Philipp J Vet Anim Sci 2022 48(2):53-64

FRESH MADRE DE AGUA (*Trichanthera gigantea*) AND MALUNGGAY (*Moringa oleifera*) LEAVES AS FEED INCLUSION FOR JAPANESE QUAIL (*Coturnix japonica*)

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ABSTRACT

The growth, egg quality and cost-benefit ratio was determined in this study wherein 120 ready-to-lay quail birds were used. The birds were distributed to six treatments, namely: T0 - control ration based on commercial feeds (quail layer mash); T1 - 10g fresh *Trichanthera gigantea* leaves (FTL); T2 - 10g fresh *Moringa oleifera* leaves (FML); T3 - 5g FTL and 5g FML, T4 - 7g FTL and 3g FML and T5 - 3g FTL and 7g FML. The egg weight, eggshell thickness, albumen and yolk weight, breadth and length, of the Japanese quail birds were gathered every two weeks. Furthermore, the body weight was measured every two weeks while feed consumption and number of eggs produced were recorded daily. The average body weight and the number of eggs produced significantly differed on week 8; T0 had the highest body weight and eggs produced, while T2 had the lowest body weight and eggs produced. Moreover, T5 had the thickest eggshells among the treatments. However, there were no significant differences in egg weight, albumen, yolk, breadth, length, and feed consumption. Furthermore, the inclusion of fresh *T. gigantea* and *M. oleifera* leaves of 3g and 7g (T5) positively affected the eggshell thickness. Moreover, it shows T5 show potential return of utilization in production.

Keywords: quail, *Trichanthera*, *Moringa*, egg

INTRODUCTION

The correct balance of calories, protein, fat, carbohydrates, vitamins, and minerals provides energy, and the variety of nutrients is what growing children and working adult needs (Tunsaringkarn *et al*., 2013). Animal protein, especially in the poultry sub-sector, is one of the most important sources of such nutrients needed in human nutrition because of its biological significance (Olorunfemi *et al*., 2016). The egg is one of the human diet's most common and abundant protein sources. Together with chicken, quail (*Coturnix japonica*) is one of the poultry species which recently gained popularity as a source of animal protein. The essential amino acid content of Japanese quail eggs comprised 50.36% of albumen protein and 48.65% of yolk protein. The polyunstarured fatty acid (PUFA) content in the phospholipid fraction of the yolk was almost 2.5 times higher than in the triglyceride fraction,

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whereas polyunstarured fatty acid:saturated fatty acid (PUFA:SFA) ratio was 0.52:1 vs 0.26:1-0.28:1 in the triglyceride fraction. Out of albumen mineral substances, the highest content was that of phosphorus, calcium and magnesium. The yolk was the richest in phosphorus and calcium, whereas the eggshell was in calcium (Genchev, 2012).

Moreover, quail eggs has a considerable number of antioxidants, minerals, and vitamins higher than other eggs (Lalwani, 2011). Due to its petite body, the Japanese quail birds only require a smaller house than chickens. The content of the essential amino acid leucine was the highest (1.37%) in the yolk of chicken eggs, comparable to the concentration of this amino acid in the yolk of quail eggs (1.4%) (Tolik *et al*., 2014). The total antioxidant of quail egg activities on the yolk and albumen extracts was reported at 186.57+6.441 mg/g and 172+10.690 mg/g ascorbic acid, respectively (Oladipo and Ibukun, 2017). The vitamin content of quail egg yolk are fat–soluble wherein vitamin E (tocopherol, 5920.0 µg/100g) was significantly higher than vitamin A (717.0 µg/100g, $P<0.001$) and vitamin D (1.14 µg/100g, $P<0.001$). Furthermore, the essential minerals of whole eggs were nitrogen (6.36%) which was mostly in egg whites (12.2%), while most trace minerals of whole eggs were iron (80.8 mg/Li) and zinc (46.9 mg/Li). Both iron (116.0 mg/Li) and zinc (70.6 mg/Li) were higher in egg yolks (Tunsaringkarn *et al*., 2013).

Most countries depend on the importation of feeds for most poultry species (including quail), especially on meals rich in protein and energy. This usually resulted in high production costs that ultimately led to an increased market price of poultry products (Bahadori *et al*., 2017). Feed cost is one of the highest costs in poultry production accounting for 70 – 80% of all components of production costs incurred (Pramono *et al*., 2018). In solving such a problem, other countries resorted to the research of the use of some organic-based materials as feed inclusion to minimize feed costs without compromising the nutrition quality (Ronald and Adamchak, 2018) In addition, sturdy eggshell indicates good egg quality, thus, calcium-based supplements must be incorporated on quail feeds. The horseradish tree (*Moringa oleifera*), locally known as *Moringa*, has proven to be an abundant and rich source of nutrients, especially vitamins and minerals (Hasan *et al*., 2019).

The research conducted by Wilson and Hettinger (2017) in the Philippines revealed that 100g or one cup of cooked *Moringa* leaves contain 3.1g of protein, 0.6g of fiber, 96mg of calcium, 29mg of phosphorus, 1.7mg of iron, 2,820mg of beta-carotene, 0.07mg of thiamin, 0.14mg of riboflavin, 1.1mg of niacin and 53mg of ascorbic acid (PCHRD-DOST, 2018). Abbas (2013) reported that *Moringa* leaf meal could be used up to 6% of the diet of growing layer chicks, 10% of laying hen diets and 5% of broiler diets without deleterious effects on their growth and laying performance. Moreover, *T. gigantea* leaf has 65.43% crude protein, 72.73% lipid, 23.08% fiber and 68.90% non-nitrogen extract digestibility, making it a palatable feed inclusion for livestock (Hien *et al*., 2018). Furthermore, the organic food market is expanding worldwide with the rising concern in food safety, health-conscious individuals and environmental protection (Malkanthi *et al*., 2021).

Due to the increasing consumer awareness and demand for organic and quality quail meat and egg, this study was conducted using *T. gigantea* and *M. oleifera* leaves as feed inclusion for Japanese quails' growth and laying performance. Moreover, the study examined the egg quality of quails fed with such formulated feeds, which usually needed to be improved in every quail study. Lastly, it also evaluated whether such materials can decrease feed costs for quail producers without compromising the quality.

MATERIALS AND METHODS

All the procedures in caring for animals in this study were submitted for review and approved by the Institutional Animal Control and Use Committee (IACUC) of Cebu Technological University (CTRU) - Main Campus with PROTOCOL no. IACUC-TU-AO5. After complying with the ethical requirements, the study was guided by the research standard.

The experimental house was constructed at the Cebu Technological University (CTU) – Tuburan Campus livestock farm. The cage size per treatment was 1m x 1m x 0.5m. The cage was made of plywood, ¼ inch mesh wires and 1in x 1in lumber for the framework (Offiong *et al.*, 2020). A linear feeder was provided outside the cage. A corrugated galvanized iron sheet was used for the roofing wherein an artificial insulator was attached.

T. gigantea and *M. oleifera* leaves were collected inside the CTU Tuburan Campus Farm. Fresh leaves were chopped and mixed into other components in the respective diets. A completely randomized design (CRD) was used in the study. A total of 120 ready-to-lay Japanese quail birds (approximately 150-200g body weight and six weeks old) were used in the experiment and purchased at the hatchery of Cebu City. The birds were distributed to six (6) treatments with four (4) replicates and five (5) samples per replicate. The treatments used were as follows:

T0 – 40g (Recommended Commercial feeds only) control
T1 – 30g Commercial quail layer mash + 10g Fresh *Trichanthera gigantea* leaves (FTL)
T2 – 30g Commercial quail layer mash + 10g Fresh *Moringa oleifera* leaves (FML)
T3 – 30g Commercial quail layer mash + 5g FTL + 5g FML
T4 – 30g Commercial quail layer mash + 7g FTL + 3g FML
T5 – 30g Commercial quail layer mash + 3g FTL + 7g FML

The Japanese quails were acclimatized for two (2) weeks prior to the administration of treatments that lasted for two (2) months. The birds were given electrolytes for three (3) days to alleviate transportation stress. Water was provided *ad libitum* throughout the experiment. Furthermore, other factors affecting the quail birds were given appropriate attention and action.

Data gathered were as follows:

1. Growth Performance

Each quail's initial body weight was collected a day before administering the treatments. Weight gain was gathered every two (2) weeks until the end of the study using a digital weighing scale.

2. Egg Parameters

The eggs produced per day were recorded. Measurement of shell thickness (mm), egg length (mm) and egg width (mm) were measured through the Mitutoyo 500-171-30 AOS Absolute Caliper 6"/ 150mm SPC. While egg weight (g) was measured using a digital weighing scale. Lastly, average egg weight (g) was calculated weekly, while other parameters were evaluated monthly until the termination of the experiment.

3. Feed consumption

Feed intake (g) and average daily gains (ADG) were computed using the formulas below:

$$\text{Feed Intake} = Feeds\ Offered - Feed\ Refusal$$

$$\text{Average Daily Gain} = \frac{Total\ weight\ gain}{Number\ of\ days\ between\ start\ weight\ and\ Current\ Weight}$$

4. Feed Proximate Composition Analysis

Each feed treatment sample was submitted to the Department of Science and Technology – Region 7 and Fast Laboratories for proximate composition analysis (crude protein, ash content, crude fiber, moisture, calcium).

5. Cost-Benefit Ratio

Cost-Benefit-Ratio was computed by the future expenses and income based on the two (2) months of study. This was calculated by dividing the future income by expenses for five (5) years using the formula below:

$$\text{Benefit-Cost Ratio} = \frac{\sum Present\ Value\ of\ Future\ Benefits}{\sum Present\ Value\ of\ Future}$$

All the data were consolidated and transferred to MS Excel for tabulation. The Analysis of Variance (ANOVA) was used to analyze significant differences among treatments, and differences among treatment means were analyzed using Tukey. Correlation among variables was analyzed using the Minitab Statistical Software.

RESULTS AND DISCUSSION

The quality and performance of the farm animals matters on the components of nutrients found in feeds. The percentage of the proximate analysis shown in Table 1 was varied, which implies that the said treatment had different compositions of nutrients.

However, the egg numbers were significantly different among treatments, as shown in Table 2. The control group had the highest while T2 with 10g of fresh *M. oleifera* leaf had

Table 1. Proximate Analaysis of *Trichanthera gigantea* and *Moringa oleifera* leaves in the treatment diets.

Nutrient	T1	T2	T3	T4	T5
Crude Protein	16.00	12.60	8.47	9.59	10.30
Crude Fiber	7.04	4.48	5.86	6.98	7.06
Crude Fat	3.86	4.82	4.21	3.84	3.99
Ash	15.95	10.03	13.30	11.28	12.01
Calcium	1.20	2.23	1.26	1.07	1.84

Crude protein (kjedahl), Crude fiber (ANKOM Fiber Analyzer) and Calcium (Flame AAS @ F.A.S.T. Laboratories, Mandaue, Cebu City.

Ash (ignition@600 celsius) and Crude fat (Soxhlet)@ Feed Lab, DA Region 7, Guadalupe, Mandaue Cebu City

Table 2. Average Number of Eggs Produced by Quail Birds Fed with Fresh *Trichanthera gigantea* and *Moringa oleifera* leaves.

Weeks	**Treatments**						***P*-value**
	T0	**T1**	**T2**	**T3**	**T4**	**T5**	
Week 2	10.430^{a}	3.100^{bc}	2.167^{bc}	7.430^{ab}	5.730^{abc}	1.429^{c}	0.000
Week 4	13.571^{a}	4.643^{bc}	1.692^{d}	5.214^{bc}	6.000^{b}	3.214^{cd}	0.000
Week 6	15.587^{a}	7.692^{b}	2.846^{c}	8.929^{b}	7.000^{b}	6.417^{b}	0.000
Week 8	14.429^{a}	6.643^{b}	2.929^{c}	8.071^{b}	6.143^{b}	6.214^{b}	0.000

[abcd]Means with different letters indicate significant differences using Tukey's test (*P*-value<0.05).

the lowest, and there were slight differences among T1, T3, T4 and T5 which is the same as reported by Shen *et al*. (2021) at 10% of *M. oleifera* leaf meal feed inclusion for laying chicken. This result is somewhat different from those of previous studies (Abou-Ellez *et al*., 2011; Abou-Ellez *et a*l., 2012; Lu *et al*., 2016; Chen *et al*., 2020; N'Nanle *et al*., 2020), which found that high levels of *M. oleifera* leaf powder (MOLP) reduced laying performance, whereas low levels of MOLP did not. The results of MOLP supplementation may depend on the breed of chicken. Moreover, the protein digestibility of *M. oleifera* leaf was about 41.42% in the study of Alain *et al*. (2016) which was lower than soybean meal by 60% in the study of Saki *et al*. (2009). The results revealed that all levels of *M. oleifera* seed meal (MOSM) had recorded higher body weight (BW) and body weight gain (BWG) compared to the control group, and 7.5% inclusion of MOSM had the best result. During the overall period, chicks fed 5% MOSM recorded significantly lower feed conversion (FC) than the control (Rory *et al*., 2016).

Replacement of 6% *M. oleifera* leaf meal given to Rhode Island chicks produced a significant increase in the feed intake, crude protein intake, average weight gain and feed efficiency compared to the control, which is contrary to the present study and these might also influence breed of animals (Melesse *et al*., 2011). Bandura *et al*. (2020) reported that the supplementation of 4-6% MOLP in diets increased egg production in the laying hens, in contrast to the present study that shows the lower egg production of Japanese quail. Birds fed with 15% *T. gigantea* leaf in their feed have a delayed point of lay than those in control. Bejar (2017) also added that 15% inclusion of *T. gigantea* leaf meal is the maximum level beneficial for the growth, production and egg quality improvement of quail.

Furthermore, there were no significant differences in the average body weight of Japanese quail during week 2 and 4 and significant differences on week 6 and 8 among treatments. Treatment 2, fed with 30g commercial feeds and 10g fresh *M. oleifera*, has the lowest body weight which is also correlated with the feed consumption, as shown in Tables 3 and 4. Moreover, there were no significant differences on week 2 among treatments on the average feed consumption of Japanese quail, but significant differences were noticeable on week 4 to 10. As shown in Table 3, T2 was the lowest compared among the treatments in terms of average body weight and feed consumption.

Moreover, Ayssiwede *et al*. (2011) reported that the use of 24% *M. oleifera* leaves in the ration of indigenous Senegal chicken decreased feed intake, similar to the result of the present study as shown in Table 3. It was also as stated by Voemesse *et al*. (2018) that chicks fed a diet containing 3% *M. oleifera* showed a significantly heavier final weight similar to the result of T3, T4 and T5 of Japanese quail as shown in Table 4. The effect of supplementation is that *M. oleifera* leaves ascription of 15% and 20% in the diet of poultry amassed body weight. In comparison, the ascription of 5% and 10% in poultry diet of broilers had no visible effect on the body weight, as also reported by Alnidawi *et al*. (2016). Forages having high pH levels, such as *T. gigantea* and Kakawate, had significantly higher voluntary intakes of organic matter (OM) and neutral detergent fiber (NDF) than forages with medium and low pH contents, such as santol, robles, gmelina and acacia (Aban *et al*., 2015).

Alabi *et al*. (2017) verified that broilers fed diets containing aqueous *M. oleifera* leaf extracts had increased body weight, low feed intake and improved feed conversion ratio compared with the pure commercial feed or the control group. These results might be related to different bioactive constituents and nutrient exploitation in *M. oleifera* leaf extracts. The pharmacological chemical compounds (carbohydrates, saponins, cardiac glycosides, terpenes, steroids, flavonoids and alkaloids) are present in the extract as reported by Ambali and Furo (2012). This result is similar to the report of Zanu *et al*. (2012) who observed that the final body weight (FBW) and daily body weight gain (DBWG) increased with an increase in dosage level until 10% and then significantly declined with increasing levels of *M. oleifera* leaf meal. Unlike the results from previous researchers (Ashong and Brown, 2011; Portugaliza and Fernandez, 2012; Cassius Moreki and Gabanakgosi, 2014), birds on the aqueous *M. oleifera* extracts (AMOLE) treatments had significantly ($P<0.05$) depressed or lowered the FBW than the control. This might be because *M. oleifera* leaf meal was incorporated into the experimental diet instead of the aqueous extracts used in the

Table 3. Average Feed Consumption of Quail Birds Fed with Fresh *Trichanthera gigantea* and *Moringa oleifera* leaves.

Weeks	**Treatments**						***P*-value**
	T0	**T1**	**T2**	**T3**	**T4**	**T5**	
Week 2, g	498.20	529.90	460.80	533.50	526.60	524.10	0.797
Week 4, g	390.71^{a}	387.79^{a}	373.39^{c}	384.79^{ab}	383.43^{ab}	379.29^{bc}	0.000
Week 6, g	391.07^{a}	387.79^{a}	363.21^{c}	385.50^{ab}	376.21^{b}	385.43^{ab}	0.000
Week 8, g	392.09^{a}	387.60^{a}	359.73^{c}	384.09^{ab}	385.00^{b}	384.09^{ab}	0.000

^{abc}Means with different letters indicate significant differences using Tukey's test (*P*-value<0.05).

Table 4. Average Mean Value Body Weight of Quail Birds Fed with Fresh *Trichanthera gigantea* and *Moringa oleifera* leaves.

Weeks	**Treatments**						***P*-value**
	T0	**T1**	**T2**	**T3**	**T4**	**T5**	
Week 2, g	140.60	133.85	131.48	132.36	137.55	135.55	0.024
Week 4, g	142.91	142.55	137.44	138.90	137.07	136.92	0.465
Week 6, g	151.56^{abc}	146.76^{bc}	145.59^{c}	145.25^{c}	157.36^{ab}	160.15^{a}	0.000
Week 8, g	164.04^{a}	161.08^{a}	148.17^{c}	155.22^{ab}	156.60^{ab}	156.38^{ab}	0.009

^{abc}Means with different letters indicate significant differences using Tukey's test (*P*-value<0.05).

present study. The antimicrobial (lipophilic compounds) and antioxidant (polyphenols, tannins, anthocyanin, glycosides compound) present in *M. oleifera* leaf extracts (MOLE) may attach to the cytoplasmic membrane and remove free radicals, activate antioxidant enzymes and inhibit oxidases, thus, making these elements more available for the birds to use (Jabeen *et al*., 2008; Luqman *et al*., 2012). Furthermore, the synergy between individual bioactive compounds in *M. oleifera* leaf meal (MOLM) extract may be an essential feature of their action. It may affect broad aspects of physiology, such as nutrient absorption and processing, redox state, or immunity (Wallace *et al*., 2010; Mikey, 2012).

Meanwhile, Abou-Ellez *et al*. (2011) confirmed undesirable effect wherein they detected decreased linear relation between the *M. oleifera* leaf dosage and egg-laying rate. This result may be due to the type of basal diets and the age of the harvested *M. oleifera*. As leaf age grows, crude fiber content becomes higher, and this increase may distress feed intake. The average daily gain was not significantly affected by varying levels of *T. gigantea* supplementation, slightly comparable to the result in the present study (Morbos *et al*., 2016).

There were no significant differences in egg weight, albumen weight, yolk weight, egg breadth, and egg length between the treatments, as shown in Table 5. Egg weight is a trait influenced by genetics and protein in rations. Based on Table 5, it appears the egg weight varies among treatments from week 2 until week 8. There are significant differences during weeks two and four, but on week 8, there is no significant difference among treatments. The egg weight ranges from 9.041g to 10.603g. The result shows T5 with 3g fresh *T. gigantea* and 7g fresh *M. oleifera* leaves have an increasing trend throughout the week.

Nevertheless, there were significant differences in both albumen and yolk weight in the last week 6 among treatments. Eggs with the heaviest yolks and the largest yolk and albumen (Y:A) ratio would likely contain the highest cholesterol. Furthermore, there were significant differences in egg breadth during weeks 2 and 4 among treatments. Furthermore, on week 6, no significant differences were noticed. However, Table 5 shows that among the treatments, T2 had the widest eggs from weeks 2 to 6. Moreover, the egg length revealed no significant differences, but T0 and T5 indicate an increasing trend.

However, significant differences were observed in eggshell thickness at week 6 wherein T5 had the highest eggshell thickness among the treatments while T3 had the lowest eggshell thickness. This might influence the absorption of the mineral's nutrients in the Japanese quail birds. Nevertheless, the amount of ash represents the content level of total minerals. *M. oleifera* is rich in mineral elements, such as calcium, iron, potassium, phosphorus, and zinc, the key elements for animal growth and development (Teixeira *et al*., 2014). Bardos *et al*. (2019) reported no differences in the quality and composition of eggs between improved Philippine Mallard Duck (IPMD) on the inclusion of *T. gigantea*; the finding indicates that there is no influence on the quality of yolk, albumen, and eggshell, irrespective of the feeding level and *T. gigantea* was not a factor for yolk color. *T. gigantea* had a moderate crude protein and a very high amount of calcium. As reported by Bidura *et al*. (2020), the effects of dietary supplementation with *Moringa* leaves powder on the external quality characteristics of laying hens exhibited higher significantly different ($P<0.05$) in eggshell thickness in the inclusion of 4% and 5% contrary to the present study. Furthermore, (Rory *et al*., 2016) revealed the albumin and albumin/globulin (A/G) ratio was significantly decreased in birds fed 7.5% MOSM compared to the control. Sharmin *et al*. (2021) observed that the egg weight, length, width, shape index, and shell thickness of the eggs laid by hens fed diets with *M. oleifera* were similar during the experimental period.

Table 5. Egg quality of Japanese quail birds fed different treatment diets.

Weeks	Treatments	Parameters					
		Egg Weight, g	Egg Breadth, mm	Egg Length, mm	Egg Shell Thickness, mm	Albumen Weight, g	Yolk Weight, g
Week 2	T0	9.031^{b}	22.613^{b}	29.220	0.249^{a}	4.316	2.802^{b}
	T1	9.430^{b}	24.093^{ab}	29.427	0.159^{b}	4.675	3.067^{b}
	T2	10.603^{a}	25.400^{a}	30.013	0.230^{a}	4.716	3.667^{a}
	T3	9.526^{b}	24.100^{ab}	29.900	0.233^{a}	4.613	3.164^{a}
	T4	9.544^{b}	24.120^{ab}	29.833	0.265^{a}	4.587	3.138^{b}
	T5	9.422^{b}	23.947^{ab}	29.607	0.281^{a}	4.390	3.277^{ab}
	P-value	0.000	0.002	0.278	0.000	0.263	0.000
Week 4	T0	9.603^{ab}	23.893^{b}	30.427	0.267^{ab}	4.753^{ab}	3.036
	T1	10.034^{a}	24.680^{a}	30.073	0.281^{a}	5.185^{a}	3.212
	T2	9.695^{ab}	24.160^{ab}	29.873	0.306^{a}	5.047^{ab}	3.078
	T3	9.240^{ab}	23.720^{b}	29.893	0.230^{b}	4.785^{ab}	2.821
	T4	9.231^{b}	23.833^{b}	29.100	0.286^{a}	4.891^{ab}	2.899
	T5	9.589^{ab}	24.073^{ab}	29.853	0.287^{a}	4.575^{b}	3.059
	P-value	0.040	0.003	0.144	0.000	0.025	0.075
Week 6	T0	9.952	24.093	30.663	0.311^{b}	5.810	3.225
	T1	9.721	24.307	29.360	0.297^{bc}	4.863	3.047
	T2	9.917	24.433	29.720	0.314^{b}	4.982	3.293
	T3	9.761	24.093	30.173	0.247^{c}	5.101	3.029
	T4	9.501	24.013	29.487	0.331^{ab}	4.737	3.085
	T5	9.921	24.073	30.507	0.376^{a}	4.930	3.154
	P-value	0.591	0.479	0.018	0.000	0.224	0.321

^{abc}Means with different letters indicate significant differences using Tukey's test (*P*-value<0.05).

These indicate that feeding with *Moringa* leaf meal up to 1.5% had no adverse effects on the eggs' external or internal qualities, similar to the present study. In contrast to the eggshell thickness, this indicates that the inclusion of 3g of *T. gigantea* and 7g of *M. oleifera* leaf have a capacity for better eggshell thickness in the long run.

The egg production was higher, while egg weight was heavier, yolk color was darker, and the FCR was better in layer quail supplemented with 5% *Moringa* leaf meal (P<0.05) as well as in White Leghorns provided with 100 mL *Moringa* leaves extract added to 1Li of water (P<0.05). On the other hand, the supplementation of *Moringa* seed meal in the diet of Babcock layers reduced the percentage of broken eggs (0.017 vs. 0.032; P<0.05). Meanwhile, the ad libitum feeding of fresh *Moringa* leaves to broiler chickens did not affect body weight gain (Briones *et al*., 2015).

The cost-benefit ratio is typically used for cost-benefit analyses, along with other measures such as the net present value, return on investment, internal rate of return, etc. Considering absolute amounts of cost and benefits sets this ratio apart from many other indicators. Table 6 shows the cost-benefit ratio analysis wherein among the treatments, T0 is better than treated diest but T3 and T4 also show potential in 5 years projection. This is indicated by a value of 1.20 and 1.21 wherein a value of more than 1.0 has a capacity to gain in the long run of production.

The results obtained in this study revealed that the inclusion of different percentages of fresh *M. oleifera* and *T. gigantea* in quail birds did not affect the production performance in terms of egg number and egg quality. However, on external quality, eggshell thickness in 3g *T. gigantea* and 7g *M. oleifera* (T5) have better results and show potential for 5 years of utilization. Therefore, the said inclusion rate of fresh *M. oleifera* and *T. gigantea* leaves could be utilized in quail layer diets. Furthermore, follow-up research is required to know the mechanism on the effects of the treatments, especially on the hatchability processes of the eggs.

Table 6. Cost-benefit ratio analysis of the different treatements.

Treatments	**Cost-Benefit Ratio**
T0	1.78
T1	0.93
T2	0.42
T3	1.20
T4	1.21
T5	0.77

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