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Original Research

Effects of Aqueous Extract of Moringa Leaves (*Moringa Oleifera*) on Growth and Laying Performances of Japanese Quails (*Coturnix Coturnix Japonica*)

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ABSTRACT

To increase the productivity of the local Japanese quails as a protein source, a study was carried out to evaluate the effects of aqueous extract of *Moringa oleifera* (AEMO) leaves on growth and laying performances. For this purpose, 96 three-week-old Japanese quails were subdivided into four groups according to a completely randomized design. The first group received feed without additives, while other groups had 0.25, 0.5, and 1% of AEMO leaves in their rations. The results showed that adding 0.5% AEMO leaves to the diet significantly ($p<0.05$) reduced feed intake compared to T0, while quails fed on 0.25% of AEMO had the highest feed intake (1113.93±99.80 g). The body weight and feed conversion ratio decreased with increasing levels of AEMO leaves in the diet. The animals fed the T0 diet recorded the highest body weight (214.02±32.98 g), whereas $T_{0.5}$ yielded the lowest (205.46±25.06 g). The inclusion of AEMO leaves in the quail's diet had no significant ($p < 0.05$) effect on the weight of the eggs and the shape index. However, there was a significant ($p < 0.05$) difference in the number of eggs between $T_{0.25}$ (18.62±6.61) and the control (11.12±4.01). It was therefore concluded that 0.25% of AEMO leaves might be used to improve egg production in Japanese quails.

KEYWORDS: Aqueous extract, egg production, growth performance, Japanese quail, *Moringa oleifera*

INTRODUCTION

Food safety, and specifically the satisfaction of meat requirements, remains a serious challenge in most developing countries, such as Cameroon, where farmers account for almost 70% of the population **(Kwayep et al., 2022)**. Indeed, the rapid population increase caused an imbalance between meat supply and demand, resulting in human malnutrition and a lack of protein, which is an essential nutrient. However, the demand for meat continues to outpace production. This situation is described by **Delgado et al. (2020)** as an animal revolution. It's also well-known that table eggs are undoubtedly becoming the primary source of animal proteins. Indeed, several studies showed that eggs are one of the animal products containing a large amount of proteins, including essential amino acids in a balanced proportion.

Quail breeding increased in popularity as a result of its numerous benefits, including rapid growth, precocity (early sexual maturity), high egg production, and prolificity (disease resistance) **(Sarabmeet and Mandal, 2015)**. They have a short life cycle and require less food and space due to their small size. Despite the benefit provided by this species, breeding techniques in Cameroon are not fully understood **(Djitie et al., 2020)**. Indeed, the production performances of this species are slightly below the standard recommendations. Because of this, antibiotics were introduced to animal feeds to prevent or treat infections, reduce morbidity and mortality, and boost growth and output **(Toghyani et al., 2010; Nasab et al., 2015).** Nevertheless, several studies have demonstrated that antibiotics have potential detrimental effects, posing a significant public health risk **(Nweze et al., 2011)**. Breeders use a wide range of chemical products (enzymes, antibiotics, and growth factors) to boost reproduction. Due to the restriction on most of these chemicals because of their disastrous consequences, many researchers are looking for alternatives. Among these alternatives, there are natural plant-based products such as essential oils and plant extracts. Plant extracts are concentrated substances that contain essential nutrients. They have several actions, including phytoestrogenic, anti-infectious, antifungal, antiparasitic, antibacterial, anti-inflammatory, antimutagenic, antimicrobial, antioxidant, and antitoxin **(Dorman et al., 2000)**. Plants such as *Moringa oleifera* were discovered while exploring other plants as phytobiotics. The aim of this study is to evaluate the effects of M. oleifera on the growth and laying performances of Japanese quails that will contribute to improve knowledge on the use of phytobiotics in poultry.

MATERIALS AND METHODS

Study Area

The study was carried out between March and July 2024 at the University of Dschang's Teaching and Research Farm and the Production and Animals Nutrition Research Unit (URPRONAN) of the Faculty of Agronomy and Agricultural Sciences (FAAS). Dschang is located at 5˚26' north latitude and 10˚26' east longitude, at an altitude of between 1400 and 2100 m. West Cameroon has an equatorial climate, with annual rainfall between 1500 and 2000 mm and average temperature ranging from 10°C in July and August to 25°C in February **(Pamo et al., 2005)**. In addition, the average annual insolation is approximately 1873 hours, with an average relative humidity of 76.8%. The dry season goes from mid-November to mid-March, and the rainy season lasts the remainder of the year.

Animal Material and Housing

For this study, 96 Japanese quails (*Coturnix japonica*) aged 21 days with an average weight of 85 g were bought from Yaoundé. The animals were housed in a wooden cage consisting of 16 boxes and galvanized mesh. The box measurements were 50 cm wide, 60 cm deep, and 45 cm high, and it held 6 quails. The lodges were equipped with an automatic drinking system and adapted feeders to reduce food wastage and ensure ad libitum service. During the experiment, both the animals and feed were weighed using an electronic scale (capacity of 10 kg and precision of 1 g). Another MELTAR electronic scale (500 g capacity, 0.01 g precision) was used to weigh eggs and internal organs. The height and diameter of the eggs were assessed using a vernier caliper.

Plant Material

The M. Oleifera used in this experiment was harvested in Bafia, dried, and milled into powder. Thereafter, it was sent to Dschang's phytopathology laboratory to be extracted into an aqueous solution. Briefly, 100 g of powder was weighed and macerated in a liter of distilled water and kept in a dark place for 48 hours. The ‘marc’ was extracted from the sucked paste using mousseline cloth and filtered through with cotton to obtain the liquid extract. To obtain the dry powder of aqueous extract, liquid was poured into aluminum plates and dried for around 2 to 3 days using an oven at 520°C. A sample of the extract was sent to the laboratory for phytochemical analysis using the method described by **Harbone (1973)**, and results are displayed in Table 1.

Table 1: Phytochemical test results aqueous extract of Moringa leaves

Compounds	Results
Alkaloids	-
Phenols	+
Flavonoids	+
Sterols	+
Triterpenoids	+
Tannins	+
Saponins	+
Anthocyanins	+
Anthraquinone	+

Presence (+)/absence (-)

Experimental diet and design

The 21-days-old quails were randomly assigned to four experimental treatments in a randomized design, with 24 quails per treatment. Each treatment has 4 replicates of 6 birds (2 males and 4 females). Throughout the trial (12 weeks), quails were fed ad libitum (water and food) a basic diet **(Table 2)** with different levels of extract incorporation:

T_0: control diet
$T_{0.25}$: T0 + 0.25% of Moringa extract,
$T_{0.5}$: T0 + 0.5% of Moringa extract,
T_1: T0 + 1% of Moringa extract.

Table 2: Composition and bromatological and of the basal diet

Ingredient (%)	Quantities (kg)
Maize	60
Wheat brand	4.5
soya beans meal	22
Fish meal	4.5
Bone meal	2
Oyster shell	2
Premix 5%	5
Total	100
Calculated nutrients composition	
Metabolized energy (kcal/kg)	2906.80
Crude proteins (%DM)	20.15
Calcium (%)	2.03
Phosphorus (%)	1.27
Lysine (%)	0.44
Methionine (%)	0.14
Sodium (%Kg DM)	0.22

*Vitamin premix provided per kilogram of diet: vitamin A: 3000000 IU; vitamin D3: 600000 IU; vitamin E: 4000 mg; vitamin K: 500 mg; vitamin B1: 200 mg; vitamin B2, 1000 mg; vitamin B6: 400 mg; vitamin B12: 4 mg; Mn: 80 mg; Fe: 8000 mg; Zn: 10000 mg; Cu: 2000 mg; Methionine, 200000 mg; Lysine: 78000 mg; Se: 20 mg.

DATA COLLECTION

Evaluation of growth performances

Feed intake (FI)

Feed was weighed and served to birds and left-overs from each group were recorded weekly using an electronic scale. The weekly feed intake was calculated by subtracting the quantity of the left over from the quantity served during this period.

FI = quantity served (g) – quantity refused (g)

The daily feed intake (g) was obtained by dividing the total feed intake by seven

Live body weight and weight gain

At the beginning of the experiment, all the quails were weighed on a weekly basis thereafter using the scale previously described. The weight gain was obtained by calculating the differences between two successive weekly weights.

Weight gain = final weight (g) – initial weight (g)

Feed conversion ratio (FCR)

The weekly feed conversion ratio was calculated by dividing the quantity of feed consumed by the weight gained (WG) during the week.

$$\mathbf{FCR} = \frac{\textbf{Total feed intake per week (g)}}{\textbf{Weight gain per week (g)}}$$

Laying and egg parameters

During the laying period, eggs were collected daily and stored in trays for up to 7 days before being weighed individually using a 500 g capacity MELTAR electronic scale with a precision of 0.01 g, and the length and height were determined using a Vernier caliper (precision: 0.01 mm). The egg shape index (SI) was calculated using the collected data by:

$$\mathbf{SI} = \frac{\textbf{width}}{\textbf{length}} \mathbf{x\ 100}$$

Statistical Analyses

The statistical software used was SPSS 26.0. Data collected were subjected to a one-way analysis of variance (ANOVA), and when there were significant differences between treatments, means were separated using the Waller Duncan test at the 5% significance level.

RESULTS

Effects of aqueous extract of M. oleifera (AEMO) leaves on growth performances

The live body weight, FCR, and weight gain of Japanese quails are displayed in Table 3. There was no significant difference ($p>0.05$) between the treatments in terms of feed conversion ratio or weight gain. However, the control group had the highest live weight (214.02±32.98 g), whereas those receiving 0.5% additive produced the smallest (205.46±25.06 g). Meanwhile, feed intake showed a significant difference ($p<0.05$) between the treatments T0 and T0.5.

Table 3: Evaluation of growth parameters of Japanese quails in response of aqueous extract M. oleifera leaves

Growth parameters	Treatments				p
	T0	T0.25	T0.5	T1	
Live weight (g)	214.02±32.98	212.34±30.60	205.46±25.06	207.89±27.91	0.89
Feed intake (g)	1105.43±83.97^{a}	1113.93±99.80^{a}	1026.63±52.20^{b}	1073.84±66.15^{ab}	0.04
FCR	4.20±0.36	4.16±0.71	4.53±0.71	4.47±0.63	0.77
Weight gain (g)	151.62±7.70	149.70±19.14	135.53±11.78	141.66±13.19	0.35

a, b: Means with the same superscript on the same column are significantly different ($p<0.05$), and ab means there in no significant difference with either a or b. p= probability. T0= negative control diet; T0.25 = T0 + 0.25g of Moringa extract; T0.5= T0 + 0.5 g Moringa extract; T1= T0 + 1g of Moringa extract. FCR= Feed Conversion Ratio

Weekly feed intake

Figure 1 shows the effect of aqueous extract of *Moringa oleifera* leaves on weekly feed intake in quails. All treatments showed a consistent pattern of increasing feed intake with age. From weeks 3 to 11, the T0.5 treatment curve was below the other treatments, while T0.25 was higher than others between weeks 3 to 6 and weeks 8 to 12.

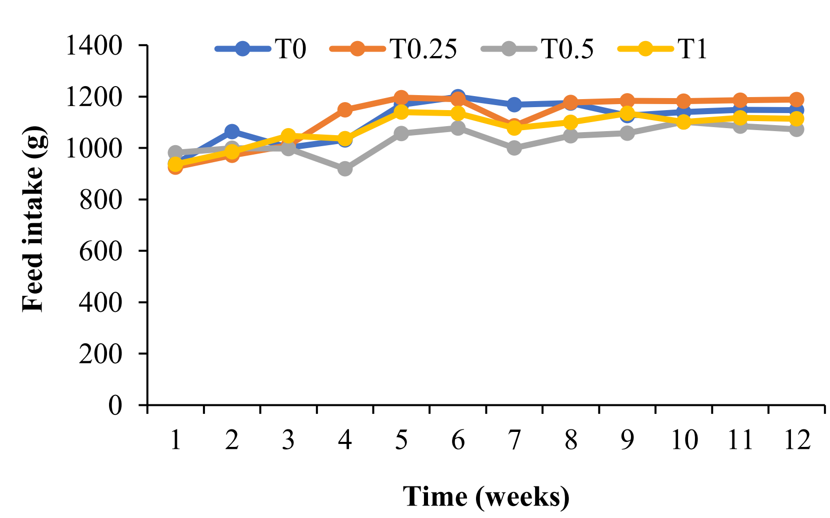

Figure 1: Evolution of weekly feed intake of Japanese quails as affected by aqueous extract of M. oleifera leaves

Live body weight

The live body weight of quails increased with age and followed a consistent pattern across all treatments

(Figure 2). From weeks 6 to 8, weight gain was steady in almost all treatments, then it began to fall.

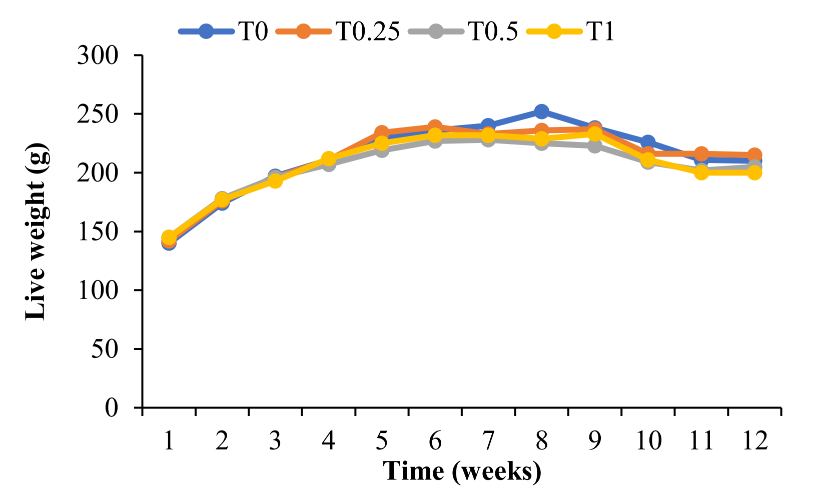

Figure 2: Evolution of live body weight of Japanese quails as affected by aqueous extract of M. oleifera.

Effect of aqueous M. oleifera leaves extract on laying rate and characteristics of egg

The treatments $T_{0.25}$ (18.62±6.61) and T_0 (11.12±4.01) had significantly ($P<0.05$) different egg counts. Animals fed 0.25% additive had the best record in all laying parameters, followed by T_1 for the number of eggs laid (13.65±5.55) and weight of eggs (11.14±1.01 cm). T_0 produced the smallest number of eggs (11.12±4.01) and weight of eggs (10.81±0.52 cm). T_1 had the smallest shape index (77.79±2.84) **(Table 4).**

Table 4: Laying parameters of Japanese quails as affected by M. oleifera feeding regimes.

Laying parameters	Treatments				P
	T_0	$T_{0.25}$	$T_{0.5}$	T_1	
Number of eggs	11.12±4.0[b]	18.62±6.6[a]	13.46±6.67[ab]	13.65±5.55[ab]	0.04
Weight of eggs	10.81±0.52	11.53±0.04	11.14±0.59	11.14±1.01	0.22
Height of eggs	3.24±0.07	3.30±0.63	3.24±0.09	3.24±0.18	0.63
Width of eggs	2.52±0.74	2.59±0.06	2.53±0.08	2.50±0.13	0.31
Shape index	78.05±0.74	78.29±1.16	78.04±1.74	77.79±2.84	0.95

a, b: Means with the same superscript on the same column are significantly different (p<0.05), and ab means there in no significant difference with either a or b. p= probability. T0= negative control diet; T0.25 = T0 + 0.25g of Moringa extract; T0.5= T0 + 0.5 g Moringa extract; T1= T0 + 1g of Moringa extract.

Evolution of the number of eggs

Egg production increased with time for all treatments **(Figure 3).** The T0.25 group showed the highest laying rates and maintained this advantage throughout the study period, whereas the control group consistently had the lowest laying rate.

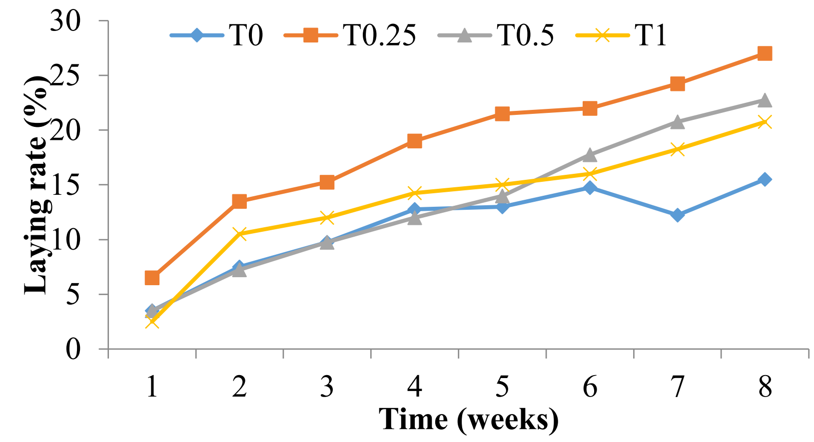

Figure 3: Evolution of laying rate affected by aqueous M. oleifera leaves extract

Evolution of the weight of eggs

The weight of eggs slightly increases with time **(Figure 4**). From weeks 1 to 3, T0.25 had the largest egg weight, while T1 had the smallest. At the end of the trial, T0 recorded the smallest egg weight as compared to animals receiving the additive.

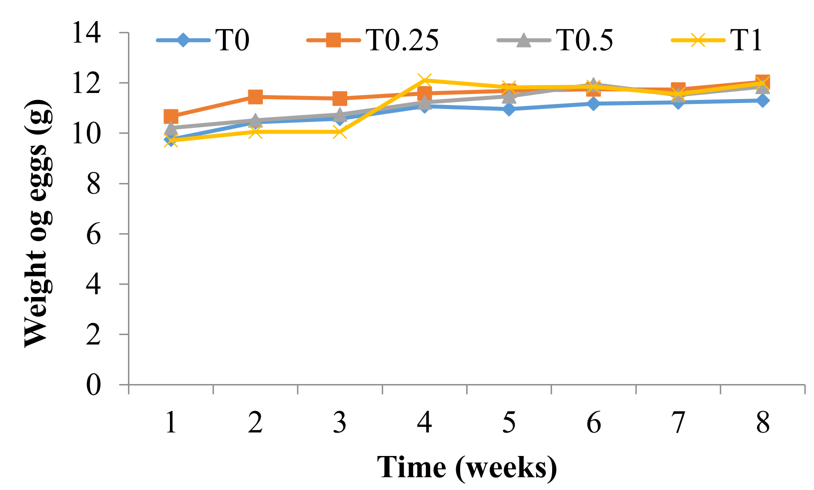

Figure 4: Evolution of the weight of eggs affected by aqueous *M. oleifera* leaves extract

Evolution of the height of eggs

The height of eggs changed with quail age in an irregular pattern across treatments **(Figure 5)**. From weeks 1 to 3, the height of the egg increased, then it became almost constant till the end of the experiment. T_1 produced the shortest egg height at the beginning of production. However, it increased faster and became comparable to other treatments.

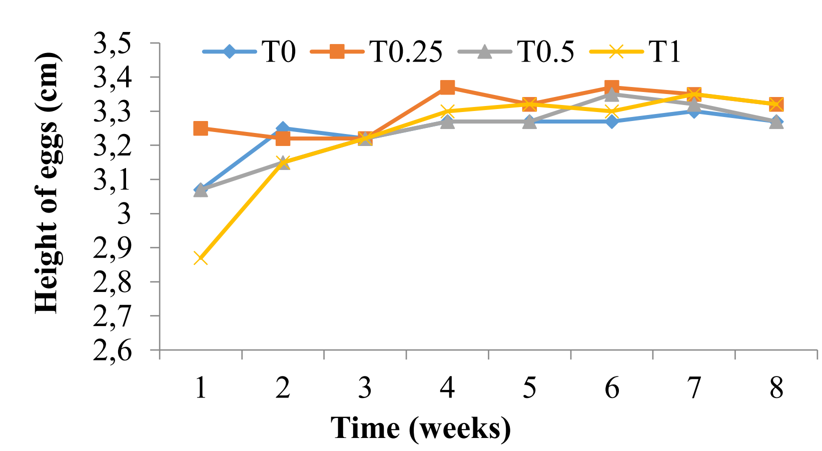

Figure 5: Evolution of the height of eggs affected by aqueous M. oleifera leaves extract

Evolution of the width of eggs

The width of eggs increased throughout time in an irregular pattern and varied with treatments **(Figure 6).**

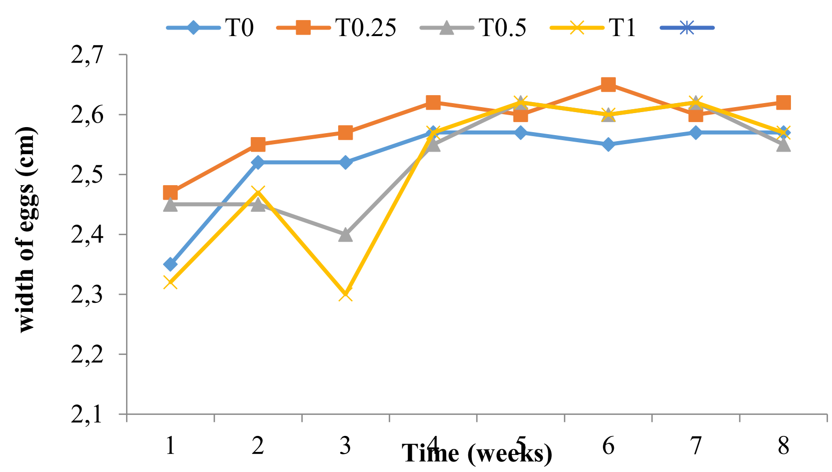

Figure 6: Evolution of the width of eggs as affected by aqueous M. oleifera leaves extract

T_1 had the lowest record at the beginning of the study but rapidly increased from week 1 to 2, then declined during the third week before increasing again in subsequent days. $T_{0.25}$ recorded the highest egg width.

Evolution of the shape index of eggs

The shape index of the eggs rose in an irregular pattern with age and changed with treatments. T1 had the highest shape index at the beginning of production, which decreased gradually until the third week. Then, it increased and became comparable to other treatments **(Figure 7)**.

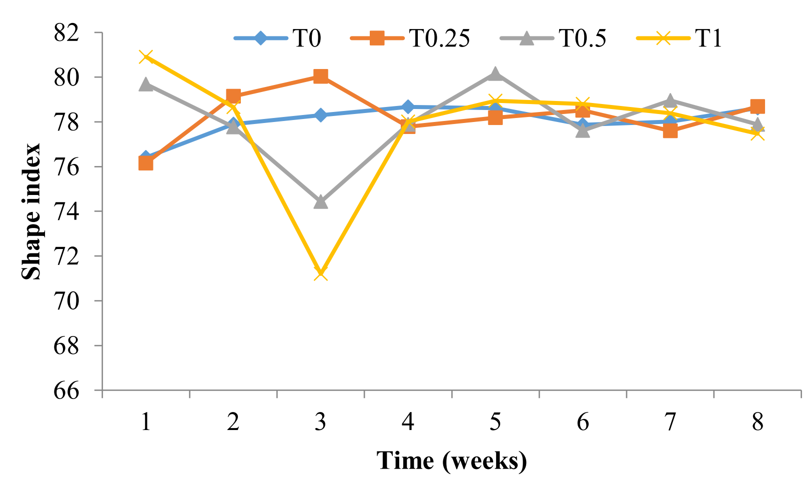

Figure 7: Evolution of the shape index of eggs affected by aqueous M. oleifera leaves extract

DISCUSSION

This study revealed that feed intake was significantly affected by the inclusion of aqueous extract of Moringa oleifera leaves in quail diets. However, it was slightly higher in T0.25 than T0. This could be due to the presence of bioactive compounds such as polyphenols in the extract affecting food flavor, aroma, and mouthfeel, which can increase feed intake as well as reduce the zootechnical performances of the animals **(Fokom et al., 2020).**

This result is similar to **Kana et al. (2017),** who reported that supplementing broiler feed with D. glomerata significantly ($p < 0.05$) reduced feed intake. This discovery is also similar to those of **Ashong and Brown (2011),** who observed that incorporating M. oleifera leaf meals in the White Leghorn diet increased feed intake. The decrease in feed intake in quails receiving 0.5 and 1% is consistent with **Portugaliza and Fernandez's (2012)** findings, who observed that adding aqueous leaf extracts of moringa in drinking water decreased broiler feed intake as the concentration increased. This could be due to moringa's increased digestion and metabolism activities, which allow quails to achieve their nutritional requirements with lesser feed intake (**Ghazalah and Ali, 2008).** Furthermore, moringa's leaves contain carotenoids, vitamins, minerals, amino acids, alkaloids, and flavonoids **(Siddhuraju and Becker, 2003).** They have a rare combination of phenolic compounds (zeatin, quercetin, kaempferol, and apigenin); the combination of these compounds is essential for growth, and they reduce disease infestation in the GIT **(Teixeira et al., 2014)**, thus improving the food utilization and leading to less feed needed to meet the requirements for maintenance and production of the birds. This result was in disagreement with **Herawati's (2010)** result, who reported that including 2% of ginger (Z. officinale) increased broiler feed intake. Live body weight was not significantly affected across treatments. The lower body weight and lower FCR in this study are different from those obtained with the experiment of **Kana et al. (2017),** who reported that incorporating 0.2% and 0.4%

D. glomerata in broiler feed had no appreciable effect on body weight.

The addition of the moringa extract influenced egg production. The quails fed T0.25 laid more eggs than those others. However, the control group had the smallest number of eggs laid. The higher number of eggs observed could be attributed to the presence of flavonoids in this plant's leaves. These bioactive compounds have antimicrobial and antioxidant properties that help in the maintenance of a healthy intestinal microbiota by reducing pathogenic bacteria while promoting the growth of beneficial ones. This improved gut environment may enhance nutrient digestion and absorption, boosting the availability of essential nutrients and energy required for egg formation and production **(Quanhang et al., 2019).** This result is consistent with **Djinandji et al. (2022),** who reported an improvement in egg production in quails fed 2% and 10% of Moringa leaf. This could be due to the fact that moringa leaves contain amino acids and nutrients **(Zarkadas et al., 1995 and Fuglie, 2002). Wu et al. (2018)** explained in their study on laying hens that laying rates depend on the laying period, especially on the amount of amino acids and proteins ingested by the hens on a daily basis. Regarding the other egg characteristics, including weight, length, width, and shape index, no significant differences were observed, suggesting that moringa leaf extract had no effect on these egg characteristics.

CONCLUSION

The aqueous extract of Moringa oleifera leaves had no effect on the growth performances of Japanese quails (*Coturnix japonica*). However, during the laying period, quails fed 0.25% extract produced more egg than other treatments. Therefore, to improve the laying performances in Japanese quails, 0.25% of aqueous extract of Moringa leaves is recommended in the diet.

AUTHOR'S CONTRIBUTION

EM and FT: Conceptualization; methodology; supervision; validation; **MM and HCE**: Methodology; supervision; validation**; CNK, ET, DCJ, and CL**: Formal analysis; investigation; methodology; writing—original draft.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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