EFFICACY OF HERBAL PRODUCTS (NEEM + MORINGA) ON THE PRODUCTION PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF JAPANESE QUAIL

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CERTIFICATE

This is to certify that the thesis entitled **“EFFICACY OF HERBAL PRODUCTS (NEEM + MORINGA) ON THE PRODUCTION PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF JAPANESE QUAIL”** submitted to the Department of Poultry Science, Faculty of **Animal Science & Veterinary Medicine**, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **POULTRY SCIENCE**, embodies the result of a piece of bonafide research work carried out by **SUKLA SIKDER**, Registration No. **19-10063** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

June, 2021

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Dedicated to

My

Beloved Parents

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The Author

EFFICACY OF HERBAL PRODUCTS (NEEM + MORINGA) ON THE PRODUCTION PERFORMANCE AND EGG QUALITY CHARACTERISTICS OF JAPANESE QUAIL

ABSTRACT

The study evaluated the comparative efficacy of Neem (*Azadirachta indica*) and Moringa (*Moringa oleifera*) leaf powder on the productive performance, health status and egg quality of commercial layer Japanese quail. A total of 27-day-old 160 Japanese quails were reared in Sher-e-Bangla Agricultural University Farm, Dhaka. Birds were divided randomly into 5 experimental groups of 4 replications and each replication contains 8 birds. These groups were allotted to five treatment designated as T_1, T_2, T_3, T_4 and T_5 Groups. T_1 was offered basal diet without any supplementation and served as a control. Whereas, group T_2,T_3,T_4 and T_5 were offered basal feed supplemented with Antibiotic, Neem + moringa – 1.2%, Neem + moringa – 1.0% and Neem + moringa – 0.75%, respectively. The results showed that the weekly feed consumption, live body weight, egg production by number and weight and % HDEP were highest in T_5 (Neem + moringa – 0.75%) and at the end of 7^{th} week it were (1.672±0.132, 1400^{a}±8.20, 572^{a}±2.60, 49.75^{a}±2.287 and 86.90^{a}±3.30, respectively) compared to control and other treatments. Again, T_5 (Neem + moringa – 0.75%) showed lowest FCR (2.900^{b}±0.108 at 7^{th} week) whereas T_4 (Neem + moringa – 1.0%) gave highest (3.525^{a}±0.269 at 7^{th} week). Similarly, T_4 (Neem + moringa – 1.0%) showed highest survivability (100%) whereas the least (94.00^{b}±3.50) was from T_2 (Antibiotic). Regarding quality parameters of egg, the highest shape index, albumen index and yolk index, was found from T_4 (Neem + moringa – 1.0%), T_3 (Neem + moringa – 1.2%) and T_2 (Antibiotic), respectively whereas T_2 (Antibiotic) showed higher haugh unit (93.77±1.163) and T_4 (Neem + moringa – 1.0%) showed higher yolk color fan (4.50±0.102) and T_1 (control) gave higher shell thickness (0.22±0.012). In conclusion, it can be said that T_5 can positively affect the productive and health status of broiler. In case of economic return, the highest gross return (Tk. 263.00), net return (Tk. 67.50) and benefit cost ratio (BCR) (1.35) was recorded from supplementation treatment T_5 (Neem + moringa – 0.75%) whereas T_2 (Antibiotic) treatment gave lowest gross return (Tk. 247.00), net return (Tk. 48.50) and BCR (1.24).

Keywords: Quail, Quality herbs, antibiotic, Egg quality

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro-Ecological Zone
BBS	Bangladesh Bureau of Statistics
BCSRI	Bangladesh Council of Scientific Research Institute
cm	Centimeter
CV %	Percent Coefficient of Variation
DAS	Days After Sowing
DMRT	Duncan's Multiple Range Test
***et al.*,**	And others
e.g.	exempli gratia (L), for example
etc.	Etcetera
FAO	Food and Agricultural Organization
g	Gram (s)
i.e.	id est (L), that is
Kg	Kilogram (s)
LSD	Least Significant Difference
m^2	Meter squares
ml	Mili-Liter
M.S.	Master of Science
No.	Number
SAU	Sher-e-Bangla Agricultural University
var.	Variety
^oC	Degree Celceous
%	Percentage
NaOH	Sodium hydroxide
GM	Geometric mean
mg	Mili-gram
P	Phosphorus
K	Potassium
Ca	Calcium
L	Liter
µg	Microgram
USA	United States of America
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Quail farming is an alternative source of protein supply, given the limitations of modern poultry farming and the need to diversify the origins of animal proteins. Quail generates great interest in Cameroon because of its many assets, notably its resistance to diseases, the low production cost associated to its small size, rapid growth and relatively short life cycle (Kayang, 2004). It also has a high egg production (Biagini, 2006) and according to Tunsaringkam *et al.* (2013), their eggs are apparently therapeutic. Poultry production is a well-known and one of the fast growing food producing industry around the globe (Hussain *et al*., 2015).

Quail farming is a subsector of the poultry industry and is famous for rapid meat production enterprise (Ghayas *et al*., 2017; Ahmad *et al*., 2018). There are several genotypes of quails around the globe but Japanese quails are mostly used for farming purpose. Japanese quails are a newly introduced species in the poultry industry (Ghayas *et al*., 2017). Quail farming has some particular benefits. Quails can be utilized for the production of meat in a short period (4–5 weeks) and it becomes mature at the age of six weeks (Hussain *et al*., 2013). Quail farming is becoming a popular business because of better overall revenues, among different segments of poultry. Japanese quails are the best choice for meat production due to better egg production, rapid growth rate, high disease resistance and shorter production time (Ahmad,2014).

For all types of poultry businesses, feed is an essential and most important part for poultry business as it constitutes 60% to 70% of the production costs (Ghayas *et al*., 2017). Various feed supplements or growth promoters have been considered to improve feed efficiency, growth and product quality and to reduce production costs (Ghayas *et al*., 2017; Singh *et al*., 2015).

The feed additives substance is applied from an expansive perspective, which could be added with basic feed to get some specific effects. The basic purpose of giving feed additives is to increase the performance of animals by enhancing their growth, improving feed conversion ratio, sustainability and to reduce mortality of poultry animals.

Most of the growth stimulants and synthetic drugs are given to poultry animals for better and faster growth, but many disadvantages such as high costs, side effects on the health of birds and longer residual properties shown by the use of these stimulants and drugs (Khatun *et al*., 2013). Thus, there's been the need of finding alternatives to the use of growth promoting antibiotics (Gauthier *et al.*, 2011). On the other hand, medicinal herbs are believed to have valuable properties such as antioxidant, antifungal and antimicrobial properties as supplements to animal and poultry feeds (Hardy, 2002). Herbal feed additive also improves nutrient utilization, absorption and the stimulation of the immune system (Gohel *et al*., 2019). Utilization of herbs and therapeutic plants in poultry feeding could be more beneficial as growth promoters and prevent many common poultry diseases. Moreover, these herbs would be easily available and can be used effectively in poultry diets (Deka *et al*.,2019).

Among these alternatives, the most used are the probiotics, prebiotics, enzymes, essential oils, herbs, spices, and vegetable extracts (Brizuela *et al*., 2009; Ayasan, 2013). Neem, moringa, tulsi etc. are some of the important native herbs that can be used in poultry diets. These herbs are not only cheaper sources of feed but also have broad medicinal properties like antiprotozoal, hepato-protective, antimicrobial (antiviral, antibacterial, antifungal) and many other properties having not any serious adverse effects and has attracted worldwide eminence (Kale *et al*.,2003).

The neem leaves, neem oil and de-oiled neem seed cake are used as animal feeds (Ogbuewu *et al*., 2010a). The neem leaves contain appreciable amounts of proteins, minerals, carotene and adequate amount of trace minerals (Ogbuewu *et al*., 2010b).The neem leaf meal has been extensively researched in the chickens (Ansari *et al*., 2008; Dey *et al*., 2011; Jawad *et al.*, 2013; Obun *et al*., 2013; Nayaka *et al*., 2012). In all of these studies in chicken, the neem leaf meal has been reported to have positive impacts on the studied parameters at varying dietary inclusion levels.

Again, there are reports that extracts from leaves of *Moringa oleifera* (Moringa) possess antimicrobial activity on Gram positive and Gram negative bacteria (Devendra *et al*., 2011). Inaddition, the leaves have nutritional and nutraceutical properties (Makkarand Becker, 1996), since they are characterized by their high content of proteins, vitamins and minerals, and low levels of anti-nutritional substances. On the other hand, the content of total phenols (105.04 mg Equivalent

Acid Gallic [EAG)]/g) and its antioxidant capacity (85.77%) of methanolic extracts of Moringa leaves show their antioxidants properties (Singh *et al*., 2009).

Therefore, the study was taken to determine the qualitative and quantitative performance of Japanese laying quail (*Coturnix japonica*) reared in open sided house under cold-dry environment using neem and moringa leaves powder in diet as feed supplementation considering its antimicrobial, nutritional and phytogenic features.

Objectives:

1. To study the effects of herbs (neem + moringa) on the production performance of Japanese quail
2. To identify the effect of herbs (neem + moringa) on the quality of quail egg

CHAPTER II

REVIEW OF LITERATURE

Poultry production is a well-known and one of the fast growing food producing industry around the globe (Hussain *et al*., 2015). Quail farming is a subsector of the poultry industry and is famous for rapid meat production enterprise (Ghayas *et al*., 2017; Ahmad *et al*., 2018). There are several genotypes of quails around the globe but Japanese quails are mostly used for farming purpose. Japanese quails are a newly introduced species in the poultry industry of Pakistan (Ghayas *et al*., 2017; Hussain *et al*., 2019). Quail farming has some particular benefits. Quails can be utilized for the production of meat in a short period (4–5 weeks) and it becomes mature at the age of six weeks (Hussain *et al*., 2013). Japanese quails are the best choice form eat production due to better egg production, rapid growth rate, high disease resistance and shorter production time (Ahmad, 2014).

For all types of poultry businesses, feed is an essential and important element for poultry business as it constitutes 60% to 70% of the production costs (Ghayas *et al*., 2017). Various feed supplements or growth promoters have been designed to improve feed efficiency, growth and product quality and to reduce production costs (Ghayas *et al*., 2017; Singh *et al*., 2015). The feed additives substance is applied from an expansive perspective, which could be added with basic feed to get some specific effects. The basic purpose of giving feed additives is to increase the performance of animals by enhancing their growth, improving feed conversion ratio, sustainability and to reduce mortality of poultry animals. Such feed additives are often called non-nutrient feed additives and known as growth promoters (Singh and Panda *et al.*, 2014).

Most of the growth stimulants and synthetic drugs are given to poultry animals for better and faster growth, but many disadvantages such as hig hcosts, sideeffects on the health of birds and longer residual properties shown by the use of these stimulants and drugs (Khatun *et al*., 2013). On the other hand, medicinal herbs are believed to have valuable properties such as antioxidant, antifungal and antimicrobial properties as supplements to animal and poultry feeds (Hardy *et al.*, 2002). Herbal feed additive also improves nutrient utilization, absorption and the stimulation of the immune system (Gohel *et al*., 2019). Utilization of herbs and therapeutic plants in poultry feeding could be more beneficial as growth promoters and prevent many common poultry diseases. Moreover, these herbs would be easily available and can be used effectively in poultry diets (Deka *et al.*, 2019)].

Neem and Moringa are some of the important native herbs that can be used in poultry diets. These herbs are not only cheaper sources of feed but also have broad medicinal properties like antiprotozoal, hepato-protective, antimicrobial (antiviral, antibacterial, antifungal) and many other properties having not any serious adverse effects and has attracted worldwide eminence (Kale *et al*., 2003). However, the current research investigated the growth performance, hematology, serum biochemistry of Japanese quails fed Neem (*Azadirachta indica*) and Moringa (*Moringa oleifera*) leaves powder with basic diet.

2.1 Utilization of leaf meals in poultry

At a higher inclusion level leaf meals have been observed to have a depressed growth rate and low feed intake in poultry birds. This may be attributed to their low digestibility and inadequate metabolizable energy content. Some of the notable leaf meals that have been used over a period of time in the poultry industry include, *Moringa oleifera,*Siam weed *(Chromolaena odorata),* Green grape leaf, *Ipomoea asarifolia, Sesbania* leaf meal, *Leucaena* leaf meal, Pawpaw leaf meal, Neem leaf meal, *Gliricidia* leaf meal, Cassava leaf meal etc. (Fasuyi, *et al.*, 2008).

The possibility of using *Moringa oleifera* leaf meal as an ingredient in cassava chip based diets fed to commercial egg strain chickens and its effect on egg quality were investigated by Olugbemi *et al*. (2009). They observed from the results obtained that cassava chips can be fed whole to laying birds and the inclusion of *Moringa oleifera* leaf meals at levels up to 10% in cassava based diets fed to commercial egg laying birds is possible without significant ($p>0.05$) negative effects in terms of egg quality parameters. Onu and Aniebo (2011) working on the influence of *Moringa oleifera* leaf meal on the performance and blood chemistry of starter broilers also reported significant ($p<0.05$) higher weight and superior feed conversion ratio than birds fed the control diet. Birds fed 2.5% and 5% MLM diets recorded significantly ($p<0.05$) better bodyweight gain. Result showed that an inclusion level of MLM at 7.5% dietary level is possible without any deleterious effect on the performance and blood characteristics of broiler starters.

Also, in a six weeks feeding trial involving 180 two weeks old Cobb broiler chicks conducted to assess the effects of partial replacement of fishmeal with moringa leaf meal on broiler chickens, Zanu *et al.* (2012) observed a decline in the final liveweight, weight gain, feed conversion efficiency as the level of Moringa leaf meal increased in the diets of the birds. They observed that at a level of 5, 10 and 15% inclusion rate of MLM, growth rates of the birds were reduced without adversely affecting mortality, carcass traits and blood variables. Gadzirayi *et al.* (2012) also conducted a study to determine the performance of broiler chickens fed mature *Moringa oleifera* leaf meal as a protein additive to soyabean meal and observed that there were no significant ($p>0.05$) difference in the amount of feed consumed by the broiler birds under the different treatments, however there was significant difference in feed conversion ratio across the treatment groups. The authors therefore concluded that the inclusion of *Moringa oleifera* leaf meal in broiler diet at 5% inclusion level produced broilers of similar weight and growth rate compared to those fed under conventional commercial feed.

Aro *et al.* (2009) working with Siam weed *(Chromolaena odorata)* leaf meal as egg yolk colourant for laying hens reported highly significant ($p<0.01$) difference among the treatment means for the yolk colour score. They observed that at the lowest level of *Chromolaena odorata* inclusion (2.5%), the minimum standard for yolk pigmentation for individual consumers and for the pastry and confectionery industries was achieved. They further stated that the leaf meal inclusion in the diet of the birds up to 7.5% level did not compromise egg weight, shell thickness, shell weight, albumen height and haugh unit. Also, Fasuyi *et al.* (2005) working with twenty four layers in their eight month of lay to determine the effects of dietary inclusion of Siam weed leaf meal on egg quality characteristics, observed that total egg production and total feed intake increased up to 5% level of inclusion, after which there was decline as from 7.5% level of inclusion. They concluded that inclusion up to 5% level in the diet of the birds will have no detrimental effect with desirable aesthetic effect on egg yolk coloration.

Mansour *et al.* (2012) also conducted a study to evaluate the effects of using different levels of green grape leaves on the performance, carcass traits, blood biochemical and immunity parameters of broilers. They observed that there were no significant ($p>0.05$) differences between experimental groups in growth performance, whereas the carcass traits, blood chemistry and immunity parameters were significantly ($p<0.05$) affected by adding different levels of green grape leaves. They reported that using up to 2% level of green grape leaves had adverse effect on the performance and carcass trait of the birds and concluded that using green grape leaves up to 1.5% did not have any negative effect on the bird's performance, carcass traits and blood biochemical parameters.

Ekenyem and Madubuike (2006) observed that birds fed 5% *Ipomoea asarifolia* (IA) leaf meal were similar to those on control diet in terms of final live weight, feed conversion ratio and daily feed intake. While levels of inclusion of the diet of the birds above 5% shows significant ($p<0.05$) decrease in live weight, feed conversion ratio and daily feed intake. Khan and Zafar (2005) also working with *Leucaena* and *Sesbania* leaf meal as additives in broiler ration reported that *Leucaena* and *Sesbania* leaf meal could be well utilized in broiler ration with no deleterious effects. They observed that replacement of crude protein at 5% level by *Sesbania* leaf meal was superior to that of *Leucaena* in respect of broiler performance.

A study conducted by Onyimonyi and Ernest (2009) to evaluate the effect of dietary inclusion of pawpaw leaf meal (PLM) on the performance of finishing broilers revealed that birds fed diet with inclusion levels of 4% PLM had a better live weight and gained significantly ($p<0.05$) higher than the birds fed 0.5 and 1.5% levels of inclusion of PLM. They concluded that up to 2% inclusion levels of PLM in the diet of finishing broilers could improve performance, carcass and organolepticindices.

Olabode (2012) also carried out an experiment to determine the effect of cassava leaf meal in the diets of broiler birds and reported that significantly ($p<0.05$) higher live weight, weight gain and feed conversion ratio were recorded in birds fed 4% dietary inclusion of cassava leaf meal when compared to the other treatment groups. Iheukwumere *et al.* (2007) carried out a 25-day feeding trial in Nigeria with 120 five-week old Anak broilers to evaluate growth, blood chemistry and carcass yield of broilers fed cassava leaf meal at dietary levels of 0, 5, 10, or 15%. Results of the trial indicated that, feed intake, body weight gain, feed conversion ratio of the control (0% leaf meal) were superior ($p<0.05$) to the group on 10 and 15% leaf meal. The total serum protein, albumin and haemoglobin at 0 and 5% leaf meal were superior to the values at 10 and 15% leaf meal. However, cholesterol, creatinine and urea showed no significant differences ($p>0.05$) between the treatment groups. The cut parts of the carcass showed superior values ($p<0.05$) in the control treatment and they differed significantly ($p<0.05$) from broilers on 5, 10 and 15% leaf meal in carcass yield. In conclusion, it was suggested that 5% inclusion of cassava leaf meal could be used in broiler finisher diet without any deleterious effect on growth, blood chemistry and carcass yield of broilers.

In a study by Odunsi *et al*. (2002), 72 laying hens were allotted to four dietary treatments containing 0, 5, 10 or 15% gliricidia leaf meal (GLM). The inclusion of the GLM in the layer diets significantly ($p<0.05$) reduced feed consumption in a linear function. Layers fed 0 and 5% GLM had similar ($p>0.05$) hen-day egg production, body weight changes and feed conversion efficiency which worsened significantly at 10 and 15% GLM levels. Egg quality values showed no significant differences ($p>0.05$) in terms of egg weight, haugh units and shell thickness while yolk index increased ($p<0.05$) with GLM and was found to be best at 10 and 15% GLM. Yolk colour was positively enhanced at all levels of GLM. Proportionally, egg membrane values were lower ($p<0.05$) on GLM diets compared to the control while the egg yolk, albumen and shell were not affected. Boiling of egg resulted in little yolk and albumen but heavier shell and membrane with a 43% reduction ($p<0.05$) in egg yolk colouration. Results of the study indicated that at dietary levels greater than 5%, GLM depressed feed intake and egg production.

2.2 Leaf meals in poultry nutrition

Leaf meals have been observed to have potentials in non-ruminant nutrition and feeding especially in poultry production. The nutrient contents of leaf meals of most leguminous plants have relatively higher crude protein content than the non-leguminous plants and cereals. Also, leaf meals contain crude fiber which is higher than other feed materials utilized by animals. In most cases, the crude fiber content of leaf meal may equal or even exceed the crude protein content (D'Mello, 1992), such as in the case of tropical plants like *Cajanus cajan, Prosopis chilensis, Albizia falacata* and *Manihot esculenta.* This tends to reduce the overall digestibility when there is significant proportion of leaf meal in the diet as well as decreasing row than egg production of birds (Tangendjaja *et al.*, 1990). Leaf meals also provide some essential vitamins such as vitamins A and C, minerals and oxycarotenoids which cause yellow colour of broiler chicken's skin, beak, shanks and egg yolk (Opara, 1996). Lysine concentration in leaf meal is relatively higher than those of grains and some by-products such as coconut oil meal (D'Mello and Acamovic, 1989), but not as high as to be compared with those of fish meal or soybean meal. They are deficient in sulphur containing amino acids though their use can be enhanced on supplementation with methionine. Except for cassava leaf meal, the metabolisableenergy content of leaf meal is generally low (D'Mello and Acamovic, 1989). This therefore entails that leaf meals cannot fully replace high quality ingredients as supplements in monogastric nutrition. Leaf meals contain carotenoids which are a class of compounds that include the carotenes, the precursors of vitamin A and the xanthophylls, which do not possess the vitamin activity of pigment. The concentration of carotenoids in leaf meal however will depend upon the duration and method of drying. Rapid drying of *Leucaena leucocephala* foliage yielded a meal with carotenes and xanthophylls concentrations of 484 and 932mg/kg dry matter respectively (Wood *et al.,* 1983). However substantial loss occurred during oven dry in gat 60^0C and 145^0C. Wood *et al.* (1983) also reported that carotenoids were more stable in sun dried *L. leucocephala* leaf than in oven dried samples.

2.3 Origin and distribution of neem tree

Neem tree comprises of three main species that include; *Azadirachta siamensis, Azadirachta excelsa* and *Azadirachta indica.* The *Azadirachta indica* is a small to medium sized tree, usually evergreen, up to 15 (30 max.) m tall, with a round, large crown up to 10 (20max.) m in diameter. Leaves alternate, crowded near the end of branches, simply pinnate, 20-40 cm long, light green, with 2 pairs of glands at the base (Orwa *et al.,* 2009). The flowers are abundant, sweet smelling white panicles in the leaf axils. The tree starts producing the yellowish ellipsoidal drupes (fruits) in about 4years, becomes fully productive in 10 years and may live for more than 200years. Fresh mature leaves yield an odorous viscous essential oil which exhibits antifungal activities (Onyimonyi *et al.,* 2009). Seed propagation in nurseries followed by direct planting in the field is the accepted method to produce plantation stands (Ogbuewu *et al.,* 2008). The neem fruit is yellow when ripe, is about one inch long and contains only one seed (Olabode, 2008).

The *Azadirachta siamensis* grows mainly in Thailand where the seeds and young leaves of the so-called'sweet'neem are used as additions to manyspices. The leaves are about twice as large as in *Azadirachta indica* and less bitter. The seeds are also considerably larger and the kernels are rather of an emerald green than white (Siddiqui *et al.,* 2003). The *Azadirachta excels* usually grows in remote areas of Malaysia and the Philippines Islands. It grows up to 160 feet (50m) and is found deep in the mostly inaccessible rainforest (Siddiqui *et al.,* 2003).

Major chemical constituents of the neem are terpenes and limonoids. The leaves mainly yield quercertin *(flavonoid)* and nimbosterol (P-sitosterol) as well as a number of limonoids (*nimbin* and its derivatives). Quercertin (a polyphenolic flavonoid) is known to have anti-bacterial and antifungal properties (Elangovan *et al.,* 2000).

2.4 Applications of neem leaf meal for production and protection, egg quality and management of poultry

Arshad *et al.* (2021) investigated a research on the growth performance, hematology, serum biochemistry of Japanese quails fed Neem (*Azadirachta indica*) and Tulsi (*Ocimum sanctum*) leaves powder with basic diet. A total number of 300 one-week old Japanese quail chicks were divided randomly into four dietary treatments with five replicates each (15 birds per replicate). Dietary treatments were: T_0 or control or basal diet, T_1 (Neem 0.5%), T_2 (Tulsi 1%) and T_3 (Neem 0.25% + Tulsi 0.5%) in basal diet. Growth performance parameters (feed intake, body weight, weight gain and feed conversion rate) were determined weekly. Hematology, serum biochemistry, carcass traits were evaluated on 35 days of the age. Neem and Tulsial one and their combination a sa dietary supplement, significantly increased the body weight and body weight gain. The combination of Neem and Tulsi also resulted in significantly lower FCR. Carcass traits were significantly better in T_3 except for the liver weight that was non- significantly ($p>0.05$) different among the treatment groups. Hemato-biochemical parameters (glucose, hemoglobin, WBCs, MCH, total cholesterol, HDL and LDL cholesterol, total protein) were different significantly different among the treatment groups. However, RBCs, HCT, MCV, MCHC, platelets, triglycerides and VLDL were not affected by herbal treatments. It was concluded that a combination of leaves 'powder of Neem and Tulsi can be used for improving the growth performance, carcass traits and health of the Japanese quails.

Dey*et al.* (2017) carried out an experiment with laying pullets to investigate the effects of feeding neem (*Azadirachta indica*) leaf meal (NLM) at different dietary concentrations on cholesterol metabolism and productivity of laying chickens. Forty, 26-week old laying pullets belonging to Shaver 579 strain was fed NLM for 12 weeks. Five dietary treatments, each of four replications, containing either 0, 5, 10, 15 or 20g NLM per kg were compared. The birds were reared in a pyramid-type laying cage. Blood and eggs were collected three times maintaining four weeks interval for the determination of cholesterol concentration respectively in serum and egg yolk. Eggs from birds laid after 6 weeks of feeding NLM were used for the determination of internal and external characteristics of eggs. Body weight gain, egg weight, total egg mass, FCR, survivability, and internal and external egg quality characteristics were studied.UseofNLMat10and15g/kgshowednegativequadraticeffectontotallipids and yolk cholesterol after 4 weeks and 8 weeks of supplementation. Similar result was obtained for serum cholesterol after 8 weeks of supplementation. Analysis of performance data showed no significant difference from control group except a linear decrease in feed consumption. A linear increasein albumen index and a positive quadratic effect on Haugh unit were also found. Based on the result, it may be concluded that NLM could be considered as a hypocholesterolemic dietary feed additive with dietary inclusion levels between 10 and 15g/kg.

Patil *et al*. (2015) conducted an experiment to examine effect of dietary supplementation of Neem (*Azadirachta indica*) leaf powder on egg quality parameters of commercial layers (BV 3000). 120 commercial layers of 22 weeks of age were housed in deep litter system and randomly divided into 4 treatment groups *viz*. T_1, T_2, T_3 and T_4 with 0% (control), 0.1%, 0.2%, 0.3% and 0.4% supplementation of Neem leaf powder (NLP), respectively, in the diet of layer birds. Each treatment had 3 replicate of 10 layers each. A feeding trail was conducted for a period of 8 weeks and for the next 4 weeks birds were provided layer feed without NLP to see post treatment effect. For recording of egg quality parameters, total experimental period of 12 weeks (22 weeks to 34 weeks) was divided into three phases; phase-I (22-26 weeks) and phase II (26-30 weeks) of NLP supplementation and phase III (30-34 weeks) of post NLP supplementation. At the end of each phase a total of 108 eggs (three consecutive day three eggs per pen per day) were randomly collected for egg quality parameter analysis. Various egg quality parameters like weight, length and width of egg; width and height of thick albumen; width and height of yolk; thickness and weight of egg shell; weight of albumen and yolk; shape index, yolk index, albumen index and Haugh units were measured. None of the egg quality parameters were found to be significantly affected by NLP supplementation during any of the three phases. Present study suggests that neem leaf powder supplementation in the diets of commercial layer has no beneficial effects on any of egg qualityparameters.

Olabode and Okelola (2014) carried a study with a total of 300 Bachelor brown laying birds to evaluate the effect of neem leaf meal (*Azadirachta indica*) on the internal egg qualities and serum biochemical indices of laying birds. The birds were randomly distributed into five treatment groups which were replicated thrice with each replicate comprising of 20 birds in a completely randomized design (CRD). A diet containing neem leaf meal (NLM) was formulated for the birds with inclusion levels of 2,4,6 and 8kg/100kg corresponding to treatment 2, 3, 4 and 5, while treatment 1 served as the control with 0% NLM. Results obtained in the study showed that there was no significant ($p>0.05$) difference for the values obtained for albumen index and haugh unit, but there was significance difference for values obtained for yolk index and yolk colour respectively. Results obtained for serum biochemical indices analyzed for showed significance namely high density lipoprotein, low density lipoprotein and triglyceride. Thus, it can be concluded based on the study that NLM can be included in the diet of laying birds up to a level of 8kg/100kg without any detrimental effects on the birds and the end consumers at a longrun.

Obun *et al.* (2013) also carried out an experiment to determine the utilization of sun-cured neem leaf meal *(Azadirachta indica*) based diets on the performance of broiler finisher birds. They observed that at a level of inclusion above 20% there was depressed growth rate, feed intake and nutrient retention in the birds. They reported that a level of 15% neem leaf meal was optimal for inclusion in the broiler's diet. They suggested high crude fibre and bioactive compounds such as tannin, nimbin, salanin, azadirachtin and limonoids as contributing factors.

Study also conducted by Obikaonu *et al.* (2011) to determine the hematological and serum biochemical indices of starter broilers fed neem *(Azadirachta indica*) leaf meal showed that a level of inclusion up to 10% reduced blood cholesterol and maintained the integrity of both the kidney and liver. However, at levels above 10%, there was a deleterious effect on the birds.

Dey *et al.* (2011) reported an inclusion level of 10 to 15g/kg of neem leaf meal in the diet of laying pullets as the optimum level for achieving a hypocholesterolemic conditions in laying pullets. Obikaonu *et al.* (2011) further reported that high levels of neem leaf meal inclusion in the diet of young starter broilers above 5% causes depressed feed intake and growth. Esonu *et al.* (2006) also carried out a 12-week feeding trial in laying hens using neem leaf meal and reported that the birds could tolerate up to 5-15% dietary levels of neem leaf meal without deleterious effects. They observed that as the level of NLM increased in the diet of the birds there was corresponding decrease in the body weight and weight gain across the treatment groups. They suggested that the effects of incomplete elimination of toxic factors in the test ingredient and nutrient imbalance could have led to the low weight gain observed across the treatment group.

Olabode (2008) also reported decrease in the feed intake, final body weight and weight gain of broiler birds when the level of inclusion of neem leaf meal rose beyond 500g/100kg diet. Other workers like Onyimonyi *et al.* (2009) also reported similar observation of low feed intake, final body weight and weight gain for broiler birds fed graded levels of neem leaf meal above 500g/100kg of diet.

Some authors like Bawa *et al.* (2007) and Uko and Kamalu, (2007) have successfully worked with neem cake on laying birds and obtained a positive result, despite the bitter components in them. Nagalaskshmi *et al.* (1996) also reported on the beneficial effect of alkali treated (10-20g NaOH) neem kernel cake incorporated into poultry feeds. It was found that the feeding value of the ration was improved as protein utilization was enhanced leading to increased growth of birds. However, no significant differences were observed among the different dietary groups in feed intake, egg production, egg quality, fertility, hatchability and chick weight (Nagalaskshmi *et al.*, 1996). Neem oil and de-oiled neem seed cake have been used as animal feed. De-oiled seed cake is rich inessential amino acids, and high in crude proteins, fibre contents, sulphur and nitrogen (Uko and Kamalu, 2007).

Different parts of the tree have over the years been researched as a source of animal feed among which include; the leaf, the oil and the cake. A study conducted by Sonaiya (2005) to determine the response of laying birds to three treatments: 10% dried neem leaves, 10% fresh neem leaves and 0% neem leaves indicated that layers receiving 10% fresh neem leaves had higher feed intake and daily egg production as well as egg weight than those on the other two diets. There seems to be a component in fresh neem leaves *(Azadirachta indica)* that enhances egg production and egg weight. Siddiqui *et al.* (2003) reported the isolation of a triterpenoid called nimbocinone from fresh neem leaves as well as two steroids identified as sitosterol and stigmasterol.

2.5 Origin and distribution of Moringa

Moringa (*Moringa oleifera*) is native to the Indian subcontinent and has become naturalized in the tropical and subtropical areas around the world, The tree is known by such regional names as Benzolive, Drumstick tree, Horseradish tree, Kelor, Marango, Mlonge, Mulangay, Saijihan and Sajna (Fahey, 2005). The plant thrives best under the tropical insular climate, it can grow well in the humid tropics or hot dry lands and can survive in less fertile soils and it is also little affected by drought (Anwar *et al.,* 2007). Moringa *(Moringa oleifera L.)* belongs to the moringaceae family, and is considered to have its origin in the north-west region of India, south of the Himalayan Mountains (Makkar and Becker,1997).

Moringa oleifera is considered as one of the World’s most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes (Khalafalla *et al.,* 2010). People use its leaves, flowers and fresh pods as vegetables, while others use it as livestock feed (Anjorin *et al.,* 2010). Leaves could serve as a valuable source of nutrients for all age groups. For example, in Haiti and Senegal, health workers have been treating malnutritioninsm all children, pregnant and nursing women with Moringa leaf powder (Price, 1985). Anwar *et al.* (2007) reported that moringa leaf powder could be used as food or for medicinal and therapeutic purposes. It is used for improved wound healing, gastriculcer, diarrhea, sore throat and cancer (Grever, 2001). In many countries, moringa leaves are used as traditional medicine for treating common ailments (Trees for Life, 2005). This tree has the potential to improve nutrition, boost food security and foster rural development (Hsu, 2006). This could be due to the claims that it increases animal productivity as it has nutritional, therapeutic and prophylactic properties (Fahey, 2005).

In animals, nutrition plays a major role in animal's ability to overcome the detrimental effects of parasitism and diseases (Anwar *et al.,* 2007). A well-nourished animal resists diseases even when exposed to infection than the one, which is already weakened through malnutrition. To gain immunity, the animal needs energy, proteins for manufacture of antibodies and cells, minerals (zinc, copper and iron) and vitamins A and E in communicating messages in parts of the animal's body to fight infections (Conroy, 2005). There are considerable variations among the nutritional values of Moringa, which depend on factors like genetic background, environment and cultivation methods (Brisibe *et al.,*2009).

The nutritional composition of Moringa of the South African ecotype has not previously been evaluated; the profile of chemical composition, fatty acids, amino acids and vitamins. Amino acids, fatty acids, minerals and vitamins are essential in animal feed. These nutrients are used for osmotic adjustment; activate enzymes, hormones and other organic molecules that enhance growth, function and maintenance of life process (Anjorin *et al.,* 2010).

Nutritional composition of the plant plays a significant role in nutritional, medicinal and therapeutic values (Al- Kharusi *et al.,* 2009). Scanty literature is available on the uses of *Moringa oleifera* plant parts as sanitizers or preservatives in foods. However, a very important step in the screening of a plant material for sanitizing/preservative activity is to evaluate its antimicrobial activity against food - borne microorganisms (Bukar *et al.*, 2010).

2.6 Effect of moringa leaf meal on poultry production and egg quality and management

Melesse *et al.* (2011) reported that use of *Moringa stenopetala* leaf meal in the diet ofRhode Island Red chicks produced significant ($P<0.05$) increase in feed and crude protein intake, average weight gain feed efficiency ratios, and protein efficiency ratios when compared to a control diet. The authors related these findings to the presence of readily available protein in moringa leaf meal, which is convenient for mono-gastric animals, and also to the higher levels of methionine and other essential amino acids when compared to the soybean meal of a control diet. *Moringa stenopetala* leaf meal in amounts of up to 6% in the diet of growing chicks to replace expensive conventional protein sources has no negative effects on the chicks.

Olugbemi *et al.* (2010) noticed that supplementation of *Moringa oleifera* leaf meal at levels of up to 10% in a cassava chip-based diet offered to laying hens had no significant effect on feed intake, feed conversion ratio, and laying percentage. Egg weight significantly increased as a result of the supplementation of *Moringa oleifera* leaf meal with cassava chip when compared to a control diet.

Abou-Elezz *et al.* (2011) mentioned that inclusion of different levels of *Moringa oleifera* leaf meal (0%, 5%, 10%, and 15%) in the laying hens' diets linearly decreased egg-laying percentage and egg mass, while egg weight and feed intake showed a quadratic trend with the increased levels of *Moringa oleifera* leaf meal with the absence of a significant effect on feed conversion ratio. Generally, Kakengi *et al.* (2007), Olugbemi *et al.* (2010), and Abou-Elezz *et al.* (2011) agreed that produce adverse effects. In a study by Kakengi *et al.* (2007) it was revealed that Moringa could be used as a source of plant protein since it was highly accepted even at high inclusion levels in commercial layers diets.

Moringa oleifera can be used as a source of micronutrient and as a dietary supplement in poultry (Mahajan *et al.*, 2007). In most of the feeding experiments in poultry, the fresh, green, and undamaged mature *M. oleifera* leaves were properly air-dried, and then the dried leaves were ground to a fine powder in a hammer mill and considered as moringa leaf powder or leaf meal. Similarly, fresh mature moringa seeds were air-dried and ground and considered as moringa seed meal. In some experiments, the ground particles were then soaked into distilled water for 24h and the filtered aqueous solution was considered as moringa extract. Due to their nutrient content, especially the high amount of crude protein (CP), vitamins, and minerals, *M. oleifera* leaves can be used as a useful resource of dietary supplementation for livestock as well as poultry (Nouman *et al.*, 2014; Moreki *et al.*, 2014; Abou-Sekken, 2015). In addition, they stated that moringa leaves can be applied as a dietary supplement in layers and broilers due to high production performance and improved eggs quality. However, still there are many debates on the chicken's performance with different doses of *M. oleifera* in the previous studies.

There are also many variables on doses and part of plant used, such as leaves, extract, sods, or seeds. Finally, many scientists agreed that *M. oleifera* plant might have a positive role in improving the production performance and health status in chickens. Further studies are still needed to detect the actual doses of application for optimum performance in chickens. Similarly, feeding with moringa leaf meal in broilers led to a lower feed intake with higher FCR, as reported by Gakuya *et al.* (2014).

Olugbemi *et al.* (2010) stated that average daily growth rate was lower with *Moringa oleifera* leaf meal at the inclusion level below 5% in diets, and the authors suggested to use maximum levelof5%withoutanyharmfuleffectsongrowthperformanceandFCR in broilers. Abdulsalam *et al.* (2015) conducted an experiment with moringa leaf meal in broilers and found that supplemented diets could enhance the growth performance at finisher period. Analyzing blood parameters is very important in detecting the health status of birds.

Mousa *et al.* (2017) conducted a study to evaluate effects of *Moringa oleifera* leaf meal (MOLM) inclusion in Japanese quail rations during lying period on egg laying performance, egg quality parameters, fertility, and hatchability. A total number of 120 females and 60 males Japanese quail 56 day old were distributed randomly into four treatment groups, each of 3 replicates of 10 females and 5 males. Dietary treatments were designed to contain 0.0 (control), 0.2, 0.4 and 0.6% *Moringa oleifera* leaf meal as growth promoters in Japanese quail diets. Data on feed consumption (FC), hen-day egg production, egg weight, and egg mass as well as mortality were recorded daily. Egg quality parameters were measured at the last week (20 wks). Fertility and hatchability of eggs, as well as mortality of birds and embryonic mortality of fertile eggs during the incubation period were recorded. The obtained results can be summarized as follows: Diet supplemented with 0.4% followed by 0.2% MOLM recorded higher egg production values but 0.4, 0.6% recorded higher average egg weight during different periods. Most external and internal egg quality parameters, especially yolk color, were improved when the diet contained MOLM. Supplementation of MOLM at 0.4% and 0.6% levels had significantly ($P \leq 0.05$) higher WBCs, RBC, Hb and Ht than control. Increasing MOLM level up to 0.6% presented significantly ($P \leq 0.05$) the highest total plasma protein and globulin. Total lipid, cholesterol and LDL decreased significantly and HDL increased significantly by

MOLM supplementation. Total antioxidant capacity was significant higher at 0.6 and 0.4% MOLM. Diet supplemented with all levels of MOLM presented significantly ($P \leq 0.05$) excellent fertility, but level 0.4% improved hatchability per total egg, while level 0.6% improved hatchability per fertile egg. In conclusion, MOLM up to 0.6% of supplementation to the diet had better positive effects on egg production, egg quality parameters, eggs fertility, and hatchability of Japanese quail.

Biduraand Partama (2019) designed the present study was to investigate the influence of *Moringa oleifera* on Laying Hens Performance, β-carotene, cholesterol, and minerals contents in egg yolk. Two hundred and forty 30 weeks of healthy laying hens with homogeneous body weight in a complete randomized design with four treatments and 6 replications. Laying hens were randomly divided in to four groups: M_0: diets without administration of *Moringa oleifera* leaves, M_1: diets with 2% *Moringa oleifera* leaves; M_2: diets with *Moringa oleifera* leaves 4%; and M_3: diets with 6% *Moringa oleifera* leaves, respectively. Each treatment consisted of six replication cages with 10 birds randomly assigned to each cage. This study showed that administration of the Moringa leaves powder were increased significantly different on egg productions, egg mass, feed efficiencies, yolk color, shell thickness, Mg and Ca contents in eggs hell, but not the efficiency of feed consumption. The administration of 2-6% Moringa leaves powder in diets results in significantly lower yolk cholesterol contents. It was concluded that supplementation of 4-6% Moringa leaves powder in diets, increased egg production, egg mass, feed efficiencies, yolk color, shell thickness, β-carotene, Mg and Ca contents in the yolk, but decreased yolk cholesterol contents in laying hens.

Garcia *et al.* (2021) carried out a study aimed to evaluate effects of inclusion of moringa in Japanese quail diets on laying performance, egg quality, blood parameters, serum biochemical profile, and behavior. One hundred and forty-four Japanese quails, approximately 35-d-old, were distributed in a completely randomized design with four treatments and six replications. Treatments were diet inclusion of 0, 2, 4 and 6% of dried and ground moringa leaves. The inclusion of moringa in diets reduces the quadratic feed intake up to the level of 1.20%, increases weight of eggs with a quadratic behavior up to 3.80%, and linearly increases yolk weight. Yolk color changes with higher levels of inclusion of moringa and resulted in more intense colors. The biochemical profile of quails changed slightly but remains within the normal range. The inclusion of 4% of moringa in diets increases alkaline phosphatase. Regarding cholesterol and triglycerides, diet with 6% moringa inclusion was lower when compared to the others. The behavior of laying quails does not change due to inclusion of moringa in diets. Up to 3.83% of *Moringa oleifera* can be included in Japanese quail diet to improve egg quality without compromising performance, biochemical profile, blood parameters and behavior.

Gayathri *et al.* (2020) conducted an experiment to study the effects of dietary supplementation of *Moringa oleifera* leaf meal (MLM) on the production performance and egg quality of Vanaraja laying hens for 12 weeks. One hundred twenty (120), Vanaraja laying hens of 24 weeks of age were selected at random and divided into four groups of 30 each with three replicates of 10 in each group in a complete randomized design. Four experimental diets were prepared with one supplemented with oxytetracycline at 50 g/quintal, while in the rest groups the birds were fed diets supplemented with MLM at levels of 0.25 (MLM-I), 0.5 (MLMII) and 1.0 (MLM-III) per cent, respectively. The total egg production/bird, hen housed egg production, egg weight, egg mass and feed conversion ratio were comparable (P>0.05) among the dietary treatments during the experimental period (25-36 weeks). All the birds gained BW during the experimental period indicating that the rewash a positive energy balance. The mean values of egg quality parameters such as albumen index, albumen and shell percentages, shell thickness, and haugh unit showed significant difference among the treatment groups. From the present findings, it is concluded that MLM up to 1 percent level in the diet of Vanaraja laying hens is beneficial in terms of production performance and egg quality characteristics.

CHAPTE III

MATERIALS AND METHODS

3.1 Statement of the experiment

The study was conducted to evaluate the effect herbal treatment on the egg production and microbial growth on feces and internal egg. A total of 27 day-old aged 160 commerciallayerJapanesequailswereusedforthisstudyincagerearingsystemunder cold-dry environment for the period of 10 weeks to assess the effect of herbal extract on the growth performance and egg quality of layer quail using herbal (neem+moringa) extract with water and also the herbal effect on eggs.

3.2 Preparation of the experimental farm

The farm had been cleaned, washed and disinfected 7days before bringing the birds. Ceiling, walls and floor were thoroughly cleaned and disinfected. The experimental house was fully covered with curtains due to cold weather. The cage of quail bird was also disinfected at the same time. PPM solution had been used as disinfectant.

3.3 Collection of experimental birds

A total of 160 commercial laying quail were collected from renowned quail farm which is located at Mouchak, Kaliyakoir, Gazipur. After a total 3.5 hours journey, birds were brought at our Poultry Science research farm of Sher-e-Bangla Agricultural University, Dhaka.

Figure 1. Quail farm

Figure 2. Receiving quail birds

3.4 Experimental materials

The collected laying Japanese quails were carried to the university poultry farm in the afternoon. After giving 15-20 minutes rest, the birds were distributed randomly in five (5) dietary treatment groups having 32 layingquailineachgroupand4replications of each treatment group having 8 birds in each replication.

Figure 3. Taking into the experimentalfarm

3.5 Experimental treatments

Five treatments including control as follows:

1. Control
2. Antibiotic (Ciproflox-100ml)
3. Neem + moringa –1.2%
4. Neem + moringa –1.0%
5. Neem + moringa –0.75%

3.6 Layout of the experiment

Single factor experiment was conducted for the present study which was laid out into randomized complete block design (RCBD) with four replications. Layout of the experiment was as follows:

Treatments with Replication (8 birds/replication)				No. of birds
T_3R_1 (n=8)	T_2R_2 (n=8)	T_5R_3 (n=8)	T_3R_4 (n=8)	32
T_1R_1 (n=8)	T_5R_2 (n=8)	T_4R_3 (n=8)	T_1R_4 (n=8)	32
T_4R_1 (n=8)	T_3R_2 (n=8)	T_1R_3 (n=8)	T_5R_4 (n=8)	32
T_2R_1 (n=8)	T_1R_2 (n=8)	T_3R_3 (n=8)	T_2R_4 (n=8)	32
T_5R_1 (n=8)	T_4R_2 (n=8)	T_2R_3 (n=8)	T_4R_4 (n=8)	32
Total				**160**

Figure 4. Distributing birds in the cage

3.7 Experimental diets

3.7.1 Collection of neem + moringa leaf

Neem leaf (*Azadirachta indica*) and Moringa leaf (*Moringa oleifera*) were collected from trees planted in the university's agriculture garden.

3.7.2 Preparation of Neem Leaf Powder (NLP) and Moringa Leaf Powder (MLP)

Collected green leaves were sun-dried and were oven-dried at 80^{o} C temperature in the subsequent day. Then the dried leaves were grinded with the blending machine. Again oven-dry was done to remove moisture. And finally the grinded powder of neem leaf and moringa leaf was stored in two different air-tight container for treatment during the experiment.

Figure 5. Preparing powder of neem and moringa leave

Figure 6. Neem and Moringa leave powder

3.7.3 Preparation of extract (NLE +MLE)

5g powder (2.5g NLP + 2.5gMLP) was added in 1L distilled water. Then the solution was heated in oven at 80°C for 2-2.5 hours. At last the heated solution was filtered and stored in a bottle.

Figure 7. Preparing extract

Figure 8. Herbal extract

Figure 9. Storing extract for further use

3.8 Management procedures

3.8.1 Measurement of room temperature and relative humidity

Daily room temperature and humidity was recorded every day with a digital thermo-hygrometer. Average room temperature was $20\text{-}24^{0}$ C and relative humidity was 55-60% for the experimental period.

Figure 10. Thermo-hygrometer

3.8.2 Feeding and watering

Everyday 25g feed per bird was supplied up to 6th week (2nd week of rearing) of age. Then 30g per bird was supplied for 7th to 15th week of age and 10 litter water was supplied to the birds. Average feed consumption was recorded regularly. Handmade feed was supplied and 30% protein concentrate (Protam) was also supplied.

Figure 11. Supplying feed

Figure 12. Supplying water

Figure 13. Mixing feed ingredients

3.8.3 Lighting

A standard lighting schedule for quail layer (natural + artificial) was maintained.

3.8.4 Bio-security measures

Bio-security was properly maintained during the experimental period. Entry of wild birds and animals were prohibited. A footbath was set just after the door of the farm to avoid the risk of pathogen transmission. PPM solution was used in footbath. Proper hygienic and sanitation program was undertaken in the farm and its premises. Strict sanitary measures were taken during the experimental period. PPM solution was used to disinfect the cage of the bird and the house also.

3.5.8 Hygiene

Proper hygienic management was maintained in the entire experiment. Litters were changed two times in a week. Waterers were cleaned in every day basis before supplying water.

3.8.6 Vaccination

To prevent diseases among the birds, chicks were vaccinated as per standard vaccination schedule.

Table 1. Vaccination schedule

Name of diseases	**Age of bird (weeks)**	**Route of administration**
Newcastle (ND) disease	5-8	Eye drop
Infectious Bronchitis (IB)	5-8	Drinking water
Newcastle (ND) disease	10-12	Eye drop
Newcastle (ND) disease	14-16	Drinking water or Intramuscular
Infectious Bronchitis (IB)	14-16	Drinking water or Intramuscular
Avian Encephalomyelitis	6-15	Drinkingwater/Wingweb

Figure 14.NDvaccine

Figure 15.Vaccination

3.8.7 Medication

Mineral supplement was added with water. Calplex® at the rate of 2.5ml per litre of water was used in this case to prevent calcium and vitD deficiency. Coxicure, at the dose of 2g per litre water, was used to prevent coccidiosis among the birds. The nameof the antibiotic which was used during the experiment was Ciproflox (100ml). The dose of the antibiotic was 1ml in 1L drinking water.

Figure 16. Antibiotic supplement

Figure 17. Calcium supplement

Figure 18. Anti-coccidial drug

3.8.8 Ventilation

The experimental shed was south facing and open-sided. Due to wire net cross ventilation, it was easy to remove polluted gases from the farm.

3.9 Study parameters

3.9.1 Measurement of parameters

Data was recorded on weekly live weight, weekly feed consumption, daily feed consumption and death of quail chicks to calculate mortality percentage. FCR was calculated from total egg production and total feed consumption per bird in each replication. Egg production and total egg weight were recorded daily.

3.9.2 Data collection

3.9.2.1 Live weight

The initial body weight and weekly body weight of each replication was kept to get final body weight gain per bird.

Figure 19. Measuring live weight

Figure 20. Collecting data

3.9.2.2 Feed consumption

Daily feed consumption of each replication was kept to get weekly FCR and total feed consumption per bird.

3.9.2.3 Mortality of quail

Death record for each replication was counted to calculate the survivability.

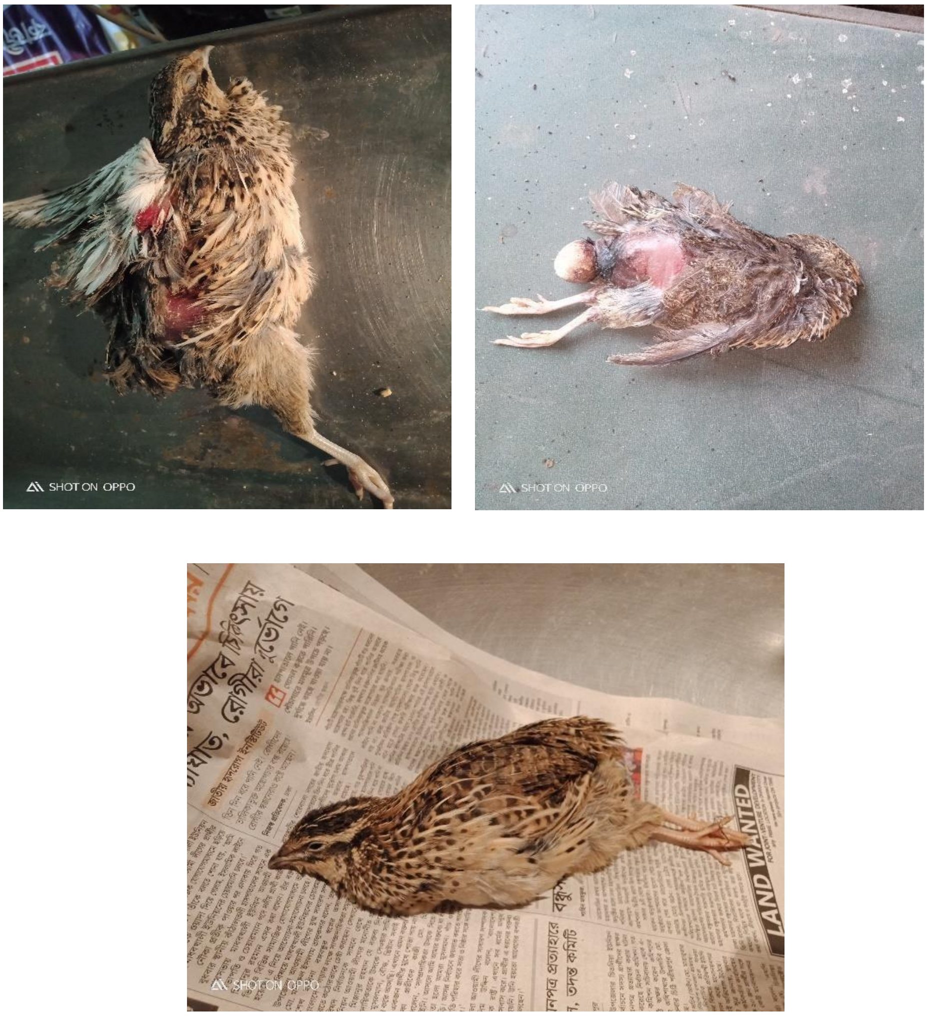

Figure 21. Some dead birds

3.10 Calculations

3.10.1 Live weight gain

The average body weight gain of each replication was calculated by deducting initial body weight from the final body weight of the birds.

Body weight gain = Final weight – Initial weight

3.10.2 Feed intake

Feed intake was calculated as the total feed consumption in a replication divided by number of birds in each replication.

$$\text{Feed intake (g/bird)} = \frac{\text{Total feed consumption in each replication}}{\text{Number of birds in each replication}}$$

3.10.3 Feed conversion ratio

Feed conversion ratio (FCR) was calculated as the total feed consumption divided by the weight of egg produced per week in each replication.

$$\text{FCR (Egg mass)} = \frac{\text{Feed intake per week (kg)}}{\text{Egg weight per week (kg)}}$$

$$\text{FCR (feed efficiency)} = \frac{\text{Feed intake per week (kg)}}{\text{Live weight gain per week (kg)}}$$

3.10.4 Uniformity

Initial uniformity weight of the birds was approximately 98.06%.

3.10.5 Flock Uniformity

r_1 = Average + (Average × 10) ÷ 100

r_2 = Average - (Average × 10) ÷ 100

$$\text{So, flock uniformity} = \frac{\text{Flock number within } r_1 \text{ and } r_2}{\text{Total flock number}} \times 100\%$$

3.10.6 Egg uniformity

r_1= Average + (Average × 10) ÷ 100

r_2= Average - (Average × 10) ÷ 100

$$\text{So, egg uniformity} = \frac{\text{Flock number within r1 and } r_2}{\text{Total number of egg}} \times 100\%$$

3.10.7 Egg production

Daily egg production was recorded. Birds matured sexually at 6th week of age. At the age of 7th week of age, birds were in production with full length.

3.10.8 Egg quality

3.10.8.1 Shape index

Egg shape index is defined as the ratio of width to length of the egg and it is an important criterion in determining egg quality. It is measured by the following equation:

$$\text{Shape index} = \frac{\text{Egg width (mm)}}{\text{Egg length (mm)}} \times 100\%$$

Figure 22. Measuring egg shape index

3.10.8.2 Yolk index

The yolk index is defined as the ratio of yolk height over yolk diameter, provides indication on the freshness of the egg. It is measured by the following equation:

$$\text{Yolk index} = \frac{\text{Yolk height (mm)}}{\text{Yolk length (mm)}} \times 100\%$$

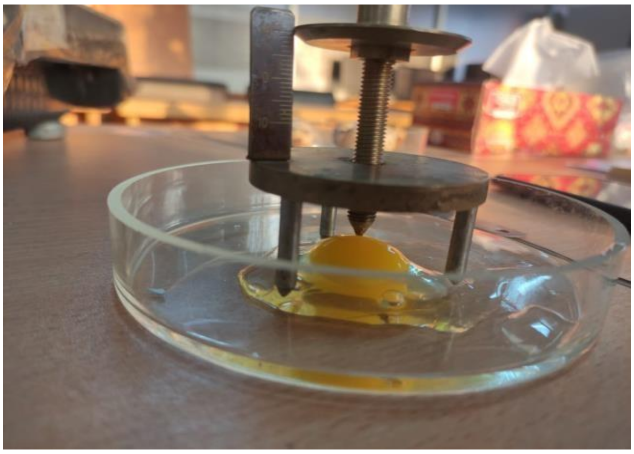

Figure 23. Measuring yolk index

3.10.8.3 Albumin index

A measure of the quality or freshness of an egg height:width ratio of the albumin when the egg is broken into a flat surface. It is measured by the following equation:

$$\text{Albumin index} = \frac{\text{Albumin height (mm)}}{\text{Albumin length (mm)}} \times 100\%$$

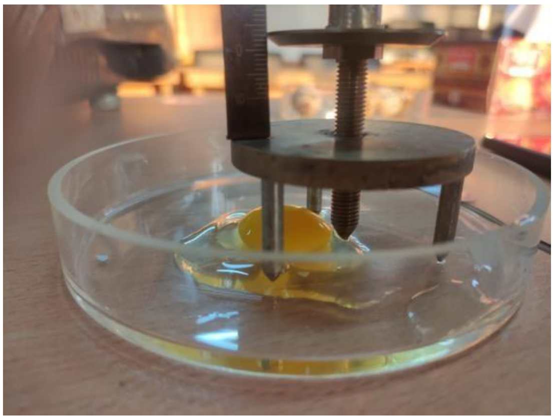

Figure 24. Measuring yolk height

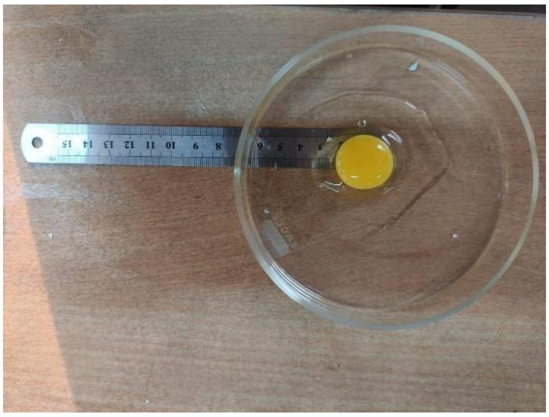

Figure 25. Measuring yolk length

3.10.8.4 Haugh unit

The Haugh unit is a measure of egg protein quality based on the height of egg white (albumen). The test was introduced by Raymong Haugh in 1937 and is an important industry measure of egg quality next to other measures such as shell thickness and strength.

$$\text{Haugh unit} = 100 \log_{10} (h - 1.7w^{0.37} + 7.6)$$

Where, h = Albumen height

w = Egg weight

3.10.8.5Yolk colour fan

Yolk colour fan was determined by Rochi yolk colour fan digital machine.

Figure 26. Detecting yolk colour

3.10.8.6 Shell thickness

Firstly shell was removed from the egg and then inner shell membrane was also removed. After that shell thickness was determined by a digital machine.

Figure 27. Measuring shell thickness

3.11 Sample collection

Egg sample was collected from each replication each week.

Figure 28. Collected sample

3.12Economic analysis

Economic analysis was done to find out the cost effectiveness of different treatments regarding cost of production and return.

3.12.1Analysis of total cost of production

All the material and non-material input cost including miscellaneous cost were considered for calculating the total cost of production. Total cost of production, gross return, net return and BCR are presented in Appendix III.

3.12.2 Gross income

Gross income was calculated on the basis of egg and bird sale. The price of egg and bird were assumed to be Tk.3.00/piece and Tk. 70.00/bird, respectively basis of current market value.

3.12.3 Net return

Net return was calculated by deducting the total production cost from gross income for each treatment.

3.12.4 Benefit cost ratio (BCR)

The economic indicator BCR was calculated by the following formula for each treatment.

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross income}}{\text{Total cost of production}}$$

3.13 Statistic analysis

The data was subjected to statistical analysis by applying one way ANOVA using statistical package for social sciences (SPSS) version 16. Differences between means were tested using Duncan's Multiple Comparison Test and significance was set at P<0.05.

CHAPTER IV

RESULTS AND DISCUSSION

Calculation of different parameters was done to assess the successfulness of quail production which compares results from different treatment groups. The performance of Japanese quails through feed supplementation is measured through different factors was as below:

4.1 Feed consumption

The results of the present study showed that the feed intake of quails (n=1) was not significantly affected by the level of feed supplementation with neem and moringa leaf extract. However, the weekly feed intake of quails as a function of the level of feed supplementation with neem and moringa leaf extract has been irregular (Table 2). At the end of 8^{th} week of age the treatment T_5 (0.25% neem + 0.25% moringa– 0.75%) induced relatively higher intake (196.75±0.047g) over other treatments followed by T_2 (Antibiotic) (193.13±0.058 g) whereas the lowest feed consumption (183.44±0.050 g) was observed from the feed supplementation treatment of T_4 (Neem + moringa – 1.0%).

At 5^{th} week, the highest feed consumption (201±0.090g) was recorded from T_5 (0.25% neem + 0.25% moringa– 0.75%) treatment and at 10^{th} and 11^{th} week of age the highest food intake (190.38±0.061 and 198.25±0.050g, respectively) also recorded from this treatment whereas the lowest feed consumption at 9^{th}, 10^{th} and 11^{th} week of age (199±0.062, 182.33±0.132 and 185.78±0.132 g, respectively) was recorded from T_4 (0.25% neem + 0.25% moringa – 1.0%), T_1 (control) and T_3 (0.25% neem + 0.25% moringa– 1.2%), respectively. The increased feed intake might be due to hunger increasing and digestion stimulating, antibacterial and hepato-protective properties of Neem and moringa, which might have helped the quails to improve their gut health. At the age of 13^{th}, 14^{th} and 15^{th} week feed consumption was significant ($p<0.05$) (Table 2). It was observed that at 12^{th}, 13^{th}, 14^{th} and 15^{th} week of age, birds of T_2 (Antibiotic) fed the highest (234.59 ± 15.28, 230.28 ± 11.43^{a}, 236.13 ± 13.46^{a} and 241.95 ± 5.92^{a}, respectively). At the age of 14^{th} and 15^{th} week, birds of T5 fed the lowest amount of feed (191.18 ± 19.16^{b} and 191.10 ± 16.97^{b} respectively) compared to other treatment groups. Again, at the age of 12^{th} and 13^{th} week, birds of T_5 fed

Table 2. Effects of different level feed supplementation in Japanese quail fed diets on feed consumption at different week of age (n=1) (8^{th} to 11^{th} weeks of age)

Treatments	Feed consumption of quails (g) (n=1)							
	8^{th} week (age)	9^{th} week (age)	10^{th} week (age)	11^{th} week (age)	12^{th} week(age)	13^{th} week(age)	14^{th} week(age)	15^{th} week(age)
T_1	190.87±0.066	212.75±0.056	182.33±0.132	189.38±0.028	215.49 ± 8.75	208.05 ± 2.08^{ab}	229.22 ± 8.59^{a}	235.24 ± 4.24^{a}
T_2	193.13±0.058	214.63±0.052	189.88±0.063	190.38±0.069	234.59 ± 15.28	230.28 ± 11.43^{a}	236.13 ± 13.46^{a}	241.95 ± 5.92^{a}
T_3	185.63±0.024	215.13±0.070	189.38±0.047	185.78±0.132	212.86 ± 18.57	221.17 ± 3.95^{ab}	226.47 ± 4.82^{ab}	218.27 ± 4.46^{ab}
T_4	183.44±0.050	199±0.062	190.25±0.017	198.25±0.033	199.61 ± 10.86	178.73 ± 2.86^{c}	205.17 ± 5.53^{ab}	199.75 ± 9.76^{b}
T_5	196.75±0.047	201±0.090	190.38±0.061	198.25±0.050	203.94 ± 6.44	203.78 ± 13.07^{b}	191.18 ± 19.16^{b}	191.10 ± 16.97^{b}
Mean ± SE	194.5±0.053	213.75±0.067	193 ±0.065	197 ±0.074	213.30 ± 5.78	208.40 ± 5.16	217.64 ± 6.02	217.26 ± 5.89
Level of significance	NS	NS	NS	NS	NS	*	*	*

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4 = 0.25% neem + 0.25% moringa – 1.0%, T_5 = 0.25% neem + 0.25% moringa – 0.75%

NS = Non-significant * = Significant at 5% level

(203.94 ±6.44 and 203.78 ± 13.07^{b} respectively) less than the T_1 (control) fed (215.49 ± 8.75 and208.05 ± 2.08^{ab} respectively). Similar findings were observed in previous studies (Nnenna & Okey *et al.,* 2013 and Kumar & Kumar *et al.,* 2013) who observed non-significant feed consumption in the birds fed with Neem and Tulsi supplemented diet. Similar findings were also observed in previous studies of the results of (Khatun *et al.,* 2013, Nath *et al.,* 2012 and Hasan *et al.,* 2016) where higher feed intake was observed in Neem fed birds. Similar findings were found (Behnamifar *et al.,* 2015) thetcaraway extract feeding with water supplement fed lowest amount compared with the control group. But from Haque *et al.,* (2018) some different findings were observed that birds supplied with 2% neem and nyshinda leaf fed the highest amount of feed at the final week of age compared to the other treatment groups.

4.2 Live weight

The overall mean live weight of different groups showed that there was significant difference (P<0.05) among different treatments of supplementation group at different weeks of age (Table 3). At the end of 8th week of age, body weight of T_5 (0.25%neem +0.25% moringa–0.75%) group (n=1) showed the highest result (176.87^{a}±5.60g) followed by T_2 (Antibiotic) (170.63^{b}±1.80 g) whereas T_1 (control) treatment group showed the lowest body weight (164.75^{d}±2.60 g) which showed non-significant difference with T_4 (0.25% neem + 0.25% moringa– 1.0%). Similarly, at 9th, 10th and 11th week of age, the maximum body weight (n=1) was recorded from T_5 (0.25% neem+0.25% moringa–0.75%) (188.88^{a}±9.00, 176.87^{a}±7.70 and 175^{a}±8.20g, respectively). On the other hand, at 9th week of age the lowest body weight (173.13^{d}±1.30 g) was achieved from T_1 (control) while at 10th and 11th week of age, the lowest body weight (162^{e}±6.20 and 163.25^{d}±6.30 g, respectively) was recorded from T_2 (Antibiotic). At the 12th, 13th, 14th and 15th week of age some different observations were found. Increase of weight was non-significant at the age of 15th week. In the T5, bird's weight was the lowest (175.79 ± 5.28 g) compared with the other groups. Bird of T2 (Antibiotic) and T3 had increased weight (184.75 ± 0.77 g and 184.56 ± 4.20 g, respectively) more than other groups. The result of the present study was similar with the findings of (Muhammad *et al.,* 2015 and Arshad, Haider, & Hussain *et al.,* 2021) who found significant variation on weekly live weight of quail using herb supplementation in diet. In the (Haque *et al.,* 2018) similar findings were observed that the author found significant ($P<0.01$) result compared with the other treatment groups.

Table 3. Effects of different levels of supplementation in fed diets of Japanese quail on live weight in different weeks (n=1)

Treatments	Live weight of quails (g) (n=1)				
	8^{th} week (age)	9^{th} week (age)	10^{th} week (age)	11^{th}week (age)	15^{th} week (age)
T_1	$164.75^d \pm 2.6$	$173.13^d \pm 1.3$	$165.75^d \pm 1.9$	$167.13^c \pm 1.4$	182.38 ± 5.16
T_2	$170.63^b \pm 1.80$	$175.88^c \pm 5.5$	$162^e \pm 6.2$	$163.25^d \pm 6.3$	184.75 ± 0.77
T_3	$166.25^c \pm 3.00$	$178.5^b \pm 4.5$	$168.5^c \pm 5.2$	$168.63^b \pm 3.7$	184.56 ± 4.20
T_4	$165.25^d \pm 1.90$	$177.75^b \pm 2.8$	$170.5^b \pm 1.9$	$169.75^b \pm 4.2$	178.66 ± 5.07
T_5	$176.87^a \pm 5.60$	$188.88^a \pm 9.0$	$175.88^a \pm 7.7$	$175^a \pm 8.2$	175.79 ± 5.28
Mean ± SE	168.75±3.40	178.75±5.3	168.75±4.5	168.63±5.0	181.23±1.94
Level of significance	*	*	*	*	NS

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4= 0.25% neem + 0.25% moringa–1.0%, T_5=0.25% neem + 0.25% moringa–0.75%

NS = Non-significant * = Significant at 5% level

4.3 Egg production (number)

Egg production by number at 9^{th}, 10^{th} and 11^{th} week of age was significantly influenced ($P<0.05$) due to different supplementation treatments to Japanese quail's diet (Table4). Results indicated that the treatment T_5 (0.25% neem+0.25% moringa–0.75%) showed over all best performance on egg production in number compared to other feed supplementation treatment whereas the treatment T_4 (0.25% neem + 0.25% moringa–1.0%) showed least performance. At 8^{th}, 9^{th}, 10^{th} and 11^{th} week of age, the highest egg production in number ($6.78^a \pm 2.869$, $5.94^a \pm 2.217$, $5.03^a \pm 3.425$ and $6.22^a \pm 2.287$, respectively) was recorded from T_5 (0.25% neem + 0.25% moringa–0.75%) whereas the lowest egg production in number ($5.78^c \pm 3.425$, $4.88^c \pm 4.378$, $4.50^b \pm 3.674$ and $4.81^c \pm 2.748$, respectively) was given by the treatment T_4 (0.25% neem+0.25% moringa–1.0%). At the age of 10^{th} week, egg production of T_5 (0.25% neem+0.25% moringa–0.75%), T_1 (control), T_2 (Antibiotic) and T_3 (0.25% neem+0.25% moringa–1.2%) showed significantly similar results among them which was also at 11^{th} week of age between T_5 (0.25% neem + 0.25% moringa– 0.75%) and T_1 (control).

Table 4. Egg production (number) of Japanese quail as influenced by different feed supplementation treatments in diet (n=1) (8^{th} to 11^{th} weeks of age)

Treatments	Egg production (number) (n=1)							
	8^{th} week (age)	9^{th} week (age)	10^{th} week (age)	11^{th} week (age)	12^{th} week (age)	13^{th} week (age)	14^{th} week (age)	15^{th} week (age)
T_1	$6.25^{b}\pm2.887$	$5.44^{b}\pm1.323$	$4.97^{a}\pm1.548$	$5.88^{ab}\pm0.707$	5.63 ± 2.12	5.56 ± 1.04^{b}	5.97 ± 0.75^{b}	6.19 ± 1.19
T_2	$6.25^{b}\pm2.273$	$5.59^{b}\pm2.175$	$4.84^{ab}\pm3.092$	$5.47^{b}\pm3.250$	5.41 ± 0.95	5.63 ± 2.27^{b}	5.66 ± 1.25^{b}	6.09 ± 1.25
T_3	$6.16^{bc}\pm2.462$	$5.47^{b}\pm1.702$	$4.78^{ab}\pm1.974$	$5.47^{b}\pm1.652$	5.66 ± 2.56	5.78 ± 1.49^{b}	6.19 ± 0.65^{ab}	6.41 ± 1.32
T_4	$5.78^{c}\pm3.425$	$4.88^{c}\pm4.378$	$4.50^{b}\pm3.674$	$4.81^{c}\pm2.748$	5.50 ± 2.65	5.31 ± 0.87^{b}	5.91 ± 2.39^{b}	6.25 ± 2.12
T_5	$6.78^{a}\pm2.869$	$5.94^{a}\pm2.217$	$5.03^{a}\pm3.425$	$6.22^{a}\pm2.287$	6.19 ± 1.56	6.72 ± 1.80^{a}	6.63 ± 2.12^{a}	6.78 ± 3.01
Mean ± SE	6.24±2.871	5.46±2.555	4.83±2.933	5.57±2.389	5.68 ± 0.96	5.80 ± 1.09	6.07 ± 0.87	6.34 ± 0.88
Level of significance	*	*	*	*	NS	*	*	NS

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

NS = Non-significant * = Significant at 5% level

At 12^{th}, 13^{th}, 14^{th} and 15^{th} week of age T5 also showed the highest result (6.19 ± 1.56, 6.72 ± 1.80^{a}, 6.63 ± 2.12^{a} and 6.78±3.01, respectively) comparedtothatofT_1 (control) and other treatment groups. T_1, T_2, T_3 and T_4 showed significant result at the 13^{th} week of age. But at the 15^{th} week of age all results were non-significant differences. Similar results were found by Elwy *et al.*, (2020) who supplied *Moringa* leaf meal at 0.1% with diet. Abu & Akangbe *et al.*, (2017) reported that 2% Moringa leaf meal increased the production performance and they found significant result in their study. These observations corroborate with the results of Tesfay & Bertling *et al.,* (2011) who studied the effect of *Moringa oleifera* leaf meal on egg laying rate of hens by exposing them to three experimental diets containing different amounts of *M. oleifera* (0%, 1% and 2%). Their results showed that diets supplemented with 1% induced high egg production in number compared to the others.

4.4 Egg production (weight)

Different treatment groups of feed supplementation in Japanese quail's diet showed significant variation ($P<0.05$) on weekly egg weight of Japanese quail (n=1) (Table5). Irregular variation was found among the supplementation treatments with the increase of duration. Results on egg week (n=1) of 8^{th} week of age, T_5 (0.25% neem + 0.25% moringa– 0.75%) treatment gave highest egg weight ($10.55^{a} \pm 3.10$g) followed by T_1 (control) ($.625^{b} \pm 4.30$g) and T_2 (Antibiotic) ($9.73^{b} \pm 2.40$ g) whereas T_4 (0.25% neem + 0.25% moringa– 1.0%) treatment showed lowest egg weight ($9.00^{d} \pm 3.80$g) at the end of 8^{th} week of age. Treatment T_1 (control) and T_2 (Antibiotic) showed non-significant variation among them at 8^{th} week of age performance. Similarly, at the end of 9^{th}, 10^{th} & 11^{th} week of age, the highest egg weight ($9.60^{a} \pm 2.50$, $8.00^{a} \pm 3.80$ and $10.21^{a} \pm 2.60$g, respectively) was achieved by T_5 (0.25% neem + 0.25% moringa– 0.75%) supplementation whereas the lowest ($7.88^{d} \pm 4.90$, $7.13^{c} \pm 4.10$ and $8.20^{d} \pm 4.10$ g) was registered from the treatment T_4 (0.25% neem + 0.25% moringa–1.0%).

At the 12^{th}, 13^{th}, 14^{th} and 15^{th} week maximum egg weight (11.58 ± 0.07^{a} g) was observed in the T5 whereas the minimum egg weight (10.60 ± 0.27g) was found in the T2(Antibiotic). Results of 12^{th} and 13^{th} non-significant but egg weights of 14^{th} and 15^{th} week of age were significantly differ among the treatment groups.

Table 5. Effects of different levels of supplementation in fed diets of Japanese quail on weekly egg production in weight basis (n=1) (8th to 11th weeks of age)

Treatments	Egg weight of quails (g) (n=1)							
	8th week (age)	9th week(age)	10th week(age)	11th week(age)	12th week	13th week	14th week	15th week
T_1	9.625^{b}±4.30	8.77^{c}±1.50	7.90^{a}±1.80	9.38^{b}±0.80	10.70 ± 0.25	10.75 ± 0.06	10.98 ± 0.04^{c}	11.20 ± 0.05^{b}
T_2	9.73^{b}±2.40	9.04^{b}±2.50	7.70^{b}±3.40	9.00^{c}±3.70	10.60 ± 0.27	10.85 ± 0.14	11.11 ± 0.08^{bc}	11.16 ± 0.07^{b}
T_3	9.57^{bc}±2.70	8.84^{c}±1.90	7.61^{b}±2.20	8.98^{c}±1.90	10.91 ± 0.15	10.98 ± 0.38	11.34 ± 0.13^{ab}	11.42 ± 0.10^{ab}
T_4	9.00^{d}±3.80	7.88^{d}±4.90	7.13^{c}±4.10	8.20^{d}±4.10	10.83 ± 0.36	10.78 ± 0.30	11.20 ± 0.12^{bc}	11.30 ± 0.11^{b}
T_5	10.55^{a}±3.10	9.60^{a}±2.50	8.00^{a}±3.80	10.21^{a}±2.60	11.16 ± 0.19	11.30 ± 0.17	11.55 ± 0.09^{a}	11.58 ± 0.07^{a}
Mean ± SE	9.70±3.50	8.82±2.90	7.66±3.30	9.16±2.90	10.84 ± 0.11	10.93 ± 0.11	11.24 ± 0.06	11.33 ± 0.05
Level of significance	*	*	*	*	NS	*	*	NS

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

NS = Non-significant * = Significant at 5% level

Similar result was also observed by Tesfay & Bertling *et al.*, (2011) who found the effect of *M. oleifera* leaf meal on egg laying rate of hens by exposing them to three experimental diets containing different amounts of *M. oleifera* (0%, 1% and 2%). Their results showed that diets supplemented with 1% induced high egg production and the heaviest eggs compared to the others. (Mahmoud & Mahmoud *et al.*, 2021).

4.5 Feed conversion ratio (FCR)

Feed conversion ratio (FCR) showed a significant difference ($P<0.05$) at 10th and 11th week of age among the treatment groups but at 8th and 9th week of age, non-significant variation ($P>0.05$) was found (Table 6). However, at 8th and 9th week of age, the highest FCR (3.025±0.298 and 3.725±0.342, respectively) was noted in T_4 (0.25% neem+0.25% moringa–1.0%) and the lowest FCR (2.825±0.189 and 3.402±0.166, respectively) was recorded in T_5 (0.25% neem+0.25% moringa–0.75%) treatment. It was also observed that the highest FCR (3.925^{a}±0.388) was in T_4 (0.25% neem + 0.25% moringa– 1.0%) treatment that was significantly similar to T_1 (control), T_2 (Antibiotic) and T_3 (0.25% neem + 0.25% moringa–1.2%) treatments whereas the lowest FCR (3.425^{b}±0.189) at 10th week of age was recorded from T_5 (0.25% neem + 0.25% moringa– 0.75%). Similarly, at 11th week of age, the highest FCR (3.525^{a}±0.269) was in T_4 (0.25% neem + 0.25% moringa– 1.0%) treatment whereas the lowest FCR (2.900^{b}±0.108) at 11th week was recorded from T_5 (0.25% neem + 0.25% moringa– 0.75%) that was significantly similar to T_1 (control), T_2 (Antibiotic) and T_3 (0.25% neem + 0.25% moringa– 1.2%) treatments. At the age of 12th, 13th, 14 and 15th week of age the FCR was significant ($p<0.05$) among the treatments (Table6). The lowest FCR (2.52 ± 0.03^{d}) was found in the T5 at the 15th week of age. However, T5 at the age of 12th, 13th, 14 and 15th week showed the lowest FCR (2.98 ± 0.05^{c}, 2.72 ± 0.03^{c}, 2.58 ± 0.05^{c} and 2.52 ± 0.03^{d} respectively) compared to that of other treatments. Result showed the highest FCR in the T2 at the age of 12th, 13th, 14 and 15th week (3.45 ± 0.03^{a}, 3.28 ± 0.03^{a}, 3.18 ± 0.03^{a} and 3.18 ± 0.03^{a} respectively). It might be due to add extra protein concentrate the result was significant. Because Francois (2020) found a non-significant result in his study. They also found significant variation among treatments with moringa supplementation regarding feed conversion ratio. Behnamifar (2015) found non-significant ($p>0.05$) FCR in his study which was regarding with thyme, caraway and garlic extract.

Table 6. Effects of different levels of supplementation in fed diets of Japanese quail on feed conversion ratio (FCR) on the basis of egg mass (8^{th} to 11^{th} weeks of age)

Treatments	Feed conversion ratio (FCR) (Egg mass) (n=1)							
	8^{th} week (age)	9^{th} week (age)	10^{th} week (age)	11^{th} week (age)	12^{th} week(age)	13^{th} week(age)	14^{th} week(age)	15^{th} week(age)
T_1	2.875±0.138	3.450±0.132	3.725^{ab}±0.293	3.000^{b}±0.135	3.18 ± 0.03^{b}	3.10 ± 0.04^{b}	3.18 ± 0.03^{a}	3.15 ± 0.03^{a}
T_2	2.900±0.108	3.425±0.165	3.575^{ab}±0.170	3.033^{b}±0.165	3.45 ± 0.03^{a}	3.28 ± 0.03^{a}	3.18 ± 0.03^{a}	3.18 ± 0.03^{a}
T_3	2.900±0.135	3.525±0.229	3.600^{ab}±0.178	3.000^{b}±0.091	3.10 ± 0.00^{b}	3.18 ± 0.05^{ab}	3.07 ± 0.03^{ab}	2.82 ± 0.03^{b}
T_4	3.025±0.298	3.725±0.342	3.925^{a}±0.388	3.525^{a}±0.269	3.10 ± 0.04^{b}	2.88 ± 0.09^{c}	2.97 ± 0.08^{b}	2.73 ± 0.03^{c}
T_5	2.825±0.189	3.402±0.166	3.425^{b}±0.189	2.900^{b}±0.108	2.98 ± 0.05^{c}	2.72 ± 0.03^{c}	2.58 ± 0.05^{c}	2.52 ± 0.03^{d}
Mean±SE	2.905±0.19	3.505±0.19	3.65±0.238	3.091±0.139	3.16 ± 0.04	3.03 ± 0.05	3.00 ± 0.05	2.88 ± 0.06
Level of significance	NS	NS	*	*	*	*	*	*

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

NS = Non-significant   * = Significant at 5% level

Similar result was recorded by Al-Ashoor *et al.*, (2020) that significant differences were found in FCR among the treatment groups. Similar result was observed by Riyed & Majid *et al.*, (2019) where significant differences were found among the treatment groups regarding FCR mass.

4.6 Percent hen day egg production (HDEP)

Percent hen day egg production (HDEP%) was significant ($P<0.05$) on different supplementation treatments at different duration (Table7). Results revealed that the treatment group T_5 (0.25% neem + 0.25% moringa– 0.75%) showed the highest %HDEP ($91.60^a \pm 2.90$, $80.35^a \pm 2.80$, $73.55^a \pm 3.80$ and $86.90^a \pm 3.30$ percent at 8^{th}, 9^{th}, 10^{th} and 11^{th} week of age, respectively) whereas the lowest %HDEP ($82.57^c \pm 6.10$, $69.65^b \pm 7.80$, $64.28^d \pm 6.60$ and $68.77^b \pm 5.00$ percent at 8^{th}, 9^{th}, 10^{th} and 11^{th} week of age, respectively) was recorded from T_4 (0.25% neem + 0.25% moringa– 1.0%) supplementation treatment. It was also observed that at 9^{th} and 11^{th} week treatment T_1 (control), T_2 (Antibiotic) and T_3 (0.25% neem + 0.25% moringa– 1.2%) showed non-significant variation with T_5 (0.25% neem + 0.25% moringa–0.75%).

At the age of 12^{th}, 13^{th} and 14^{th} week of age almost similar non-significant differences were found among the treatment groups (Table 7). But at the15^{th} week of age %HDEP was found significant. The highest %HDEP (91.58 ± 2.92) and the lowest (64.28 ± 6.56) were found in T_5 (0.25% neem + 0.25% moringa– 0.75%) and T_4 (0.25% neem + 0.25% moringa–1.0%), respectively. Tesfay & Bertling *et al.*, (2011) also found similar result with the present study and observed experimental diets containing different amounts of *M. oleifera* (0%, 1% and 2%). showed significant variation on egg production and diets supplemented with 1% induced high egg production and the heaviest eggs compared to the others. Similar result was found by Al-Ashoor *et al.*, (2020) which was significant differences among the treatment groups.

Table 7. Effects of different levels of supplementation in fed diets of Japanese quail on percent HDEP (Hen day egg production) (8th to 11th weeks of age)

Treatments	% HDEP (Hen day egg production) (n=1)							
	8th week (age)	9th week (age)	10th week (age)	11th week (age)	12th week (age)	13th week (age)	14th week (age)	15th week (age)
T_1	$88.85^b \pm 5.50$	$79.28^a \pm 4.60$	$67.85^c \pm 4.80$	$83.85^a \pm 1.50$	81.25 ± 2.08	80.35 ± 2.82	73.53 ± 3.86	86.92 ± 3.25^a
T_2	$89.28^b \pm 4.10$	$80.62^a \pm 3.80$	$71.18^b \pm 4.00$	$83.10^a \pm 4.10$	89.28 ± 4.06	80.62 ± 3.76	71.18 ± 4.02	83.10 ± 4.05^a
T_3	$87.95^b \pm 4.40$	$78.13^a \pm 3.00$	$68.30^c \pm 3.50$	$83.60^a \pm 3.90$	87.95 ± 4.40	78.12 ± 3.04	68.30 ± 3.53	83.61 ± 3.91^a
T_4	$82.57^c \pm 6.10$	$69.65^b \pm 7.80$	$64.28^d \pm 6.60$	$68.77^b \pm 5.00$	82.58 ± 6.13	69.64 ± 7.82	64.28 ± 6.56	68.75 ± 4.97^b
T_5	$91.60^a \pm 2.90$	$80.35^a \pm 2.80$	$73.55^a \pm 3.80$	$86.90^a \pm 3.30$	88.84 ± 5.51	79.26 ± 4.60	67.86 ± 4.82	83.84 ± 1.46^a
Mean±SE	88.1*±4.50	77.6*±4.10	69.0*±4.19	81.20*±3.44	88.05 ± 2.00	77.60 ± 2.11	69.03 ± 1.10	91.58 ± 2.92
Level of significance	*	*	*	*	NS	NS	NS	*

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

NS = Non-significant   * = Significant at 5% level

4.7 Weekly Growth (gram) Performance

Non-significant variation (P>0.05) was recorded on weekly growth performance of Japanese egg lying quail (n=1) observed at 8th, 9th, 10th and 11th week of age due to the effect of different levels of supplementation to quail's diet (Table 8). However, it was observed that at 8th week of age, reduced (negative) growth performance (-0.17±0.010g) was found from previous week but all were showed increased growth performance (positive) and the highest positive growth performance (7.34±0.009g) was in T_1 (control) treatment. At 9th week of age, all treatments showed positive growth performance and the highest (12.41±0.018g) was observed from T_4 (0.25% neem + 0.25% moringa–1.0%) whereas the lowest growth performance (5.31±0.043g) was recorded from T_2 (Antibiotic) regarding body weight of 8th week of age. At 10th week of age, all treatments gave negative growth performance i.e. body weight was decreased compared to body weight of previous week (9th week of age). The maximum growth performance (12.41±0.018g) was recorded from T_4 (0.25% neem + 0.25% moringa– 1.0%) whereas the minimum (0.13±0.018g) was found from T_3 (0.25% neem + 0.25% moringa– 1.2%). Similarly, at 11th week of age, the maximum growth performance (1.25±0.011g) was found in T_2 (Antibiotic) treatment whereas the minimum (0.13±0.018g) was recorded in T_3 (0.25% neem + 0.25% moringa– 1.2%) treatment. T4 and T5 showed negative growth performance (-0.81±0.027 g and -1.72±0.014 g respectively).

At the age of 12th, 13th and 14th week of age T5 showed the maximum growth performance (22.00 ± 1.08^{a}, 21.00 ± 1.23, 22.75 ± 0.25^{a} and 24.75 ± 1.38^{ab}g, respectively) compared to that of the other treatment groups (Table 8). 12th, 14th and 15th week of age results showed the significant differences whereas at13th week of age the result showed non-significant difference. In the entire result T_2 (Antibiotic) showed the maximum growth performance (30.00 ± 1.78^{a} g) whereas T_4 showed the minimum growth performance (15.25 ± 2.63^{b} g). Significant result was found by Riyed & Majid *et al.*, (2019) for 2.5g/kg marjoram leaf powder which showed the highest growth performance. Non-significant result was found by Cakir, Midilli, & Erol (2008) where the highest growth performance was observed with Avilamycin antibiotic.

Table 8.Weekly growth performance of Japanese quail at different duration influenced by different levels of supplementation in fed diets (8th to 11th weeks of age)

Treatments	Weekly growth performance (g)							
	8th week(age)	9th week(age)	10th week(age)	11th week(age)	12th week	13th week	14th week	15th week
T_1	7.34±0.009	8.34±0.015	-7.29±0.010	1.21±0.014	21.00 ± 0.41^{ab}	18.25 ± 2.02	19.50 ± 1.19^{ab}	14.50 ± 1.94^{c}
T_2	4.75±0.011	5.31±0.043	-13.9±0.044	1.25±0.011	17.25 ± 2.29^{ab}	16.25 ± 1.18	17.25 ± 2.29^{b}	30.00 ± 1.78^{a}
T_3	4.41±0.015	12.22±0.026	-9.97±0.018	0.13±0.018	17.50 ± 1.66a^{b}	19.00 ± 2.35	22.00 ± 1.23^{a}	24.25 ± 4.01^{ab}
T_4	2.75±0.008	12.41±0.018	-7.18±0.024	-0.81±0.027	15.25 ± 2.63^{b}	16.00 ± 2.61	20.00 ± 1.47^{ab}	22.25 ± 1.25^{b}
T_5	-0.17±0.010	10.64±0.037	-10.6±0.022	-1.72±0.014	22.00 ± 1.08^{a}	21.00 ± 1.23	22.75 ± 0.25^{a}	24.75 ± 1.38^{ab}
Mean±SE	3.75^{NS}±0.0114	10.0^{NS}±0.0299	10.13^{NS}±0.0275	0.0^{NS}±0.0155	18.60 ± 0.92	18.10 ± 0.89	20.30 ± 0.73	23.15 ± 1.47
Level of significance	NS	NS	NS	NS	*	NS	*	*

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25% neem+0.25% moringa–1.0%, T_5=0.25% neem+0.25% moringa–0.75%

NS = Non-significant   * = Significant at 5% level

4.8 Survivability

Different supplementation treatment showed significant variation on survivability (Table 9). Results indicated that the treatment T_4 (0.25% neem + 0.25% moringa– 1.0%) showed the maximum survivability (100.0^{a}±00percent) which was significantly similar to the treatment T_1 (control) and T_3 (0.25% neem + 0.25% moringa– 1.2%) whereas the minimum survivability (94.00^{b}±3.50 percent) was recorded from the treatment T_2 (Antibiotic) which was significantly same with T_5 (0.25% neem + 0.25% moringa–0.75%).Similar result was also observed by the findings of Dey *et al.*, (2017).

At the next 4 weeks (12^{th}, 13^{th}, 14^{th} and 15^{th} week of age), there was not found any death case. In this time period the survivability was 100% and mortality was 0%. It was done possible only by proper monitoring considering feed supply, water supply, proper bio-security maintenance, proper lighting management, proper hygiene management etc.

Table 9. Effect of different levels of supplementation in fed diets of Japanese quail on survivability

Treatments	Survivability
T_1	97.00^{ab}±3.00
T_2	94.00^{b}±3.50
T_3	97.00^{ab}±3.00
T_4	100.0^{a}±00
T_5	94.50^{b}±3.30
Mean±SE	96.5 ±3.51
Significant level	*

T_1 = Control, T_2 = Antibiotic, T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4 = 0.25% neem + 0.25% moringa– 1.0%, T_5 = 0.25% neem + 0.25% moringa– 0.75%

* = Significant at 5% level

4.9 Quality performance

4.9.1 Shape index

Egg shape index differed significantly due to different feed supplementation treatments (Table 10). Results showed that the treatment T_4 (Neem+moringa–1.0%) showed the highest shape index ($80.96^a \pm 2.565$) followed by T_1 (control) and T_5 (Neem +moringa-0.75%) treatments. On the other hand, the lowest shape index ($76.66^c \pm 1.197$) was recorded from T_2 (Antibiotic). Tesfay *et al.* (2011) also found similar result and observed that *M. oleifera* leaf meal had significant effect on egg quality parameters. Patil *et al*. (2015) also found similar result with the present study.

4.9.2 Albumen index

Significant variation was recorded on albumen index as influenced by different feed supplementation treatments (Table 10). Results indicated that the highest albumen index ($11.84^a \pm 0.566$) was found from T_3 (Neem + moringa – 1.2%) treatment which was significantly same to T_2 (Antibiotic) and T_4 (Neem+moringa–1.0%) whereas the lowest albumen index ($11.07^b \pm 0.742$) was observed from T_5 (Neem + moringa – 0.75%) which was statistically identical with T_1 (control) treatment ($11.08^b \pm 0.612$). Patil*etal*.(2015)andOlabodeandOkelola(2014)observedsimilarresultwithpresent study. Dey *et al.* (2017) also found similar result using neem leaf meal and Gayathri *et al.* (2020) also found similar result using moringa leaf meal.

4.9.3 Yolk index

Egg yolk index differed significantly due to different feed supplementation treatments (Table 10). Results showed that the treatment T_2 (Antibiotic (Ciproflox-100ml) showed the highest yolk index ($57.42^a \pm 1.69$) which was significantly same with T_3 (Neem + moringa–1.2%) ($57.26^a \pm 1.23$). On the other hand, the lowest yolk index ($53.36^b \pm 1.37$) was recorded from T_4 (Neem + moringa – 1.0%) which was significantly same with T_1 (control) and T_5 (Neem + moringa – 0.75%). Similar result was also observed by the findings of Olabode and Okelola (2014) and Patil *et al*. (2015).

Table 10. Effect of different levels of supplementation in fed diets of Japanese quail on quality performance

Treatments	Quality performance					
	Shape index	Albumen index	Yolk index	Haugh unit	Yolk color fan	Shell thickness
T_1	79.65^b±0.329	11.08^b±0.612	53.37^b±2.17	92.95±0.923	4.25±0.102	0.22±0.012
T_2	76.66^c±1.197	11.80^a±0.567	57.42^a±1.69	93.77±1.163	4.44±0.188	0.21±0.012
T_3	78.60^b±0.439	11.84^a±0.566	57.26^a±1.23	93.17±1.314	4.25±0.144	0.20±0.015
T_4	80.96^a±2.565	11.79^a±0.814	53.36^b±1.37	93.22±1.449	4.50±0.102	0.17±0.003
T_5	78.41^b±0.365	11.07^b±0.742	54.24^b±1.70	92.21±0.905	4.44±0.063	0.17±0.006
Mean±SE	78.86±1.38	11.52±0.65	55.13±1.48	93.06±0.96	4.38±0.125	0.19±0.014
Level of significance	*	*	*	NS	NS	NS

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

NS = Non-significant * = Significant at 5% level

4.9.4 Haugh unit

Non-significant variation was recorded on haugh unit as influenced by different feed supplementation treatments (Table 10). However, results indicated that the highest haugh unit (93.77±1.163) was found from T_2 (Antibiotic) whereas the lowest haugh unit (92.21±0.905) was observed from T_5 (Neem + moringa – 0.75%). Olabode and Okelola (2014) obtained similar result with the present study and obtained non-significant variations among the treatments on haugh unit.

4.9.5 Yolk color fan

Non-significant variation was found for yolk colour fan due to different feed supplementation treatments (Table 10). However, the treatment T_4 (Neem + moringa – 1.0%) showed the highest yolk colour fan (4.50±0.102) whereas treatment T_1 (control) and T_3 (Neem + moringa – 1.2%) showed the lowest (4.25±0.102 and 4.25±0.144, respectively) yolk colour fan. Mousa *et al.* (2017) also found similar result with the present study.

4.9.6 Shell thickness

Non-significant variation was recorded on shell thickness as influenced by different feed supplementation treatments (Table 10). However, results indicated that the highest shell thickness (0.22±0.012) was found from T_1 (control) treatment whereas the lowest shell thickness was observed from T_5 (Neem + moringa – 0.75%) (0.17±0.006) and T_4 (Neem + moringa–1.0%) (0.17±0.003). Aro *et al.* (2009) and Odunsi *et al*. (2002) also reported similar result with the present study.

4.10 Economic analysis

Economic analysis is included total cost of production, gross return (Tk./unit), net return (Tk./unit) and finally benefit cost ration (BCR) (Table 11 and Appendix 8). Results indicated that the highest BCR (1.35) was achieved from the food supplementation treatment T_5 (Neem+moringa–0.75%) with higher gross return(Tk. 263.00) and net return (Tk.67.50) followed by T_1(control) and T_3 (Neem + moringa – 1.2%) treatments whereas the lowest BCR (1.24) was recorded from the treatment T_2 (Antibiotic) with lowest gross return (Tk. 247.00) and net return (Tk. 48.50). The lowest cost of production (Tk. 193.50 per quail) was achieved from T_1 (control) followed by T_5 (Neem + moringa – 0.75%) treatment which showed Tk. 195.50 per quail whereas the highest cost of production (Tk.198.50per quail) was from T_2 (Antibiotic; Ciproflox-100ml). It was revealed that Neem + moringa powder @ 0.75% as feed supplement in Japanese quail's diet ensured higher productiveperformancewhichresultedhighestreturn.Fromeconomicpointofview,itisapparentfromtheaboveresultsthattreatment T_5(Neem+moringa–0.75%)wasthe more profitable than rest of the treatment combinations for quailproduction.

Table 11. Total cost of production, income and benefit cost ratio (BCR) of Japanese quail rearing at 8th to 15th week of age (n=1)

Treatment	Total cost of production (Tk.)	Income from egg and bird (Tk.)		Gross income (Tk.)	Net income (Tk.)	BCR
		Egg selling price (Tk.)*	Selling price of birds at the end of 7th week (Tk.)**			
T_1	193.50	195.00	63.00	258.00	64.50	1.33
T_2	198.50	186.00	61.00	247.00	48.50	1.24
T_3	197.50	189.00	63.00	252.00	54.50	1.28
T_4	196.50	183.00	65.00	248.00	51.50	1.26
T_5	195.50	201.00	62.00	263.00	67.50	1.35

T_1= Control, T_2= Antibiotic, T_3= Neem + moringa – 1.2%, T_4= Neem + moringa – 1.0%, T_5 = Neem + moringa – 0.75%

* Price of egg = Tk. 3.00/piece

** Price of bird = Tk. 65.00/piece

CHAPTER V

SUMMARY AND CONCLUSION

A study was conducted with Japanese quail to investigate the effect of herb (neem + moringa) on layer Japanese quail and alternative of antibiotics. The study was planned to determine the comparative efficacy of leaf powder of Neem (*Azadirachta indica*) and Moringa (*Moringa oleifera*) on the productive performance, health status and egg quality of commercial layer Japanese quail.

A total of 27 day-old 160 layer Japanese quail chicks were reared in Sher-e-Bangla Agricultural University Poultry Farm, Dhaka. Chicks were divided randomly into 5 experimental groups of 4 replications and each replication contains 8 chicks. These groups were allotted to five treatment designated as T_1 (control T_2 (Antibiotic; Ciproflox-100ml), T_3 (Neem + moringa – 1.2%), T_4 (Neem + moringa – 1.0%) and T_5 (Neem + moringa – 0.75%) treatment group.

The results showed that the weekly live body weight in 4th week was significantly higher in T_5 (Neem + moringa – 0.75%) treatment group than control group (T_1). Final live weight was significantly higher in T_5 (Neem + moringa – 0.75%) (1400^a±8.20 g) than control as well as other groups.

Weekly feed consumption (FC) was non-significant in different group but total FC significantly higher in T_5 (Neem+moringa–0.75%) than other treated group including control. Weekly FCR was significantly lower in T_5 (Neem + moringa – 0.75%) group than T_1, T_2, and T_3 group in 4th week to 7th week whereas T_4 showed highest FCR at in 4th week to 7th week. In case of weekly growth performance, T_1 (control) treatment showed better performance than other treatments group.

Survivability rate was higher (100%) in T_4 (Neem+moringa–1.0%) group than others whereas T_2 (Antibiotic (Ciproflox-100ml) group showed lowest performance (94.00^b±3.50percent).

In case of egg production by number and weight, T_5 (Neem + moringa – 0.75%) registered the maximum production at 4th week to 7th weeks compared to other treatments groups whereas T_4 (Neem + moringa – 1.0%) showed least performance.

Regarding %HDEP (Hen day egg production), T_5 (Neem + moringa – 0.75%) gave higher result compared to others whereas T_4 (Neem+moringa–1.0%) showed lowest results. Again, T_3 (Neem + moringa – 1.2%) showed lower microbial load (faces contains) and T_2 (Antibiotic; Ciproflox-100ml) showed higher result.

Considering quality parameters of egg, shape index, albumen index and yolk index showed significant variation among the treatment groups whereas haugh unit, yolk color fan and shell thickness did not differ significantly among the treatments.

Regarding shape index, albumen index and yolk index, treatment T_4 (Neem + moringa – 1.0%), T_3 (Neem + moringa – 1.2%) and T_2 (Antibiotic (Ciproflox-100ml), respectively gave best result while T_2 (Antibiotic (Ciproflox-100ml) showed higher haugh unit and T_4 (Neem + moringa – 1.0%) showed higher yolk color fan and T_1 (control) gave higher shell thickness.

The result showed that inclusion of Neem (*Azadirachtaindica*) and Moringa (*Moringa oleifera*) leaf powder up to 1.2% dietary levels can be used as growth promoters in the Japanese quail diets without serious adverse effects. It was evident that low energy diet led to poor performance.

The highest gross return (Tk. 263.00), net return (Tk. 67.50) and benefit cost ratio (BCR) (1.35) per quail was recorded from supplementation treatment T_5 (Neem + moringa – 0.75%) whereas T_2 (Antibiotic) treatment gave lowest gross return per quail (Tk. 247.00) with lowest net return (Tk. 48.50) and BCR (1.24).

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APPENDICES

Appendix 1. Weekly feed consumption (g/bird) of quail

Treatment	Replication	8th	9th	10th	11th	12th	13th	14th	15th
T_1	R_1	197.50	218.63	190.00	205.00	219.58	212.72	228.93	230,83
	R_2	205.63	221.38	197.38	205.00	191.55	203.67	219.59	238.27
	R_3	191.43	219.43	197.14	205.00	217.25	183.96	221.78	214.87
	R_4	192.88	219.13	197.63	203.50	233.56	205.57	214.91	226.30
T_2	R_1	183.38	224.57	190.14	196.71	220.11	229.33	224.64	226.69
	R_2	207.25	222.50	197.38	205.00	208.83	231.66	215.28	234.02
	R_3	206.13	223.00	197.75	205.00	208.89	212.27	210.61	234.02
	R_4	190.25	221.38	226.29	205.00	235.46	188.22	229.17	210.60
T_3	R_1	196.57	215.86	191.57	204.57	230.62	200.72	210.06	200.14
	R_2	204.88	225.00	198.00	193.75	217.06	212.54	218.17	216.48
	R_3	198.13	222.38	198.00	192.50	189.93	226.11	226.10	220.56
	R_4	197.63	224.13	198.00	192.25	180.89	216.62	221.58	207.29
T_4	R_1	182.88	196.50	191.63	201.63	186.20	171.26	204.37	178.00
	R_2	178.38	208.38	189.50	202.13	177.12	171.26	190.75	189.87
	R_3	191.25	212.75	194.88	203.25	210.96	178.34	208.18	209.64
	R_4	189.75	178.25	185.00	186.00	224.14	186.20	217.40	221.51
T_5	R_1	193.22	213.89	195.00	205.00	235.96	209.02	205.51	179.31
	R_2	184.11	218.00	192.11	199.44	223.95	205.51	198.00	226.88
	R_3	188.75	223.57	189.00	182.71	191.02	209.46	215.90	204.93
	R_4	188.67	198.11	195.11	196.56	212.24	233.18	179.31	190.29

Appendix 2. Weekly egg weight (g/replication) of quail

Treatment	Replication	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}	13^{th}	14^{th}	15^{th}
T_1	R_1	77.30	66.40	61.33	62.88	68.62	68.61	71.54	74.46
	R_2	69.53	57.93	52.83	66.16	59.86	65.70	68.62	74.37
	R_3	59.59	67.77	63.40	77.14	70.08	70.24	81.86	76.79
	R_4	70.68	62.11	51.43	66.13	73.01	64.24	67.16	72.98
T_2	R_1	66.69	69.51	49.11	70.73	71.87	81.90	80.23	83.57
	R_2	71.96	62.17	52.89	67.68	61.43	70.20	67.29	73.12
	R_3	73.55	72.03	63.74	71.84	61.43	64.35	65.81	73.13
	R_4	60.08	57.91	63.59	57.73	76.89	65.19	84.49	75.29
T_3	R_1	69.81	72.64	55.53	65.60	85.02	71.69	80.02	81.72
	R_2	61.26	55.09	48.71	60.43	70.02	68.56	74.40	77.31
	R_3	71.93	62.20	55.66	67.66	61.27	72.94	72.94	78.77
	R_4	73.45	66.40	59.89	65.83	58.35	65.64	71.48	71.48
T_4	R_1	67.82	53.66	45.88	54.61	60.07	61.53	65.94	65.87
	R_2	68.19	64.98	58.16	67.49	57.14	65.93	61.59	70.32
	R_3	66.89	63.55	58.50	63.21	65.93	61.56	71.87	77.70
	R_4	48.81	38.13	37.43	44.45	74.72	60.13	77.62	79.11
T_5	R_1	59.46	65.28	49.21	65.18	67.66	66.33	67.65	63.78
	R_2	75.04	62.81	61.70	66.34	66.36	67.67	67.55	80.67
	R_3	74.99	74.29	55.66	70.63	75.28	88.70	98.68	93.68
	R_4	61.69	52.73	44.36	67.67	65.06	76.76	63.77	65.12

Appendix 3. Weekly feed conversion ratio of quail

Treatment	Replication	8^{th}	9^{th}	10^{th}	11^{th}	12^{th}	13^{th}	14^{th}	15^{th}
T_1	R_1	2.60	3.30	3.10	3.20	3.2	3.1	3.2	3.1
	R_2	3.00	3.80	3.70	3.10	3.2	3.1	3.2	3.2
	R_3	3.20	3.20	3.10	2.60	3.1	3	3.1	3.2
	R_4	2.70	3.50	3.80	3.10	3.2	3.2	3.2	3.1
T_2	R_1	2.70	3.20	3.90	2.80	3.5	3.2	3.2	3.1
	R_2	2.90	3.60	3.70	3.03	3.4	3.3	3.2	3.2
	R_3	2.80	3.10	3.10	2.80	3.4	3.3	3.2	3.2
	R_4	3.20	3.80	3.60	3.50	3.5	3.3	3.1	3.2
T_3	R_1	2.80	3.00	3.40	3.10	3.1	3.2	3	2.8
	R_2	3.30	4.10	4.10	3.20	3.1	3.1	3.1	2.8
	R_3	2.80	3.60	3.60	2.80	3.1	3.1	3.1	2.8
	R_4	2.70	3.40	3.30	2.90	3.1	3.3	3.1	2.9
T_4	R_1	2.70	3.70	4.20	3.70	3.1	2.8	3.1	2.7
	R_2	2.60	3.20	3.30	3.00	3.1	2.7	3.1	2.7
	R_3	2.90	3.30	3.30	3.20	3.2	2.9	2.9	2.7
	R_4	3.90	4.70	4.90	4.20	3	3.1	2.8	2.8
T_5	R_1	3.20	3.30	4.00	3.10	3.1	2.8	2.7	2.5
	R_2	2.50	3.50	3.10	3.00	3	2.7	2.6	2.5
	R_3	2.50	3.01	3.40	2.60	2.9	2.7	2.5	2.5
	R_4	3.10	3.80	4.40	2.90	2.9	2.7	2.5	2.6

Appendix 4. Weekly HDEP (%) of quail

Treatment	Replication	8th	9th	10th	11th	12th	13th	14th	15th
T_1	R_1	100.00	83.93	78.57	87.50	100.00	83.93	78.50	87.50
	R_2	91.07	73.21	67.86	82.14	91.07	73.21	67.86	82.14
	R_3	87.76	85.71	81.63	95.92	87.76	85.71	81.63	95.92
	R_4	87.50	78.57	66.07	82.14	87.50	78.57	66.07	82.14
T_2	R_1	87.50	79.63	63.27	87.76	87.50	79.63	63.27	87.76
	R_2	94.64	78.57	67.86	83.93	94.64	78.57	67.86	83.93
	R_3	96.43	91.07	82.14	89.29	96.43	91.07	82.14	89.29
	R_4	78.57	73.21	71.43	71.43	78.57	73.21	71.43	71.43
T_3	R_1	80.36	80.36	62.50	81.63	80.36	80.36	62.50	81.63
	R_2	80.36	69.64	62.50	75.00	80.36	69.64	62.50	75.00
	R_3	94.64	78.57	71.43	83.93	94.64	78.57	71.43	83.93
	R_4	96.43	83.93	76.79	93.88	96.43	83.93	76.79	93.88
T_4	R_1	89.29	67.86	58.93	67.86	89.29	67.86	58.90	67.86
	R_2	89.29	82.14	75.00	73.21	89.29	82.10	75.00	73.21
	R_3	87.50	80.36	75.00	78.57	87.50	80.36	75.00	78.57
	R_4	64.23	48.21	48.21	55.36	64.23	48.21	48.21	55.36
T_5	R_1	77.78	82.54	63.49	80.95	77.78	82.54	63.49	80.95
	R_2	98.41	79.37	79.37	82.54	98.41	79.37	79.37	82.54
	R_3	98.21	88.46	71.43	87.76	98.20	88.46	71.43	87.76
	R_4	80.95	66.67	57.14	84.13	80.95	66.67	57.14	84.13

Appendix 5. Percent relative humidity (%RH) during experiment in November-December, 2021

Age in weeks	Period (day)	Average relative humidity (%RH)				Weekly average %RH
		8.00 AM	12.00 AM	4.00 PM	8.00 PM	
4^{th}	20.11.21 - 26.11.21	82	78	81	76	79.25
5^{th}	27.11.21 - 03.12.21	77	75	74	72	74.50
6^{th}	04.12.21 - 10.12.21	80	78	75	70	75.75
7^{th}	11.12.21 - 17.12.21	76	72	68	71	71.75

Appendix 6. Average temperature (°C) during experiment in November-December, 2021

Age in weeks	Period (day)	Average temperature (°C)				Weekly average temp. (°C)
		8.00 AM	12.00 AM	4.00 PM	8.00 PM	
4^{th}	20.11.21 - 26.11.21	24	27	26	23	25.00
5^{th}	27.11.21 - 03.12.21	25	26	26	25	25.50
6^{th}	04.12.21 - 10.12.21	23	25	27	24	24.75
7^{th}	11.12.21 - 17.12.21	22	24	25	23	23.50

Appendix 7. Total cost of production, total income and BCR per quail basis

Treatment	Total input cost (Tk.) (n=1)	Supplementation cost (Tk.) (n=1)	Total cost of production (Tk.)	Egg production till 15^{th} week	Egg selling price (Tk.)	Selling price of birds at the end of 15^{th} week (Tk.)	Total income (Tk.)	BC R
T_1	193.50	0.00	193.50	65.00	195.00	63.00	258.00	1.33
T_2	193.50	5.00	198.50	62.00	186.00	61.00	247.00	1.24
T_3	193.50	4.00	197.50	63.00	189.00	63.00	252.00	1.28
T_4	193.50	3.00	196.50	61.00	183.00	65.00	248.00	1.26
T_5	193.50	2.00	195.50	67.00	201.00	62.00	263.00	1.35

T_1 = Control, T_2 = Antibiotic (Ciproflox), T_3 = 0.25% neem + 0.25% moringa– 1.2%, T_4=0.25%neem+0.25%moringa–1.0%,T_5=0.25%neem+0.25%moringa–0.75%

Here,

- Structural cost of residence for 1 chicks = 12.50Tk.
- Chick cost per unit (quail) = 35.00Tk.
- Per quail feed/day = 25 g = 1.25 Tk. (According to 1sack feed = 50 kg = 2500 Tk.)
- So, feed cost/quails for 15 weeks = 132.00Tk.
- Feed cost at 15^{th} week of rearing = 132.00Tk.
- Vaccine, medicine and treatment cost for 1chicks at 15^{th}week of rearing = 7.00 Tk.
- Miscellaneous cost for 1 quail up to 15^{th} week of rearing = 7.00Tk.
- Feed supplementation cost for 1 quail at 15^{th} week of rearing for –

  T_1 = 0.00Tk, T_2 = 5.00 Tk. T_3 =4.00 Tk. T_4 = 3.00 Tk.T_5 = 2.00 Tk.
- Egg selling price = 3.00Tk./piece
- Bird selling price at the end of 7^{th} week = 65.00Tk./piece