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Physical Quality of Broiler Meat Fed Diets Containing Mealworm Protein Concentrate

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Abstract

The research aimed to evaluate the physical quality of broiler meat fed with diets containing mealworm protein concentrate. Mealworms are beetle larvae of *Tenebriomolitor*, local insects that are potential to be used as feed material in Indonesia and expected to replace Meat and Bone Meal (MBM) that are still imported. Mealworm protein content were higher than the MBM, about 45.87% and 42.94%, respectively. The materials used for this research were 100 DOC (Day Old Chick) Lohman strain (MB 202) broiler male with average body weightof 46.72±1.32 g/ head. The broilers were reared for 35 days. The experimental design was Completely Randomized Design (CRD) with two treatments and five replications, and each replication consisted of ten broiler chickens. The treatments consisted of T0 and T1. T0 was feed containing mealworm protein concentrate0% and 5% MBM as a control and the T1 was feed containing 5% mealworm protein concentrateand 0% MBM. Data were analyzed using T-test. The variables measured were pH, Tenderness, Water Holding Capacity (WHC), and cooking loss. The result showed that feed with mealworm protein concentrates had no significant effect ($P < 0.05$) on tenderness and cooking loss. While, T1 had higher pH and WHC value than T0. It can be concluded that the utilization of mealworms protein-containing feed can replace MBM and showed better influence on the physical quality of broiler meat (pH, tenderness, cooking loss, and WHC).

Keywords: mealworm, protein, physical quality of the meat, broiler

1. Introduction

Mealworm or *yellow mealworm* is beetle larvae of *Tenebriomolitor* [1]. In Indonesia, it is popular as -ulathongkong‖ (hongkongcaterpillar). Mealworm is one of the local insects that could potentially be used as feed material in Indonesia. Reference [2] reported that mealworm contains good nutrients including protein, fat, carbohydrates and vitamins. In addition to having a high nutrient, mealwormis also easily found, can grow quickly, and the feed is not complicated. It also requires a low input in breeding.

Some studies related to mealworm have been reported. Reference [3] found that mealworm contained complete essential amino acid composition. Mealworm has been industrially produced as feed for pets and animals at the zoo, including birds, reptiles, small mammals, amphibians and fish [4]. This caterpillar has proven to be a source of protein that can be accepted by the African catfish

[5], chicks [6], laying hens [7], and pork [6]. Reference [6] used mealworm as a substitute soybean meal in feed chicks. In Europe, the mealwormhas been widely used not only as animal feed, but also human consumption [1].

Reference [9] showed that mealworm can be used as an alternative to imported feed materials in Indonesia, namely *Meat Bone Meal* (MBM) in broiler chicken feed. Substitution of MBM by mealworm is considerable since it has higher protein (45.87%) than MBM (42.94%). Mealworm in the form of extract and flour could increase its protein content. The use of mealworm intact in broiler chicken feed unaltered the performance, but no research has been done related to the quality of meat and protein extraction of mealworm [10]. The physical quality of the meat shows great effects on consumer acceptance. Physical or chemical quality of the meat were affected by the feed [11]. Therefore, this study was conducted to evaluate the use of the mealworm protein concentrates to the quality of broiler meat.

2. Material and Methods

The research was conducted at the cages of Animal Husbandry Faculty, Bogor Agricultural University in July-September 2016. The physical quality analysis was conducted at the Laboratory of the Department of Ruminant.

This study used 100 DOC *(Day Old Chick)* male broiler chickens with brands MB 202 *(Lohmanstrain)* that were divided into two treatments and five replications, and each replication consisted of 10 animals.

2.1.Feed Production

Mealworm protein was extracted using dry and rendering methods [12]. The composition of feed ingredients in the ration was exhibited in Table 1. Feed on starter and *finisher* phase was formulated according to [13]. Details of treatment were:
R0 : Feed containing mealworm protein concentrate 0%, MBM 5% (control)
R1 : Feed containing mealworm protein concentrate5%, MBM 0%

2.2.Maintenance and Slaughter

Maintenance of broilers was conducted for 35 days. The feeding and drinking method was performed *ad libitum*, 3 times a day(at 07.00 (morning), 12.00 (noon)and 16.00(afternoon). At the end of the experiment, the chickens were slaughtered after fasting for 24 hours. Chicken samples were taken at random, respectively 10% in each plot. Samples were taken on the breast to test the quality of the meat.

2.3.Physical Quality of Broiler Meat

pHvalue [14]. Measurement was performed using pH meter (Hanna, USA). Cathode was calibrated, and then dipped in the sample to obtain constant pH value displayed in the pH meter. Cathode was rinsed with distilled water for next measurement.

Tenderness [11]. The meat was boiled at 80 ^{0}C. The meat samples were drained and cooled for 1 hour to obtain constant weight. Samples were formed by following the directions *correr* meat fibers. Strips of flesh was measured by *Warner-Blatzer Shear Force* to determine the value of the power breakdown.

Cooking Loss [15]. Cooking loss represented the weight ratio of pre-cooked and post-cooked meat at 80 °C for 15 minutes.

WHC [15]. Hamm methods can be used to describe the WHC of meat. Samples (0.3 g) were set between filter papers and pressed with load 35 kg. After 5 minutes, the wet area surrounding the covered area was marked and measured.

Table 1. The composition of feedstuffs treatment (starter and finisher)

Material Composition	Starter		Finisher	
	R0 (%)	R1 (%)	R0 (%)	R1 (%)
Corn	54.18	54.09	63.77	64.70
Rice bran	3.50	4.00	3.50	3.50
Soybean meal	30.81	29.78	20.78	19.69
MBM	**5**	**0**	**5**	**0**
Mealworm protein concentrate	**0**	**5**	**0**	**5**
CPO	4.04	3.00	4.59	3.20
$CaCO_3$	0.85	1.50	0.66	1.35
DCP	0.30	1.35	0.45	1.33
Salt	0.45	0.44	0.45	0.41
L-Lysine	0.08	0.18	0.09	0.19
DL-Methionine	0.28	0.22	0.21	0.13
Premix	0.50	0.50	0.50	0.50
Total	100	100	100	100
***Nutritional Content:**				
Dry ingredients (%)	89.63	89.87	89.69	89.88
Metabolizable energy (kkal/kg)	3050	3050	3150	3150
Crude protein (%)	22	22	18	18
Fat (%)	6.94	6.43	7.79	6.96
Crude Fiber (%)	2.82	3.32	2.76	3.22
Calcium (%)	0.95	0.97	0.89	0.89
Phosphor (%)	0.68	0.66	0.67	0.61
Lysine (%)	1.30	1.30	1	1
Methionine (%)	0.65	0.57	0.52	0.43
Methionine+Cystine (%)	0.95	0.96	0.76	0.75

*The Result of Calculation

Table 2. Chicken carcass as result of mealworm protein concentrate addition

Parameters	Feed Containing	
	MBM	Mealworm
Final Body Weight (g)	1631 ± 62	1680 ± 72
Carcass weight (g)	1093 ± 53	1159 ± 60
Carcass percentage (%)	67	69

Table 3. Physical quality of broiler meat treated with addition of mealworm protein concentrate

Parameters	Feed Containing	
	MBM	Mealworm
pH	5.95 ± 0.04a	6.19 ± 0.12b
Tenderness	7:01 ± 0.48a	6.69 ± 0.61a
Cooking Loss (%)	35.66 ± 6.89a	32.96 ± 6.08a
WHC (%)	23:19 ± 2.74a	34.02 ± 3.21b

The different letters following the values in the same row indicate significant difference ($P < 0.05$)

Wet area was outside of the circle, the circle area was measured using planimeter to obtain mgH_2O.

$$mgH_2O = \frac{\text{wet area } (cm^2)}{0.0948} \times 8.0$$

2.3.Statictical Analysis

Completely randomized design was selected for experimental design. The data were analyzed by t-test using SPSS software.

3. Result and Discussion

Percentage of broiler carcass with treatment of mealworm protein concentrate is presented in Table 2.

The results showed that final body weight of chicken was not different. However, the percentage of chicken carcass with treatment of mealworm protein concentrate has a higher value. Chicken carcass as result of mealworm protein concentrate additionwere evaluated it's meat quality.

Meat quality is attribute to high brightness and not stink. In addition, pH, tenderness, cooking loss and water holding capacity (WHC) of meat contributed to meat quality in term of consumer acceptance [11]. The physical quality of broiler chicken meat is displayed in Table 3.

3.1. Potential Hydrogen (pH)

Table 3 indicates that the administration of feed containing mealworm protein concentrate shows significant differences ($P < 0.05$) in pH values of male broiler chicken breast meat. After cutting process, the pH value of broiler meat was 6.31, and then decreases [16]. The pH in this study was measured at three hours after cutting.Therefore, the pH value is not extremely decreased. The absence of blood after the slaughtering discontinues oxygen supply to the brain, and causes glycogen scarcity in the muscles.Consequently, some changes are observed in the muscle including temperature, pH, and process of rigormortis. The decrease in pH value was associated with high acidity due to production of lactic acid. This condition led to formation of open structure of the meat and lowered the WHC [17]

3.2. Tenderness

Table 3 showed that the treatments (MBM and Mealworm protein concentrate) had no significant effects ($P > 0.05$) on the meat tenderness (7.01 ± 0.48 and 6.69 ± 0.61, respectively). Tenderness represented the pressure needed to cut a product per unit area (kg cm-2), suggesting that the smaller value showed more tenderness of the meat [11]. The higher value of *Warner Blatzler* means more force required to break the fibers of the meat square percentimeter. This means high meat tenderness [18]. The level of meat tenderness was determined by the extent of connective tissue proteins, namely collagen, miofibril, actomyosin and elastin [16].

In the study, we tested breastmeat to produce relatively equal tenderness. The breastmuscleis considered to have low activity, thus the breast muscle is less structured. In addition, less myofibril protein meat lead to lower water holding capacity, contributing to higher meat tenderness. This is in accordance with [19] that the high activity muscles have greater myofibril fibers, and proteins in the muscle meat as liaisons have an important effect on the value of meat tenderness. The higher the protein content of meat, the meat tenderness is lower.

3.3. Cooking Loss

T-test showed that the treatments showed no significant effects on percentage of cooking loss ($P > 0.05$). Cooking loss is affected by the protein content of feed. The feed has similar protein content, 22% in the starter phase and 18% in the finisher phase (food prepared in iso protein), resulting in similar cooking loss. However, Table 3 indicated that feed containing mealworm

protein concentrate tend to produce lower cooking loss. Reference [11] reported that desirable meat had low cooking loss due to less nutritional disintegration. This figure relates to the binding power of water by protein meat. Low WHC of meat is attributed to high fluid loss, resulting in decreased meat weight. In this study, the cooking loss is in acceptable value.Acceptable values of cooking shrinkage of chicken meat was 15-40% [16].

3.4. Water Holding Capacity (WHC)

Water holding Capacity (WHC) is the ability of the meat protein to bind water. Thus, WHC, expressed as percent, represents the level of meat protein damage. The ability to bind water is an important factor, especially in the meat to be used in the food industry. Administration of mealworm protein concentrate in the feed showed significant differences ($P < 0.05$) as exhibited in Table 3. Reference [19] found that the decrease rate of pH in *postmortem* meat is a key determinant for water holding capacity. The pH value and the value of WHC was inversely correlated in this study. This is consistent with the statement [11] that the pH value of meat is directly proportional to the water holding capacity.The higher the pH value of the meat, the greater the ability of meat to bind water, vice versa. Furthermore, reference [20] suggests that changes in water holding capacity of meat due to the change ions are bound by protein meat. The decline in water holding capacity is due to the increasing number of lactic acid that accumulates as a result of damaged miofibriler proteins. Thus the ability of protein to bind water is reduced. High protein content of meat is attributed to higher water binding power. The expansion of the network of proteins or protein miofibril development (particularly myosin) was due to the weakening of hydrogen bonds or hydrophobic bonds that cause more mobilized between miofibril, resulting in higher water holding capacity [20].

Conclusion

Feed supplementation by meal worm protein concentrates was considerable to substitute MBM, and exhibited better effects on physical properties of broiler meat.

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