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# Growth performance of colored (Hubbard) broiler chicken *(Gallus domesticus)* fed with commercial ration supplemented varying levels of frozen black soldier fly larvae *(Hermetia illucens)* under confined condition

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**Abstract**

This study was conducted atcmU Poultry Production Project, Musuan, Maramag, Bukidnon to evaluate the effect of Black soldier fly larvae *(Hermetia illucens)* on the growth performance of colored broiler chickens. A total of 48-day old chicks regardless of sex were used in the study. These were randomly distributed into four treatments which were replicated three times with 4 birds per replication and these were observed for 38 days under supplementation of varying levels of Black soldier fly larvae *(Hermitia illucens)*. The experimental treatments were as follows: Treatment 1- 100% commercial feeds (control), Treatment 2- 95% commercial feeds + 5% g Black soldier fly larvae, Treatment 3- 90% commercial feeds + 10% g Black soldier fly larvae, Treatment 4- 85% commercial feeds + 15% g Black soldier fly larvae, The result of this study revealed non-significant differences among treatment means on the average initial weight as well as the final weight, total weight gain, and average daily gain weight. A highly significant result was observed among treatment means at ($P<0.05$) in average feed consumption and average treatment consumption. A significant result was observed at ($P<0.05$) in feed efficiency.

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## Introduction

Raising broiler chicken in the country has been recognized as one of the easiest forms of animal raising because broiler can be raised as short as thirty-five (35) days. Poultry production does not only provide income but also satisfies the protein requirement of the human diet, (Amoncio, 2009). The most limiting nutrient in the diet of Filipinos is protein. This limitation could best be patched-up by animal protein sources of the animal protein sources, the broiler is one of the most efficient converters of feeds to meat and its production is considered as a quick measure to supply the demand of today's increasing population, as cited by Intong (1988).

The Production cost of broiler at present has enormously increased due to the interminable rising price of broiler feeds which contributes 60-80% (FAO, 2007), and fishmeal makes up a substantial stake in the cost. This situation demands the exploration of the possible materials believed to have nutritional value not only for broiler but also for other species of domesticated livestock, as cited by Intong (1988). Today many researchers had endeavored much in establishing alternative ingredients particularly that of protein sources because those that are prepared commercially are very costly.

The black soldier fly is an extremely resistant species dealing with demanding environmental conditions, such as drought, food storage, or oxygen deficiency (Diener, 2011). Rearing *Hermitia illucens* has been proposed since the 1990s as an efficient way to dispose of organic wastes by converting them into a protein-rich and fat-rich biomass suitable for various purposes, these include animal feeding for all livestock species, and biodiesel and chitin production (van Huis, 2013 and Diener 2011). The black soldier fly is an extremely resistant species capable of dealing with demanding environmental conditions, such as drought, food shortage, or oxygen deficiency (Diener, 2011). One major advantage of *Hermetia illucens* over other insect species used for biomass production is that the adult does not feed and therefore does not require particular care and is not a potential carrier of any diseases. The Black Soldier Fly larvae can be used as feed (42% protein, 35% fat) for a variety of livestock. This feedstuff when dried has an estimated value comparable to soybean or meat and bone meal (Newton *et al.*, 1997, Sheppard *et al.*, 1994). Thus, this study is to explore the possibility to minimize cost of protein concentrates and as an alternative source of protein feeds to chicken.

## Materials and methods

*Culture Media Facilities*

The materials that were used were weighing scale, basin, PVC pipe and elbow (2 inches), net, rubber band, 6-liter plastic container, packaging tape, salmon can, plastic cellophane, and a record book.

*Poultry Facilities and Equipment*

The poultry facilities and equipment that were used in the study include the brooding house, rearing pens feeding troughs, waterers, weighing scale, and electric bulbs. Old newspapers and empty sacks were utilized as bedding material to help maintain the desired temperature of chicks during the brooding period.

*Experimental Animals and Design*

A total of 48 day-old chickens regardless of sex were used in the study. These were distributed at random into four dietary treatments. Each treatment was replicated three times with four birds per replication following the Completely Randomized Design (CRD).

A commercial ration was used and black soldier larvae supplementation was made at different levels which were the following:

| | |
|---|---|
| Treatment 1= | 100% commercial feeds (control) |
| Treatment 2= | 95% commercial feeds + 5% Black soldier fly larvae |
| Treatment 3= | 90% commercial feeds + 10% Black soldier fly larvae |
| Treatment 4= | 85% commercial feeds + 15% Black soldier fly larvae |

*Care and Management of Experimental Birds*

*Confined Area*

A total of 48 birds were raised in the cage throughout the study period.

The cages were made out of wire mesh that was used to accommodate four birds per replication. With a space allowance of 1.0sq. ft. per bird. 48 day-old chicks were reared and provided access to feeders and drinkers.

*Brooding*

Floor spacing of the brooding cages and rearing pens were followed as well as proper ventilation. All the experimental birds were provided with 50 watts of electric bulb for 28 days until such time that the birds were ready to regulate their body temperature. Old Newspapers were used as bedding materials to conserve heat and to maintain the required temperature during the brooding period, Feeding.

During the brooding stage the birds were fed *ad libitum* basis with vitamin-mineral supplementation. For the first day until 28 days of life of chicks they were fed with chick booster mash alone. The chicks in their 28 days of life were randomly distributed into four dietary treatments. From day 28 to day 66, the birds were given different levels of Black Soldier Fly Larvae along with the broiler starter crumble feeds.

*Drinking-Water*

Drinking water is an essential nutrient for the broiler. In the study, drinking water was made available at all times throughout the study. Cleaning and changing of water were done early in the morning and in the afternoon.

**Table 1.** Composition and analysis of chick booster mash.

| Particulars | | |
|---|---|---|
| Ingredients | | |
| Corn | Meat and Bone Meal | Lysine Sulphate |
| Cassava Meal | Brewer's Dried Grains and Yeast | DL-Methionine |
| Soybean Meal | Crude Coconut Oil | Choline Chloride |
| Full Fat Soya | Crude Palm Oil | Vitamin Mineral Premix |
| Rice Bran | Molasses | Enzymes |
| Wheat Pollard | Limestone | Toxin Binders |
| Fish Meal | Inorganic Phosphate | Mold Inhibitor |
| Pork Meal | Iodized Salt | Antioxidants |
| Poultry Meal | L-Lysine and L-Threonine | |
| Guaranteed Analysis | | |
| Crude Protein | 24.00% min. | |
| Crude Fiber | 5.00% max. | |
| Crude Fat | 3.00% min. | |
| Calcium | 0.90% min. | |
| Phosphorus | 0.55% min. | |
| Moisture | 12.00% max. | |

Source: B-MEG (2013)

**Table 2.** Composition and analysis of broiler starter crumble.

| Particulars | | |
|---|---|---|
| Ingredients | | |
| Corn | Meat and Bone Meal | Lysine Sulphate |
| Cassava Meal | Brewer's Dried Grains & Yeast | DL-Methionine |
| Soybean Meal | Crude Coconut Oil | Choline Chloride |
| Full Fat Soya | Crude Palm Oil | Vit. Min. Premix |
| Rice Bran | Molasses | Enzymes |
| Wheat Pollard | Limestone | Toxin Binders |
| Fish & Pork Meal | Inorganic Phosphate | Mold Inhibitor |
| Copra Meal | Iodized Salt | Antioxidants |
| Poultry & Feather Meal | L-Lysine and L-Threonine | |
| Corn Bran | Corn Gluten Feed | |
| Corn Germ & Gluten Meal | | |
| | Guaranteed Analysis | |
| Crude Protein | 21.00% min. | |
| Crude Fiber | 6.00% max. | |
| Crude Fat | 4.00% min. | |
| Calcium | 0.90% min. | |
| Phosphorus | 0.55% min. | |
| Moisture | 12.00% max. | |

Source: B-MEG (2013)

**Table 3.** Experimental rations composition and calculated analysis of broiler starter crumble (BSC).

| Particulars | Treatment | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Commercial Ration (g) | 1000 | 950 | 900 | 850 |
| Black Soldier Fly Larvae (g) | 0 | 50 | 100 | 150 |
| Total (g) | 1000 | 1000 | 1000 | 1000 |
| Calculated Analysis | | | | |
| Crude Protein (%) | 21.00 | 22.39 | 23.80 | 25.194 |
| Crude Fiber (%) | 6.00 | 6.16 | 6.31 | 6.46 |
| Crude Fat (%) | 4.00 | 5.11 | 6.23 | 7.34 |
| Calcium (%) | 0.9 | 0.97 | 1.04 | 1.10 |
| Phosphorus (%) | 0.55 | 0.56 | 0.56 | 0.57 |
| Moisture (%) | 12.00 | 14.55 | 17.09 | 19.65 |

*Preparation of the Treatment*

The Black Soldier Fly Eggs were introduced and reared at the kitchen wastes media to be cultured at a certain period; the media weighed ten kilograms. The black soldier fly larvae were harvested at a certain period. These were stored in the refrigerator for preservation.

**Table 4.** Analysis of black soldier fly larvae (*Hermetia illucens*).

| Particulars | Amount |
|---|---|
| Total CP (%) | 32.25 |
| Total N (%) | 5.16 |
| Moisture (%) | 62.54 |
| Dry Matter (%) | 37.46 |
| Ash (%) | 11.28 |

Source: Soil and Plant Analysis Laboratory, (2014)

*Acquisition of Experimental Animals*

Colored broiler chickens were obtained from Tarlac. The day-old chicks were subjected to a brooding period for 28 days before exposing them to different treatments. The experimental animals were placed in a confined study area.

Data Gathered

The following data were gathered for statistical analysis with their corresponding formula:

1. Initial Weight (IW) = Weight of experimental birds at the start of the study
2. Final Weight (FW) = Weight of experimental birds at the end of the study
3. Total Weight Gain (TWG) = Final Weight – Initial Weight
4. Average Daily Gain (ADG) = Final Weight – Initial Weight Number of Feeding Days
5. Feed Consumption (FC) = Total Amount of Feed Given – Feed Left Over
6. Feed Conversion Ratio (FCR) = Total Feed Consumed Total Weight Gain
7. Treatment Consumption = Feed intake x% Black Soldier Fly larvae meal
8. Return Above Feed and Supplementation Cost = Gross sale – (Feed Cost + Supplementation)

*Statistical Analysis*

All the data gathered at the end of the study were tabulated and statistically analyzed using the Analysis of Variance (ANOVA) in a Complete Randomized Design (CRD). The Duncan's Multiple Range Test (DMRT) was also used to compare any significant differences among treatment means.

**Results and discussion**

As shown in Table 6, the average initial weights showed no significant difference among treatment means. Although birds in Treatment 4 had the highest average initial weight of 733.75g followed by Treatment 3 with 732.50g, Treatment 1 with 731.41g and Treatment 2 730.17g, the lowest yet they were comparable with each other. The initial weight was taken on the 28th day of the study.

**Table 5.** Average initial weight (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*)

| Treatment | Observation | | | Mean$^{ns}$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 782.50 | 688.00 | 723.75 | 731.41 |
| 2 | 742.50 | 760.50 | 687.50 | 730.17 |
| 3 | 737.50 | 706.25 | 753.75 | 732.50 |
| 4 | 780.00 | 687.50 | 733.75 | 733.75 |

CV = 5.48%

ns = non-significant

*Average Final Weight*

Table 7 presents the average final weight of colored broiler chicken. Results showed no significant difference among treatment means on the average final weight gain of colored broiler chicken fed with commercial ration supplemented with frozen black soldier fly larvae. The average final weights have a positive effect but are not enough to show a significant difference among treatment means. Treatment 4 showed the highest final weight of 2399.67g but this is comparable to the rest of the treatments such as Treatment 3 with the final weight of 2376.33g while Treatment 1 had the lowest final weight of 2126.00g and -Treatment 2 with the final weight of 2242.00g.

**Table 6.** Average Final weight (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | Mean$^{ns}$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 2217.00 | 1980.00 | 2181.00 | 2126.00 |
| 2 | 2244.00 | 2405.00 | 2077.00 | 2242.00 |
| 3 | 2528.00 | 2180.00 | 2421.00 | 2376.33 |
| 4 | 2450.00 | 2226.00 | 2523.00 | 2399.67 |

CV = 6.88%

ns = non-significant

*Average Daily Gain*

The average daily gain (ADG) of broiler chicken fed commercial ration supplemented with various levels of black soldier fly larvae is shown in Table 9. No significant differences among treatment mean in the average daily gain of colored broiler chicken fed with commercial ration supplemented with black soldier fly larvae were observed. Treatment 4 showed the highest average daily gain of 43.84g followed by Treatment 3 with 43.26g while Treatment 1 has the least average daily gain of 36.70g but comparable to Treatment 2 with 39.78g.

*Total Weight Gain*

Total weight gains of colored broiler chicken fed with commercial ration supplemented with various levels of black soldier fly larvae was presented in Table 8. Results revealed no significant difference among treatment means Treatment 4 showed the highest average total weight gain of 1665.92g followed by Treatment 3 with the average total weight gain of 1643.83g while Treatment 1 has the least average total weight gain of 1394.58g but comparable to Treatment 2 with 1511.83g.

**Table 7.** Total Weight Gain (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | Mean$^{ns}$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 1434.50 | 1292.00 | 1457.25 | 1394.58 |
| 2 | 1501.50 | 1644.50 | 1389.50 | 1511.83 |
| 3 | 1790.50 | 1473.75 | 1667.25 | 1643.83 |
| 4 | 1670.00 | 1538.50 | 1789.25 | 1665.92 |

CV = 8.24%

ns = non-significant

**Table 8.** Average Total Weight Gain (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | mean$^{ns}$ |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 37.75 | 34.00 | 38.35 | 36.70 |
| 2 | 39.51 | 43.28 | 36.57 | 39.78 |
| 3 | 47.12 | 38.78 | 43.88 | 43.26 |
| 4 | 43.95 | 40.49 | 47.09 | 43.84 |

CV = 8.24%

ns = non-significant

*Average Total Feed Consumption*

A recent study by Hale, 1973 as a component of a complete diet, black soldier fly larvae meal has been found to support good growth in chicks. Chicks fed a diet containing dried black soldier fly larvae as the protein supplement gained weight at a rate of 96% (non-significant) with that of chicks fed soybean meal plus fat, but they only consumed 93% (significant) as much feed. Table 10 showed the total feed consumption of colored (Hubbard) broiler chicken fed with commercial ration supplemented with various levels of frozen black soldier fly larvae.

Statistical analysis showed that the treatment means were highly significant at ($p>0.05$). Treatment 4 had the Total feed consumption with an average initial

weight of 3474.80g followed by Treatment 3 with 3618.82g, Treatment 2 with 3728.50g and Treatment 1 had the lowest with 3831.81g.

**Table 9.** Average Total feed consumption (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | Mean ** |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 3889.89 | 3772.85 | 3832.69 | 3831.81$^{a}$ |
| 2 | 3730.26 | 3770.74 | 3684.50 | 3728.50$^{ab}$ |
| 3 | 3558.10 | 3678.66 | 3619.70 | 3618.82$^{b}$ |
| 4 | 3539.63 | 3519.39 | 3365.39 | 3474.80$^{c}$ |

CV = 5.50%

*= significant at (p<0.05) level

*Feed Conversion Ratio*

Feed conversion ratio (FCR) is a measure of an animal's efficiency in converting feed mass into increased body mass gain, over a specified period (Anonymous, 2013). Thus, the lower the value the more efficient is the broiler in converting feed to live weight gain. Due to the high crude fat of black soldier fly larvae some recent studies may suggest that fat enhances feed efficiency via an "extra caloric" effect with older turkeys (Jensen, 1970).

On the other hand, there are differences in digestion and absorption of dietary fat as older chicks can utilize fat more efficiently than younger ones (Turner, 1999). Other beneficial effects of fat in improving energy utilization was due to retardation of the rate of intestinal feed passage allowing for better absorption of nutrients from the gut (Mateos and Sell, 1981). Table 11 showed the average feed conversion ratio of the colored (Hubbard) broiler chicken fed with commercial ration supplemented with frozen black soldier fly larvae.

It was noted that birds in Treatment 4 had a better feed conversion ratio of 2.10 as compared to Treatment 3 which had 2.22, Treatment 2 with 2.47, and Treatment 1 with 2.75. There were significant differences observed at (p<0.05) which means that feed conversions were affected by black soldier fly larvae supplementation.

**Table 10.** Average Feed conversion ratio of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | Mean * |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 2.71 | 2.92 | 2.63 | 2.75$^{a}$ |
| 2 | 2.48 | 2.29 | 2.65 | 2.47$^{ab}$ |
| 3 | 1.99 | 2.50 | 2.17 | 2.22$^{b}$ |
| 4 | 2.12 | 2.29 | 1.88 | 2.10$^{b}$ |

CV = 8.48%

*= significant at (p<0.05) level

*Black Soldier Fly Larvae (Hermetia illucens) Treatment Consumption*

Analysis of variance (ANOVA) on the black soldier fly larvae consumption showed highly significant differences (*P*<0.05) among treatment means. Table 12 showed the average black soldier fly larvae consumption of colored (Hubbard) broiler chickens. As expected, birds in Treatment 4 had the highest black soldier fly larvae of 521.22 gms, followed by Treatment 3 with 361.88gms and Treatment 2 with 186.42 gms and Treatment 1 which has 0.00521.22 black soldier fly larvae consumption.

**Table 11.** Average treatment consumption (g) of colored (Hubbard) broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Treatment | Observation | | | Mean** |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| 1 | 0.00 | 0.00 | 0.00 | 0.00$^{d}$ |
| 2 | 88.82 | 89.78 | 87.73 | 186.42$^{c}$ |
| 3 | 169.44 | 175.18 | 172.37 | 361.88$^{b}$ |
| 4 | 252.84 | 251.39 | 240.39 | 521.22$^{a}$ |

CV = 2.92%

** = highly significant at 5% level

Means with no common letters are significantly different from each other (DMRT) Return Above Feed and Supplementation Cost For now, Black Soldier Fly Larvae are a non-conventional feedstuff, if it is available to the market the suggested price would be PhP 15.00 per kilo. The economics of Black Soldier Fly Larvae supplementation was more encouraging where treated groups generated more profit than that of the control group.

Table 13 showed the average return above feed and supplementation cost of colored broiler chicken fed with commercial ration supplemented with Black Soldier Fly Larvae.

Among all the treatments, Treatment 4 had the highest return of PhP 120.16, followed by Treatment 3 with PHP 114.53 and Treatment 2 with PHP 92.43 while Treatment 1 had PHP 74.99.

**Table 12.** Return above feed and supplementation cost (PHP) of colored (Hubbard) broiler chicken fed with commercial ration supplemented with frozen black soldier fly larvae (*Hermetia illucens*).

| Particulars | Treatment | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| Final live weight,kg | 2.13 | 2.24 | 2.38 | 2.40 |
| Price perkg, Ph₱ | 150.00 | 150.00 | 150.00 | 150.00 |
| Gross return per head, Ph₱ | 319.50 | 336.00 | 357.00 | 360.00 |
| Cost of day-old chicks per head, Ph₱ | 40.00 | 40.00 | 40.00 | 40.00 |
| Feed consumption per head,kg | | | | |
| Chick booster mash | 2.92 | 2.92 | 2.92 | 2.92 |
| Broiler starter crumble | 3.83 | 3.54 | 3.26 | 2.95 |
| Price perkg feed, Ph₱ | | | | |
| Chick booster mash | 32.00 | 32.00 | 32.00 | 32.00 |
| Broiler starter crumble | 29.00 | 29.00 | 29.00 | 29.00 |
| Total feed cost, Ph₱ | | | | |
| Chick booster mash | 93.44 | 93.44 | 93.44 | 93.44 |
| Broiler starter crumble | 111.07 | 102.66 | 94.54 | 85.55 |
| Total BSFL Consumed, kilograms | 0.00 | .498 | .966 | 1.39 |
| Price per kilograms of BSFL, Ph₱ | 15 | 15 | 15 | 15 |
| Total BSFL cost, Ph₱ | 0.00 | 7.47 | 14.49 | 20.85 |
| Return above feed and supplementation cost, Ph₱ | 74.99 | 92.43 | 114.53 | 120.16 |

**Conclusions and recommendation**

A total of 48 day-old chicks regardless of sex were randomly distributed into four dietary treatments in a Complete Randomized Design (CRD). The four dietary treatments were replicated three times.

The data gathered in the study consisted of an initial weight, final weight, total body weight, average daily gain, total feed consumption, feed conversion ratio, and Black Soldier Fly Larvae consumption which were analyzed using the analysis of variance (ANOVA) of a Complete Randomize Design (CRD) except for the return above feed and supplementation cost. Significant differences among the treatment means that were observed were compared using Duncan's Multiple Range Test (DMRT).

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