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Growth Performance of Broiler Chicken Fed with Fresh Vermi Supplementation under Total Confinement Management System

Marcos Erram Bollido[1]

Agriculture and other Related Programs Northwest Samar State University[1]

ABSTRACT— The study evaluated the effects of different levels of fresh vermi (*Eisenia foetida*) in broilers chicken growth and profitability in total confinement management systems. Sixty-one-day-old broiler chickens were tested in Completely Randomized Design of four treatments with three replications: T1 - Commercial Feeds (PCF), T2 (2 % Fresh Vermi (FV) + 98 % Commercial Feeds (CF)), T3 (3 % FV + 97 % CF), and T4 (5 % FV + 95 % CF). Results reported that water consumption and feed consumption was not significantly difference, T3 was lower with 3 % FV, while the feed consumption was lower in T4 with 5 % FV. The average weight gain, dressing percentage, feed conversion ratio was similar in value; T1 was comparable with T4 in terms of weight gain and feed conversion ratio but was not significantly different in all treatments. The supplementation of FV at higher concentrations produced higher carcass weight was significantly difference. Considering the average dressing percentage, there was no significant difference observed, however, birds fed with 5 % FV had the highest dressing percentage (82.71 %) and higher average carcass weight (1.92 kg). Finally, treatment 4 had the highest average carcass weight with a comparable revenue with other treatments, however, the same with other treatments incurred higher production cost, so the Return of Investment was negative.

KEYWORDS: broiler chicken, commercial feeds, confinement, fresh vermi, profitability

1. INTRODUCTION

Broiler (*Gallus gallus domesticus*) production plays a major role in the economic sector in most of the country's economy, including the Philippines. People depend on poultry production as their source of food and alternative livelihood option. Broiler chicken inventory was highest in Central Luzon at 658.91 thousand metric tons of birds or 35.88 percent of the total broiler chicken inventory [15]. The modern poultry industry aims at high production of quality birds at a low cost. In contrary, there is an increase cost in poultry farming especially due to high cost of feeding. Commercial feeds are the dominant sources of dietary input used in the poultry industry around the globe. Feeds are one of the most important inputs in raising poultry. High quality feeds are a critical factor that impedes the rapid expansion of poultry industry. However, feeds are the most expensive part of broiler production. Major issues facing the commercial poultry sector are finding alternative sources of protein because protein source in feed leads to an increase in poultry production cost [2]. In poultry farming, approximately 70 to 75 % of the operating costs constitute feeding costs; of which, about 15 % are from proteins sources. The protein requirement of poultry is provided by feedstuff rations and usually by soybean meal or fish meal. Limited production opportunities and price increases have led to the need for the use alternative feed additives that can be substituted for these products without adverse effect on production. A study has suggested that worms which are rich in essential amino acids, with high digestible protein can be used as substitutes or alternative protein source in poultry diets [8]. The poultry industry requires alternatives sources of animal protein due to high cost of high- quality protein input for poultry feeds. It has been confirmed that termites and earthworms have high nutritional value, and that they may be important source of protein, carbohydrate, fats, vitamins, and minerals. Nutritionally, it has been shown that termites and earthworms can

be compared favorably with fish meal, which is a main animal protein source in poultry diets [10]. The average weight gains of chickens numerically increased as supplementation of vermi or earthworm (EW) increased. On the other hand, the overall feed conversation ratio was slightly greater in broiler chickens fed without EW, and it decreased linearly as dietary EW supplementation increased. Differences were observed between carcass and ileum characteristics of broiler chickens under treatments. Similarly, the meat quality of broiler chicken was markedly affected linearly by the supplementation of increased dietary EW. Briefly, diets containing 30 g EW can positively affect the growth performance of broiler chickens and can produce meat with better characteristics [2]. Feed conversion ratios have increased by 12.64 and 22.45 % when 3 and 5 % vermi or earthworm powder was added. Supplementing diet with 5 % vermi powder incurs no negative effects on the growth of pullets, but with increased antioxidant enzyme (superoxide dismutase, catalase and glutathione peroxidase) activities in the liver. The study suggested that dietary supplementation with 1 – 5 % earthworm powder is safe for broiler pullets [19].

In this regard, [14] reported that weight gain and feed conversion ratio improved in quails' feed diets supplemented with 10 % vermi. [20] reported that the average feed consumption and the feed conversion rate of birds fed with earthworm powder decreased compared with 0 % fishmeal + 0 % of earthworm powder, and there were no significant differences among all the test groups. The 3 % fishmeal + 2 % earthworm powder had the highest daily weight gain at all stages. By the later period of growth, there was no significant difference between the fishmeal and the control group. However, the 3 % fishmeal + 2 % earthworm powder and 0 % fishmeal + 5 % earthworm powder had significant differences on daily weight gain from the control group, the increase weight gain was 10.57 and 8.77 % respectively. In a similar study, [3] showed that the addition of 2% vermi meal into the diet of broiler chicken improved the feeding habit of broilers that made the feed intake increased compared to 3%, 5%, and commercial feeds respectively. The higher feed consumption of broiler fed low inclusion of vermi meal was related to the fact that the diet was more palatable to the experimental broilers compared to the other rations with different levels of vermi meal. Furthermore, [17] showed that vermi significantly led to gain weight and improved feed conversion ratio in broiler chicken. According to the study of [12], birds fed 3 % vermi or earthworm had the highest body weight gain, followed by birds fed 5 % vermi or earthworm diet. The highest feed consumption was seen in birds fed 0 to 1 % vermi, with the least feed consumption seen in birds fed 7 % vermi for all the weeks. There was a significant difference in feed consumption for week 4 and week 6 [12]. In a study on carcass characteristics and meat quality of broilers fed with vermi or earthworm meal, where the control group was fed standard broiler feed, the second experimental group was fed a diet in which 50 or 100 % of fish meal was substituted with vermi or earthworm meal, while the third group consumed feed without a fish meal but was given fresh chopped vermi or earthworms ad libitum from day 1 to day 42 [7]. The replacement of fish meal with fresh earthworms resulted in significantly lower carcass weights in comparison with birds fed with the standard broiler feed. The differences in drumstick, thigh, and breast meat share relative to the carcass mass were not significant. The lowest fat content in the thigh and breast meat was seen in birds in which fish meal was replaced with earthworm meal. The lightness of thigh and breast meat was highest in the broilers fed fresh vermi or earthworm ad libitum [7]. It has been found out that the inclusion levels of earthworm in poultry diet do not affect meat quality attributes such as pH, color, drip loss, and cooking loss. There are no negative effects of vermi or earthworms reported on chicken meat quality. Supplementation of protein by vermi or earthworm increases protein myoglobin of broilers, which is richly pigmented. Meat becomes redder or darker when there is more myoglobin in the cells [6].

In the study of [9], earthworm powder meal contained large amounts of protein (31.7 %), iron (241.1 ppm), soluble nitrogen (1.8 %), zinc (32.34 ppm), manganese (17.2 ppm) and copper (4.501 ppm) together with notable quantities of potassium, calcium, magnesium, phosphorus, and carbohydrate. Indicating that this type

of earthworm contains potentially useful quantities of many nutrients that are important to animal and human health. In a comparable study on the proximate and amino acids composition of maggot, earthworm and soybean meals for use as feedstuffs, the total amino acid contents of maggot meal were at 58.4 g/100 g crude protein, earthworm meal at 56.3 g/100 g crude protein and soybean meal at 34.9 g/100 g crude protein [1]. When comparing the quality of amino acids of feedstuffs on a pair wise basis, the coefficients of alienation were fairly low with 24.0 and 40.7 %, meaning that there was a better relationship with different ingredients [1]. These percentages were higher than the percentage of fish protein (45 %) and meat protein (51 %) [14]. Hence, the study was conducted to determine the growth response of broiler fed with fresh vermi supplementation and commercial feeds. The result of the study served as baseline information for the farmers who engage in broiler production to minimize the use of expensive commercial feeds. The general objective of this study was to determine the efficiency of fresh vermi on the growth performance of broiler. Specific objectives were to:(i) measure the optimum ratio of fresh vermi that enhances growth performance of broiler, (ii) evaluate the effect of fresh vermi on the growth performance of broiler in terms of weight gain, and feed conversion ratio and (iii) determine the return of investment (ROI) of broilers as affected by the different levels of fresh vermi supplementation.

2. MATERIALS AND METHODS

2.1 Broiler and management

This was done by constructing 2 main poultry cages measuring 7.32 x 0.76 m^2 with each cage divided into 6 partitions with a size of 0.61 x 0.76 m^2, enough for 5 heads of broiler per compartment as replication with a total of 60 one-day-old broiler chickens. Seven days after the arrival of the broiler chicks, they were vaccinated against Newcastle Disease (ND) using LaSota vaccine. Concomitantly, after 14 and 28 days, the birds were equally vaccinated against coccidiosis and infectious bronchitis (IB), respectively, using recommended vaccines [4].

2.2 Preparation of fresh vermi

Fresh vermi was cultured on animal dung such as cattle wastes, poultry dropping, and vegetable wastes. Culturing was done in a wooden box with 1 x 1.5 x 0.5 m3 size. Culture bed or worm bed was prepared by placing either sawdust or rice straw at the bottom of the container and all layers were moistened with water to maintain the moisture level. The culture media set up was stocked with adult Eisenia foetida that develop and lay eggs. Fresh adult African Night Crawler (ANC) were harvested after three months by handpicking method and were cleaned using tap water.

2.3 Experimental design and treatments

This study used the Completely Randomized Design (CRD) with four treatments replicated thrice and each replication having five broilers. A total of sixty chickens were used in this study. The treatments were: T1 (100 % commercial feeds (CF), T2 (98 % CF + 2 % fresh vermi (FV), T3 (97 % CF + 3 % FV) and T4 (95 % CF + 5 % FV).

2.4 General management practices

About one week before the arrival of chicks, all facilities, and equipment including the area were cleaned and disinfected to prevent any disease-causing organisms. The brooding of day-old chicks lasted for 14 days. Continues lighting during day and night was provided to keep the chicks warm and facilitate feed consumption. The cages were covered especially at night time to maintain the required temperature. Old newspapers were used as litter materials during brooding for birds. Water and feed were provided to the birds ad libitum and daily replacement of unconsumed water and feed was done and uneaten feed measured. Manure

removal of litter was done every other day or even daily as the need arises. Proper sanitation and management were observed during the entire duration of the study.

2.5 Feeding management

Upon the arrival of the chicks, they were allowed to drink a 5 % sugar solution to recover from transportation stress. During the first 2 weeks, each chick fed 50 grams of chick booster mash (CBM) per day. On the third and fourth weeks, 75 grams of starter crumble was given to each bird and on the fifth to the eighth week (finishing stage), 120 grams of broiler finisher crumble was fed to each bird. Fresh vermi was chopped and used as a supplement according to treatments.

Table 1: Total commercial feeds (CF)＋fresh vermi (FV) requirements in grams (per head)

Treatments	Chick Booster Mash (gram)	Fresh Vermi (gram)	Broiler Starter Crumble (gram)	Fresh Vermi (gram)	Broiler Finishing Crumble (gram)	Fresh Vermi (gram)
T_1 Control	50	0	75	0	120	0
T_2 98 % CM+2 %FV	49	1	73.5	1.5	117.6	2.4
T_3 97 % CF+3 % CF	48	1.5	72.75	2.25	116.4	3.6
T_4 95 %CF+ 5 % FV	47.5	2.5	71.25	3.75	114	6
TOTAL	194.50	5.00	292.50	7.50	468.00	12.00

2.6 Growth performance

Generally, the study aimed to determine the efficiency of fresh vermi on the growth performance of the broiler. Specifically aimed to determine the optimum ratio of fresh vermi enhancing growth performance of broiler, evaluate the effect of fresh vermi on the growth performance of broiler; in terms of weight gain, and feed conversion ratio and to calculate the cost and return analysis as affected by a different level of fresh vermi supplementation, similar to the study conducted by [18] which investigated on the effect of supplementing earthworm meal on the growth performance and nutrient digestibility of feed in broiler chicks. A total of 120 broilers chicks at 7 days of age were fed the experimental diets containing 0%, 0.2%, and 0.4% of earthworm meal for 6 weeks. Data collection procedures of growth response and profitability data were collected every week. The following parameters were based on the data collected in response to the different treatments: Average initial weight was the weight of broilers at the start of the study divided by the number of the birds per treatment. Broilers were weighed by the use of a digital weighing scale. The average final weight was relative to the weight of broilers divided by the number of birds per treatment at the end of the finishing period. Average weight gain was determined by the difference between the final and initial weights of the birds per replicate and on an average basis. Average feed consumption was calculated by subtracting the feed wasted and leftover from the number of feeds given in every treatment. The feed conversion ratio was calculated by dividing the total feed consumed by the total weight gain of the broilers at the growing stage and water consumption was the amount of water given in 24 hours minus the remaining amount of water before the next drinking day.

2.7 Dressing percentage

In this study, the dressing percentage was measured by dividing the live weight by the carcass weight of the broiler chicken, then multiplied by 100.

Live weight of the birds (kg)

$$\textbf{DP} = \frac{\text{Carcass weight of the birds (kg)}}{\text{Carcass weight of the birds (kg)}} \times 100$$

Before slaughtering, birds were weighed to get the live weight of the broilers. After the slaughtering, all entrails were removed including the head and feet to get the carcass. [11] studied the effect of earthworm meal inclusion on dressing and physical-chemical characteristics of quail meat and concluded that earthworm meal inclusion during 42 days could represent a protein complement to improve dressing percentage and nutritional profile of quail meat.

2.8 Cost-benefit analysis

In this study, all costs incurred in the research were included and the profit derived from the broiler sales was computed (Table 5). The return on investment was computed as the final value of investment less the initial value of an investment divided by the cost of investment and multiplied by 100. [13] stated that earthworm was still expensive compared to conventional protein sources but improvements could be made to make it more attractive since it can be reared on low-grade bio-waste and can turn bio-waste into high-quality proteins. The cost-benefit analysis was done in the study to analyze broilers' production using fresh vermi in contrast with commercial feed. The researcher determined the value for tangible project costs versus expenses, income, profit, and return of investment. The cost-benefit analysis was the basis of the researcher to develop a reasonable conclusion.

2.9 Data analysis

Analysis of variance (ANOVA) using software STAR (Statistical Tool for Agricultural Research) was used in this study and significant difference among treatment means was obtained using LSD test (Least Significance Difference).

3. RESULTS AND DISCUSSION

3.1 The water and feed consumption

The average water and feed consumption of broiler were not significantly influenced by the supplementation of 2, 3, and 5 percent fresh vermi but showed a comparable result among treatments (Table 2). The similarity of water and feed consumed of broilers between treatments 1, 2, 3, and 4 may be probably due to the ratio of feed mixture in which it was closely proportional. The percentage of feed mixture between commercial feeds and fresh vermi probably did not influence the palatability and quality of the feed supplement as a result of the comparative amount of water and feed consumed. The finding of this study was in agreement with the report of [16], that feed intake of broilers was not statistically affected by dietary treatments.

Table 2: The average, water consumption and average feed consumption of broilers in a different varying amount of fresh vermi supplementation in 35 days

Treatments	Average Water Consumption (ml)	Average Feeds Consumption (g)
T1- PCF	7576.00 ± 614.19^{d}	2577.76 ± 376.87^{a}
T2- 98 % CF+2 % FV	7271.67 ± 268.05^{c}	2592.86 ± 22.29^{c}
T3-97 % CF+ 3 % FV	6801.67 ± 285.52^{b}	2581.42 ± 780.92^{b}
T4- 95 % CF+5 % FV	6792.00 ± 355.71^{a}	2693.47 ± 7.30^{d}

Means in a column with or without common letter designation were not significantly different, based on LSD Test at $p<0.05$

3.2 Growth performance

The initial weight of broilers between treatments was statistically difference ($p>0.05$) (Table 3). Moreover, the average final weights were significantly influenced ($p<0.05$) by fresh vermi supplement. The volume of water and the amount of feed consumed by the broilers between treatments 2, 3, and 5 % fresh vermi supplementation, thus, weights of chickens were comparable relative to the feed conversion ratio. Although, [14], reported that body weight gain tends to decrease as vermi substitution increases, however, the least significant difference (LSD) test showed that there was no significant effect between 5 and 10 % vermi supplementation, but the use of 15 % gave a significant effect when compared to the other treatments.

The comparable body weight gain among treatments may be due to the intake of above 90 % commercial feed by all birds. This was in conformity with the report of [5] that 2 % of earthworm meal compared to the control and 6 % earthworm meal significantly increased body weight and feed intake but had no significant effect on feed conversion ratio.

Table 3: The average gain weight, final weight and feed conversion ratio of broilers in 35 days

Treatments	Average Initial Weight (g)	Average Gain Weight (g)	Average Final Weight (g)	Average feed Conversion Ratio
T_1 PCF	56 ± 0.00^{b}	1245.72 ± 46.38^{d}	1301.70 ± 46.38^{d}	2.07 ± 0.12^{a}
T_2 98 % CM+2 %FV	54.67 ± 4.37^{a}	1095.84 ± 66.76^{b}	1150.59 ± 71.11^{b}	2.38 ± 0.17^{c}
T_3 97 % CF+3 % FV	56 ± 6.11^{c}	1091.61 ± 46.17^{a}	1147.61 ± 47.87^{a}	2.37 ± 0.07^{b}
T_4 95 %CF+ 5 % FV	57.33 ± 1.33^{d}	1103.2 ± 24.31^{c}	1160.53 ± 25.63^{c}	2.44 ± 0.05^{d}

Means in a column with or without common letter designation were not significantly different, based on LSD Test at $p<0.05$

3.3 Carcass weight and dressing percentage

The effect of treatments on average carcass weight of the birds indicated that carcass weight was not significantly influenced ($p>0.05$) by vermi supplementation (Table 4). The supplementation of fresh vermi at higher concentrations produced numerically higher carcass weight and dressing percentage. This result agreed with the findings of [16], that using 2, 3, 4, and 6 % vermi on broilers had no significant effect on carcass weight. Similarly, the average dressing percentage was not significantly affected by the level of vermi supplementation. However, the supplementation of 5 % fresh vermi had the highest numerical value for dressing percentage (82.71 %) and equally had the higher average carcass weight (1.92 kg). [2] indicated that earthworm dietary treatments had no influence on carcass composition. Additionally, the earthworm treatments had no remarkable variations on the morphology of ileum relative weight, and villus height, length, width, surface, and diameter in comparison with the control.

Table 4: The average carcass weight and the average dressing percentage of broilers in 35 days

Treatments	Average Carcass Weight (kg)	Average Dressing Percentage
T1-Commercial Feeds (CF)	1.15 ± 0.10^{c}	81.31 ± 5.03^{b}
T2- 98 % CF +2 % FV	1.04 ± 0.02^{a}	82.54 ± 3.58^{c}
T3- 97 % CF+3 % FV	1.07 ± 0.02^{b}	80.63 ± 1.67^{a}
T4- 95 % CF +5 % FV	1.92 ± 0.06^{d}	82.71 ± 5.33^{d}

Means in a column with or without common letter designation were not significantly different, based on LSD Test at $p<0.05$

3.4 Production cost and return on investment

The highest total cost was obtained in T4 having 194.14 followed in T3 with 169.8, T2 151.31, and the lowest was T1 with 132.81 (Table 5). However, the highest revenue among all the treatments was T1 and the lowest was T4 with 154.88, with a different effect in return of investment among T1, T2, and T3 while T4 had the lowest result among the treatments. The result also confirmed that the lower operating return of investment was T4 due to the exalted inputs of fresh vermi since vermi is expensive. Treatment 4 had the highest average carcass weight in the experiment with a comparable revenue with other treatments. However, because of high production cost, Return of Investment was negative.

Table 5: Production Cost and Return on Investment per head of broiler (Peso)

Cost and Return Analysis	Treatments			
	1	2	3	4
Total Cost (peso)	32.81 ± 62.13^{a}	151.31 ± 70.94^{c}	169.8 ± 80.18^{c}	194.14 ± 92.35^{d}
Revenue (peso)	188 ± 30.87^{d}	171.16 ± 27.84^{d}	175.95 ± 28.67^{d}	154.88 ± 24.60^{c}
Profit (peso)	55.19 ± 27.60^{c}	19.85 ± 9.93^{b}	6.15 ± 3.07^{b}	-39.26 ± 19.63^{b}
Return on Investment (peso)	41.56 ± 38.81^{b}	13.12 ± 65.73^{a}	3.62 ± 81.83^{a}	-20.22 ± 116.70^{a}

4. CONCLUSION

Fresh vermi can be utilized to lessen the usage of commercial feeds. In this study, treatment 1 had the highest revenue with 88.00 peso per head, followed with treatment 3 with 175.95 peso, treatment 2 with 171.16.00 peso, and treatment 4 with 154.88 peso, respectively. The result of the study recommends that vermi be readily available for the farmers. The researcher further suggests to modify the supplementation of fresh vermi into higher concentration to further assess its effects in broiler production.

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6. CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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