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Visceral organ of colored broiler chicken (*Gallus domesticus*) fed with commercial ration supplemented with varying levels of black soldier fly frozen larvae (*Hermetia illucens*) under free range

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Abstract

This study was conducted atcmU Poultry Production Project, Musuan, and Maramag Bukidnon to evaluate the effect of Black Soldier Fly Larvae (*Hermetia illucens*) under a free-range condition in the commercial ration on the visceral organ of colored broiler chicken. A total of 12 birds were obtained from a flock of 48 colored broiler chickens from a growth performance study. The treatments were as follows: Treatment 1 = 100g commercial feeds (control), Treatment 2 = 95% commercial feeds + 5% BSF larvae, Treatment 3 = 90% commercial feeds + 10% BSF larvae and Treatment 4 = 85% commercial feeds + 15% BSF larvae. Based on the result of analysis of variance (ANOVA), it showed no significant differences among the parameters of the studied weights of the crop with and without fill, weight of proventriculus without fill, weight of small intestine with and without fill, large intestine with and without fill, caeca with and without fill, weight of heart, and weight of gall bladder. However, the weight of proventriculus plus gizzard with fill, weight of liver, weight of spleen, weight of pancreas revealed significant differences based on Duncan's Multiple Range Test (DMRT). Furthermore, Black Soldier Fly Larvae (*Hermetia illucens*) were highly recommended to animals because there were no detrimental observed in the study. This result indicates that using Black Soldier Fly Larvae (*Hermetia illucens*) as supplementation ration can improve the visceral organ performance of broiler chicken.

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Introduction

The poultry industries particularly on the part of the raisers, continuously find means to lessen their cost of production. One way is to look for alternative source of feed supplement that is not only cheap but economically viable and environmentally friendly. Poultry production is one of the fastest-growing and most important sectors in the broad field of animal production. It has become the major source of income for big and small farmers. As well as one of the most profitable business ventures considering it being a fast multiplier and requires only a short period time to obtain average market weight.

The Broiler industry provides a large part of the increasing demand for animal protein, cash income, and creating employment opportunities. Poultry meat contributes approximately 37% of the total animal protein supplied in the country. There is a great possibility of growth and enlargement of this sector both at the domestic and commercial levels. But, broiler producers are facing many difficulties with availability and higher prices of feed ingredients. Feed cost account 65-70% of the total poultry rearing cost (Bhuiyan, 1998) and protein cost account 15% of feed cost (Banerjee, 1992 and Singh, 1990). The animal protein source is the costliest ingredient for the formulation of poultry diets than any other source of the nutrients. Visceral organs of broiler chicken in the Philippines now a day have a significant value knowing that these are now intended for human consumption. Considering that all feed intake passes through the digestive system, some feed intake will affect the lengths of the visceral organs. Many of the street foods now are selling most of the internal organs in the consumer. Visceral organs of broiler chicken in the Philippines nowadays have a significant value knowing that these are now intended for human consumption. Considering that all feed intake passes through the digestive system, some feed intake will affect the lengths of the visceral organs. Many of the street foods now are selling most of the internal organs in which consumers prefer more to eat not just it is cheap but also it has good taste. Black Soldier Fly (*Hermetia illucens* (L.), is a non-pest tropical and warm-temperate region insect that is useful for managing large concentrations of animal manure and other bio-solids. Manure management relying on wild fly oviposition has been successful in several studies. Today, many researchers had endeavored much in establishing alternative ingredients particularly that of protein sources because commercially prepared protein sources is very costly. These study aims to lessen the input of feed cost were farmers have been encountered and to evaluate the effect of the Black Soldier fly larvae as an alternative protein source of feed ingredients of the chicken.

Black soldier fly can replace to fish meal as a source of protein. The larvae are highly efficient in converting proteins, containing up to 42% of protein, and a lot of calcium and amino acids. This study wants to explore the possibility of utilizing Black Soldier Fly Larvae (*Hermetia illucens*) as a supplement in broiler chicken diet that provides new information contributing to the farmers and the poultry industry.

Materials and methods

Facilities and equipment

The following facilities and equipment were used in performing the study such as measuring device (tape measure or ruler), weighing scales, dressed chicken and the visceral organs of broiler chicken, knives, record book, cooler with ice, plastic cellophane and the thread that was used to tie the different end of the digestive parts.

Experimental animals

The colored broiler chicken at day old was subjected to 25th day of the brooding period before introducing to different treatments to adjust the environment providing that they were given 24/7 proper care and handling.

Experimental treatments

The following dietary treatments were as follows:

Treatments ration

Treatment 1 100%commercial feeds (control)
Treatment 2 95% commercial feeds + 5% BSF larvae
Treatment 3 90% commercial feeds + 10% BSF larvae
Treatment 4 85% commercial feeds + 15% BSF larvae

Table 1. Ingredient Composition of Chick Booster Mash Source: B-MEG (2013).

PARTICULARS		
Ingredients		
Corn	Meat and Bone Meal	Lysine Sulphate
Cassava	Brewer's Dried Grains and 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 Meal	Inorganic Phosphate	Mold Inhibitor
Pork Meal	Iodized Salt	Antioxidants
Poultry Meal	L-Lysine and L-Threonine	
Guaranteed Analysis		
Crude Protein	22.00% min.	
Crude Fiber	5.00% max.	
Crude Fat	4.00% min.	
Calcium	0.90% min.	
Phosphorus	0.55% min.	

Table 2. Experimental Rations Composition and Calculated Analysis of Chick Booster Mash (CBM).

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 (%)	22.00	23.348	24.696	26.044
Crude Fiber (%)	5.00	5.205	5.41	5.615
Crude Fat (%)	4.00	5.1145	6.229	7.3435
Calcium (%)	0.9	0.968	1.036	1.104
Phosphorus (%)	0.55	0.556	0.562	0.568

Preparation of the Black Soldier Fly Larvae

The Black Soldier Fly Eggs were introduced and reared at the kitchen wastes media and cultured at certain period; the media weigh five (5) kilograms. Kitchen wastes media were collected from our kitchen wastes. The black soldier fly larvae were stored in the refrigerator for preservation.

Data gathered

1. Total length of Digestive System
2. Total weight of Digestive System
3. Length of small intestine
4. Length of large intestine
5. Length of caeca
6. Length of pancreas
7. Weights of crops with or without fill
8. Weight of proventriculus plus gizzard with or without fill
9. Weight of small intestine
10. Weight of large intestine
11. Weight of caeca
12. Weight of spleen
13. Weight of pancreas
14. Weight of gall bladder
15. Weight of liver
16. Weight of heart

Handling of Visceral Organ

At the end of the feeding period,12 birds were taken from the nearest to the mean of the average final weight from the growth performance study from the four (4) dietary treatments, with one (1) bird per replication.

The birds were eviscerated using the slaughtering procedure for evisceration which involves the cutting of the throat from the outside on the bird's neck just behind and below the earlobe. With downward pressure, the knives was pulled downwards for a short distance behind the lower mandible and the head were rolled with the left hand. A single clean stroke was desirable since several cuts may Enrollment the clotting and preventing from bleeding. The birds were allowed to bleed for about two minutes. In scalding process, the birds were immersed in boiled water. This is to facilitate the ease of removal of the feathers. After evisceration, the visceral organs were placed in the plastic bags individually and placed in the cooler with ice to avoid drying up and turgidity.

Statistical Analysis

All data gathered, were organized, tabulated and subjected to statistical analysis using Analysis of Variance (ANOVA) in Completely Randomized Design (CRD). Duncan's Multiple Range Test (DMRT) was used to compare any significant differences among treatments.

Results and discussions

Weight of Crop with Fill

The average weight of crop with fill of colored broiler chicken was presented in Table 3. Non-significant differences among the different treatment were observed for the weight of crop with fill. Birds in Treatment 3 had a heaviest mean weight of 19.33 grams followed by Treatment 1 with 17.67 grams, Treatment 2 with 16.00 grams and Treatment 4 with 15.33 grams. These results shows that the supplementation of Black Soldier Fly Larvae in the diet of birds did not affect on the parameters.

On the other hand, no significant differences were also observed on the weight of crop without fill as presented in Table 4. Treatment 4 had the highest mean weight of 12.67 grams followed by Treatment 3 with 12.33 grams, Treatment 2 with 11.00 grams and Treatment 1 with 10.66 grams. This result implies that the supplementation of varying treatments cannot affect the weight of the crop without fill. One of the factor that it no significant effect was that, colored broiler chicken are types of chicken that can consumed their feeds at once.

The significant function of the crop is to store food when the birds are eating rapidly. The size and shape of the crop is generally dependent on the eating habit and size of the broiler (Anunciado 2007).

Table 3. Weight of crop with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	15.00	14.00	24.00	17.67
2	10.00	23.00	15.00	16.00
3	13.00	20.00	25.00	19.33
4	20.00	14.00	12.00	15.33

CV%= 16.58

ns= Non significant

Weight of Proventriculus plus Gizzard With and Without Fill

Tables 6 and 7 show the average weight of proventriculus plus gizzard with fill and without fill of colored broiler chicken fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition different from each other.

Table 4. Weight of crop without fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	9.00	15.00	15.00	10.66
2	10.00	19.00	14.00	11.00
3	13.00	10.00	13.00	12.33
4	9.00	9.00	11.00	12.67

CV%=21.43

ns= Non significant

In Table 5 the weight of proventriculus plus gizzard with fill showed, Treatment 1 obtaining the highest mean weight of 73.67 grams which was followed by the birds in Treatment 2 with 62.33 grams, Treatment 3 with 57.53 and Treatment 4 obtained the lowest mean weight of 56.00 grams. These imply that the without the addition of Black Soldier Fly Larvae in the diet of birds increase its weight and further shows the significant effect the reason behind might be because the fact that they are at free-range condition, the natural food that they can get in the surroundings.

Table 6 presents the average mean weight of the proventriculus plus gizzard without fill, in which Treatment 1 had the highest treatment mean of 53.67 grams while Treatment 3 had the lowest treatment mean of 43.33 grams. This indicates that the amount of feed given to the birds did not affect the weight of proventriculus plus gizzard without fill of the birds.

The proventriculus is a standard part of avian anatomy. It constitutes the glandular region of the chicken stomach that may store or commence digestion before it progresses to the gizzard.

The gizzard is an organ in the digestive tract found in birds. This specialized stomach constructed of thick, muscular walls used for grinding up food. Gizzards are secondary stomachs used by birds to grind their food before digestion. It contains a very tough inner membrane, surrounded by a muscular pouch which provides the grinding action (Anonymous, 2013).

Table 5. Weight of proventriculus plus gizzard with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (Hermetia illucens) under free-range condition.

Treatments	Observation			Mean*
	1	2	3	
1	73.00	73.00	62.00	73.67[a]
2	71.00	56.00	56.00	62.33[ab]
3	77.00	60.00	60.00	57.53[b]
4	58.00	50.00	52.00	56.00[b]

CV%= 9.92

*= significant

Means having different letters differ significantly.

Table 6. Weight of proventriculus plus gizzard without fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean[ns]
	1	2	3	
1	53.00	54.00	49.00	53.67
2	51.00	45.00	45.00	48.67
3	57.00	42.00	50.00	43.44
4	47.00	39.00	45.00	46.67

CV%= 8.47

ns= Non significant

Weight of Small Intestine With and Without Fill

The average weights of small intestine with and without fill are presented in Table 7 and 9. Small intestine with fill in Table 8, it was observed that Treatment 4 had a heavier weight of 127.00 grams, then followed by Treatment 3 with 117.00 grams, Treatment 2 with 109.67 grams and the lowest mean was obtained by Treatment 1 with 106.33 grams, while Table 9 presents the average weight of small intestine without fill in which birds in Treatment 4 obtained the highest treatment mean of 73.00 grams which was followed by Treatment 1 with a mean of 62.00 grams, then Treatment 3 with 58.00 and the lowest weight was Treatment 2 with 48.67 grams.

Furthermore, both Tables 9 and 10 showed no significant differences among treatment means. These indicate that the supplementation of different levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) in the diet did not effect on the weight of small intestine of the birds.

From the ventriculus, the food enters the small intestine through a valve called the pylorus. The pylorus only allows a small amount of food to pass at a time, to the small intestine to allow for digestion to take place. The small intestines are lined with villi and microvilli. Villi are fingerlike projections and each villus; there is a rich capillary bed and a modified lymphatic capillary. The microvilli are tiny projections that line the outside of the villi and carry enzymes that break down into smaller particles; it is absorbed into the capillary systems and transported back to the liver (Winter, 2003).

Table 7. Weight of small intestine with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean[ns]
	1	2	3	
1	91.00	126.00	137.00	106.33
2	107.00	99.00	120.00	109.67
3	121.00	106.00	135.00	117.33
4	104.00	108.00	126.00	127.00

CV%= 12.22

ns = Non significant

Table 8. Weight of small intestine without fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean[ns]
	1	2	3	
1	49.00	53.00	55.00	62.00
2	62.00	52.00	69.00	48.67
3	75.00	50.00	79.00	58.00
4	41.00	69.00	71.00	73.00

CV%= 15.22

ns= Non significant

Weight of Large Intestine With and Without Fill

The average weight of large intestine with fill in Table 9 shows no significant effect, which was Treatment 3 had the heaviest mean weight of 16.33 grams, followed by Treatment 2 with 16.00 grams then Treatment 4 with 15.33 grams and the lowest mean was observed in Treatment 1 with 14.33 grams. These imply that the treatment has no significant difference in this parameter.

Table 10 presents the average weight of large intestine without fill. Birds in Treatment 4 showed a heaviest mean weight of 14.00 grams followed by Treatment 3with 13.67 grams then Treatment 2 with 13.33 grams and Treatment 1 observed as the lowest mean weight with 11.00 grams.

The nonsignificant difference among treatment means indicate that the different levels of Black Soldier Fly Larvae did not affect the parameters.

The large intestine's main function is to absorb water, dry out indigestible foods and eliminate waste products. The large intestines have bacteria that metabolize the remaining nutrients and then absorb them back into the system along with water. It is generally believed that the large intestine in birds do not play any significant role in the digestion and absorption of feed (Carpenter, 2003).

Table 9. Weight of large intestine with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	13.00	21.00	19.00	14.33
2	12.00	14.00	17.00	16.00
3	18.00	14.00	12.00	16.33
4	13.00	16.00	15.00	14.67

CV%= 21.13

ns= Non significant

Table 10. Weight of large intestine without fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	11.00	18.00	17.00	11.00
2	8.00	10.00	16.00	13.33
3	14.00	13.00	13.00	13.67
4	12.00	11.00	13.00	14.00

CV%= 23.92

ns= Non significant

Weight of Caeca With and Without Fill

The average weights of caeca with and without fill are presented in Tables 11 and 12. The weight of caeca with fill showed no significant differences among treatment means in Table 11. The birds in Treatment 4 with 22.33 grams observed having the average weight followed by Treatment 3 with 20.00 grams then, Treatment 2 and Treatment 1 with the same mean weight of 21.67 grams which observed having the lowest average mean weight.

Table 12 shows the average weight of caeca without fill. Treatment 4 having the weighted mean of 11.67 grams while Treatment 3,2 and 1 with corresponding treatment means of 9.33 grams, 9.67 grams and 10.00 grams, respectively.

This would imply that supplementation of varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) in the diet of broiler chicken had no effect on the weight of caeca with and without fill.

The factor that may explain the non-significant effect was that the enlargement of caeca was depending on the feed they had eaten. In this case beside the fact that they are subjected to free-range study the area where they are placed doesn't have any grasses that mainly develop the caeca of chicken. In addition, the feed that they have eaten maybe just a minute amount that it couldn't stay longer in the crop.

The caeca (plural form of cecum) are two blinded pouches located where the small and large intestines join. Some of the water remaining in the digested material is reabsorbed here. Another important function of the caeca is the fermentation of any remaining coarse materials.

During the fermentation, the caeca produce several fatty acids as well as the 8 B vitamins (thiamine, riboflavin, niacin, pantothenic acid, pyridoxine, biotin, folic acid, and vitamin B 12). Because the caeca are located so close to the end of the digestive tract, however, few of the produced nutrients are absorbed and available to the chickens (Jacquie, 2012).

Table 11. Weight of caeca with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	21.00	24.00	20.00	21.67
2	20.00	19.00	19.00	21.67
3	21.00	21.00	27.00	20.00
4	22.00	19.00	21.00	22.33

CV%= 12.57

ns= Non significant

Table 12. Weight of caeca without fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	12.00	11.00	8.00	10.00
2	8.00	8.00	11.00	9.67
3	10.00	9.00	13.00	9.33
4	10.00	11.00	11.00	11.67

CV%=15.55

ns= Non significant

Weight of Liver

Table 13 shows the average weight of the liver of colored broiler chicken supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-ranged condition.

Treatment 4 exhibited the treatment mean of 72.00 grams, followed by the Treatments 1,3 and 2 with corresponding weight means of 61.33 grams, 57.00 grams and 55.33 grams respectively.

This would imply that the supplementation of varying levels of Black Soldier Fly Larvae at 15% in the diet of colored broiler chicken increase the weight of the liver which statistically shows a significant result.

The liver plays a major role in metabolism and has a number of functions in the body, including glycogen storage, decomposition of red blood cells, plasma synthesis and detoxification (Anonymous, 2013b).

Table 13. Weight of liver (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean*
	1	2	3	
1	65.00	59.00	60.00	61.33^{ab}
2	49.00	59.00	58.00	55.33^{b}
3	51.00	65.00	55.00	57.00^{b}
4	66.00	80.00	70.00	72.00^{a}

CV%= 9.79

*= Significant

Means having different letters differ significantly.

Weight of Pancreas

Table 14 shows the average weight of pancreas in which birds in weight was exhibited by Treatment 4 with 6.33 grams, while Treatment 3 and Treatment 4 had the lowest mean weight of 4.33 grams.

Statistical analysis revealed significant differences were observed among treatment means. This indicates that the supplementation of varying levels of Black Soldier Fly Frozen Larvae in Treatment 4 at 15% in the diet of colored broiler chicken had an effect on the weight of the pancreas. The nutrients which were a protein that is present in Black Soldier Fly Larvae are completely used by the system. It completes the job of breaking down protein, carbohydrates, and fats using digestive juices of pancreas combined with juices from the intestine. It secretes hormones that affect the level of sugar in the blood. It also produces a chemical that neutralizes stomach acids that pass from the stomach into the small intestine by using substances in pancreatic juice (Vanessa, 2010).

Table 14. Weight of pancreas (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean*
	1	2	3	
1	4.00	4.00	5.00	4.33^{b}
2	6.00	4.00	5.00	5.00^{b}
3	5.00	4.00	4.00	4.33^{b}
4	7.00	6.00	6.00	6.33^{a}

CV%= 14.14

*= Significant

Means having different letters differ significantly.

Weight of Spleen

Table 15 shows a significant difference on the average mean weight of the spleen of the experimental birds. Treatment 4 had observed having the heaviest mean weight of 9.00 grams compared to Treatments 1 which distinguished being the lightest mean weight of 5.67 grams. Furthermore, Treatment 1 and Treatment 3 observed having the comparable average mean weight that varies only with their corresponding points.

This indicates that the supplementation of Black Soldier Fly Frozen Larvae at 15% in dietary treatment of colored broiler chicken had an effect on the weight of spleen of the birds.

The spleen functions in the destruction of old red blood cells and holding a reservoir of blood. The spleen is a blood filter and is of primary importance in the immune system; antibodies to viruses, bacteria, parasites are stored in the spleen and can be activated to neutralize these pathogens when they are recognized in the body (Anonymous, 2013c).

Table 15. Weight of spleen (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean*
	1	2	3	
1	6.00	5.00	6.00	6.67b
2	3.00	5.00	6.00	4.67b
3	3.00	8.00	5.00	5.33b
4	10.00	9.00	8.00	9.00a

CV%= 25.64

*= Significant

Means having different letters differ significantly.

Weight of Heart

Table 16 shows the average weight of the heart where Treatment 3 and 2 observed as a mean weight of 13.67 grams among all treatments, followed by Treatments 3 and 4 with a corresponding mean weight of 13.33 grams and 12.00 grams, respectively.

Non-significant differences were observed among treatment means which would imply that the supplementation of varying levels of Black Soldier Fly Larvae in the diet of colored chicken did not affect the weight of the heart experimental animals. Like the human heart, the chicken heart has four chambers- a right atrium and ventricle which receives oxygenated blood from the lungs and sends it to the body. Birds have a much higher metabolic rate than humans. All of these factors place a great demand on the chicken's heart which has to work much harder than a human heart (Wissman, 2007).

Table 16. Weight of the heart (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	16.00	13.00	12.00	13.67
2	13.00	13.00	15.00	13.67
3	13.00	13.00	14.00	13.33
4	13.00	10.00	13.00	12.00

CV%= 11.39

ns= Non significant

Weight of gall bladder

Table 17 shows the average weight of gall bladder where Treatment 2 observed as the heaviest mean weight of 2.33 grams among all treatments, followed by Treatments 1and 2 with corresponding mean weight of 2.00 grams and Treatment 3 with 1.67 grams, and observed as the lightest mean weight. Non-significant differences were observed among treatment means which indicate that the supplementation of varying levels of Black Soldier Fly Frozen Larvae in the diet of colored broiler chicken did not affect the weight of the gall bladder of experimental animals.

Table 17. Weight of gall bladder (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	1.00	2.00	3.00	2.00
2	1.00	2.00	4.00	2.33
3	2.00	1.00	2.00	1.67
4	1.00	3.00	2.00	2.00

CV%= 27.64

ns= Non significant

Total Weight of Visceral Organ With

The average weight of the visceral organ with fill is presented in Table 18. Treatment 4 exhibited the highest weight mean of 336.67 grams, followed by Treatment 1 with 320.67 grams, followed by Treatment 3 with 311.67 grams and lastly Treatment 2 with 306.67 grams. The results indicate that supplementation of 15% level of Black Soldier Fly Frozen Larvae increase its weight of visceral organ although it showed a non-significant result.

Table 18. Total weight of visceral organ with fill (gram) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	308.00	307.00	347.00	320.67
2	279.00	350.00	291.00	306.67
3	288.00	304.00	343.00	311.67
4	329.00	356.00	325.00	336.67

CV%= 8.66

ns= Non significant

Length of Small Intestine

The average length of the small intestine is presented in Table 20, in which Treatment 4 had the longest length of 218.16cm, followed by Treatment 2 with 206.67cm, Treatment 3 with 202.33cm and Treatment 2 had the shortest length of 196.00cm. This indicates that the supplementation of varying levels of Black Soldier Fly Frozen Larvae in the diet of colored broiler chicken did not affect the length of the small intestine of the birds. The length of the small intestine directly relates to the total surface area for absorbing nutrients as determined by many circular folds and minute projection of the inner surface (Anunciado, 2007).

Table 19. Length of small intestine (cm) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	212.00	198.00	210.00	206.67
2	206.00	206.00	176.00	196.00
3	202.00	200.00	204.00	202.00
4	194.00	232.00	230.00	218.67

CV%= 6.95

ns= Non significant

Length of Large Intestine

Table 21 shows the average length of the large intestine in which Treatment 3 had the longest length of 12.67cm, followed by Treatment 1and 4 having the same average mean weight with 12.33cm and Treatment 2 with 12.00cm as the shortest length mean. These differences however, is not significant in which indicates that the supplementation of varying levels of Black Soldier Fly Frozen Larvae in the diet of colored broiler chicken did not affect these parameters.

Table 20. Length of large intestine (cm) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	11.00	12.00	14.00	12.33
2	13.00	11.00	12.00	12.00
3	13.00	12.00	13.00	12.67
4	13.00	11.00	13.00	12.33

CV%= 9.07

ns= Non significant

Length of Caeca

Non-significant results were observed in Table 21. This result indicates that by supplementation of Black Soldier Fly Frozen Larvae to the commercial ration did not affect in the parameter. Although it is not significant, Treatment 4 with the average value of 49cm is slightly longer compared to Treatment 2 with the mean value of 45cm, Treatment 3 with 44.00cm, and Treatment 1 with 41.33cm value.

Table 21. Length of caeca (cm) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	48.00	23.00	53.00	41.33
2	48.00	49.00	39.00	45.33
3	42.00	45.00	45.00	44.00
4	48.00	48.00	50.00	49.00

CV%= 19.04

ns= Non significant

Length of Pancreas

In Table 22 presents the average length of the pancreas as Treatment 4 with the longest mean of

28.67cm followed by Treatment 3 with 25.33cm, then Treatment 1 with 19.33cm and the shortest length was observed in Treatment 2 with average mean weight of 19.00cm. The data showed a non-significant difference on the treatment means furthermore it indicates that there is no effect on the length of pancreas of the bird. This indicates that the colored broiler chicken fed with commercial ration supplemented with Black Soldier Fly Frozen Larvae did not affect the length of pancreas.

Table 22. Length of the pancreas (cm) fed commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	20.00	12.00	26.00	19.33
2	22.00	22.00	13.00	19.00
3	22.00	28.00	26.00	25.33
4	30.00	26.00	30.00	28.67

CV%= 21.47

ns= Non significant

Total Length of Visceral Organ

The average length of the visceral organ is presented in Table 23. Treatment 4 exhibited the longest mean of 308.67cm, followed by Treatments 3 with 284.00cm, then Treatment 1 with 279.67cm and 272.33cm, respectively. No significant differences were observed among treatment means implying that the supplementation of varying levels of Black Soldier Fly Frozen Larvae at 15% helped increased its length although it did not show significant effect of colored broiler chicken fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae did not affect the total length of the visceral organ.

Table 23. Total length of the visceral organ (cm) fed with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition.

Treatments	Observation			Mean^{ns}
	1	2	3	
1	291.00	245.00	303.00	279.67
2	289.00	288.00	240.00	272.33
3	279.00	285.00	288.00	284.00
4	286.00	317.00	323.00	308.67

CV%= 8.08

ns= Non significant

Conclusion and Recommendations

A total of 12 birds were used in the study regardless of sex and were randomly distributed into four dietary treatments in a Completely Randomized Design (CRD). The four dietary treatments were replicated three times. The data gathered in the study consisted of weight of the crop with and without fill, the proventriculus plus gizzard with and without fill, the small intestine with and without fill, large intestine with and without fill, the caeca with and without fill, weight of liver, the pancreas, spleen, heart, total weight of the visceral organ, length of small intestine, large intestine, caeca, pancreas and the total length of the visceral organ which were analyzed using the Analysis of Variance (ANOVA) of a Completely Randomized Design (CRD). Statistical differences among treatment mean that were observed were compared using Duncan's Multiple Range Test (DMRT).

The result showed non-significant difference among treatment means for the weight of the visceral organ of crop with and without fill, proventriculus without fill, small intestine with and without fill, large intestine with and without fill, caeca with and without fill, pancreas, gall bladder and total length of visceral organ. Length of the intestine with and without fill, large intestine with and without fill, and caeca with and without fill. However, significant differences were observed among treatment mean for the weight of proventriculus plus gizzard with fill at (P> 0.05), liver at (), spleen at (P> 0.05), (P> 0.05) and pancreas at (P> 0.05). It could be concluded that feeding with commercial rations supplemented with varying levels of Black Soldier Fly Frozen Larvae (*Hermetia illucens*) under free-range condition had no detrimental effects on the weights and lengths of visceral organs of different parameters and showed a positive effect on the visceral organ of colored broiler chicken. As a result of the study conducted, it is recommended that further study of feeding Black Soldier Fly Frozen Larvae as a feed substitute of protein for colored broiler chicken to the commercial ration is conducted not only in poultry species, but also to other species to have a consistency of the results.

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