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Addition of Black Soldier Fly Larvae (*Hermetia illucens* L.) and Propolis to Broiler Chicken Performance

I Kinasih^{1*}, U Julita¹, Y Suryani¹, T Cahyanto¹, D S Annisa¹, A Yuliawati², R E Putra³

¹Department of Biology, Faculty of Science and Technology, Universitas Islam Negeri Sunan Gunung Djati Bandung, Bandung, 40164, Indonesia

²Department of Biology Education, Faculty of Tarbiyah and Teacher training, Universitas Islam Negeri Sunan Gunung Djati Bandung, Bandung, 40164, Indonesia

³School of Life Sciences and Technology, Institut Teknologi Bandung, Jalan Ganesha No. 10 Bandung, 40132, Indonesia

* email: idakinasih@uinsgd.ac.id

Abstract. Concern on the environmental impact of conservative feed material made the search for alternative feed becomes global challenge. Insect have been addressed as a possible alternative feed due to their high nutrient and extremely low environmental impact. The present research studied for the potential application of black soldier fly larvae (BSFL) (*Hermetia illucens*) in substitution to fish powder in the diet for broiler chickens. Furthermore, propolis extract also added to enhance the performance of broiler chickens. Growth performances, blood traits, and meat quality were considered in this study. A total of 40 male broiler chicks as one-day of age were randomly allotted to 4 dietary treatments: P0 (100% basal diet + 1 ml aquadest), P1 (100% basal diet + 1 ml propolis extract 3%), P2 (85% basal diet + 15% BSFL powder + 1 ml aquadest), and P3 (85% basal diet + 15% BSFL powder + 1 ml propolis extract 3%). The total weight of 35 days old chicken was recorded at P3 (979 g) slightly higher than other group. The broiler chicken breast meat with significant lowest fat content recorded at P1 (1.19%) and highest crude protein at P3 (32,67%) ($p < 0.05$). On the other hand, control chicken has highest red blood count, P1 has highest haematocrit, P2 has highest haemoglobin, and P3 has highest white blood cell count. BSFL and propolis inclusion showed satisfactory growth, blood traits, much healthier meat quality, thus suggesting this method as a promising to develop local based feed ingredient for chickens.

1. Introduction

Livestock industries have been considered as one of the agroindustry with low sustainability, especially in developing countries. One of the main factors, that lowering the sustainability of this industry, is the continuous availability of feedstock to produce increasing demand of livestock products [1]. Future forecasting projection of meat demand of meat should rise by 75% in 2050 than 2005-2006 [2][3], which put more pressure to feed production. In general, the ingredients of feed are material either produced by agricultural system or harvested from nature stocks that increase the environmental pressure in term of water use and biodiversity. Thus, it is necessary to development rapid and innovative feed solutions to answer this challenge.



One of the possible sustainable alternatives feed source for monogastric animals is insect. Insects are rich in nutrient content and have extremely low environmental impact [4][5][6][7]. Insects generate low greenhouse gas and ammonia emissions, favorable feed conversion ratio, require few water and soil to grow [8][9]. Moreover, insect could be fed with food wastes thus not competing with humans for natural resources while in the same time provides solution for human problem [9][10].

Among insect species, black soldier fly (BSF, *Hermetia illucens*) has been considered as one of the most promising candidate [11]. This insect is not a pest and able to convert various types of organic waste into biomass which rich in nutrient [10][12]. In Indonesia, BSF usually applied as fed for aquaculture while application as poultry feed ingredient relatively limited although its potential as an alternative protein source to soybean meal and fish meal [13][14][15][16][17].

Many poultry farms in Indonesia also plague with disease which made application of antibiotics is a common practice. However, due to increasing demand on poultry product with fewer antibiotics content it is necessary to find natural product with antibiotic properties. Propolis is a sticky gummy resinous substance collected and mixed by worker honeybees (*Apis mellifera*), in temperate regions, and *Trigona* sp., in tropical regions, from the young shoots and buds of certain trees and shrubs [18]. This substance is known for having strong antibacterial, antifungal and antiviral properties and safe for human. One of the natural products which is considered safe for human while has antibacterial and antifungal activity is propolis [19][20][21][22][23][24][25].

Therefore, the present research studied for the first time the potential application of combination of mill derived from the black soldier fly larvae and propolis in broiler chickens diets. The effect on productive performance (growth performance, carcass weight, and meat quality) and animal welfare that evaluated by hematological parameter were considered in this study.

2. Methods

The trial was performed at the Departement of Biology, Universitas Islam Negeri Sunan Gunung Djati Bandung.

2.1. Black Soldier Fly Larvae (BSFL) Mill

The BSFL was originated from population stock, which reared in Laboratory of Animal Physiology, Universitas Islam Negeri Sunan Gunung Djati Bandung. Prepupae of BSFL were oven dried and milled to obtain the BSFL mill.

2.2. Propolis Extraction

Raw propolis was extracted by ethanolic extraction to obtain highest amount of phenolic compound [26]. Propolis extract then placed inside waterbath with temperature 50°C for 2-3 hours in order to remove the ethanol. The final product was a sticky gummy solution. About 3 gram of this solution diluted with 100 ml aquadest by hot plat and magnetic stirrer to obtain solution that used in this study.

2.3. Diet regimes

The trial was carried out to evaluate the effects of a partial replacement of fishmeal with BSFL mill on broiler chicken. A total of 40 broiler chicks (Ross 308) at one-day of age (DOC) were randomly allotted to 4 dietary treatments, each consisting of 10 chicks as replicates. The groups consisted of

P0: Control group, chicks were fed with 100% commercial feedstock.+ 1 ml aquadest administrated by oral feeding.

P1: Chicks were fed with 100% commercial feedstock + 1 ml solution of 3% propolis administrated by oral feeding.

P2: Chicks were fed with 85% commercial feedstock + 15% BSFL mill + 1 ml aquadest administrated by oral feeding.

P3: Chicks were fed with 85% commercial feedstock + 15% BSFL mill + 1 ml solution of 3% propolis administrated by oral feeding.

2.4. Feeding

Forty broiler chicks (Ross 308) were reared until 21 days of age in heated pen (1 m wide and 1.5 m long) and fed with the same standard control grower diet. At day 21, chicks were separated and randomly allocated to individual cages (0.5 m wide and 0.5 m long) fitted with treatment diet regimes for two weeks.

2.5. Growth Performances

Clinical signs and mortality of the chicks were monitored daily during whole experimental period [27]. Body weight was recorded every week until the end of study period (day 35). Carcass weight, water, crude protein, and crude lipid of breast were recorded at the end of study period after the chickens were slaughtered.

2.6. Hematological parameters

At the end of the experiment (day 35), blood samples were collected from 4 birds. Blood samples were obtained using 3 ml sputit that injected into vena pectoralis. About 2.5 ml blood collected then placed in a microtube filled with EDTA. The total red and white blood cell determined in an improved Neubauer haemocytometer.

2.7. Statistical Analysis

The statistical analysis was performed using SPSS 16 software for Windows. Data were tested by one-way ANOVA, followed by Duncan's post-hoc test. Significance was declared at $p < 0.05$.

3. Results and discussion

3.1. Body Weight

During course of this study all chickens remained healthy (absence of clinical signs) and no mortality occurred during the trial. Among all groups, highest weight was recorded at group P3. On the other hand, partial replacement of commercial feed with BSFL mill and addition of propolis produced slightly heavier carcass although not significant compare with other groups (Figure 1).

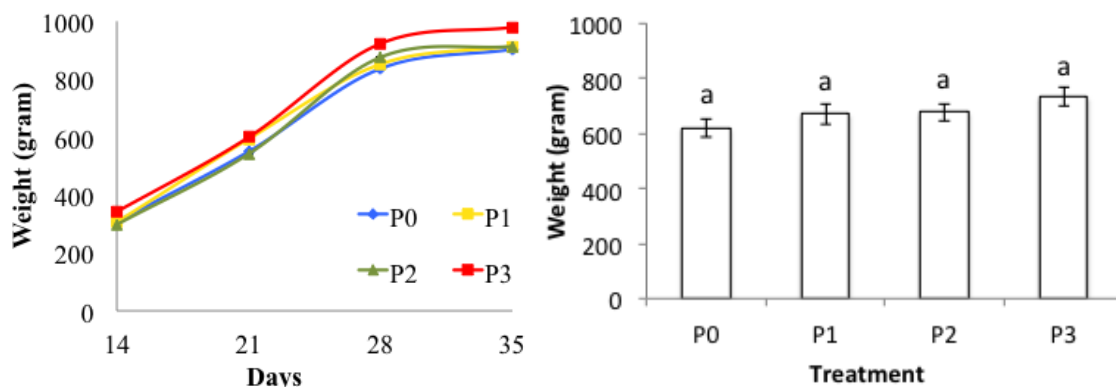


Figure 1. Growth pattern of chicken (left) and average weight of carcass (right)

This result indicated the potency of black soldier fly meal as a valuable source of energy and digestible amino acids for chicken, thus being a potential feed ingredient for chicken diets in the near future [28]. The result agree with other trial that tested BSFL as an alternative protein source to soybean meal and revealed positive results in terms of productive performance [13][27][29]. The result also agreed with studies reported positive effect of propolis supplementation to body weight [20][30][31][32]. The lipid acid of BSFL as expected effect the crude lipid profile of broiler chickens as also reported by Schiavone et al. [27] (Figure 2).

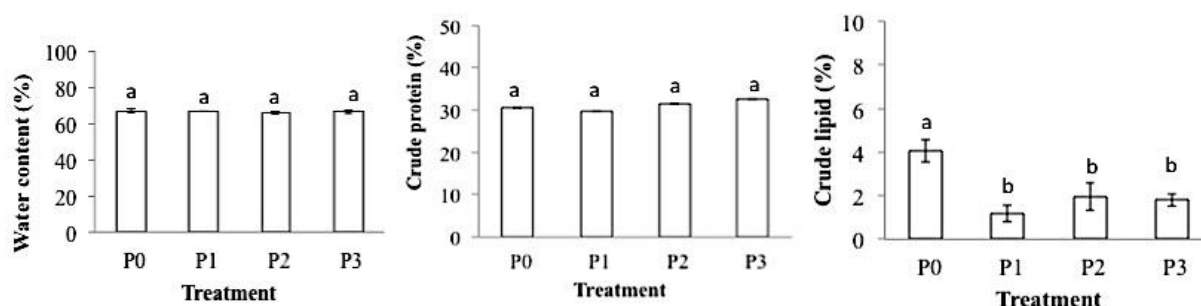


Figure 2. Water content, crude protein and crude lipid of broiler chicken fed with various combination of BSFL mill and propolis supplementation

3.2. Hematological parameters

Number of red blood cells was not significantly affected by replacement of diet with BSFL meal and supplementation with propolis (Table 1). The result indicated that change in diet regime may not have a stimulatory effect on the synthesis and release of these cells from bone marrow, which is contradictive to studies reported by Abdel-Rahman and Mosaad [33]. The differences in environmental condition or types of diet may explain the differences although further studies are required to test this hypothesis.

Combination of BSFL meal and propolis supplementation improve total numbers of white blood cells which indicated the stimulatory effect on leucocyte synthesis which related to better immune system in chicken (Table 1). The result is contradictive to other reports showed not significant effect of propolis supplementation to number of white blood cells [34][35]. The combination also significantly improves haemoglobin concentration that suggested the improvement in utilisation of iron and lower regeneration efficiency of haemoglobin. Improvement in haemoglobin may help prevent the anaemia syndrome in poultry (Table 1) [36].

Haematocrit were not significantly affected by the dietary treatments (Table 1) and fell within the physiological ranges [27][37], thus suggesting that dietary maggot inclusion does not affect haematocrit level of poultry.

Table 1. Hematological parameters of chicken during study

	P0	P1	P2	P3
Red blood cells ($10^6/\mu\text{l}$)	20.49 ± 2.82a	16.77 ± 1.88a	19.63 ± 2.17a	16.67 ± 2.62a
White blood cells ($10^6/\mu\text{l}$)	6.81 ± 1.45a	7.59 ± 1.66a	6.79 ± 2.15a	18.99 ± 4.96b
Haemoglobin (g/ μl)	7.86 ± 1.60a	6.43 ± 1.45a	20.14 ± 4.92b	11.00 ± 1.72c
Haematocrit (%)	20.71 ± 2.31a	22.86 ± 2.21a	17.86 ± 1.98a	20.00 ± 2.40a

Different letter indicated significance difference ($P < 0.05$)

4. Conclusion

Application of BSFL meal as partial replacement of common feedstock of local broiler chicken combined with propolis showed satisfactory productive performances, carcass traits and meat quality. Combination of both treatment improve health status of local broiler chicken which may provide another strategy to develop better local poultry industry based on local commodity

5. Acknowledgement

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