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Growth Performance of Japanese Quail (*Coturnix Coturnix Japonica)* Fed with Superworm (*Zophobas morio)* Larvae Meal

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Abstract:

Aim: Quails are increasingly recognized for their potential in sustainable poultry production due to their rapid growth, high egg production, and adaptability to various rearing systems. Covid- 19 Pandemic has brought disruption of primary source protein sources such as fishmeal and soybean meal. This makes it necessary to search for alternative sources of protein source feed ingredient without sacrificing quality of produce. Insect meals as alternative sources of poultry feedstuff is a recent topic. Therefore, the study was conducted to investigate the effects of different levels of Superworm (*Zophobas morio*) Larvae Meal in Japanese quail (*Coturnix coturnix japonica*) diets on productive performance and egg quality indices.

Methodology: The study was laid out out following the completely randomized design and utilized the following treatments with Treatment 1- Formulated ration without Superworm Meal larvae (SML), Treatment 2- 5% Superworm Meal larvae (SML), Treatment 3- 10% Superworm Meal larvae (SML), Treatment 4- 15% Superworm Meal larvae (SML), Treatment 5- 20% Superworm Meal larvae (SML). A total of Three Hundred (300) apparent healthy unsexed day-old Japanese quail birds were used within a four (4) weeks of the experimental trial.

Results: Results of the study on the Weekly Body Weight (g) of Japanese Quail Fed with Super worm Larvae Meal found no significant results on the Initial and First week of the study, however on the second, third and fourth week of the study, a highly significant differences was observed within the T1, T2, T3 and T4 groups compared to T5 groups in terms of weekly body weight (g) of the Japanese quails. On the Weekly Gain in Weight (g) of Japanese Quail Fed with Super worm Larvae Meal, it was observed that the following treatment are comparably higher T1 – Formulated Ration w/o SML 25.50g, T2 – 5% SML 18.70g, T3 – 10% SML 18.25g, T4 – 15% SML 18.25g, respectively compared to T5 – 20% SML with only 7.58g gain in weight. In terms of the cumulative gain weight of Japanese quail it was sought that maximum value was found on T2 – 68.53g, followed by T3 – 68.17g, T1 – 67.73g, T4 – 63.25g, while T5 – 28.70g showed relatively lower weight gain. Anyhow, on the second, third and fourth week of the study it was revealed by the analysis that there are no significant differences between treatments was observed on the gain in weight of Japanese quail. The Weekly Feed Consumption (g) of Japanese Quails fed with Superworm Meal were significantly affected during conduct of the experimental trail with birds in T5 (20% SML) gained lowest feed consumption. Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quail Fed with Super worm Larvae Meal result showed significant result in terms of the Feed conversion ratio of Japanese quails having T3 (5.08) being good in conversion feed to lean, followed by T2 (5.25), T1 (5.46), T4 (5.85) and T5 (11.20) having the least favorable in terms of feed utilization. Same result was sought on the Feed Conversion Efficiency (%) on the growing Japanese quails.

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Conclusion: During the conduct of the growing trial of Japanese Quail fed with varying levels of Super worm meal it was evident that incorporation of Super worm meal significantly affected the growth performance parameters of the birds, it was also noted that inclusion of 20% Super worm meal resulted to the decrease performance in different growth parameters evaluated such as Weekly Body Weight (g), Weekly Gain in Weight (g), Weekly Feed Consumption (g), and Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quail Fed with Super worm Larvae Meal. Thus, feeding varying levels of SML on the growth of Japanese quail gained high economical returns.

Keywords: Growth, Superworm, Japanese Quail

INTRODUCTION

Quails are increasingly recognized for their potential in sustainable poultry production due to their rapid growth, high egg production, and adaptability to various rearing systems. As the demand for alternative protein sources rises, incorporating novel feed ingredients can enhance the nutritional profile and overall growth and laying performance of quails.

Covid- 19 Pandemic has brought disruption of primary source protein sources such as fishmeal and soybean meal. The price of these ingredients also inclined, for which these ingredients are required for formulating a balanced ration diet for the animals. This makes it necessary to search for alternative sources of protein source feed ingredient without sacrificing quality of produce.

One of the more recently investigated insects with great nutritional potential for future use as an alternative feedstuff is *Zophobas morio* (ZM), also known as superworm Kulma et al., (2020). One such promising ingredient is the superworm (*Zophobas morio*), a nutrient rich insect that has gained attention in the feeds and nutrition field for its high protein content, essential amino acids, beneficial fatty acids and minerals, making them a valuable supplemented to traditional feed. This may potentially lead to improve growth and laying production of Quails.

The utilization of Z. morio as an alternative nutrient and protein source holds promises for the future. The route to the better exploitation of Z. morio comprehends several challenges. Apart of constituting solely a protein and nutrient source, the challenge is to illustrate the functional properties of Z. morio-derived diets. Zielińska et al., (2017), suggested that together with other insect species, Z. morio larvae are a valuable, largely unexploited source of antimicrobial peptides with antiradical activity, therefore, their consumption could potentially have an immune-triggering and health promoting effect.

Superworm larvae is gaining popularity as sustainable, and environmentally friendly protein source for animals. It has high nitrogen content ranges between 6.2% and 8.6% (Araujo et al., 2019). Superworm can be farmed in controlled environments and have a fast growing cycle, allowing for quick and efficient production. They can be fed on organic waste, contributing to circular food system. Therefore, superworm has the full potential of playing a significant role in the future of insects as food and feed and research on this species should emphasize on highlighting the advantages of its use and shading light on unexplored aspects that need to be considered.

Japanese quail production is a promising industry to supply the egg requirements of the country. Exploring on alternative protein sources like superworm can possibly lead to an improved production efficiency, thus this study was prepared.

Objectives of the Study

This study aimed to evaluate the effect of Superworm larvae meal incorporation on the growth performance of Japanese Quails.

Specifically, it aimed to:

1. assess the effect of superworm larvae meal on the body weight (g), gain in weight (g), feed consumption (g), feed conversion ratio (FCR), and feed conversion efficiency (FCE); and
2. determine the economy of incorporating superworm larvae meal on the Japanese quail diets.

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METHODS

Experimental Cages

The experimental cages were made of corrugated bars as frames, plastic mesh (1" hole) as walls and steel matting as support to the flooring of each tier. Three (3) tier cages were used with each cages dimension of 3m x 0.60m x 1.75m. Each layer consists of 5 cages and each cages floor space of 162 cm2.

Cage preparation

Prior to the arrival of the experimental birds, the brooding area, housing facility, and its premises were thoroughly cleaned and chlorinated.

Experimental Animals

A total of Three hundred (300) apparent healthy unsexed day-old Japanese quail birds were used in the experimental trial and were purchased from Gaffud's Breeder Farm at Malibago, Echague, Isabela. In the first experiment, During the first four (4) weeks of the experimental trial a total of three hundred (300) unsexed Japanese quail birds were used during the growing period.

Care and Management

Brooding is an important operation in the early age of the experimental birds. Chicks were provided with required artificial heat (32°C to 35 °C) all day long during the 14 days of the acclimatization and brooding period. During the brooding period feed was given in an ad-libitum basis. Clean and fresh drinking water was given at all times. It was changed twice a day (morning and afternoon) or as need arises. Sanitation was strictly followed, which includes cleaning of the water and feeding troughs daily. Waste generated from the experimental area was cleaned and disposed in the designated waste pit to ensure proper sanitation and health of the Japanese quails.

Rearing of the Superworm larvae meal and preparation of insect meal

The experiments were conducted using Superworm larvae meal. Adult Superworm were placed in a plastic basin that will aid in the growth of the Darkling beetles to produce Superworm larvae. Adult beetles were allowed to deposit eggs before the start up to the last weeks of the feeding trial. The beetles and larvae were reared at about 4-5 months under small-scale production in plastic basins. They were fed with fresh fruits and vegetables. The larvae were collected through sieve by separating them from other stages and were starved for 48 hours to remove some of the feces and were immersed in hot water (60°C) for 5 minutes then dried for 15 minutes at 180°C in the air fryer and added to the diets after grinding, as insect meal. The inactivating method was chosen on the basis of a recommendation by (Larouche et al., 2019, Singh et al., 2020, Cacchiarelli et al., 2022).

Experimental Design and Treatment

The birds were randomly distributed into five (5) treatments. Each treatment was replicated thrice with the total of fifteen (15) experimental units. On the first trial there were twenty (20) birds assigned per replicates during the growing stage. The experiment was laid out using the completely randomized Design (CRD) with the following treatments:

Treatment 1- Formulated ration without Superworm Meal larvae (SML)
Treatment 2- 5% Superworm Meal larvae (SML)
Treatment 3- 10% Superworm Meal larvae (SML)
Treatment 4- 15% Superworm Meal larvae (SML)
Treatment 5- 20% Superworm Meal larvae (SML)

Experimental Lay-Out

Completely Randomized Design (CRD)

T1R1	T2R3	T4R3	T2R1	T4R1
T5R3	T3R3	T1R2	T5R2	T4R2
T1R3	T3R1	T2R2	T3R2	T5R1

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Analysis of feed samples and Superworm larva meal content

Chemical analysis of the superworm larvae meal was done using the FOSS analytical A/S, NIRS DA1650 (Denmark), at the College of Agriculture, Isabela State University – Echague Campus to serve as basis in the calculation of the formulated ration for the Japanese Quails. Nutrient composition such as crude protein (%CP), crude fiber (%CF), moisture (%), fat (%) and ash (%) were gathered.

Diets

A baseline diet consisting of corn, soybean, and rice bran was created and served as the control group (T1), (T2) with 5% SML, (T3) with 10% SML, (T4) with 15% SML, and (T5) with 20%. All diets were designed to suit the nutrient needs of Japanese quail chicks. Throughout the four (4)-week trial, food and water were provided ad libitum.

Table 1. Composition of the Starter Feed Diet (%)

Ingredients	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Treatment 5
Corn	48.70	50.75	48.90	47.55	47.99
RB D1	8.40	1.05	0.30	0.00	0.00
Soybean	25.75	28.06	22.45	14.77	1.80
Fish Meal	13.00	10.08	12.00	15.35	22.00
Molasses	3.00	1.20	1.10	0.70	1.00
Vegetable Oil	0.50	2.50	4.30	5.92	6.89
Limestone	0.04	0.00	0.01	0.00	0.00
Dicaphos	0.04	1.00	0.40	0.25	0.00
Salt	0.25	0.25	0.25	0.05	0.15
Lysine	0.01	0.01	0.05	0.14	0.14
Methionine	0.10	0.05	0.01	0.03	0.03
Vit.Premix	0.21	0.05	0.23	0.24	0.1
Superworm Larva Meal	-	5.00	10.00	15.00	20.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

CALCULATED ANALYSIS

Metabolizable Energy	2900	2900	2900.04	2900.19	2900.12
Percent Crude Protein	24.00	24.02	24.03	24.08	24.02
Calcium	1.08	1.11	1.01	1.05	0.80
Phosphorus	0.44	0.53	0.46	0.50	0.30
Methionine	0.60	0.50	0.45	0.47	0.50
Lysine	1.30	1.30	1.30	1.30	1.30

Note: Formulation used for the experimental trial was formulated after the acquisition of the Super worm Larvae Meal proximate analysis.

Growth performances

Birds undergone acclimatization for two (2) weeks, four (4) weeks trial and the the total rearing period for growth was six (6) weeks. Clinical signs and mortality were monitored daily during the whole experimental period. Body weight gain (BWG) and feed consumption were recorded weekly during the experimental period, feed consumption (FC), daily weight gain (DWG) and feed conversion ratio (FCR) was determined for the overall experimental period (4 weeks). All measurements were performed on the pen/cage basis using a high precision electronic scale (EZUK™ Weight 110 lb/50 Kg(Black)).

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Statistical Analysis

All the gathered data was collated, tabulated and analyzed using the Analysis of Variance following the Completely Randomized Design (CRD). The Least Significant Differences (LSD) was used to compare significant result.

RESULTS and DISCUSSION

OBSERVATION

Upon the arrival of the birds, it was observed that all were active and alert despite the stress from the travel. Mortality was also recorded during the growing period due to the weather conditions during the months of October 2023 in Apayao, but overall, all birds were found to be in their prime state during the conduct of the experimental trial.

Growth Period (four weeks duration)

Weekly Body Weight (g) of Japanese Quail Fed with Super worm Larvae Meal

Table 2, showed the Weekly Body Weight (g) of Japanese Quail Fed with Super worm Larvae Meal. No significant differences on the initial and first weekly body weight gain of Japanese quail having a mean range from 43.25g to 46.67g, and 54.25g to 68.75g, respectively.

However, during the second, third and fourth week of the study, a highly comparable results was observed within the mean values of Treatment 1, Treatment 2, Treatment 3, and Treatment 4 compared to Treatment 5 in terms of weekly body weight (g) of the Japanese quails. The study findings were in agreement with Sabirli & Cudafar (2019), which studied on mealworm meal on the performance and carcass traits of quail, who found significant results on Body weights of quails. Furthermore, an inclusion of 3g/kg of mealworm scales is more efficient as compared to lower inclusion levels (1% and 2%). Loponte et al., (2017), investigated the effect of *T. molitor* and *H. illucens* adding 250 to 500 g of mealworms feed/kg of feed-in partridge improved growth performance. Magsalay et al., (2024), demonstrates that incorporating Superworm (*Zophobas morio*) as a protein substitute in the diet of grower native chickens has the potential to positively influence their growth performance.

In contrast to the findings of Biasato et al., (2016) observed that addition of 7.5% mealworm to the diet of chicken fed with corn-soybean based diets did not significantly affect performance. Bovera et al., (2015), reported that there was no difference on the body weight and body weight gain of 30% inclusion of TM meal in the diet of Shaver brown broilers. This result is critical since SWM has been known to contain chitin, and it contains 11.56 mg/g of chitosan (Jin et al., 2016). The chitin contents of superworm meal probably reduced the feed palatability which causes the negative effect on quail feed intake as also explained by Bovera et al., (2015).

Table 2. Weekly Body Weight (g) of Japanese Quail Fed with Super worm Larvae Meal

Treatment	Initial	Week 1	Week 2	Week 3	Week 4
T_1 – Formulated Ration w/o SML	43.25	68.75	91.33[a]	101.25[a]	110.98 [a]
T_2 – 5% SML	44.50	59.33	86.08[a]	98.33 [a]	113.03[a]
T_3 – 10% SML	44.83	65.08	88.83 [a]	99.42 [a]	113.00[a]
T_4 – 15% SML	44.75	63.00	92.15 [a]	102.42 [a]	108.00[a]
T_5 – 20% SML	46.67	54.25	67.58[b]	77.67[b]	75.37[b]
ANOVA	ns	ns	**	**	**
$LSD_{0.01}$	-	-	13.70	15.56	16.61
% CV	5.95	9.94	6.21	6.28	6.17

Note. Means with common letter notations are statistically the same.
**- significantly different @ 5% level, **- significantly different @ 1% level.*

Weekly Gain in Weight (g) of Japanese Quail Fed with Super worm Larvae Meal

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Table 3, shows the Weekly Gain in Weight (g) of Japanese Quail Fed with Super worm Larvae Meal. Significant results among treatments were observed during the first week of feeding super worm meal to Japanese quail. The quail given 20% Superworm meal (T_5) were significantly lower with those quails in T_1, T_2, T_3, and T_4, however Treatments 1, 2, 3, and 4 were comparable with each other. Insignificant results were observed from week 2 until the end of the study. This only showed that the 20% Superworm meal (T_5) inclusion on the growing quail diets affects the gain in weight of the birds.

In terms of the cumulative gain weight of Japanese quail highly significant result was sought. The maximum value was found on T_2 – 68.53g, followed by T_3 – 68.17g, T_1 – 67.73g, T_4 – 63.25g, while T_5 – 28.70g showed relatively lower weight gain. Findings of the present study are identical with Benzertiha et al., (2020) and Elahi et al., (2020), who reported that dietary inclusion of dried meal worm quadratically and linearly increased the starter gain in weight of Japanese quail, which incorporated (0.2 and 0.3%) and 4%, respectively. (Cullere et al., 2016), who studied black soldier fly on the diets of broiler chicken with 15% inclusion level and (Maurer et al., 2016), who experimented on *Hermitia illucens* on the diets of layers, both found out that there is a negative effect of increasing supplementation of insect meal to birds. Bellezza Oddon et al., (2021), observed that the provision of live *Tenebrio molitor* larvae to broiler chickens (5% of the expected feed intake) had no effect on growth. In conclusion to this, Zadeh et al., (2019), said that differences in results might be due to varying nutrient composition of the insect meals. Moreover, the quail chicks remain healthy (absence of clinical signs) throughout the study.

Table 3. Weekly Gain in Weight (g) of Japanese Quail Fed with Super worm Larvae Meal

Treatment	Week 1	Week 2	Week 3	Week 4	Cumulative
T_1 – Formulated Ration w/o SML	25.50[a]	22.58	9.92	9.73	67.73[a]
T_2 – 5% SML	18.17[a]	23.42	12.25	14.70	68.53[a]
T_3 – 10% SML	20.25[a]	23.75	10.58	13.58	68.17[a]
T_4 – 15% SML	18.25[a]	29.15	10.27	5.58	63.25[a]
T_5 – 20% SML	7.58[b]	13.33	10.08	-2.30	28.70[b]
ANOVA	*	ns	ns	ns	**
$LSD_{0.01}$	9.68	-	-	-	15.50
% CV	29.63	25.06	32.29	88.54	10.10

Note. Means with common letter notations are statistically the same.
**- significantly different @ 5% level, **- significantly different @ 1% level.*

Weekly Feed Consumption (g) of Japanese Quail Fed with Super worm Larvae Meal

Table 4 shows the Weekly Feed Consumption (g) of Japanese Quail Fed with Super worm Larvae Meal. Quails fed with formulated ration without Superworm meal (T_1), formulated ration with 5% SML (T_2), formulated ration with 10% SML (T_3), and formulated ration with 15% SML (T_4), were comparable to each other but significantly different with birds fed with formulated ration with 20% SML (T_5), however quails in T_5 (20% SML) were comparable with T_3 (10% SML). Same trend was observed during the Fourth week of the study. In terms of the Overall feed consumption same result was noted. It was evident that as the inclusion of super worm meal increases there is a significant decreased in feed consumption. This result may be due to the chitin contents of the super worm meal that probably reduce the palatability of feed that resulted to the negative effect on the feeding behavior of the birds. The result of the present study was in accordance to the result of Loponte et al., (2017), came up with the same conclusion that adding 250 to 500 g of mealworms feed/kg of *Tenebrio molitor* meal in diets of partridges improved feed intake. Results are also agreed to the trials of Liu et al., (2021) and Bovera et al., (2015), who reported positive result of inclusion of *Tenebrio molitor* onto feed intake and performance of chicken.

However, on the second week of the study revealed no significant differences among treatments with a mean range from 74.68g to 94.20g, and third week of the study has the same result with means ranging from 84.52g to 97.45g. Result of the present experiment was in accordance to the report of Zadeh et al., (2019), who reported negative effect of adding 30 g/kg of feed *Tenebrio molitor* supplementation on the feed intake of Japanese quail. Moreover, Biasato et al., (2016), reported that inclusion of 75 g/kg of *Tenebrio molitor* did not affect the feed intake of chickens. The chitin contents of mealworm meal (*Tenebrio molitor*) probably might reduce the feed palatability which cause the negative effect on quail feed intake as also explained by Bovera et al., (2015). This result

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is critical since SWM has been known to contain chitin, and it contains 11.56 mg/g of chitosan (Jin et al. 2016). Chitin is an effective compound due to the functional role in improving the immune status of poultry (Khajarern et al., 2003). However, Xiao et al., (2016) reported that chitosan supplementation decreases IL-7 expression in the jejunum through changing intestinal microbiota. The microflora of the intestine could be a key factor to explain the influence of chitin on the microbiota and its subsequent impact on the immune system.

Table 4. Weekly Feed Consumption (g) of Japanese Quail Fed with Super worm Larvae Meal

Treatment	Week 1	Week 2	Week 3	Week 4	Cumulative
T_1 – Formulated Ration w/o SML	78.30a	94.20	97.45	98.56a	368.51a
T_2 – 5% SML	77.12a	91.00	85.83	104.35a	358.30a
T_3 – 10% SML	74.80ab	81.90	95.00	93.50ab	345.20ab
T_4 – 15% SML	79.33a	95.03	95.50	98.50a	368.37a
T_5 – 20% SML	66.12b	74.68	84.52	78.26b	306.58b
ANOVA	*	ns	ns	**	**
$LSD_{0.01}$	8.91	-	-	15.97	42.10
% CV	6.52	9.43	8.83	6.52	4.66

Note. Means with common letter notations are statistically the same.
**- significantly different @ 5% level, **- significantly different @ 1% level.*

Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quail Fed with Super worm Larvae Meal

Table 5, displays the Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quails Fed with Super Worm Larvae Meal. The results showed a substantial outcome in terms of the feed conversion ratio of Japanese quails, with T3 (5.08) being the best at converting feed to lean, followed by T2 (5.25), T1 (5.46), T4 (5.85), and T5 (11.20) having the least favorable feed utilization. The same result was sought for feed conversion efficiency (%) in growing Japanese quails.

Furthermore, the findings of the present study coincide with that of Biasato et al., (2017) who noted that supplementing chickens feed with *Tenebrio molitor* meal negatively affect FCR. Similarly, Marareni & Mnisi (2020) also reported negative effect of varying insects' meals in the diet on FCR of broilers. Ait-Kaki et al. (2021), observed a significant reduction in FCR of Japanese quail fed with dried mealworm and olive leaves. Magsalay et al., (2024), reported that FCR were 10.20 to 12.30kg which is slightly higher on the normal FCR values of native chicken. Likewise, Ballitoc & Sun (2013) noted a decreased trend in FCR when *Tenebrio molitor* was added from 0-10% in broiler diets.

Table 5. Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quail Fed with Super worm Larvae Meal

Treatment	FCR	FCE (%)
T_1 – Formulated Ration w/o SML	5.46b	18.42a
T_2 – 5% SML	5.25b	19.19a
T_3 – 10% SML	5.08b	19.73a
T_4 – 15% SML	5.85b	17.19a
T_5 – 20% SML	11.20a	9.42b
ANOVA	**	**
$LSD_{0.01}$	3.69	4.80
% CV	21.73	11.05

Note. Means with common letter notations are statistically the same.
**- significantly different @ 5% level, **- significantly different @ 1% level.*

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Cost Benefit Analysis of Growing Quail

Presented in Table 6, was the cost benefit of rearing growing Japanese quail. Data shows that Treatment 3, Treatment 4, and Treatment 5 accumulated higher returns compared to Treatment 1 and Treatment 2, due to lower cost of production. Thus, Treatment 5 obtained the highest returns with 78.43%.

Table 6. Cost Benefit Analysis of Growing Quail

Particular	T1	T2	T3	T4	T5
Cost of Day-old Quails	12.00	12.00	12.00	12.00	12.00
Feed Consumption (kg)	0.37	0.36	0.35	0.37	0.31
Price of Formulated Diets	30.14	31.90	29.63	28.96	27.41
Cost of Feed Consumed	11.11	11.43	10.37	10.71	8.50
Other Expenses (housing, labor, etc.)	0.80	0.80	0.80	0.80	0.80
Total Cost	23.91	24.23	23.17	23.51	21.30
Gross Income	38.00	38.00	38.00	38.00	38.00
Net Income	14.09	13.77	14.83	14.49	16.70
Cost Benefit Ratio	58.96	56.83	64.01	61.60	78.43

Conclusion

During the conduct of the growing trial of Japanese Quail fed with varying levels of Super worm meal it was evident that incorporation of Super worm meal significantly affects the growth performance parameters of the birds, it was also noted that inclusion of (T5) 20% Super worm meal resulted to the decrease performance in different growth parameters evaluated such as Weekly Body Weight (g), Weekly Gain in Weight (g), Weekly Feed Consumption (g), and Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of Japanese Quail Fed with Super worm Larvae Meal. However, in terms of cost benefit analysis, it was found out that incorporation of 5%, 10%, 15%, and 20% SML meal obtained high economic returns.

Recommendations

Based from the results found in the experimental trial for the growing phase of the Japanese quail, it delineates a decrease trend in different growth parameters following the analysis of the results when incorporating 20% SML. However, it is recommended to use 20% inclusion of Superworm meal on the growth of Japanese quail due to its better return on investment.

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