score different sensory of meat samples. Raw meat samples (thigh portion) for the five treatments were cut into small cubes and were coded A to E. The remaining meat portions for the 5 treatments were boiled under the same conditions, cooled before being cut into small pieces (without skin) and were coded with letters F-J. Five raw meat and 5 cooked samples were then presented to each member of the taste panel. The tasters were given questionnaires to rate, colour of raw meat and cooked meat, tenderness and juiciness of the meat samples. These were mainly scored on scales of 1-5.

➢ *Statistical Analysis*

Data regarding growth performance, carcass traits, and meat sensory test were analysed using SPSS using one-away analysis of variance (ANOVA) following Gen-Stat 18. Means were separated by Duncan Multiple Procedure test at least significant different of 5%.

III. RESULTS

➢ *Growth Performance*

The evaluation results compared live weight, average daily gains, daily feed intake and feed conversion ratios at different stages of growth. Growth performance of broiler chickens are summarised in Table 2. There were no significant ($P>0.05$) differences in all parameters evaluated.

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Table 2 Effect of Dietary Blood Meal Replacement by TM Meal on the Growth Performance of Broiler Chickens

Variable	Age	Dietary treatment					P	s.e.d
		0 %	25 %	50 %	75 %	100 %		
LW (g)	14d	344.3	335.7	331.2	341.2	338.1	0.826	11.7
	35d	1854.5	1922.2	1849.5	1823.0	1820.1	0.372	53.3
ADG (g/d)	1-7d	34.0	31.6	33.7	29.9	33.3	0.465	2.7
	1-14d	35.8	35.2	36.3	35.6	34.3	0.397	1.45
DFI (g/d)	1-14d	55.8	54.9	56.2	55.4	55.4	0.971	1.95
	1-35d	121.3	129.1	125.2	124.4	121.8	0.955	11.20
FCR (g/g)	1-7d	1.18	1.23	1.24	1.20	1.28	0.075	0.032
	1-14d	1.41	1.45	1.47	1.42	1.45	0.485	0.033
	1-35d	1.57	1.56	1.57	1.60	1.56	0.374	0.023

LW = live weight; ADG = average daily gain; DFI = daily feed intake; FCR = feed conversion ratio

➢ *Carcass Traits*

Table 3. Effect of Dietary Replacement of Blood Meal for TM Meal on the Carcass Traits of Broiler Chickens.

Variable	Dietary treatments					P	s.e.d
	0 %	25 %	50 %	75 %	100 %		
FW (g)	1797.8	1781.8	1769.5	1771.1	1759.6	0.984	69.30
CW (g)	1339.8	1339.6	1281.1	1296.8	1285.4	0.855	71.85
Dressing%	74.5	75.2	72.4	73.2	73.0	0.690	2.16
Shanks (%)	3.38	3.36	3.46	3.52	3.39	0.909	0.195
Head (%)	2.36	2.73	2.59	2.47	2.44	0.371	0.189
Liver (%)	2.21	2.25	2.29	2.32	2.30	0.862	0.108
Gizzard (%)	1.39	1.45	1.55	1.36	1.45	0.380	0.094
Heart (%)	0.50	0.53	0.55	0.49	0.48	0.408	0.037
Intestine (%)	3.31	3.39	3.34	3.31	3.46	0.968	0.244
Abdominal fat (%)	1.80	1.97	1.65	2.00	1.75	0.696	0.281

FW = fasted weight; CW = carcass weight

Evaluation of carcass traits in terms of fasted weights, carcass weight, dressing percentage, shanks, liver, gizzard, heart, intestines, abdominal fat, and head. With regard to table 3. results indicate that replacing blood meal for TM meal had no significant different (P >0.05) on all carcass traits measured.

➢ *Meat Sensory Test Scores Results*

Table 4. Effect of Replacing Blood Meal for TM Meal in Broiler Starter Diets on Meat Sensory Test Scores.

Parameters	Treatments Diets					s.e.d	P
	0%	25%	50%	75%	100%		
Colour of raw meat	2.2	2.2	2.3	2.6	2.1	0.24	0.855
Colour of cooked meat	4.42^{b}	2.32^{a}	1.9^{a}	1.88^{a}	3.0^{a}	0.17	0.001
Tenderness	4.0^{b}	2.33^{ab}	2.0^{a}	1.67^{a}	1.33^{a}	0.84	0.004
Juiciness	3.70	3.70	3.8	3.80	3.92	0.61	0.840

P = probability, ^{ab} Means ±SEM. Means in the same row not sharing a common superscript are significantly different (P<0.05).

The replacement of blood meal for TM meal did not influenced (P>0.05) colour of raw meat, and meat juiciness. However, replacement of blood meal for TM meal in broiler starter diets had significantly influenced colour of cooked from 25% to 100% replacement rate the panellist also identified 50% to 100% replacement were significantly influenced (P<0.05) meat tenderness using scores of 1-5.

IV. DISCUSSIONS

The primary objective of the study was to determine the effect of replacing blood meal for TM meal in starter diets on growth performance and carcass traits and meat sensory test of broiler chickens. In this study, replacing blood meal for TM meal had no effect on growth performance, carcass traits in broiler chickens, this was due to balanced protein and energy diets. These findings are in agreement with the observations of (Ilahi et al. 2020, Biasato et al. 2019, Schiavone et al. 2017, Cullere et al. 2016. Sedgh-gooya et al.2022 and Zsedely et al. 2023). Differently, Sarica et al. 2019 reported improved body weight at 25% replacement of

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fishmeal for meal larvae in broiler diets. Petkov et al. (2024) indicated significant lower body weight when broiler chicks were fed mealworm larvae based diets, also indicated decreased feed conversion ratio, carcass weight, improved neck. Moreover, Attivi et al. (2020) found lower liver weight and increased intestine length attributed by 75% to 100% replacement fish meal for black solder fly larvae in broiler diets. TM meals have an excellent amino acid profile which compares well with blood meal and fish meal (Thevenot et al, 2018) which are animal proteins traditionally used in broiler feeds. Colour of meat is one of the important traits that consumers use to select meat products, environmental conditions and feed type affects the colour of meat (Qiao et al.2002). Based on the sensory analysis scores there were no significant differences on the juiciness and colour of raw meat samples between the 0 % and 100% mealworm larvae. Meat quality it is very importance for business it gives the entity ability to satisfy the expressed and implicit needs of its user or consumer. Type of feed plays an important role in changing quality of meat Mohamed (2017). It is important that chicken meat consumption meets the requirements of the consumers who generally ignore their implicit needs from meat consumption. Similar observations were made by Altmann et al. (2018), who noted lower hardness and higher tenderness of meat from birds receiving black solder fly larvae meal, compared with the control group. Ilahi et al. (2020), who evaluation of yellow mealworm meal as a protein feed stuff in the diet of broiler chicks, found a smell of broiler meat fed by mealworm larvae meal. However, the of cooked meat colour differences found in broiler chickens fed with TM meal of the present study appear to be of little practical relevance and potentially incapable of affecting the consumers' willingness to buy meat. Bovera et al. (2016) observed effects of replacing soya bean meal for meal larvae in broiler diets indicated no significant different in colour. Marco et al. (2019), who studied meat quality and sensory traits no significant different reported when black solder fly larvae fat was replacing soya bean oil in broiler finisher diet.

V. CONCLUSION

The analysed data for this study have revealed that TM meal can completely replace blood meal in broiler starter diets without affecting growth performance, carcass traits. However, replacing blood meal for TM meal in starter diets had reduced scores for meat tenderness and colour of cooked meat. It is clear that, TM meal could be an alternative animal protein for the broiler starter diets.

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➢ *Author Contributions*

Conceptualisation, Maphios Mpofu, Robert Ndlovu, Gevious Sisito, Marco Mare Data collection, Maphios Mpofu, Robert Ndlovu, Data analysis, G. Sisito, Proximate analysis of feeds stuffs and organoleptic test, Theresa Rukuni. Editing Marco Mare, Tendai Dominic Matekenya

➢ *Disclosure Statement*

The authors declare no conflict of interest.

➢ *Data Availability Statement*

The data that support the findings of this study is available from the corresponding author upon reasonable request.

REFERENCES

[1]. Attivi K, K. Agboka, G.K. Mlaga, O.E. Oke, A. Teteh, O. Onagbesan and K. Tona, 2020. Effect of black soldier fly (Hermetiai llucens) maggots meal as a substitute for fish meal on growth performance, biochemical parameters and digestibility of broiler chickens. Int. J. Poult. Sci., 19: 75-80.

[2]. Beski S.S.M, R.A. Swick and P.A. Iji. 2015. Specialized protein products in broiler chicken nutrition: A review. Animal Nutrition, Vol 1:47-53

[3]. Bovera, F., Loponte, R., Marono, S., Piccolo, G., Parisi, G., Iaconisi, V., … Nizza, A. (2016). Use of Tenebrio molitor larvae meal as protein source in broiler diet: Effect on growth performance, nutrient digestibility, and carcass and meat traits. Journal of Animal Science, 94, 639–647. https://doi.org/10.2527/jas.2015-9201

[4]. Cullere1 M, G. Tasoniero1, V. Giaccone1, R. Miotti-Scapin1, E. Claeys2, S. De Smet2 and A. Dalle Zotte1†Black soldier fly as dietary protein source for broiler quails: apparent digestibility, excreta microbial load, feed choice, performance, carcass and meat traitsAnimal (2016), 10:12, pp 1923–1930 The Animal Consortium 2016 doi:10.1017/S1751731116001270

[5]. Dao ANC, Sankara F, Pousga S, Coulibaly K, Nacoulma JP, Ouedraogo S, Kenis M, Somda I. 2020. Traditional meth ods of harvesting termites used as poultry feed in Burkina Faso. Int J Trop Insect Sci. 40(1):109–118.

[6]. Kone N, Sylla M, Nacambo S, Kenis M. 2017. Production of housefly larvae for animal feed through natural ovipos ition. J Insect Food Feed. 3(3):177–186.

[7]. Marco Cullere 1,*, Achille Schiavone 2 , Sihem Dabbou 2 , Laura Gasco 3,4 and Antonella Dalle Zotte 1 Meat Quality and Sensory Traits of Finisher Broiler Chickens Fed with Black Soldier Fly (Hermetia Illucens L.) Larvae Fat as Alternative Fat Source Animals 2019, 9, 140; doi:10.3390/ani9040140

[8]. Mohammed A Evaluation of Black Soldier Fly (Hermetia illucens) Larvae Meal as an Alternative Protein Source in Broiler Chicken Diets: Effect on Carcass and Eating Quality of Broiler Chicken Research & Reviews: Journal of Food Science and Technology ISSN: 2278-2249 (Online), ISSN: 2321-6468 (Print) (2017) Volume 6, Issue 3

[9]. National Research Council (NRC). 1994. Nutrient requirements of Poultry. 9th revised edition. National Academy Press, Washington DC.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/25jul636

[10]. Petkov, E.; Popova, T.; Dimov, K.; Vlahova-Vangelova, D.; Balev, D.; Kolev, N.; Dragoev, S. Low-Fat Tenebrio molitor Meal as a Component in the Broiler Diet: Growth Performance and Carcass Composition. Insects 2024, 15, 979. https://doi.org/10.3390/ insects15120979
[11]. QiaoM, Fletcher DL, Smith DP, 2002, The relationship between raw broiler breat meat colour and composition. Poultry Sci. 81: 422-427 tract morphology and carcass yield. The Journal of Animal and Plant Science, 22(3); 570-575
[12]. Ullah, M.S., T.N. Pasha, Z. Ali, Saima, F.M. Khattak and Z. Hayat. 2012. Effect of different pre-starter diets on broiler performance, gastrointestinal United States Department of Agriculture Food safety and inspection services, Meat and Poutry, 2011. Retrieved from http//www.fsis.usad.gov
[13]. Veldkamp, T., and G. Bosch. 2015. Insects: a protein-rich feed ingredient in pig and poultry diets. Animal Frontiers 5:45-50. doi:10.2527/af.2015-0019
[14]. Zsedely, E.; Cullere, M.; Takacs, G.; Herman, Z.; Szalai, K.; Singh, Y.; Dalle Zotte, A. Dietary Inclusion of Defatted Silkworm (Bombyx mori L.) Pupa Meal for Broiler Chickens at Different Ages: Growth Performance, Carcass and Meat Quality Traits. Animals 2023, 13, 119. https://doi.org/10.3390/ ani13010119
[15]. Sipho Moyoa , Patrick Julius Masikaa,b ,Voster Muchenjea and Ishmael Festus Jajaa