Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)

जापानी बटेर (*कोटर्निक्स जैपोनिका*) के प्रदर्शन पर मोरिंगा पत्ती चूर्ण (*मोरिंगा ओलीफेरा*) खिलाने का प्रभाव

KRISHAN GURJAR

THESIS

Master of Science in Agriculture

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MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY,

UDAIPUR- 313001 (RAJ.)

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Thesis

Submitted to the

Maharana Pratap University of Agriculture & Technology, Udaipur

in partial fulfillment of the requirements for the degree of

Master of Science in Agriculture

(Livestock Production Management)

BY

KRISHAN GURJAR

2023

<u>CERTIFICATE – I</u>

CERTIFICATE OF ORIGINALITY

The research work embodied in this thesis titled **"Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)"** submitted for the award of degree of **Master of Science in Agriculture** in the subject of Livestock Production Management to Maharana Pratap University of Agriculture and Technology, Udaipur (Raj.) is original and bonafide record of research work carried out by me under the supervision of **Dr. Lokesh Gupta,** Professor, Department of Animal Production, Rajasthan College of Agriculture, MPUAT, Udaipur. The content of the thesis, either partially or fully, have not been submitted or will not be submitted to any other institute or University for the award of any degree or diploma.

The work embodied in the thesis represents my ideas in my words and where others' ideas have been included; I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Dated: / /2023

This is to certify that the thesis entitled **"Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)"** submitted for the degree of **Master of Science** in Agriculture in the subject of Livestock Production Management**,** embodies bonafide research work carried out by **Mr. Krishan Gurjar** under my guidance and supervision and that no part of this thesis has been submitted for any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of this thesis was also approved by the advisory committee on / /

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This is to certify that the thesis entitled **"Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)"** submitted by **Mr. Krishan Gurjar** to the Maharana Pratap University of Agriculture and Technology, Udaipur in partial fulfillment of the requirements for the degree of **Master of Science** in Agriculture' in the subject of **Livestock Production Management** after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination held on .…/…./2023 was found satisfactory; we therefore, recommend that the thesis be approved.

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This is to certify that **Mr. Krishan Gurjar** student of **Master of Science in Agriculture, Department of Animal Production,** Rajasthan College of Agriculture, Udaipur has made all corrections/ modifications in the thesis entitled **"Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)"** which were suggested by the external examiner and the advisory committee in the oral examination held on   /   /2023. The final copies of the thesis duly bound and corrected were submitted on   /   /2023 are enclosed here with for approval.

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ABBREVIATION

/	Per
%	Per cent
&	And
@	At the rate of
Ad lib	Ad libitum
Av.	Average
B. W.	Body weight
BIS	Bureau of Indian Standard
CF	Crude fibre
CP	Crude protein
CRD	Completely randomized design
DCP	Digestible Crude Protein
DM	Dry matter
DMI	Dry matter intake
DMD	Dry matter digest
d.f.	Degree of freedom
DE	Digestibility energy
EE	Ether extract
FCR	Feed conservation ratio
FI	Feed intake
FE	Feed efficiency
G	Gram
g/d	Gram per day
Kcal	Kilocalorie
Kg	Kilogram
ME	Metabolic energy
Mg	Milligram
NFE	Nitrogen free extract
NS	Non-significant
S.E.	Standard error
Viz.	Namely
Wt.	Weight
WI	Water intake
DORB	De oiled rice barn
GE	Gross energy
GNC	Groundnut cake
MOLP	*Moringa oleifera* leaf powder

1. INTRODUCTION

Quails are the smallest avian species that are raised for meat and egg production with their unique flavor. The economic importance of quail is related to its low cost maintenance, short generation interval and high resistance to disease (Vali, 2008). There are about 70 domestic quail breeds around the world. The Japanese quail belong to the order Galliformes, family Phasianidae, genus *Coturnix* and species *japonica*. The scientific designation for Japanese quail is *Coturnix japonica*, different from the common quail "*Coturnix Coturnix*". The first record of wild Japanese quail appeared in the eighth century in Japan**.**

Japanese quails (*Coturnix japonica*) are used as a laboratory animal model for multiple areas of scientific research, but not limited to developmental biology, endocrinology, aging, immunology, behavior studies and a variety of human genetic disorders. The quail embryo is an amniote with early developmental patterns remarkably as humans; as such they present significant experimental advantages for the study of amniotes e.g., rapid reproductive maturation, modest size of breeding adults, ease of breeding in laboratory animal facilities, resilience to research manipulations, availability of transgenic lines, a fully sequenced genome, and tools for molecular manipulations (Janet *et al*., 2015).

The Japanese quail (*Coturnix japonica*) breeding industry has exploded in recent years. Quail production is a new branch of the poultry industry that adds variety to poultry meat. The meat of quail has high nutritional value and adds variety to the human diet, which is highly valued by consumers. Moreover, quail meat is low in lipids, making it a more cost-effective source of animal protein. The main obstacle to the long-term viability of intensive quail production is the high cost of feed, which accounts for about 70% of overall production expenses (Minj *et al*., 2018).

Eggs and meat from quails are source of high quality dietary protein that can be used to enhance food and nutritional security particularly in resource poor communities of developing countries. Quail eggs are more nutritious than other poultry eggs because of its comparatively more protein, phosphorus, iron, vitamin A, B_1 and B_2 and can play a vital role to meet the demand of food and nutrition (Talukdar *et al*., 2020).

Quails are small birds and commercially grown for their eggs and meat. In India, commercial farming of these birds is increasing day-by-day as the investment and maintenance is very less compared to other birds. Quail eggs are very nutritious than poultry eggs. Quails are very famous in the world and first commercial farming of quails is started in Japan and now it spread across the globe. The main advantage of the quail farming is these birds can be raised along with other poultry birds. In India, due to the high population, meat and eggs requirement is growing day-by-day and there is no doubt that quail farming will be popular like poultry farming in near future. Quail farming can be a great source of handsome income and employment opportunity in the state of Rajasthan. Along with the economic importance quail farming is also very pleasuring and entertaining.

The state of Rajasthan comprising of 33 districts and is the largest state in India by area. The state has a total geographical area of about 3.42 lakh Sq. Km. which is 10.41 per cent of the total land area of the country. Majority of the people inhabiting there are still unaware of the importance of the quail. Quails can adapt themselves very well with almost all types of climates and environment. Rajasthan is very suitable for raising quails commercially. Speaking about Southern Rajasthan climate, it is said that the state has quite a pleasant weather throughout the year. The frequent occurrence of draught in the state cause failure of agriculture resulted economic loss to the farmers, under such situation the adoption of dairying is also very difficult for marginal and landless farmers due to higher cost on feed and fodder. The quail farming is one of the remunerative enterprises for poor and weaker section of the society as evident from input output ratio of birds. Quail farming required less establishment cost which can easily be afforded by this class of society.

Feeding has a great effect in poultry growth, egg production and meat quality. Feeds and feeding are integral parts of poultry production which accounts for 60-70% of total cost of production. Poultry feed cost in developing countries are continuing challenge improving feed efficiency and reduce feed cost, make poultry production a remunerative one.

The use of plant based feedstuffs in poultry feeding are reported in improving of yolk colouration and high content in macronutrients which is the key element of protein source. For this use, of plant based feedstuffs with possible nutraceutical properties such as *Moringa oleifera* can be a cost effective and safe strategy to improve the performance and the product quality of intensively reared quails. The leaves are very rich with large amounts of vitamins (A, B and C), protein, iron, calcium and phosphorus. Also, it contains sufficient amounts of methionine, cysteine, carotene, ascorbic acid and iron. *Moringa oleifera* is a plant that possesses multiple advantages. Effect of *Moringa oleifera* leaves on egg quality of quail were not much investigated (Talukdar *et al*., 2020).

Being a herbal plant, *Moringa oleifera* is considered as the most efficient because leaves contain higher amount of protein besides its several therapeutic and medicinal uses. Moringa is the sole genus in the flowering plant family Moringaceae. It is locally known as Munga or Sahjan. One such plant is *Moringa oleifera,* commonly known as the drumstick tree (Makkar and Becker, 1997). There are about 13 species of Moringa tree in the family Moringaceae. They are native to India, the Red Sea area or parts of Africa. The trees also grow in tropical and subtropical climates. The plant was reported to contain various amino acids, as a highly potent anti-inflammatory and hepatoprotective (Pari and Kumar, 2002) properties. Every part of the *Moringa oleifera* tree, from the roots to the leaves has beneficial properties. The leaves of the trees have been reported to have an antioxidant activity due to higher amount of polyphenols (Mayo *et al*., 2012). The leaf extract was found to regulate cholesterol level in rats (Ghasi *et al*., 2000).

Moringa oleifera leaf meal contains 86% DM, 29.7l% CP, 22.5% CF, 4.38% EE, 27.9% calcium, 0.26% phosphorus and negligible amount of tannin (1.23g/kg). The leaves are highly nutritious containing significant quantities of vit. A, B and C, Ca, Fe, P and protein. Researchers have great interest in finding natural growth promoters to enhance poultry production and to reduce feed cost. *Moringa oleifera* is a plant that possess multiple advantages, because different parts of the tree (leaves, fruits, immature pods and flowers) are edibles and entered in traditional diets in many tropics and sub-tropics countries. The antioxidant compounds (phenols, vitamin C, E, β carotene, zinc, selenium, flavonoids) in *Moringa oleifera* have been reported to improve shelf-life and the quality of meat products in the pre-slaughter or post-slaughter stages that is incorporating natural antioxidants in animal diets or on the meat surface or active packaging. Moringa is concentrated in nutrients and in the raw form, it seems to reduce the activity of pathogenic bacteria and moulds and improve the digestibility of other foods, thus helping chickens to express their natural genetic potential. *Moringa oleifera* seed extracts produced inhibition effect on Salmonella typhii, Vibrio cholerae and Escherichia coli, which normally cause water borne diseases. Many chemical compounds were found in *Moringa oleifer*a such as: fluoride (quercetin and kaercetin) which were identified as the most potent antioxidants in Moringa leaves. Their antioxidants activity was higher than the conventional antioxidants such as ascorbic acid, which is also present in large amount in Moringa leaves. *Moringa oleifera* contained Polyphenols like ellagic acid, gallate, methylgallate, catechol and kaempferol quercetin. *Moringa oleifera* is a highly valued food plant characterized by a multipurpose use. Dietary supplementation of Moringa formulated diets for broilers was effective in enhancing the oxidative stability of chicken meat. Furthermore, *Moringa oleifera* can play an important role in the economy of poultry industry. Partial substitution of fish meal for *Moringa oleifera* leaf meal has been found to decrease the feed cost (Mousa *et al*., 2017).

Research done in India has shown that *Moringa oleifera* leaves can be used for livestock feeding. Young leaves are used by farmers in India as cattle fodder to improve milk yields. *Moringa oleifera* leaves are packed with nutrients importance both for humans and animals. The crude protein percentage of 25- 27% is suggestive that the leaves are a good source protein for livestock. Research have indicated that Moringa leaves have negligible tannins and saponin content. Moringa is well known for its multipurpose attributes, wide adaptability and ease of establishment. The tree is fast growing and high yielding, initial trial in Nicaragua have shown a high biomass production of up to 120 tonnes dry matter/ha/year in 8 cuttings after planting one million seeds/hectare (Makkar and Becker, 1997) and the tree bears for 30-40 years. The drought tolerant nature of the tree makes it particularly suited to those marginal areas where the cost associated with cultivation and harvesting of other commercial crops. The tree is resistant to most pests and diseases, thus making it a cheap source of feed for animals. Under such conditions, *Moringa oleifera* becomes the crop of choice to explore in poultry production.

Keeping all the facts in view, the present study has been undertaken with the following objectives:

i. To study the effect of feeding Moringa Leaf Powder on feed intake and feed conversion ratio of Japanese quail.

ii. To study the effect of feeding Moringa Leaf Powder on growth performance of Japanese quail.

iii. To study the effect of feeding Moringa Leaf Powder on egg production performance of Japanese quail.

2. REVIEW AND LITRATURE

In this chapter, the effect of supplementation of Moringa Leaf Powder on growth, feed intake, feed conversion ratio and egg production in Japanese quail is reviewed based on available scientific literature.

2.1 Feed intake and feed conversion ratio

Kakengi *et al.* (2007) investigated the effect of substituting *Moringa oilefera* leaf meal (MOLM) for sunflower seed meal (SSM) as a protein source in egg strain commercial chickens. Four dietary treatments based on MOLM and SSM as plant protein sources were formulated such that MOLM reciprocally replaced SSM at levels of 20, 15, 10 and 0% giving the dietary treatments containing 0, 5, 10 and 20% MOLM levels for MOLM-0, MOLM-10, MOLM-15 and MOLM-20 respectively. Dry matter intake and feed intake significantly increased progressively at 10 and 20% MOLM levels. The results, therefore, suggest that MOLM could replace SSM up to 20% without any detrimental effect in laying chickens. However, for better efficiency 10% inclusion level is optimal and an addition of MOLM above 10% high energy-based feeds are required for better utilization.

Ashong and Brown (2011) evaluated the safety and nutritional efficacy of *Moringa oleifera* leaf meal. At 7 days of age, 60 White-leghorn type chicks were randomly assigned to 4 isocaloric and isonitrogenous experimental diets formulated to contain 0% (control group), 10%, 20% and 30% Moringa leaf powder. There were 5 chickens per cage with 3 replicates per diet. Daily feed intake was recorded. There were no signs of abnormal behavior and/or toxicity and mortality during the entire period of the experiment. The control group had a higher feed intake compared with the other treatment groups. Chicks fed with 10% Moringa leaf meal, had the lowest feed intake. These results suggest that although incorporation of Moringa leaf meal may reduce intake this ingredient otherwise is not toxic to growing poultry.

Onu and Aniebo (2011) conducted an experiment to determine the effect of Moringa leaf meal on 128 broiler birds to evaluate FCR. Birds were randomly divided into 4 treatments namely A (control group), B (2.5% *Moringa oleifera* leaf meal), C (5% *Moringa oleifera* leaf meal) and D (7.5% *Moringa oleifera* leaf meal). FCR was significantly ($P<0.05$) lower in T_3 treatment group. There were significant ($P < 0.05$)

variations in the feed intake of the birds among the treatments. There was significant ($P < 0.05$) increased in feed consumption with increase in inclusion level of MOLM. However, there was a marked reduction in the feed consumption of birds fed T_4 diet.

Abbas and Ahmed (2012) conducted an experiment to evaluate the effects of *Moringa oleifera* undecorticated seeds powder (MOUSP) on the performance and carcass characteristics of broilers. A total of one hundred sixty, day old unsexed broiler chicks were assigned into 16 pens (four groups) of ten chicks (replicates) in a pen, in a completely randomized design. First experimental diet was free of MOUSP (control diet). Other three experimental diets contained 0.37, 0.75 and 1.5% MOUSP. It was found that, addition of (MOUSP) up to 1.5% in broiler chicks diet significantly increase feed consumption.

Banjo (2012) conducted an experiment to investigate the inclusion of *Moringa oleifera* leaf as feed additive in broiler chicks. The level of inclusion of *Moringa oleifera* leaf meal was 0% which served as the control, 1%, 2% and 3% in the diet. Feed intake and feed conversion were not significantly affected by inclusion of *Moringa oleifera* leaf meal in the diet.

Hermogenes *et al.* (2014) conducted an experiment to evaluate the effects of feeding *Moringa oleifera* leaf powder and leaf meal on the performance of layer and broiler. The treatments include: T_1-Basal diets; T_2-0.20% MOLM; T_3-0.30% MOLM; T_4-0.40% MOLM; T_5-0.50% MOLM. The results reveal that feed consumption and FCR were not significantly different ($P<0.05$) among different treatments. Broiler performance in-terms of feed intake and FCR were not relatively better over the control.

Dey and Partha (2013) conducted an experiment to study the influence of *Moringa oleifera* leaves (MOL) as a functional feed additive on the growth performance, carcass characteristics and serum lipid profile of broiler chickens. 288-day-old commercial broiler chicks were randomly divided into three equal groups containing 2 replicates of 48 chicks. Chicks were offered a standard broiler diet or *Moringa oleifera* leaves supplemented diet @ 0.25% (MOL-1) and 0.40% (MOL-2) on dry matter basis by partial replacement of sesame cake of control diet for 42 days. Incorporation of MOL at both 0.25% and 0.40% levels significantly improved feed efficiency.

Gakuya *et al*. (2014) evaluated the effect of supplementing *Moringa olifera* leaf meal (MOLM) at different levels in broiler chicken. MOLM was first analyzed for crude protein and then added to diets at levels of 0% (T_1), 7.5% (T_2), 7.5% (T_3) (without Methionine and lysine), 15 (T_4) and 30% (T_5). Two hundred day-old broiler chicks were randomly allocated into the 5 treatment groups with 4 replicates of 10 birds each. The feed intake, feed conversion ratio (FCR), weight gain and feed digestibility were determined. MOLM supplementation at levels above 7.5% decreased the feed intake.

Okafor *et al*. (2014) studied the effect of *Moringa olifera* leaf protein concentrate MLPC supplemented feed on nutritional parameters and growth performance of broiler chicks. MLPC was prepared by a standardized method and was used to formulate a diet which contained a 20% replacement level of MLPC for soyabean meal. Fifty chicks were fed for four weeks with top commercial feed after which they were starved for twelve hours. Forty of them each weighing 500 g were selected and shared into two dietary treatment groups. Results showed that the weekly feed intake for the control and test groups were not significantly different (1220±2.20 g and 1237.5±1.50 g) respectively.

Nkukwana *et al*. (2014) conducted a study to assess the effects of dietary *Moringa oleifera* leaf meal (MOLM) supplementation as a possible alternative to antibiotic growth promoters on bone breaking strength (BBS), tibia bone morphology and inorganic ash content in broiler chickens. A total of 2400 one-day old cobb-500 broiler chicks of mixed sex were randomly allocated to five dietary treatments in 6 replicates of 80 birds per pen. Dietary treatments were as follows: T_1, positive control, 668 g salinomycin and 500 g zinc bacitracin per kg of feed; T_2, T_3 and T_4, graded levels of MOLM, that is (starter (1, 3 and 5 g), grower (3, 9 and 15 g) and finisher (5, 15 and 25 g)) per kg of feed; and T_5, a negative control (without supplementation). Feed intake (FI) of broilers was measured weekly, and feed conversion ratio (FCR) was calculated accordingly. There were no significant dietary effects in feed intake. FCR (feed : gain) was highest in T_3 and lowest in T_1 birds.

Hassan *et al*. (2015) studies the effect of different levels of *Moringa olifera* leaves meal on productive performance and FCR. The 1st treatment fed a commercial basal diet as a control, while, the other treatments 2nd, 3rd and 4th were fed the commercial basal diet supplemented with MOLM (0.1, 0.2 and 0.3%, respectively).

The results showed that feed conversion ratio was recorded better values as the level of MOLM increase.

Mohammadreza *et al.* (2016) conducted an experiment to determine effects of Probiotics on growth performance. Two hundred one-day-old male chickens were allocated to one of five treatments (four replicates of 10 birds per treatment): control and the same control diet supplemented with 0.005%, 0.01%, 0.015% and 0.02% probiotics. Probiotics in feed at 0.01% or higher levels of supplementation improved feed conversion rate compared with the control.

Alabi *et al*. (2017) studied the effect of aqueous *Moringa olifera* leaf extracts on growth performance and carcass characteristics of hubbard broiler chicken. The birds were randomly allocated into six treatments with four replicates, and each replicate containing 10 broiler chicks, CRD used. Results of feed intake showed that birds on positive control had the highest (84.70 g) and the on 90ml/litre of AMOLE had the lowest (73.19 g); while the results of feed conversion ratio indicated that birds on AMOLE 90 and AMOLE 120 performed better than the positive control treatment.

Jayanti *et al*. (2017) evaluated the effect of supplementation of *Moringa oleifera* leaf powder on growth performance of broilers. The control group was fed basal diet and birds in treatment group T_1, T_2 and T_3 were offered *Moringa oleifera* leaf powder at 0.2%, 0.4% and 0.6%, respectively. The result show that the FCR among the all treatment groups were found to be better as compared to control. Slightly reduced feed intake was observed in all treatment groups compared to control.

Yadav *et al*. (2018) conducted an experiment to study the effect of graded levels of satavari root meal on feed conversion ratio, body weight on coloured chicken. The dietary treatments T_1- basal diet (broiler starter diet till 4 weeks, broiler finisher diet till eight weeks), T_2- T_1+0.25% Shatavari root meal (SRM), T_3- T_1+0.5% SRM, T_4- T_1+0.75% SRM, T_5- T_1+1% SRM, T_6- T_1+1.25% SRM and T_7- T_1+1.5% SRM, having three replicates each with ten coloured chicken. T_2 birds had a significantly better ($P<0.05$) FCR at 2^{nd} week as compared to T_1, T_6 and T_7.

Castillo *et al.* (2018) evaluated the nutritional, nutraceutical, antimicrobial, as well as the growing promoter effect of *Moringa olifera* (MOLM) leaves flour in fodders for fattening Japanese quails. A completely random design with 4x2 factorial arrangements was used. Fodders included 0%, 7%, 14%, and 21% of MOLP, with and without Virginiamycin (100 ppm), during 35 day of fattening 480 one-day old unsexed quails were used, each treatment had 5 replicates with 12quails/cage. The inclusion of MOLP in the period from 1 to 14 day increasing feed conversion, without affecting the feed intake. They concluded that flour from leaves of *Moringa oleifera* is available alternative to be included up to 14% in commercial diets of birds with advantage.

Bidura *et al*. (2020) investigated the influence of *Moringa oleifera* on laying hen performance at 0, 2, 4 and 6% respectively. It was observed that the supplementation of 4-6% MOL in diet increased feed efficiency.

2.2 Growth performance

Melesse *et al*. (2011) evaluated the effects oí Moringa stenopetala leaf meal (MSLM) on nutrient intake and weight gain (WG). Forty unsexed Rhode Island Red chicks were randomly assigned to 4 treatment groups. The control diet (T_l) (MSLM 0%), the experimental diets contained MSML at a rate of 2% (T_2), 4% (T_3), and 6% (T_4) of the diets (as fed basis) to replace 3%, 5.9% and 8.8% of the crude protein (CP) of the control diet. Daily feed, dry matter and average weight gain (AWG) of birds fed MSLM diets were higher ($p<0.05$) than those fed the control diet. Chicks fed T_4 showed higher ($p<0.05$) AWG than those on T_2 and T_3.

Onu and Aniebo (2011) conducted an experiment to determine the effect of Moringa leaf meal on 128 broiler birds to evaluate FCR. Birds were randomly divided into 4 treatments namely A (control group), B (2.5% *Moringa oleifera* leaf meal), C (5% *Moringa oleifera* leaf meal) and D (7.5% *Moringa oleifera* leaf meal). Birds fed T_3 (5%) diets recorded significantly ($P < 0.05$) the highest body weight gain.

Chongwe (2011) conducted two experiments to evaluate the effect of Moringa leaf meal as a feed supplement on the growth and health of indigenous Zambian chickens. In one experiment sixty indigenous chickens were randomly assigned to receive isonitrogenous and isocaloric diets containing 0, 10, 20 and 30% Moringa leaf meal on weight basis. The second experiment was conducted to evaluate further the effects of Moringa leaf meal on the health of indigenous Zambian chickens at inclusion levels of less than 20% Moringa. This was arrived at, based on indications from the first experiment, that the indigenous chickens fed Moringa below 20% had less mortality. Thus, 60 indigenous Zambian chickens were divided equally between sex and type into 12 groups and assigned at random to three isonitrogenous and isocaloric dietary treatments supplemented with 5, 10 and 15% *Moringa oleifera* leaf meal on weight basis. The results from the two experiments indicate that 10% inclusion rate of Moringa leaf meal in the diet promotes growth.

Banjo (2012) held a feeding experiment to assess the effect of *Moringa oleifera* leaf meal on broiler birds. 80 broiler birds of 2 weeks age were randomly allotted to four treatments. Treatment groups were: T_1 (control group), T_2 (1% *Moringa oleifera* leaf meal), T_3 (2% *Moringa oleifera* leaf meal) and T_4 (3% *Moringa oleifera* leaf meal). He observed that growth rate of broiler birds in treatment group T_2 (1% *Moringa oleifera* leaf meal) was significantly ($P<0.05$) higher than other treatment groups.

Bolu *et al*. (2013) conducted a trial on one hundred and twenty chicks to determine the suitability of feeding MOLM. The experimental diets consisted of 0, 2.5, 5 and 7.5% MOLM. A reduction in performance was observed as the level of MOLM increased beyond 5%. Broilers could be fed diet containing *Moringa olifera* leaf meal up to 5% inclusion level without deleterious effect on final live weight. The inclusion of leaf meals in broiler diets above 5% resulted in depressed performance.

Aderinola *et al*. (2013) conducted an eight week feeding trial, using *Moringa oleifera* leaf meal (MOLM) as a feed supplement at five varying inclusion levels (0, 0.5, 1.0, 1.5 and 2.0%). A total of one hundred and fifty day old broiler chicken was equally and randomly allotted to the five treatments. Daily feed intake and feed conversion ratio was estimated. At the end of 8 weeks experimental period, six birds per treatment (2 per replicate) were randomly selected and starved for 24 hours. Result showed that birds fed diet with 0% *Moringa oleifrea* leaf meal (MOLM) gained significantly ($P < 0.05$) higher weight than birds fed MOLM based diets. Birds on T_2, T_3, T_4 and T_5 were observed to be comparable ($P>0.05$) in average daily weight gain but its value decreased as inclusion of MOLM increased.

Okafor *et al*. (2014) studied the effect of *Moringa olifera* leaf protein concentrate (MLPC) supplemented feed on nutritional parameters and growth performance of broiler chicks. MLPC was prepared by a standardized method and was used to formulate a diet which contained a 20% replacement level of MLPC for soyabean meal. Fifty chicks were feed for four weeks with top commercial feed after which they were starved for twelve hours. Forty of them each weighing 500 g were selected and shared into two dietary treatment groups. Results showed that the birds in the test group recorded a higher daily weight gain of 84.6±1 compared with the control group which had a daily weight gain of 68.9±0.8 g.

Nkukwana *et al*. (2014) conducted a study to assess the effects of dietary *Moringa oleifera* leaf meal (MOLM) supplementation as a possible alternative to antibiotic growth promoters on bone breaking strength (BBS), tibia bone morphology and inorganic ash content in broiler chickens. A total of 2400 one-day old cobb-500 broiler chicks of mixed sex were randomly allocated to five dietary treatments in 6 replicates of 80 birds per pen. Dietary treatments were as follows: T_1, positive control, 668 g salinomycin and 500 g zinc bacitracin per kg of feed; T_2, T_3 and T_4, graded levels of MOLM, that is (starter (1, 3 and 5 g), grower (3, 9 and 15 g) and finisher (5, 15 and 25 g)) per kg of feed; and T_5, a negative control (without supplementation). Body weight of broilers was measured weekly. There were no significant dietary effects in body weight at placement at day 35. However,on 7 and 21 day, T_4 had highest body weight and lowest body weight in T_1 birds.

Hassan *et al*. (2015) studies on effect of different levels of *Moringa olifera* leaves meal on productive performance of broiler chicks reared under heat stress conditions. The 1st treatment fed a commercial basal diet as a control, while, the other treatments 2nd, 3rd and 4th were fed the commercial basal diet supplemented with MOLM (0.1, 0.2 and 0.3%, respectively). The results showed that body weight gain was increased significantly as the level of MOLM increase.

Khan *et al*. (2016) studies on effect of *Moringa olifera* leaf powder (MOLP) supplementation on growth performance of broiler chickens. 100 day-old broilers were randomly divided into five groups with four replicates each having five birds. Birds were fed a corn-based basal diet or the same diet supplemented with 0.6, 0.9, 1.2 and 1.5% MOLP body weight. The results on dietary supplementation of 1.2% MOLP are better growth performance on broilers.

Omer and Hyder (2016) conducted an experiment to assess the effect of Moringa leaf meal on growth parameters of 200 broiler birds. Four experimental groups were fed with T_1 (control group), T_2 (2% Moringa leaf meal), T_3 (4% Moringa leaf meal) and T_4 (5% Moringa leaf meal). They observed that final body weight (g) was higher in all treatments groups T_2, T_3 and T_4 as compared to control, while, final body weight of birds in T_2, T_3 and T_4 groups was at par.

Nihad *et al*. (2016) supplemented broiler diet with *Moringa Oleifera* leaf meal (MOL) at 0, 5, 10, 15, 20% respectively. The most effective of supplementation of MOL poultry diets body weight of broiler, were 612, 1733, and 2391 gm, of treatment (20%), after 14,28 and 42 days, respectively. The effect of supplementation of MOL poultry diets on body weight of broiler, were 608, 1718 and 2318 gm, of treatment (15% MOL), after 14, 28 and 42days, respectively. While the effect of supplementation of MOL poultry diets at treatment of (5 and 10%), on body weight of broiler, were 2133 and 2141 gm, after 42 days, respectively.

Sarker *et al*. (2017) conducted a study to investigate the effect of dietary Moringa leaf meal (MLM) as a natural alternative to antibiotic on the growth performance of broiler chicken. Chicks were distributed in 4 different inclusion levels of MLM in diets; 0.5%, 1.0%, 1.5% and 2.0% with 2 control diets negative and positive. The birds were fed the experimental diets and water was provided without restriction throughout the experimental period. The results showed significant ($P<0.05$) effect on final body weight and weight gain in dietary supplementation of 1.5% MLM as compared to that of control group.

Castillo *et al.* (2018) conducted a study on 480 one-day old Japanese quail and fed Moringa flour supplemented diet at 0, 7, 14 and 21% and reported that inclusion of MOR in the period from 1 to 14 day inhibited the body weight and body weight gain. However, in the period of 15 to 35 day MOR not affect weight gain.

Egu (2019) experimented on Ninety-six (96) CHI broiler chickens aged 4 weeks to determine the effect of *Moringa oleifera* leaf meal (MOLM) on growth performance. The 96 broiler chickens were randomly allocated to 4 treatment groups, identified as T_1, T_2, T_3 and T_4. Each treatment group consisted of 24 birds replicated 3 times with 8 birds per replicate in a completely randomized design (CRD) with four levels of *Moringa oleifera* leaf meal as treatments. The levels of *Moringa oleifera* leaf meal were 0.00%, 6.00%, 8.00% and 10.00%. Treatment one (T_1) which contained no *Moringa oleifera* leaf meal served as the control. The results of this study indicate that *Moringa oleifera* leaf meal enhanced growth performance and weight gain in the treated birds compared to the control group with the best result at 8.00% inclusion level.

Sarmad *et al.* (2020) conducted an experiment to investigate the effects of feed supplementation with rosemary (*Rosmarinus officinalis L.*) powder (RP) on the performance, carcass traits, blood variables, antibody responses, and gut microbiota of quails. The diets contained RP at levels of 0 g/kg of feed (T_1), 5 g/kg of feed (T_2), 10 g/kg of feed (T_3), 15 g/kg of feed (T_4), 20 g/kg of feed (T_5) or 25 g/kg of feed (T_{25}). The trial lasted 42 days. Body weight was measured weekly by pen. Quails fed with RP had higher weight gain.

Sherief *et al.* (2021) investigated the impact of dietary inclusion of *Moringa oleifera* leaf meal (MLM) as a substitution for soybean meal on growth-related hormones, and growth performance of buffalo calves. Thirty buffalo calves eight to nine months of age with an average body weight of approximately 153.7 ± 0.97 kg were randomly distributed through three dietary treatments (ten calves/ treatment). MLM inclusion rates were 15% and 20%, replacing soybean meal by 50 and 75% in the concentrate mixture, respectively. The results indicated that the dietary inclusion of 15% MLM significantly improved ($p < 0.001$) final body weight and daily weight gain.

2.3 Egg production performance

Asasi and Jaafar (2000) studied the effect of sex ratio on egg production in Japanese quail. Four groups of adult 65-95-day-old Japanese quail were selected and randomly grouped with sex ratios of one male to 1, 2, 3 or 4 females, labelled as groups 1 to 4 respectively. The total hen daily egg production was 81.6, 89.3, 95.8 and 92.3% and the mean egg weight was 10.97, 11.00, 11.63 and 11.60 g in groups 1 to 4 respectively. These 2 parameters were significantly higher in groups 3 and 4 than in groups 1 and 2 ($P<0.05$).

Amad and Zentek (2022) reported that inclusion of different levels of *Moringa oleifera* leaf meal (0%, 5%, 10% and 15%) in the laying hens' diets. The result showed that improved egg weight and egg production by hen get 5% MOLP.

Hermogenes *et al.* (2014) evaluated the effects of *Moringa oleifera* leaf powder and leaf meal on chicken layer and broiler diets. The treatments include: T_1-Basal diets; T_2-0.20% MOLM; T_3-0.30% MOLM; T_4-0.40% MOLM; T_5-0.50%

MOLM. The results reveal that egg production, characteristics of egg and shell thickness of old layers were not significantly different.

Wubalem *et al*. (2016) conducted an experiment to evaluate effects of MOLM substitution to soybean meal in layers ration on egg laying performance, fertility and hatchability of dual purpose Koekoek hens. Four treatment rations contained MOLM i.e., T_1 (0% MOLM), T_2 (5% MOLM), T_3 (10% MOLM) and T_4 (15% MOLM)] were fed to layers. Hen-day egg production (%) was significantly highest in T_2 group.

Mabusela *et al*. (2018) conducted an experiment to determine how the partial supplementation of *Moringa oleifera* whole seed meal (MOWSM) would affect layer performance, egg quality and egg fatty acid profile. Dietary treatments consisted of 0 (control), 1, 3, and 5% MOWSM. Layer performance was monitored over a period of 8 weeks. The inclusion of MOWSM in layer diets reduced the rate of lay, egg weight, and egg mass. Yolk colour was significantly improved by 1, 3 and 5% inclusion levels, while the albumen height decreased. The albumen weight, yolk weight, eggshell weight, eggshell thickness, and egg shape index showed no statistical differences across all treatment groups.

Riry *et al*. (2018) conducted a study to determine the response to partial substitution of MOSM instead of soybean meal on Japanese quail laying performance; egg production, egg quality, some plasma constituents and reproductive performance. It could be concluded that partial replacement of soybean meal by MOSM at levels of 5.0, 7.5 and 10.0% of the quail diets improved productive performance.

Voemesse *et al*. (2019) conducted an experiments in laying hens by feeding of *Moringa oleifera* leave meal (MOLM) at the level of 0%, 1% and 3% in diet. The result of this study showed a positive influence on egg production in laying hen. From the point of view of egg production, the use of 1% *Moringa oleifera* leaves in the diet of laying hens should be encourage.

Siti *et al* (2019) investigated the influence of Moringa oleifera leaf powder on feed digestibility and egg quality characteristics of laying hens up to 32 weeks old. One hundred and twenty 32 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 into four groups: M0: basal diets without administration of *Moringa oleifera* leaves, M1: basal diets with 2% *Moringa oleifera* leaves; M2: basal diets with *Moringa oleifera* leaves 4%; and M3: basal diets with 6% *Moringa oleifera* leaves, respectively. Each treatment consisted of six replication cages with 5 hens randomly assigned to each cages. This study showed that administration of 4-6% the Moringa leaves powder were increased yolk and egg shell percentages, and shell thickness but not the albumen of eggs. It was concluded that supplementation of 4-6% % Moringa leaves powder in diets increased external egg qualities of laying hens up to 32 weeks old.

Bidura *et al.* (2020) investigated the influence of *Moringa oleifera* feeding at 0, 2, 4 and 6% on laying hen performance. It was observed that the supplementation of 4-6% MOL in diet ,increased egg mass, yolk colour, shell thickness, Ca and Mg in the yolk.

2.4 Nutrient utilization

Kakengi *et al.* (2007) investigated the effect of substituting *Moringa oilefera* leaf meal (MOLM) for sunflower seed meal (SSM) as a protein source in egg strain commercial chickens. Four dietary treatments based on MOLM and SSM as plant protein sources were formulated such that MOLM reciprocally replaced SSM at levels of 20, 15, 10 and 0% giving the dietary treatments containing 0, 5, 10 and 20% MOLM levels for MOLM-0, MOLM-10, MOLM-15 and MOLM-20 respectively. Dry matter intake and feed intake significantly increased progressively at 10 and 20% MOLM levels.

Chongwe (2011) conducted two experiments to evaluate the effect of *Moringa oleifera* leaf meal as a feed supplement on the growth and health of indigenous Zambian chickens. In one experiment sixty indigenous chickens were randomly assigned to receive isonitrogenous and isocaloric diets containing 0, 10, 20 and 30% Moringa leaf meal on weight basis. The second experiment was conducted to evaluate further the effects of Moringa leaf meal on the health of indigenous Zambian chickens at inclusion levels of less than 20% Moringa. This was arrived at based on indications from the first experiment that the indigenous chickens fed Moringa below 20% had less mortality. Thus, 60 indigenous Zambian chickens were divided equally between sex and type into 12 groups and assigned at random to three isonitrogenous and isocaloric dietary treatments supplemented with 5, 10 and 15% *Moringa oleifera* leaf meal on weight basis. The results from the two experiments indicate that the apparent digestibility for Metabolisable energy for 0 and 10% were significantly higher than those for 20 and 30%. These were 89.56%, 85.15%, 76% and 80%, respectively. Apparent digestibility of crude protein was significantly higher up to 10% inclusion level of Moringa leaf meal whereas further inclusion levels the digestibility significantly reduced.

Melesse *et al*. (2011) evaluated the effects *Moringa oleifera* stenopetala leaf meal (MSLM) on nutrient intake and weight gain (WG). Forty unsexed Rhode Island Red chicks were randomly assigned to 4 treatment groups. The control diet (T_l) (MSLM 0%), the experimental diets contained MSML at a rate of 2% (T_2), 4% (T_3), and 6% (T_4) of the diets (as fed basis) to replace 3%, 5.9% and 8.8% of the crude protein (CP) of the control diet. Daily feed, dry matter and CP intake of birds fed MSLM diets were higher ($p<0.05$) than those fed the control diet. The results indicated that MSLM could be included to 6% in the diet of grower chicks to substitute expensive conventional protein sources.

Nkukwana *et al*. (2014) conducted a study to assess the effects of dietary *Moringa oleifera* leaf meal (MOLM) supplementation as a possible alternative to antibiotic growth promoters on bone breaking strength (BBS), tibia bone morphology and inorganic ash content in broiler chickens. A total of 2400 one-day old cobb-500 broiler chicks of mixed sex were randomly allocated to five dietary treatments in 6 replicates of 80 birds per pen. Dietary treatments were as follows: T_1, positive control, 668 g salinomycin and 500 g zinc bacitracin per kg of feed; T_2, T_3 and T_4, graded levels of MOLM, that is (starter (1, 3 and 5 g), grower (3, 9 and 15 g) and finisher (5, 15 and 25 g)) per kg of feed; and T_5, a negative control (without supplementation). There were no significant differences in apparent digestibility for ash, ether extract (EE), crude fibre (CF), crude protein (CP) among treatments. It was concluded that supplementation of *Moringa oleifera* leaf meal up to 25 g per kg of feed did not impair nutrient utilization efficiency, but enhanced the bird's genetic potential for growth performance.

Sebola *et al.* (2017) found that the inclusion of *Moringa oleifera* leaf meal in chickens diets did not have negative effect on nutrient digestibility but appeared to reduce CP digestibility. They concluded that Moringa leaves can be used as a functional feed ingredient in poultry diets without affecting nutrient utilization.

Latif and Latif (2019) conducted an experiment to study the effect of using different levels of *Moringa oleifera* leaves powder (MOLP) in growing Sasso chicks diet as feed additives on performance, carcass characteristics, digestibility of nutrients and economically efficiency. One hundred and fifty one day old, unsexed of Sasso broiler chicks were distributed into five treatment groups. Each group contain three replicates of 10 birds, each. The first group was fed control diet (without no addition). Whereas, 2nd, 3rd, 4th and 5th groups were fed diets contain grade levels of 0.1, 0.2, 0.3 and 0.4% MOLP respectively as feed supplementation. The results showed that broiler chicks were fed on commercial diet supplemented with different levels of MOLP recorded highly significant differences ($p<0.01$) in the digestibility of crude protein (CP). The greatest value of crud protein digestion coefficient recorded for birds fed 0.1% MOLP compared with other dietary treatment groups. However, birds fed all grade levels of MOLP in their diet had no significant ($p>0.05$) in other nutrients such as dry matter (DM), organic matter (OM), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE).

Siti *et al.* (2019) investigated the influence of *Moringa oleifera* leaf powder on feed digestibility and egg quality characteristics of laying hens up to 32 weeks old. One hundred and twenty 32 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 into four groups: M0: basal diets without administration of *Moringa oleifera* leaves, M1: basal diets with 2% *Moringa oleifera* leaves; M2: basal diets with *Moringa oleifera* leaves 4%; and M3: basal diets with 6% *Moringa oleifera* leaves, respectively. Each treatment consisted of six replication cages with 5 hens randomly assigned to each cages. This study showed that administration of 4-6% the Moringa leaves powder were increased dry matter and organic matter digestibility. It was concluded that supplementation of 4-6% % Moringa leaves powder in diets, increased feed digestibility of laying hens up to 32 weeks old.

3. MATERIALS AND METHODS

The present research entitled "Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)" was conducted for a period of 14 weeks. The materials and methods followed during the present investigation have been described as follows:

3.1 Experimental site

The experiment was conducted at poultry farm, Department of Animal production, Rajasthan College of Agriculture, MPUAT, Udaipur, in humid region at latitude 24.57 North and longitude of 73.70 East with height from mean sea level 598 meters. The mean maximum and minimum temperature of the last decade were 38.3^{o} C in summer and 11.6^{o} C in winter, while the mean annual rainfall was 63.7 cm.

3.2 Plan of work

The research work was carried out with 180 Japanese quail chicks of day-old age procured from the poultry farm, Department of Animal production, Rajasthan College of Agriculture, Udaipur. The chicks were wing banded and distributed randomly in 4 treatment groups, consisting of 45 birds in each treatment group with three replications of 15 chicks in each.

3.2.1 Experimental details:

1.	Period	:	September, 2021 to January, 2022
2.	Breed	:	CARI Pearl
3.	Total treatments	:	4
4.	Replications	:	3 (15 birds in each replication)
5.	Total number of birds	:	180
6.	Experimental design	:	CRD
7.	Housing	:	Cage system

3.2.2 Housing, feeding and watering Management

The brooder house, hover, feeder and waterer were cleaned and disinfected well before starting the experiment. The chicks were brooded up to 2 weeks under hover by using electricity for which 200watt bulb were fixed in hover and temperature was adjusted to about 95 ºF at first week and 5 ºF temperature were reduced every week up to 6th week of age. After that 65 ºF temperature was maintained. Brooder houses were provided with adequate ventilation and continuous light. Space was provided as per standard in cage system of management.

3.2.3 Experimental feed and treatments

The quail chicks were fed chick/grower ration from day old to 6th weeks of age thereafter layer ration was fed for the period of 7th to 14th week of age. The ration was prepared with maize, groundnut cake (GNC), de oiled soyabean cake (DOSC), de oiled rice bran (DORB) and *Moringa oleifera* Leaf Powder (MOLP). The dietary treatments consisted of the feed as control (T_1), T_1+supplementation of Moringa Leaf Powder @ 5% (T_2), T_1+supplementation of Moringa Leaf Powder @ 10% (T_3), T_1+supplementation of Moringa Leaf leaf Powder @ 15% (T_4). The Moringa Leaf Powder was purchased from Earth Expo Company, Bhavnagar, 364002, Gujrat, India. Isonitrogenous and isocaloric diet for chick/grower (CP-24% and ME-2900 Kcal/kg) and for layer (CP-20% and ME-2900 Kcal/kg) were used for feeding of experimental birds.

3.2.3.1 Detail of experimental treatments

Table 3.1 Treatment details

Treatments number		**Treatment details**
T_1	:	Control (conventional feed)
T_2	:	T_1+ 5% Moringa Leaf Powder
T_3	:	T_1+ 10% Moringa Leaf Powder
T_4	:	T_1+ 15% Moringa Leaf Powder

3.3 Ingredient composition of ration

Ingredient composition of chick/grower and layer ration in different treatments are presented in table 3.2 and 3.3, respectively.

Table 3.2: Ingredient composition of chick/grower ration

Feed ingredients	Treatments			
	T_1	**T_2**	**T_3**	**T_4**
Maize (kg)	54	52	52	50
GNC (kg)	17	16	12	12
Soya DOC (kg)	20	19	19	18
DORB (kg)	9	8	7	5
MOLP (kg)	0	5	10	15
Total	**100**	**100**	**100**	**100**

Table 3.3: Ingredient composition of layer ration

Feed ingredients	Treatments			
	T_1	**T_2**	**T_3**	**T_4**
Maize (kg)	57	57	55	52
GNC (kg)	15	17	12	13
Soya DOC (kg)	12	9	11	8
DORB (kg)	16	12	12	12
MOLP (kg)	0	5	10	15
Total	**100**	**100**	**100**	**100**

3.4 Observations to be recorded during the experimental period

3.4.1 Feed intake and feed conversion ratio

(A) Feed intake

The feed intake was measured in each treatment group at weekly interval during 1st to 6th week of age. Total feed offered and residue thereof was weighed to obtain feed intake.

Feed intake (g) = Feed offered during the current day (g) – Feed leftover at the next day (g)

(B) Feed conversion ratio (FCR)

Feed conversion ratio was estimated at weekly interval as well as for the entire growth period *i.e.* from 1st to 6th week of age. Feed conversion ratio was calculated by using following formula.

$$\text{Feed Conversion Ratio} = \frac{\text{Feed consumed in a particular period (g)}}{\text{Body weight gain during same period (g)}}$$

3.4.2 Growth performance of birds

(A) Weekly body weight

Body weight was measured in each treatment group at weekly interval by 1.0 gram accuracy weighing balance in the morning before offering the feed.

(B) Weekly body weight gain

Body weight gain was measured in each treatment group at weekly interval.

Weekly body weight gain (g) = Current week body weight (g) – Previous week body weight (g)

3.4.3 Egg production performance

(A) Age at first egg (days): Age at first lay was determined by the total number of days from the date of hatching to laying first egg in a group.

(B) Body weight at first egg (g): Body weight of quail at the age of first egg laid was recorded.

(C) Weight of first egg (g): Average weight of first egg was recorded by weighing balance.

(D) Hen day egg production: Egg production was recorded 7th to 14th week of age, it was calculated as hen day egg production (HDEP) formula:

$$\text{HDEP (\%)} = \frac{\text{Total no. of egg production during the period}}{\text{No. of birds during the period}} \times 100$$

(E) Hen housed day egg production: Hen housed day egg production was calculated by the following formula:

Hen housed day egg production (%) =

$$\frac{\text{Total no. of eggs laid on a day}}{\text{Total no. of female birds housed at the beginning of laying period}} \times 100$$

3.4.4 Metabolism trial

A metabolism trial was conducted during 6^{th} week age on 6 birds per treatment. From each treatment the birds were randomly selected and shifted in cage. The birds were individually fed with experimental treatment diet. The birds were given adaptation period of 7 days followed 3-day collection of excreta voided which was throw out. During the collection period quantity of feed offered, left over and excreta voided recorded taken to determine the nutrient utilization. The quantity of excreta voided by individual treatment birds was collected and weighed quantitatively after every 24 hours at 8:30 a.m. representative feed samples were collected and preserved for further analysis similarly aliquot of excreta sample was also processed for nutrient analysis.

3.4.5 Nutrient utilization

The proximate principle in the feed and excreta were analysed as per AOAC 2003.

i. Determination of dry matter

Sample of feed taken through metabolic trial and taken pre-weight petri dish and kept in hot air oven at 100^0 C for 24 hours. Weight of petri dish dry sample taken after 24 hours. dry matter was calculated use following formula:

$$\text{Dry matter (\%)} = \frac{b}{a} \times 100$$

Where,

a = Fresh weight of sample (g)

b = weight of sample after oven dry (g)

Moisture (%) = 100 – Dry matter (%)

ii. Determination of total nitrogen and crude protein

The crude protein was determined by Kjeldahl method. For the determination of protein 2 g of sample was taken in a flask and addition of 3 g of digestion mixture of K_2SO_4: $CuSO_4$ in 9:1 ratio and 20 ml concentrated H_2SO_4. The content was digested till a green/blue transparent liquid was obtained. Cooling the volume of digest sample with 100 ml distilled water. A 20 ml aliquot of digest mixture was distilled with 40 percentage NaOH solution and ammonia was collected in 20 ml of 2 % boric acid solution containing 2 to 3 drops of mixtured indicator. The ammonia titrated against 0.1 N HCL. A blank was similarly digested and distilled. total nitrogen was calculated percentage using following formula:

$$N(\%) = \frac{\text{Sample of titre} - \text{Blank titre} \times \text{Normality of HCL} \times 14 \times \text{Volume of made up}}{\text{Diluents of digest mixture} \times \text{Weight of sample taken}}$$

Crude protein percentage calculated as follows:

$$\text{Crude protein } (\%) = \text{Nitrogen } (\%) \times 6.25$$

iii. Determination of total ash

For the determination of ash percentage 5 g sample was taken in pre-weighted silica crucible. The crucible with sample was kept on heater and burn till no more smoke was given off by burn mass of sample. Thereafter, the silica crucible containing charred mass of feed sample was transferred into muffle furnace with help of mental tong and inflame at 600^0 C for 2 hours, the crucible containing ash was removed from the muffled furnace and then transferred into desiccator, cooled and weight. Total ash was calculated by following formula:

$$\text{Total ash } (\%) \text{ on dry matter basis} = \frac{a-b}{c} \times 100$$

Where,

a = weight of silica crucible with ash (g)

b = weight of empty silica crucible (g)

c = weight of sample taken for ashing on dry matter basis (g)

iv. Determination of total ether extract

Soxhlet method was used for the determination of Ether extract. In this method 2 g dry and crush sample was transferred into thimble and taken weight of empty oil flask. Thimble was placed in Soxhlet's apparatus and refluxed with petroleum ether form eight hours in straight position. Petroleum ether (boiling point 40 – 60^0 C) used as a solvent for the evaporation. After eight hours thimble was taken out the oil flask containing ether extract was put on hot air oven for evaporation of ether, after removed from hot air oven, and keep for cooling and desiccated area and taken weight. Ether was calculated used following formula:

$$\text{Ether extract (\%)} = \frac{b}{a} \times 100$$

Where,

a = weight of sample

b = (weight of oil flask after extraction) – (weight of oil flask before extraction)

v. Determination of crude fibre

The dry weight sample after de-Etherting was taken from spoutless beaker of 1 liter capacity and add in beaker, 200 ml of 1.25 % H_2SO_4. It was refluxed for 30 minutes on hot plate after the boiling started and thereafter, filtered through muslin cloth. The acid free the residue was washed 5-6 time with hot water. The residual material on the muslin cloth was again transferred to beaker and in beaker 200 ml of 1.25 % NaOH solution was added. Free from alkali after the boiling started it was again refluxed for 30 min and for thereafter filled through muslin cloth washed with hot water for 5-6 times. Thereafter, total residue was transferred in a clean, dry silica crucible and dried in hot air oven at 100^0 C for 24 hours. Then it was cooled in desiccator and taken weight. The residue was then burning in muffle oven at 600^0 C for 2 hours. After 12 hours silica crucible containing ash was removed from the oven and transferred into desiccator, cooled and take weight again. Weight loss during inflame was recorded as the weight of crude fibre. Crude fibre was calculated used following formula:

$$\text{Crude fibre (\%) on dry matter basis} = \frac{a-c}{a} \times 100$$

Where,

a = weight of sample on dry matter basis (g)

b = weight of silica crucible before burning (g)

c = weight of silica crucible containing residue after burning (g)

vi. NFE (Nitrogen-free extract)

Nitrogen free extract in feed and faces was calculated using following formula:

NFE = Total dry matter – (CP+CF+ASH+EE)

vii. Digestibility of nutrients

During the end of metabolic trial analysis of feed and faeces sample data was taken from all 4 treatments of experiment. For the digestibility percentage of nutrient analysis according to standard method and the results were calculated by using following formula.

$$\text{Digestibility percentage} = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \times 100$$

3.5 Statistical analysis

The experiment was conducted in completely randomized design (CRD) and the data pertaining to various parameters obtained during growth, metabolic trial and egg production of the present study were analysed analysis of variance using as described by Snedecor and Cochran (1994).

de oiled soyabean cake

De oiled rice bran

Groundnut cake

Moringa leaf powder

Maize

Fig. 3.1: **Feed ingredients**

Plate 3.2: Japanese quail birds

Plate 3.3: Weighing of feed intake

Plate 3.5: Weighing of eggs

Plate 3.6: Metabolic trial

Plate 3.4: Weighing of body weight

Plate 3.7: Nutrient analysis

4. RESULTS

The results obtained in the present study entitled **"Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)"** are presented in this chapter and described with the help of appropriate tables and figures.

4.1 Chemical composition

The proximate nutrient composition of maize, groundnut cake (GNC), de oiled soyabean cake (DOSC), de oiled rice bran (DORB) and Moringa leaf powder (MOLP) used in this experiment is presented in Table 4.1. The proximate composition of MOLP which was used, contained 89.8% DM, 25.7% CP, 18.7% CF, 2.2% EE, 13.5% total ash and 39.9% NFE. The CP content in maize, GNC, DOSC and DORB was 9.2%, 42.3%, 47.4% and 12.85%, respectively.

4.2 Nutrient composition of ration

Nutrient composition of chick/grower and layer ration in different treatments are presented in Tables 4.2 and 4.3, respectively. Isonitrogenous and isocaloric ration was prepared for birds in all the treatments. The feed was prepared as per the recommendations of NRC (1994). The CP percent in chick/grower ration ranged from 23.08 to 23.60 among different treatments. The ME (kcal/kg) ranged from 2889 to 2898. Similarly, CP per cent in layer ration ranged from 19.01 to 19.36 and ME (kcal/kg) ranged from 2849 to 2875 among different treatments.

Table 4.1 Chemical composition of ingredients

Particular	MAIZE	GNC	DOSC	DORB	MOLP
DM	87.2	92.4	90.12	89.9	89.8
CP	9.2	42.3	47.4	12.85	25.7
CF	3.1	5.4	6.85	14.3	18.7
EE	5.2	9.1	1.98	1.6	2.2
Total ash	2.1	4.6	7.9	11.8	13.5
NFE	69.2	32.1	25.99	49.55	39.9

Table 4.2 Nutrient composition of chick/grower ration

Particular	T_1	T_2	T_3	T_4
DM	89.45	89.45	89.32	89.35
CP	23.56	23.6	23.08	23.41
CF	4.85	5.49	6.07	6.62
EE	4.71	4.6	4.33	4.28
Total ash	4.38	4.78	5.15	5.47
NFE	51.95	51.51	51.72	51.1
ME (kcal/kg)	2896	2889	2898	2895

Table 4.3 Nutrient composition of layer ration

Particular	T_1	T_2	T_3	T_4
DM	89.33	89.28	89.2	89.23
CP	19.01	19.36	19.14	19.28
CF	5.22	5.34	5.55	5.69
EE	4.77	4.61	4.38	4.33
Total ash	4.42	4.66	4.97	5.21
NFE	54.94	54.87	54.97	54.6
ME (kcal/kg)	2849	2875	2863	2851

4.3 Feed intake and feed conversion ratio

4.3.1 Feed intake (g)

The data pertaining to feed intake of chicks from 1th week of age to 6th week of age at weekly interval is presented in Table 4.4 and Fig. 4.1. The data revealed that the difference in feed intake was non-significant at 1st week of age and thereafter significant difference was recorded among different treatments from 2nd to 6th week of age.

At 1st week of age feed intake was 4.33±1.45, 3.77±1.12, 3.67±0.72 and 4.00±1.15 g in T_1, T_2, T_3 and T_4, respectively. The differences among treatments were found non-significant. At 2th week of age feed intake was 10.00±0.57, 8.99±1.15, 9.30±0.35 and 9.83±0.60 g in T_1, T_2, T_3 and T_4, respectively. At 2nd week of age feed intake was significantly higher in T_1 and T_4 as compared to T_2 and T_3. The difference between T_1 and T_4 as well as between T_2 and T_3 was non-significant. At 3rd week of age feed intake was 16.60±1.80, 13.83±0.16, 14.35±0.20 and 14.67±0.33 g in T_1, T_2, T_3 and T_4, respectively. At 3rd week of age feed intake was significantly highest in T_1 as compared to rest of the treatments. The difference between T_2, T_3 and T_4 was found non-significant. At 4th week of age feed intake was 15.66±0.66, 12.00±0.57, 14.33±0.33 and 15.33±0.33 g in T_1, T_2, T_3 and T_4, respectively. At 4th week of age feed intake was significantly highest in T_1 while, significantly lowest feed intake was recorded in T_2. The difference in feed intake between T_3 and T_4 was found non-significant. At 5th week of age feed intake was 21.33±0.88, 16.67±0.88, 19.00±1.52 and 20.00±2.50 g in T_1, T_2, T_3 and T_4, respectively. At 5th week of age feed intake was significant highest in T_1 while, significantly lowest feed intake was recorded in T_2. The difference in feed intake between T_3 and T_4 was found non-significant. At 6th week of age feed intake was 19.67±1.45, 18.67±0.88, 19.00±2.08 and 19.33±2.33 g in T_1, T_2, T_3 and T_4, respectively. At 6th week of age feed intake was significantly highest in T_1 as compared to rest of the treatment groups except T_4. Significantly lowest feed intake was observed in T_2 as compared to rest of the treatment groups except T_3. However, the difference in feed intake between T_1-T_4, T_3-T_4 and T_2-T_3 was found to be statistically non-significant. The total feed intake up to 6th week of age was 615.27±25.98, 519.33±12.02, 559.40±16.31 and 584.14±28.89 g in T_1, T_2, T_3 and T_4, respectively. The total feed intake was significantly lowest in T_2 as compared to rest of the treatment groups except T_3. The difference in feed intake between T_1, T_3 and T_4 as well as between T_2 and T_3 was found non-significant.

4.3.2 Feed conversion ratio

The data pertaining to feed conversion ratio of Japanese quail from 1st week of age to 6th week of age at weekly interval and average overall feed conversion ratio are presented in Table 4.5.

The feed conversion ratio in 1st week was 5.02±1.56, 2.73±0.50, 3.95±0.64 and 4.43±1.07 in T_1, T_2, T_3 and T_4, respectively. In 1st week FCR was significantly lowest in T_2 and significantly highest in T_1. The difference in FCR between T_3 and T_4 was found non-significant. In 2th week FCR was 4.42±0.51, 3.34±0.15, 3.92±0.33 and 4.32±0.33 in T_1, T_2, T_3 and T_4, respectively. In 2th week significantly highest FCR was observed T_1 as compared to rest of the treatment groups except in T_4 while, significantly lowest feed intake was found in T_2. The difference between T_1 and T_4 as well as between T_3 and T_4 was found non-significant. In 3th week FCR was 3.70±0.52, 2.60±0.36, 2.90±0.29 and 3.04±0.13 in T_1, T_2, T_3 and T_4, respectively. In 3th week significantly highest FCR was observed T_1 while, significantly lowest FCR was observed in T_2 except T_3. The difference between T_3 and T_4 as well as between T_2 and T_3 was found non-significant. At 4th week of age FCR was 3.24±0.39, 2.19±0.09, 2.80±0.10 and 3.14±0.36 in T_1, T_2, T_3 and T_4, respectively. The significantly lowest FCR was in T_2 and significantly higher in T_1 and T_4 as compared to rest of the treatment groups. The difference between T_1 and T_4 was found non-significant. At 5th week of age FCR was 4.77±1.41, 3.10±0.44, 3.91±0.22 and 4.38±0.52 in T_1, T_2, T_3 and T_4, respectively. The significantly lowest FCR in T_2 and significantly higher in T_1 and T_4 as compared to rest of the treatment groups. The differences between T_1 and T_4 as well as T_3 and T_4 were found non-significant. In 6th week feed conversion ratio was 5.16±1.07, 3.84±0.67, 4.38±0.59 and 5.01±0.75 in T_1, T_2, T_3 and T_4, respectively. In 6th week feed conversion ratio was significantly lowest in T_2 and significantly higher in T_1 and T_4. The difference between T_1 and T_4 was found non-significant. The overall feed conversion ratio was 4.23±0.02, 2.95±0.08, 3.54±0.03 and 3.91±0.10 in T_1, T_2, T_3 and T_4, respectively.

The overall feed conversion ratio was significantly lowest in T_2. Significantly highest overall FCR was found in T_1 as compared to rest of the treatment groups except T_4. The difference in overall FCR between T_1 and T_4 was small and found statistically non-significant.

4.4 Growth rate

4.4.1 Weekly body weight

The data pertaining to body weight of Japanese quail from day-old of age to 6th week of age at weekly interval is presented in Table 4.6. The data revealed that the difference in body weight was significant among different treatments at all stage of growth except at day-old age, which was found non-significant.

The mean body weight of chicks at day-old age ranged from 9.50±0.20 to 11.00±0.26 g among different treatment groups and the difference was found statistically non-significant. The mean body weight at 1st week of age ranged from 15.54±0.24 to 20.66±0.97 g among different treatment groups. At 1st week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight at 2nd week of age was 31.39±1.38, 39.49±1.31, 33.22±2.30 and 32.12±1.21 g in T_1, T_2, T_3 and T_4 groups, respectively. At 2nd week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight at 3rd week of age ranged from 62.79±2.06 to 76.73±3.91 g among different treatment groups. At 3rd week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight at 4th week of age was 96.67±4.41, 115.00±1.73, 103.67±2.33 and 100.00±1.52 g in T_1, T_2, T_3 and T_4 groups, respectively. At 4th week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight at 5th week of age was 128.00±3.21, 152.67±5.20, 137.67±3.75 and 132.00±2.30 g in T_1, T_2, T_3 and T_4 groups, respectively. At 5th week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight at 6th week of age was 154.67±5.23, 186.67±4.80, 168.00±4.35 and 159.00±3.51 g in T_1, T_2, T_3 and T_4 groups, respectively. At 6th week of age the mean body weight was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant.

4.4.2 Weekly body weight gain

The data pertaining to body weight gain of Japanese quail from 1st to 6th week of age at weekly interval is presented in Table 4.7. The data revealed that the difference in body weight gain was significant among different treatment groups from 1th to 6th week of age.

The mean body weight gain at 1st week of age was 6.04±0.16, 9.66±0.98, 6.49±0.22 and 6.32±0.75 g in T_1, T_2, T_3 and T_4 groups, respectively. At 1st week of age the body weight gain was significantly highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight gain at 2th week of age was 15.85±1.39, 18.83±2.15, 16.60±1.95 and 15.93±0.78 g in T_1, T_2, T_3 and T_4 groups, respectively. At 2th week of age the body weight gain was significantly ($P<0.05$) highest in T_2 followed by T_3 and lowest was found in T_1 and T_4. The difference in body weight gain between T_1 and T_4 was found non-significant. The 3th week body weight gain ranged from 31.40±3.00 to 37.24±4.68 g among different treatment groups. At 3rd week of age the body weight gain was significantly highest in T_2 and lowest in T_1 as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant. The 4th week body weight gain was 33.88±2.55, 38.27±2.21, 35.78±1.27 and 34.15±3.35 g in T_1, T_2, T_3 and T_4 groups, respectively. At 4th week of age the body weight gain was significantly highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The 5th week body weight gain was 31.33±7.17, 37.67±3.48, 34.00±3.05 and 32.00±3.60 g in T_1, T_2, T_3 and T_4 groups, respectively. At 5th week of age the body weight gain was significantly highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant. The mean body weight gain at 6th week of age was 26.67±7.44, 34.00±6.42, 30.33±3.52 and 27.00±2.08 g in T_1, T_2, T_3 and T_4 groups, respectively. The data revealed that the body weight gain in 6th week of age was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. Significantly lowest body weight gain was trend in T_1 as compared to rest of the treatment groups except T_4. The difference in body weight gain between T_1 and T_4 as well as between T_3 and T_4 was found non-significant. The mean overall body weight gain was 145.16±5.07, 175.66±4.54, 157.86±4.53 and 149.13±3.51 g in T_1, T_2, T_3 and T_4 groups, respectively. The data revealed that the overall body weight gain was significantly ($P<0.05$) highest in T_2 as compare to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant.

4.5 Egg production performance

An age at first egg (days), body weight at first egg (g) and weight of first egg (g) of Japanese quail fed diets containing T_1 (control), T_2 (T_1+5% Moring Leaf Powder), T_3 (T_1+10% Moringa Leaf Powder) and T_4 (T_1+15% Moringa Leaf Powder) up to 14 weeks of age are presented in Table 4.8.

Table 4.8 Effect of feeding Moringa leaf powder on age at first egg(days), body weight at first egg (g) and weight of first egg(g)

Treatment	Age at first egg (days)	Body weight at first egg (g)	Weight of first egg (g)
T_1	$45.33^{a} \pm 0.33$	$178.33^{c} \pm 3.28$	8.07±0.08
T_2	$42.33^{c} \pm 0.66$	$216.00^{a} \pm 2.64$	8.23±0.05
T_3	$43.67^{bc} \pm 0.33$	$194.33^{b} \pm 5.60$	8.12±0.10
T_4	$45^{ab} \pm 0.57$	$184^{bc} \pm 3.46$	8.17±0.12
CD 5%	1.63	12.80	NS

Figures bearing different superscripts in a column differ significantly (P<0.05) from each other

The age at first egg was significantly higher in T_1 (control) group as compared to rest of the treatment groups except T_4 (15% Moringa Leaf Powder). The lowest age at first egg was found in T_2 (42.33±0.66 days) as compared to rest of the treatment groups except T_3. The difference in age at first egg between T_1 and T_4, T_3 and T_4 as well as between T_2 and T_3 was found non-significant.

The mean body weight at first egg was 178.33±3.28, 216.00±2.64, 194.33±5.60 and 184±3.46 g in T_1, T_2, T_3 and T_4 groups, respectively. The data revealed that the body weight at first egg was significantly highest in T_2 and significantly lower in T_1 followed by T_3 and T_4. The difference between T_3 and T_4 as well as T_1 and T_4 was found non-significant.

The difference in weight of first egg among different treatment group was found non-significant.

4.5.1 Egg number (Hen day egg production %)

Egg number (Hens Day Egg Production) of Japanese quail fed diets containing control (T_1), T_1+5% Moring Leaf Powder (T_2), T_1+10% Moringa Leaf Powder (T_3) and T_1+15% Moringa Leaf Powder (T_4) from 7th to 14th week of age is presented in Table 4.9.

The egg number (HDEP%) differed significantly (P<0.05) among different treatment groups from 8th week to 14th week of age. The difference in egg number in 7th week was non-significant among different treatment groups. In 8th week egg number was significantly highest (53.78±0.43) in T_2 and lowest in control group (45.66±0.03) as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant. In 9th week egg number was significantly highest (57.51±1.09) in T_2 and lowest in control group (48.86±1.17) as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant. The mean data of egg number in 10th week was significantly highest (60.13±0.73) in T_2 and lowest in control group (51.83±0.34) as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant. The mean data of egg number in 11th week was significantly highest (62.86±0.31) in T_2 and lowest in control group (56.52±0.73) as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant. In 12th week egg number was significantly highest (66.21±0.28) in T_2 and lowest in T_3 and control group (60.56±0.17) as compared to rest of the treatment groups. The difference between T_1 and T_3 was found non-significant. The mean data of egg number in 13th week was significantly highest (73.43±0.17) in T_2 as compared to rest of the treatment groups. Significantly lowest egg number was found in T_1 as compared to rest of the treatment groups except T_4. The difference between T_3 and T_4 as well as T_1 and T_4 was found non-significant. The mean data of egg number in 14th week was significantly highest (77.06±0.25) in T_2 and lowest in control group (68.92^c±1.79) as compared to rest of the treatment groups. The difference between T_3 and T_4 was found non-significant.

4.6 Nutrient utilization

A metabolic trial was conducted at 6th week of age for one week with three days collection period to study the digestibility. The data pertaining to nutrient utilization during the metabolic trial is presented in Table 4.10.

The dry matter intake (DMI) in quail was 17.06±0.26, 15.89±0.38, 16.54±0.23 and 17.22±0.19 g in T_1, T_2, T_3 and T_4, respectively. DMI was significantly highest in T_4 as compared to rest of the treatment groups except T_1. Significantly lowest DMI was observed in as T_2. The difference between T_1 and T_4 as well as T_1 and T_3 was found non-significant.

The digestibility coefficient of dry matter (DM) was 77.34±0.25, 79.19±0.19, 78.52±0.38 and 78.03±0.33 in T_1, T_2, T_3 and T_4, respectively. The digestibility coefficient of dry matter was significantly highest in T_2 followed by T_3 and T_4 while, lowest DM digestibility coefficient was found in T_1. The difference between T_3 and T_4 was found non-significant.

The crude protein intake (CPI) was 4.02±0.16, 3.75±0.08, 3.82±0.21 and 4.03±0.11 g in T_1, T_2, T_3 and T_4, respectively. The crude protein intake (CPI) was significantly higher in T_1 and T_4 and significantly lower CPI was found in T_2 and T_3. The difference between T_1 and T_4 as well as T_2 and T_3 was found non-significant.

The crude protein (CP) digestibility coefficient was 68.11±0.61, 70.23±0.85, 69.04±0.22 and 68.87±0.42 in T_1, T_2, T_3 and T_4 groups, respectively. The crude protein digestibility coefficient was significantly ($P<0.05$) highest in T_2 as compared to rest of the treatment groups. The difference among T_1, T_3 and T_4 was found non-significant.

The crude fibre intake (CFI) was 0.83±0.06, 0.87±0.01, 1.00±0.05 and 1.14±0.02 g in T_1, T_2, T_3 and T_4, respectively. The crude fibre intake was significantly highest in T_4 followed by T_3 and significantly lowest CFI was found in T_1 and T_2. The difference between T_1 and T_2 was found non-significant.

The crude fibre digestibility coefficient was 26.44±0.37, 27.71±0.66, 27.34±0.29 and 26.67±0.30 in T_1, T_2, T_3 and T_4, respectively. The crude fibre digestibility coefficient was significantly higher in T_2 and T_3 and significantly lower in T_1 and T_4. The difference between T_2 and T_3 as well as T_1 and T_4 was found non-significant.

The ether extract intake (EEI) was 0.80±0.06, 0.73±0.12, 0.72±0.05 and 0.74±0.02 g in T_1, T_2, T_3 and T_4 groups, respectively. The ether extract intake was significantly ($P<0.05$) highest in T_1 as compared to rest of the treatment groups. The difference among T_2, T_3 and T_4 was found non-significant.

The ether extract digestibility coefficient was 75.91±0.38, 77.34±0.22, 76.78±0.21 and 76.05±0.16 in T_1, T_2, T_3 and T_4, respectively. The ether extract digestibility coefficient was significantly higher in T_2 and T_3 and significantly lower in T_1 and T_4. The difference between T_2 and T_3 as well as T_1 and T_4 were found non-significant.

The nitrogen free extract intake (NFEI) was 8.86±0.04, 8.18±0.11, 8.55±0.06 and 8.80±0.14 g in T_1, T_2, T_3 and T_4 groups, respectively. The nitrogen free extract intake was significantly ($P<0.05$) higher T_1 and T_4 followed by T_3 and significantly lowest in T_2. The difference between T_1 and T_4 was found non-significant.

The NFE digestibility coefficient was 68.09±0.46, 72.74±0.28, 71.64±0.32 and 70.69±0.16 in T_1, T_2, T_3 and T_4 groups, respectively. The NFE digestibility coefficient was significantly highest in T_2 and lowest in T_1. The difference in NFE digestibility coefficient between T_3 and T_4 was found non-significant.

Table 4.4 Effect of feeding Moringa leaf powder on feed intake (g/bird/day)

Treatments/Weeks	1st	2nd	3rd	4th	5th	6th	Total intake
T_1	4.33±1.45	10.00^{a}±0.57	16.60^{a}±1.80	15.66^{a}±0.66	21.33^{a}±0.88	19.67^{a}±1.45	615.27^{a}±25.98
T_2	3.77±1.12	8.99^{b}±1.15	13.83^{b}±0.16	12.00^{c}±0.57	16.67^{c}±0.88	18.67^{c}±0.88	519.33^{b}±12.02
T_3	3.67±0.72	9.30^{b}±0.35	14.35^{b}±0.20	14.33^{b}±0.33	19.00^{b}±1.52	19.00^{bc}±2.08	559.40^{ab}±16.31
T_4	4.00±1.15	9.83^{a}±0.60	14.67^{b}±0.33	15.33^{b}±0.33	20.00^{b}±2.50	19.33^{ab}±2.33	584.14^{a}±28.89
CD 5%	NS	0.51	0.91	0.50	1.19	0.63	62.72

Figures bearing different superscripts in a column differ significantly ($P<0.05$) From each other

Table 4.5 Effect of feeding Moringa leaf powder on weekly feed conversion ratio

Treatments/Weeks	1st	2nd	3rd	4th	5th	6th	Overall FCR
T_1	5.02^{a} ±1.56	4.42^{a} ±0.51	3.70^{a} ±0.52	3.24^{a} ±0.39	4.77^{a} ±1.41	5.16^{a} ±1.07	4.23^{a} ± 0.02
T_2	2.73^{c} ±0.50	3.34^{c} ±0.15	2.60^{c} ±0.36	2.19^{c} ±0.09	3.10^{c} ±0.44	3.84^{c} ±0.67	2.95^{c} ± 0.08
T_3	3.95^{b} ±0.64	3.92^{b} ±0.33	2.90^{bc} ±0.29	2.80^{b} ±0.10	3.91^{b} ±0.22	4.38^{b} ±0.59	3.54^{b} ± 0.03
T_4	4.43^{b} ±1.07	4.32^{ab} ±0.33	3.04^{b} ±0.13	3.14^{a} ±0.36	4.38^{ab} ±0.52	5.01^{a} ±0.75	3.91^{a} ±0.10
CD 5%	0.53	0.45	0.26	0.31	0.63	0.43	0.41

Figures bearing different superscripts in a column differ significantly ($P<0.05$) from each other

Table 4.6: Effect of feeding Moringa leaf powder on weekly body weight (g)

Treatments/Weeks	Day old	1st	2nd	3rd	4th	5th	6th
T_1	9.50±0.20	15.54^{b} ±0.24	31.39^{b} ±1.38	62.79^{b} ±2.06	96.67^{b} ±4.41	128.00^{b} ±3.21	154.67^{b} ±5.23
T_2	11.00±0.26	20.66^{a} ±0.97	39.49^{a} ±1.31	76.73^{a} ±3.91	115.00^{a} ±1.73	152.67^{a} ±5.20	186.67^{a} ±4.80
T_3	10.13±0.18	16.62^{b} ±0.40	33.22^{b} ±2.30	67.89^{b} ±1.23	103.67^{b} ±2.33	137.67^{b} ±3.75	168.00^{b} ±4.35
T_4	9.87±0.26	16.19^{b} ±0.4	32.12^{b} ±1.21	65.85^{b} ±2.18	100.00^{b} ±1.52	132^{b} ±2.30	159^{b} ±3.51
CD 5%	NS	1.94	5.26	8.29	8.96	12.52	15.20

Figures bearing different superscripts in a column differ significantly ($P<0.05$) from each other

Table 4.7 Effect of feeding Moringa leaf powder on weekly body weight gain (g)

Treatments/Weeks	1^{st}	2^{nd}	3^{rd}	4^{th}	5^{th}	6^{th}	Overall
T_1	6.04^{b} ±0.16	15.85^{c} ±1.39	31.40^{c} ±3.00	33.88^{b} ±2.55	31.33^{b} ±7.17	26.67^{c} ±7.44	145.16^{b}±5.07
T_2	9.66^{a} ±0.98	18.83^{a} ±2.15	37.24^{a} ±4.68	38.27^{a} ±2.21	37.67^{a} ±3.48	34.00^{a} ±6.42	175.66^{a}±4.54
T_3	6.49^{b} ±0.22	16.60^{b} ±1.95	34.66^{b} ±3.28	35.78^{b} ±1.27	34.00^{b} ±3.05	30.33^{b} ±3.52	157.86^{b}±4.53
T_4	6.32^{b} ±0.75	15.93^{c} ±0.78	33.73^{b} ±1.11	34.15^{b} ±3.35	32^{b} ±3.60	27.00^{bc} ±2.08	149.13^{b}±3.51
CD 5%	1.17	1.24	2.03	2.45	3.22	3.35	14.75

Figures bearing different superscripts in a column differ significantly ($P<0.05$) from each other

Table 4.9: Effect of feeding Moringa leaf powder (*Moringa oleifera*) on egg production (HDEP%)

Treatment/ Week	7	8	9	10	11	12	13	14
T_1	46.53±0.49	45.66^{c} ±0.03	48.86^{c} ±1.17	51.83^{c} ±0.34	56.52^{c} ±0.73	60.56^{c} ±0.17	67.93^{c} ±0.28	68.92^{c} ±1.79
T_2	51.56±0.40	53.78^{a} ±0.43	57.51^{a} ±1.09	60.13^{a} ±0.73	62.86^{a} ±0.31	66.21^{a} ±0.28	73.43^{a} ±0.17	77.06^{a} ±0.25
T_3	48.63±1.55	49.11^{b} ±0.79	53.41^{b} ±0.34	55.86^{b} ±0.98	59.16^{b} ±0.81	60.56^{c}±0.31	70.33^{b} ±0.28	73.11^{b} ±1.79
T_4	47.93±1.84	47.87^{b} ±0.53	51.65^{b} ±0.37	54.16^{b} ±0.80	60.32^{b} ±0.37	63.35^{b} ±0.43	69.86^{bc} ±1.36	71.89^{b} ±1.01
CD 5%	NS	1.74	2.78	2.49	1.97	1.07	2.35	2.89

Figures bearing different superscripts in a column differ significantly (P<0.05) from each other

Table 4.10 Effect of supplementation MOLP on digestibility during growth of Japanese quail

Particulars	**T_1**	**T_2**	**T_3**	**T_4**	**CD 5%**
DMI (g/bird/day)	17.06^{ab} ±0.26	15.89^{c} ±0.38	16.54^{b} ±0.23	17.22^{a} ±0.19	0.56
Dig. DMI (g/bird/day)	13.19^{a} ±0.13	12.58^{b} ±0.24	12.99^{a} ±0.09	13.44^{a} ±0.17	0.27
DM Dig. Cof.	77.34^{c} ±0.25	79.19^{a} ±0.19	78.52^{b} ±0.38	78.03^{b} ±0.33	0.61
CPI (g/bird/day)	4.02^{a} ±0.16	3.75^{b} ±0.08	3.82^{b} ±0.21	4.03^{a} ±0.11	0.18
Dig. CPI (g/bird/day)	2.74^{a} ±0.04	2.63^{b} ±0.03	2.64^{b} ±0.02	2.78^{a} ±0.06	0.07
CP Dig. Cof.	68.11^{b} ±0.61	70.23^{a} ±0.85	69.04^{b} ±0.22	68.87^{b} ±0.42	1.14
CFI (g/bird/day)	0.83^{c} ±0.06	0.87^{c} ±0.01	1.00^{b} ±0.05	1.14^{a} ±0.02	0.11
Dig. CFI (g/bird/day)	0.22^{b} ±0.05	0.24^{b} ±0.02	0.27^{ab} ±0.08	0.30^{a} ±0.01	0.05
CF Dig. Cof.	26.44^{b} ±0.37	27.71^{a} ±0.66	27.34^{a} ±0.29	26.67^{b} ±0.30	0.45
EEI (g/bird/day)	0.80^{a} ±0.06	0.73^{b} ±0.12	0.72^{b} ±0.05	0.74^{b} ±0.02	0.05
Dig EEI (g/bird/day)	0.61 ±0.07	0.57 ±0.06	0.55 ±0.04	0.56 ±0.03	0.06
EE Dig. Cof.	75.91^{b} ±0.38	77.34^{a} ±0.22	76.78^{a} 0.21	76.05^{b} ±0.16	0.69
NFEI (g/bird/day)	8.86^{a} ±0.04	8.18^{c} ±0.11	8.55^{b} ±0.06	8.80^{a} ±0.14	0.23
Dig. NFEI (g/bird/day)	6.03^{a} ±0.08	5.95^{b} ±0.05	6.13^{a} ±0.12	6.22^{a} ±0.09	0.11
NFE Dig. Cof.	68.09^{c} ±0.46	72.74^{a} ±0.28	71.64^{b} ±0.32	70.69^{b} ±0.16	1.03

Figures bearing different superscripts in a column differ significantly ($P<0.05$) from each other

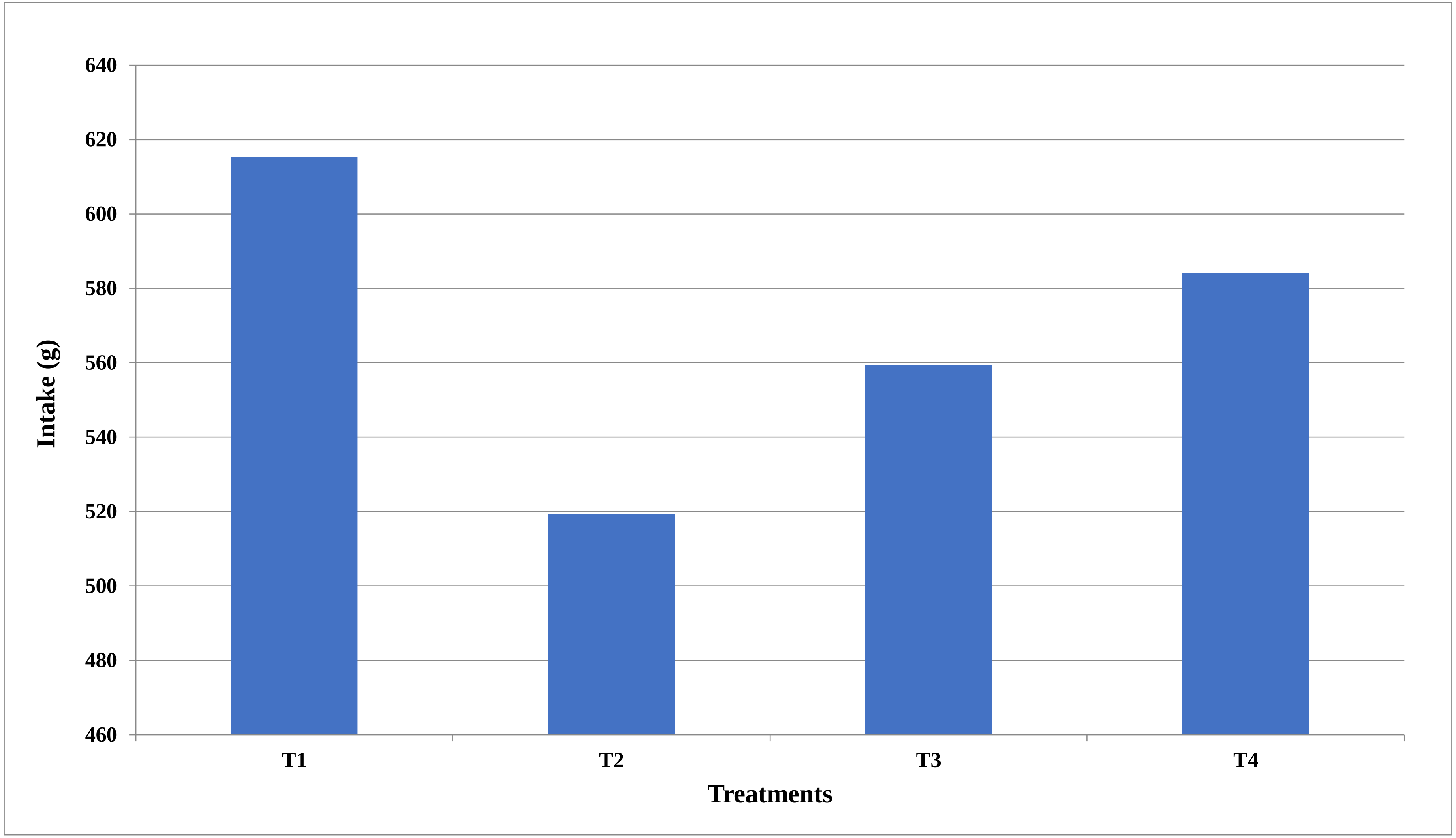

Fig.4.1 Effect of feeding Moringa leaf powder on total feed intake (g/bird/day)

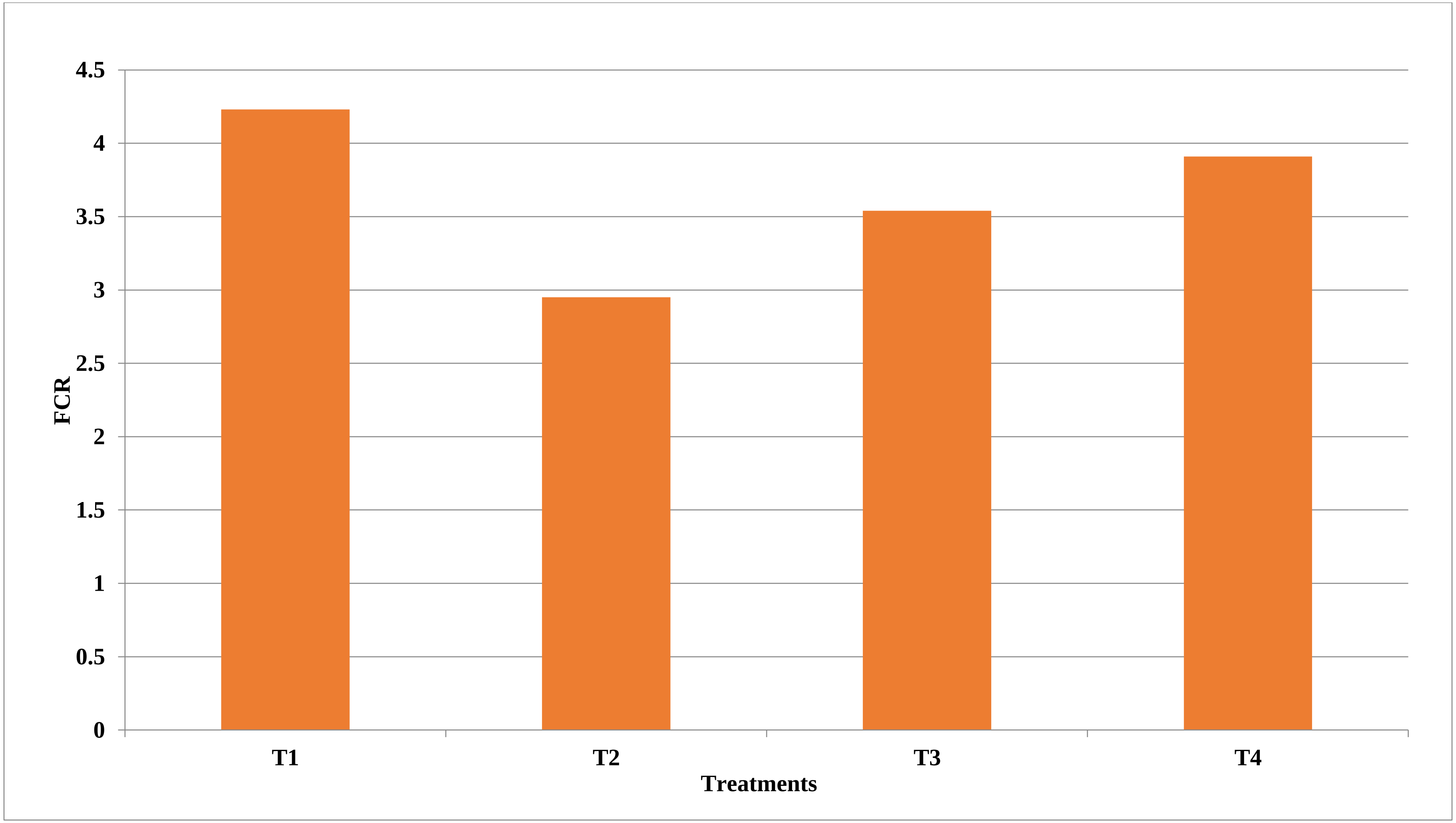

Fig. 4.2 Effect of feeding Moringa leaf powder on over all feed conversion ratio

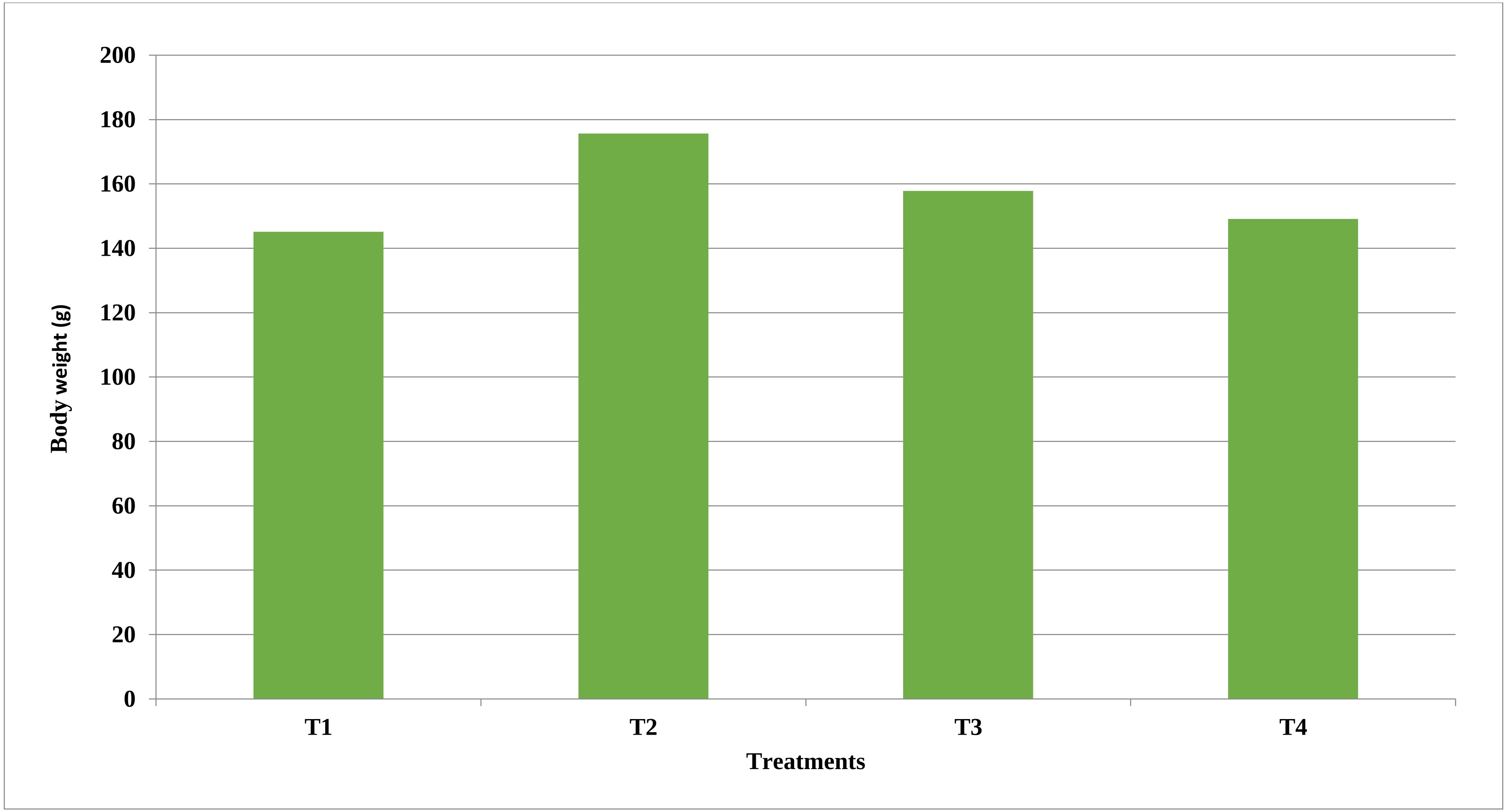

Fig. 4.3 Effect of feeding Moringa leaf powder onoverall body weight gain (g)

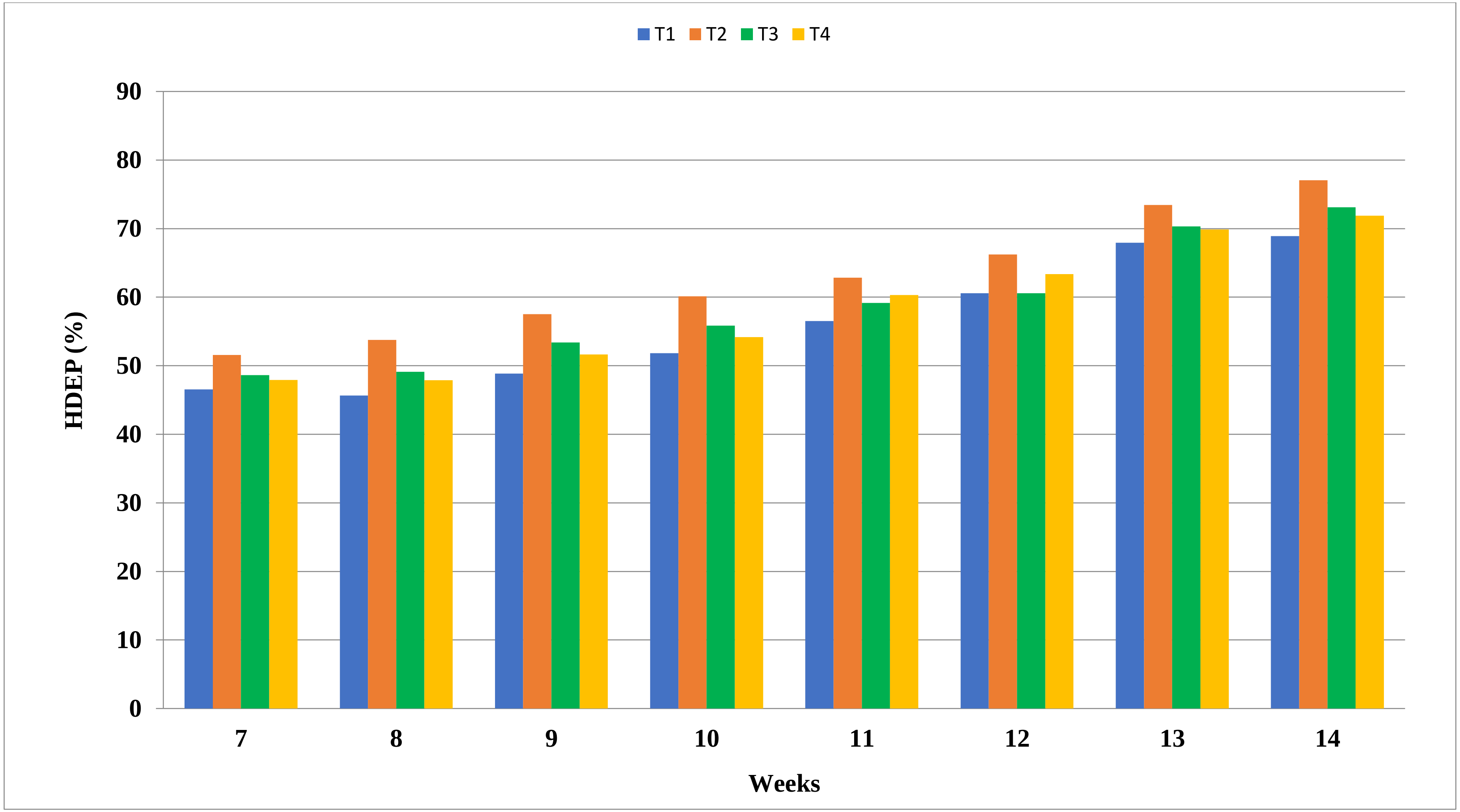

Fig. 4.4 Effect of Moringa Leaf powder on egg number (HDEP %)

5. DISCUSSION

The present investigation entitled "The Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)" was conducted during September, 2021 to January, 2022. The results obtain in the present investigation have been discussed under the following sub-heads:

5.1 Nutrient composition of ration

The chick/grower and layer ration were formulated as per the recommendation by NRC (1994). Isocaloric and isonitrogenous rations were made in all the treatment groups. The CP content of chick/grower and layer ration were 23.56, 23.6, 23.08 and 23.41 and 19.01, 19.36, 19.14 and 19.28% in T_1, T_2, T_3 and T_4, respectively. The CP content ration used in present study is similar to that reported by Pirzado *et al*. (2016), Suwarta and Suryani (2019) and Hassan *et al.* (2022). The CF content in layer ration is similar to that reported by Hassan *et al*. (2022).

The ME content of chick/grower and layer ration was 2896, 2889, 2898 and 2895 and 2849, 2875, 2863 and 2851 (kcal/kg) in T_1, T_2, T_3 and T_4, respectively. The ME (kcal/kg) content of chick/grower and layer ration in present study is in close agreement with the reports of Mousa *et al*. (2017).

5.2 Chemical composition of MOLP

The data revealed that *Moringa oleifera* Leaf Powder (MOLP) contain 89.8, 25.7, 18.7, 2.2, 13.5 and 39.9 percent dry matter, crude protein, crude fibre, ether extract, total ash and nitrogen free extract, respectively which is in close agreement with the findings Oduro (2008), Nuhu (2010) and Nihad *et al*. (2016). However Nihad *et al*. (2016) obtained little less value for ash percent.

Gupta *et al.* (1989) also reported similar values for crude protein and ash as 26.4 and 12%, respectively. In addition, Kakengi *et al*. (2003) found that *Moringa oleifera* leaves meal contained 86% DM, 29.7l% crude protein, 22.5% crude fibre, 4.38% ether extract. Similarly, Oduro (2008) revealed that MOLP contained 27.51% crude protein, 19.25% crude fiber 2.3% crude fat and 7.13% ash. However, Nuhu (2010) reported values of crude protein, ether extract, crude fiber and ash to be 29.55, 2.3, 19.5 and 7.13%, respectively. The variation in all these values reported by different authors would be due to agro-climatic conditions and maturity of the plant during the harvest Gakuya *et al.* (2014).

5.3 Feed Intake

The total feed intake up to 6th week of age was 615.27±25.98, 519.33±12.02, 559.40±16.31 and 584.14±28.8 g in T_1, T_2, T_3 and T_4, respectively. The data of the present study revealed that the feed intake of quails decreases when the *Moringa oleifera* Leaf Powder was included in the ration at 5% level but when the inclusion level increases beyond 5% the feed intake increases.

Jayanti *et al*. (2017) evaluated the effect of supplementation of *Moringa oleifera* leaf powder on growth performance of broilers and reported that slightly reduced feed intake was observed in all treatment groups compared to control. Ashong and Brown (2011) reported that chicks fed with 10% Moringa leaf meal, had the lowest feed intake and suggested that although incorporation of Moringa leaf meal may reduce intake this ingredient otherwise is not toxic to growing poultry. Gakuya *et al*. (2014) also reported that MOLM supplementation at levels above 7.5% decreased the feed intake in broiler chicks. These reports are in close agreement with the findings of present study. The decreased feed intake in birds fed on MOLP based diet may be due to the increased bulk (Olugbemi *et al*., 2010) and decreased palatability at higher levels of diet (Kakengi *et al*., 2003).

Similarly, Abbas and Ahmed (2012) found that, addition of *Moringa oleifera* undecorticated seeds powder (MOUSP) up to 1.5% in broiler chicks diet significantly increase in feed consumption. Alabi *et al*. (2017) observed that feed intake increases when aqueous *Moringa olifera* leaf extracts was added in the diets of broiler chicks. On the other hand, non-significant effect of supplementation of *Moringa oleifera* leaf meal (MOLM) on feed intake was observed by Castillo *et al.* (2018) in quails, Nkukwana *et al*. (2014), Okafor *et al*. (2014), Hermogenes *et al.* (2014) and Banjo (2012) in broiler chicken.

5.4 Feed conversion ratio

The overall feed conversion ratio was 4.23±0.02, 2.95±0.08, 3.54±0.03 and 3.91±0.10 in T_1, T_2, T_3 and T_4, respectively. The overall feed conversion ratio was significantly lowest in group of fed 5% *Moringa oleifera* leaf powder with the increase in the level of MOLP in the ration beyond 5% level, there is increase in the feed conversion ratio.

The results of the present study are in close agreement with the findings of Abu *et al*. (2020) who reported that feed conversion ratio of birds improved at level of 5% MOLM in the diet of birds. Kumar *et al.* (2018) reported that feed conversion ratio for 5% MOLM diet group was found to be significantly lower than all other treatment groups. Dey and Partha (2013) who reported that incorporation of MOL significantly improved feed efficiency of broiler chicken. Nkukwana *et al*. (2014) conducted a study to assess the effects of dietary *Moringa oleifera* leaf meal (MOLM) supplementation as a possible alternative to antibiotic growth promoters on bone breaking strength (BBS), tibia bone morphology and inorganic ash content in broiler chickens and found that FCR (feed : gain) was higher in MOLM-supplemented birds and lowest in control group. Similarly, Hassan *et al*. (2015) and Jayanti *et al*. (2017) observed improved feed conversion ratio as the level of MOLM increases in the basal diet of broiler chicks. Bidura *et al*. (2020) investigated the influence of *Moringa oleifera* on laying hen performance at 0, 2, 4 and 6% respectively and observed that the supplementation of 4-6% MOL in diet, increased feed efficiency. Onu and Aniebo (2011) conducted an experiment to determine the effect of inclusion of Moringa leaf meal at 0, 2.5, 5 and 7.5% level on FCR on broiler birds. FCR was significantly higher in all treatment groups as compared to control group.

However, Banjo (2012) reported that feed conversion was not significantly affected by inclusion of *Moringa oleifera* leaf meal in the diet of broiler chicks. Similarly, Hermogenes *et al.* (2014) also found that FCR was not significantly different ($P<0.05$) among different treatments.

These previous reports are in agreement with the findings of the present study. The improvement in feed conversion ratio may be attributed to rich content of nutrients in MOLM (Kakengi *et al*., 2003) and antimicrobial properties of Moringa (Fahey *et al*., 2001). Cinnamic acid, a phenolic acid present in *Moringa oleifera* leaves can cause increased glycolysis and increased utilization of glucose for energy production (Kasetti *et al*., 2012 and Mbikay, 2012), increased nutrient utilization by stimulating the production of digestive enzymes such as trypsin and amylase (Windisch *et al*., 2008). This may justify the better FCR in birds that were fed diets supplementated with MOLM.

5.5 Body weight and body weight gain

The 6th week the body weight (g/bird) was 154.67±5.23, 186.67±4.80, 168.00±4.35 and 159.00±3.51 in T_1, T_2, T_3 and T_4 groups, respectively. The mean overall body weight gain was 145.16±5.07, 175.66±4.54, 157.86±4.53 and 149.13±3.51 g in T_1, T_2, T_3 and T_4 groups, respectively. In the present study, body weight at 6th week of age and overall body weight gain was found highest in group of birds fed 5% MOLP (T_2) as compared to other treatments. Further increase in the levels of MOLP in diet reduces the body weight and body weight gain.

The results of present study are in close agreement with the findings of Onu and Aniebo (2011) who fed experimental diets consists of Moringa leaf meal at 0, 2.5, 5 and 7% level and reported that body weight gain of broilers significantly increased at 5% level. Bolu *et al*. (2013) also reported that a reduction in performance was observed as the level of MOLM increased beyond 5%. Broilers could be fed with diets containing *Moringa oleifera* leaf meal up to 5% inclusion level without deleterious effect on final live weight. The inclusion of leaf meals in broiler diets above 5% resulted in depressed performance which is in close agreement with the results obtained in the present study. Egu (2019) indicated that *Moringa oleifera* leaf meal enhances growth performance and weight gain in the treated birds compared to the control group with the best result at 8.00% inclusion level. Melesse *et al*. (2011) reported that chicks fed 4% *Moringa stenopetala* leaf meal (MSLM) showed higher AWG. Okafor *et al*. (2014) studied the effect of *Moringa olifera* leaf protein concentrate (MLPC) supplemented feed on nutritional parameters and growth performance of broiler chicks. Results showed that the birds in the test group recorded a higher daily weight gain compared with the control group. Hassan *et al*. (2015) conducted studies on effect of different levels of *Moringa olifera* leaves meal on productive performance of broiler chicks reared under heat stress conditions and the results showed that body weight gain was increased significantly as the level of MOLM increase. Minj *et al*. (2018) concluded that when MOLP was included at 1.5, 3 and 4.5% in quails diets, the best result on growth performance was shown by the birds fed on 1.5-3% MOLP than control diet. Nihad *et al*. (2016) supplemented broiler diet with *Moringa Oleifera* leaf meal (MOLM) at 0, 5, 10, 15, 20%, respectively. They found that supplementation of MOLM at 5% and 10% level in poultry diets resulted in higher body weight after 42 days. Sarker *et al*. (2017) conducted a study to investigate the effect of dietary Moringa leaf meal (MLM) as a natural alternative to antibiotic on the growth performance of broiler chicken and observed significant ($P<0.05$) effect on final body weight and weight gain in dietary supplementation of 1.5% MLM as compared to control group.

The improvement in body weight and body weight gain may be due to the antimicrobial abilities in *Moringa oleifera* leaves (Suarez *et al.*, 2005) and pharmacological properties (Mehta *et al.*, 2003). It also contained sufficient quantities of carotene, ascorbic acid, iron, methionine and cysteine which my enhance performance of birds (Makkar and Becker 1997). In addition, Yang *et al.* (2006) reported that Moringa is a potential plant that could be used to enhance immune response and to improve intestinal health of broiler chicken. Decreased weight gain at higher inclusion level may be attributed to higher crude fiber content, which may impair nutrient digestion and absorption (Onu and Aniebo, 2011).

5.6 The egg production performance

The age at first egg was earlier (42.33 days) in birds supplemented with 5% Moring Leaf Powder as compared to others. The body weight at first egg was significantly highest (216.00 g) in 5% Moring Leaf Powder diet. The weight of first egg ranged from 8.07 to 8.23 g among different treatments and non-significant difference among the treatments was observed. Differences in egg number (HDEP %) was significant among treatments from 8^{th} week to 14^{th} week of age. The data revealed that HDEP% was significantly highest in group of birds fed 5% MOLP (T_2) and lowest in control group (T_1). The HDEP% increases when the MOLP included in the diet up to 5% level but further increases in the level of MOLP in diet reduces the hen day egg production.

The results of the present study are in close agreement with Wei *et al*. (2016) who also reported that dietary supplementation of 5% MOLM increased the egg production. Ebenebe *et al*. (2013) also reported that supplementation of *Moringa oleifera* leaf meal at 5% level, resulted in significantly better egg production. Mousa *et al.* (2017) reported that the 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. In conclusion, MOLM up to 0.6% supplementation in the diet had better positive effects on egg production of Japanese quail. Voemesse *et* *al*. (2019) observed that feeding of *Moringa oleifera* leave meal (MOLM) showed a positive influence on egg production in laying hen. From the point of view of egg production, the use of 1% *Moringa oleifera* leaves in the diet of laying hens should be encouraging. Bidura *et al.* (2020) observed that the supplementation of 4-6% *Moringa oleifera* feeding (MOL) in diet, increased egg mass, yolk colour, shell thickness, Ca and Mg in the yolk. Abou-Elezz *et al.* (2012) reported that *Moringa oleifera* fresh leaves had higher egg laying rate and daily egg mass production. Improving laying parameters may be due to the effects of higher protein availability of *Moringa oleifera* (Kaijage *et al.*, 2015) and could relieve the harmful effects of tannins on egg production performance where it contains essential nutrients with anti-nutritional factors (Alikwe and Omotosho, 2003).

On the other hand, Abou-Elezz *et al.* (2011) reported 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 showed a quadratic trend with the increased level of *Moringa oleifera* leaf meal. Mabusela *et al*. (2018) reported that inclusion of *Moringa oleifera* whole seed meal (MOWSM) in layer diets reduced the rate of lay, egg weight and egg mass. Hermogenes *et al.* (2014) evaluated the effects of *Moringa oleifera* leaf powder and leaf meal on chicken layer and broiler diets. The results revealed that characteristics of egg and shell thickness of old layers were not significantly different. Talukdar *et al*. (2020) investigated the effect of feeding diets containing different levels of *Moringa oleifera* leaf meal on egg quality traits and reported that the egg quality traits like egg weight did not differ significantly.

5.7 Nutrient utilization

5.7.1 Nutrient digestibility

The dry matter intake (DMI) in quail was 17.06±0.26, 15.89±0.38, 16.54±0.23 and 17.22±0.19 g in T_1, T_2, T_3 and T_4, respectively. The crude protein intake (CPI) was 4.02±0.16, 3.75±0.08, 3.82±0.21 and 4.03±0.11 g in T_1, T_2, T_3 and T_4, respectively. The crude fibre intake (CFI) was 0.83±0.06, 0.87±0.01, 1.00±0.05 and 1.14±0.02 g in T_1, T_2, T_3 and T_4, respectively. The ether extract intake (EEI) was 0.80±0.06, 0.73±0.12, 0.72±0.05 and 0.74±0.02 g in T_1, T_2, T_3 and T_4 groups, respectively. The nitrogen free extract intake (NFEI) was 8.86±0.04, 8.18±0.11, 8.55±0.06 and 8.80±0.14 g in T_1, T_2, T_3 and T_4 groups, respectively. The digestibility coefficient of dry matter (%) was 77.34±0.25, 79.19±0.19, 78.52±0.38 and 78.03±0.33 in T_1, T_2, T_3 and T_4, respectively. The crude protein (CP) digestibility coefficient was 68.11±0.61, 70.23±0.85, 69.04±0.22 and 68.87±0.42% in T_1, T_2, T_3 and T_4 groups, respectively. The crude fibre (CF) digestibility coefficient was 26.44±0.37, 27.71±0.66, 27.34±0.29 and 26.67±0.30% in T_1, T_2, T_3 and T_4, respectively. The ether extract (EE) digestibility coefficient was 75.91±0.38, 77.34±0.22, 76.78±0.21 and 76.05±0.16% in T_1, T_2, T_3 and T_4, respectively. The NFE digestibility coefficient was 68.09±0.46, 72.74±0.28, 71.64±0.32 and 70.69±0.16% in T_1, T_2, T_3 and T_4 groups, respectively. It can be visualized from the data that DMI and CPI was leass in T_2 but digestibility coefficient of DM and CP was higher as compared to rest of the treatments. CFI was highest in T_4 but digestibility coefficient was higher in T_2 and T_3. EEI was highest in control (T_1) but digestibility coefficient was higher in T_2 and T_3. Similarly NFEI was lowest in T_2 but digestibility coefficient of NFE was highest in T_2 and lowest in control (T_1) group. It can be visualized from the data obtained in the present study that digestibility coefficient of nutrients increases when the MOLP was included in the diets at the level of 5% compared to control. However, further increases in the level of supplementation of MOLP reduces the digestibility.

Similarly, the results of present study are in close agreement with the findings of Meena *et al.* (2022) who reported that the digestibility coefficient of DM, EE, CP, CF and NFE were significantly higher in the birds fed 5% Moringa leaf powder as compared to control and 10% MLP. The improvement in crude protein digestibility for the birds fed dietary Moringa confirmed the results of live body weight and body weight gain. El-Badawi *et al.* (2014) found that supplementation of *Moringa oleifera* dry leaves of growing rabbits diets at 0.15 or 0.30% of the daily ration improved protein utilization efficiency. Similarly, Latif and Latif (2019) also reported that the greatest value of crud protein digestion coefficient recorded for birds fed 0.1% MOLP compared with other dietary treatment groups. However, birds fed all grade levels of MOLP in their diet had no significant ($P<0.05$) in other nutrients such as dry matter (DM), organic matter (OM), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE). Siti *et al.* (2019) reported that supplementation of 4-6% Moringa leaves powder in diets, increased feed digestibility of laying hens up to 32 weeks old.

Gakuya *et al*. (2014) concluded that *Moringa oleifera* leaf meal (MOLM) was good tolerated and could only be included in layer and chicken feed to levels up to 7.5% where higher levels affect digestibility.

However, Nkukwana *et al.* (2014) found that there were non-significant differences in apparent digestibility for ash, ether extract, crude fiber and crude protein. Gehad (2019) also revealed that there were no significant differences between dietary treatments in the digestibility coefficients for all nutrients of the diets when Japanese quail was fed on dietary MOLM at 0.2, 0.4 and 0.6%. Sebola *et al.* (2017) reported that Moringa leaves can be used as a functional feed ingredient in poultry diets without negative affecting nutrient utilization.

6. SUMMARY AND CONCLUSION

The present study was carried out to evaluate "The Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)" with following objectives.

i. To study the effect of feeding Moringa Leaf Powder on feed intake and feed conversion ratio of Japanese quail.

ii. To study the effect of feeding Moringa Leaf Powder on growth performance of Japanese quail.

iii. To study the effect of feeding Moringa Leaf Powder on egg production performance of Japanese quail.

The results of the research work are summarized as under:

The mean cumulative feed intake (g) decreased on feeding *Moringa oleifera* Leaf Powder in Japanese quails. The total feed intake was significantly lowest ($P<0.05$) in T_2 (5% MOLP) as compared to rest of the treatment groups except T_3 (10% MOLP). The lowest feed conversion ratio was observed in T_2 (2.95) followed by T_3 (3.54) and highest FCR was found in T_1 (4.23) and T_4 (3.91).

Inclusion of *Moringa oleifera* Leaf Powder at 5% level in the ration of quails improved the weekly body weight and overall weight gain at 6^{th} week of age. The birds supplemented with 5% MOLP reported to have 186.67 and 175.66 g cumulative body weight and overall body weight gain respectively, which was significantly higher ($P<0.05$) as compared to rest of the treatment groups.

Significantly highest age at first egg was found in T_1 (control) group as compared to rest of the treatment groups except T_4 (15% MOLP). Lowest age at first egg was found in T_2 (42.33 days) as compared to rest of the treatment groups except T_3. Body weight at first egg was found significantly highest in T_2 (216.00 g) as compared to rest of the treatment groups. The weight of first egg varied from 8.07 to 8.23 g among different treatment groups and difference was found to be non-significant.

The HDEP% was significantly highest in group of birds fed 5% Moringa Leaf Powder (MOLP) and lowest in control group. The HDEP% increases when the

Moringa Leaf Powder (MOLP) was included in the diet up to 5% level but further increases in the level of Moringa Leaf Powder (MOLP) in diet reduces the hen day egg production of Japanese quails.

The dry matter (DM) and crude protein (CP) intake was low in group of birds fed 5% Moringa Leaf Powder (MOLP) but the digestibility coefficient of DM (dry matter) and CP (crude protein) was significantly highest ($P<0.05$) as compared to rest of the treatment groups. Similarly, crude fibre digestibility coefficient was higher in T_2 (5% MOLP) and T_3 (10% MOLP) as compared to rest of the treatment groups. Ether extract intake was highest in control (T_1) but digestibility coefficient was higher in T_2 and T_3. Similarly, NFE intake was lowest in T_2 but digestibility coefficient of NFE was highest in T_2 and lowest in control (T_1) group.

From the results, it may be concluded that supplementation of 5% *Moringa oleifera* Leaf Lower of total feed is beneficial in improving weekly body weight, body weight gains, feed conversion efficiency, nutrient utilization and egg production performance of Japanese quails. Further inclusion of Moringa Leaf Powder beyond 5% level decreases the performance of quails.

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Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)

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ABSTRACT

The present study was conducted to assess the "Effect of Feeding Moringa Leaf Powder (*Moringa oleifera*) on Performance of Japanese Quail (*Coturnix japonica*)". One hundred eighty unsexed Quail chicks (day-old) were used in a completely randomized design in 4 treatments with 3 replications, each consisting of 15 chicks. The treatments were T_1: control, T_2: T_1+5% Moringa Leaf Powder (MOLP), T_3: T_1+10% Moringa Leaf Powder (MOLP), T_4: T_1+15% Moringa Leaf Powder (MOLP). In the present study body weight, body weight gain, feed intake, FCR, egg production performance and nutrient utilization parameters were measured to assess the effect of different treatments in Japanese quail. A total of 180 birds were used in the experiment divided into 4 treatment groups having 3 replication (15 birds) in each treatment.

The overall feed conversion ratio was significantly lowest in T_2 (2.95) followed by in T_3 (3.54) and highest in T_4 (3.91) and control group (4.23).

At 6^{th} week of age body weight (g) was significantly highest in T_2 (186.67) followed by T_3 (168.00) and T_4 (159.00) and significantly lowest in T_1 (154.67). Overall body weight gain was significantly highest in T_2 (175.66 g) followed by T_3 (157.86 g) and T_4 (149.13 g) and lowest in control group (145.16 g).

Lowest age at first egg and highest body weight at first egg was found in group fed on 5% Moringa Leaf Powder (MOLP) as compared to control group. The Hen Day Egg Production (HDEP%) was significantly highest in group of birds fed 5% Moringa Leaf Powder (MOLP) (T_2) and lowest in control group (T_1). The HDEP% increases when the Moringa Leaf Powder (MOLP) was included in the diet up to 5% level but further increases in the level of Moringa Leaf Powder (MOLP) in diet reduces the hen day egg production of Japanese quails.

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The data revealed that digestibility coefficient of DM (dry matter), CP (crude protein), CF (crude fibre), EE (ether extract) and NFE (nitrogen free extract) was significantly higher in the group of birds fed 5% Moringa Leaf Powder as compared to control.

It may be concluded that feeding of 5% Moringa Leaf Powder (MOLP) in the diets of quail improves the weekly body weight, body weight gain, feed conversion ratio, nutrient utilization and egg production parameters. Therefore, feeding of Moringa Leaf Powder (MOLP) at 5% level would be beneficial in terms of growth and egg production of Japanese quail.

जापानी बटेर (*कॉटर्निक्स जैपोनिका*) के प्रदर्षन पर मोरिंगा पत्ती चूर्ण (*मोरिंगा ओलीफेरा*) खिलाने का प्रभाव

कृष्ण गुर्जर *
शोधकर्ता

डॉ. लोकेश गुप्ता**
मुख्य सलाहकार

अनुक्षेपण

वर्तमान अध्ययन ''जापानी बटेर (*कॉटर्निक्स जैपोनिका*) के प्रदर्शन पर मोरिंगा पत्ती चूर्ण (*मोरिंगा ओलीफेरा*) खिलाने का प्रभाव'' का आंकलन करने के लिए आयोजित किया गया था। एक सौ अस्सी बिना निशेचन बटेर चुने (एक दिन की उम्र) को 4 उपचारों में 3 प्रकृति के साथ पूरी तरह से यादृच्छिक प्रारूप में इस्तेमाल किया गया था, प्रत्येक प्रतिकृति में 15 चूजें शामिल थे। टी$_1$: नियत्रंण, टी$_2$: टी$_1$ + 5% मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) टी$_3$: टी$_1$ + 10% मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.), टी$_4$: टी$_1$ + 15% मोरिंगा पत्ती चूर्ण, उपचार थे। वर्तमान अध्ययन में जापानी बटेर में विभिन्न उपचारों के प्रभाव का आंकलन करने के लिए शरीर का वजन, शरीर के वजन में वृद्धि, भोजन ग्रहण, भोजन रूपातंरण अनुपात, अण्डा उत्पादन प्रदर्शन और पौषक तत्वों के उपयोग के मापदण्डों को मापा गया। प्रत्येक उपचार में 3 प्रतिकृति (154 पक्षी) वाले 4 उपचार समूहों में विभाजित करके, प्रयोग में कुल 180 पक्षियों का उपयोग किया गया था।

समग्र भोजन रूपातंरण अनुपात टी$_2$ (2.95) में निम्नतम था। इसके बाद टी$_3$ (3.54) और टी$_4$ (3.91) और नियत्रंण समूह (4.23) में उच्चतम था।

6वें सप्ताह की उम्र में शरीर का वजन (ग्राम) टी$_2$ (186.67) में उच्चतम था इसके बाद टी$_3$ (168.00) और टी$_4$ (159.00) और टी$_1$ (154.67) में निम्नतम था। कुल शरीर भार में वृद्धि टी$_2$ (175.66) में उच्चतम था, इसके बाद टी$_3$ (157.86 ग्राम) और टी$_4$ (149.13 ग्राम) और नियत्रंण समूह (145.16 ग्राम) में निम्नतम था।

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नियत्रंण समूह की तुलना में 5% मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) पर खिलाये गये समूह में पहले अण्डे का समय सबसे कम उम्र और उच्चतम शरीर का वजन पाया गया। मुर्गी दिवस अण्डा उत्पादन (एच.डी.ई.पी %) 5% मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) (टी$_2$) खिलाये गये पक्षियों में उच्चतम था और नियत्रंण समूह (टी$_1$) में सबसे कम था। मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) को आहार में 5% स्तर तक शामिल करने पर एच.डी.ई.पी % बढ़ जाता है लेकिन आहार में मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) के स्तर में और वृद्धि होने से जापानी बटेर का मुर्गी दिवस अण्डा उत्पादन कम हो जाता है।

आंकडो से पता चला कि डी.एम (शुष्क पदार्थ), सीःपी, (कच्चा प्रोटीन), सी.एफ (कच्चा रेशा), ई.ई (ईथर एक्ट्रेक्ट) और एन.एफ.ई (नाइट्रोजन मुफ्त एक्ट्रेक्ट) का पाचन गुणांक, नियत्रंण समूह की तुलना में 5% मोरिंगा पत्ती चूर्ण खिलाये गये, पक्षियों के समूह में उच्चतम था।

यह निष्कर्ष निकाला जा सकता है कि बटेर के आहार में 5% मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) खिलाने से सप्ताहिक शरीर के वजन, शरीर के वजन में वृद्धि, भोजन रूपातंरण अनुपात, पोषक तत्वों की उपयोगिता और अण्डा उत्पादन मापदण्डों में सुधार होता है, इसलिए मोरिंगा पत्ती चूर्ण (एम.ओ.एल.पी.) को खिलाने से जापानी बटेर के विकास और अण्डा उत्पादन के मामले में 5% स्तर पर लाभदायक होगा।

Appendix I

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight (g)

Source of variation	Age (week)								
	Day old					1st			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	3.67	1.22	7.57	4.07	48.25	16.08	15.11	4.07
Error	**8**	1.29	0.16			8.52	1.06		
Total	**11**								

Appendix II

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight (g)

Source of variation	Age (week)								
	2nd					3rd			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	123.35	41.12	5.26	4.07	322.68	107.56	5.54	4.07
Error	**8**	62.53	7.82			155.32	19.42		
Total	**11**								

Appendix III

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight (g)

Source of variation	**Age (week)**								
	4^{th}					5^{th}			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	572.33	190.78	8.42	4.07	1051.58	350.53	8.22	4.07
Error	**8**	181.33	22.67			341.33	42.67		
Total	**11**								

Appendix IV

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight (g)

Source of variation	**Age (week)**				
	6^{th}				
	df	SS	MSS	F cal	F tab
Treatment	**3**	1811.58	603.86	9.83	4.07
Error	**8**	491.33	61.42		
Total	**11**				

Appendix V

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight gain (g)

Source of variation	**Age (week)**								
	1st					2nd			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	26.00	8.67	7.17	4.07	17.44	5.81	0.70	4.07
Error	**8**	9.68	1.21			66.13	8.27		
Total	**11**								

Appendix VI

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight gain (g)

Source of variation	**Age (week)**								
	3rd					4th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	52.33	17.44	0.54	4.07	36.66	12.22	0.67	4.07
Error	**8**	258.15	32.27			145.62	18.20		
Total	**11**								

Appendix VII

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight gain (g)

Source of variation	**Age (week)**								
	5^{th}					6^{th}			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	72.92	24.31	0.38	4.07	105.67	35.22	0.41	4.07
Error	**8**	515.33	64.42			681.33	85.17		
Total	**11**								

Appendix VIII

Analysis of variance for effect of feeding Moringa leaf powder on weekly body weight gain (g)

Source of variation	**Age (week)**				
	Overall gain				
	df	SS	MSS	F cal	F tab
Treatment	**3**	1653.30	551.10	9.25	4.07
Error	**8**	476.43	59.55		
Total	**11**				

Appendix IX

Analysis of variance for effect of feeding of Moringa Leaf Powder on feed intake (g/bird/day)

Source of variation	**Age (week)**								
	1st					2nd			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	0.79	0.26	0.07	4.07	1.96	0.65	0.41	4.07
Error	**8**	31.44	3.93			12.91	1.61		
Total	**11**								

Appendix X

Analysis of variance for effect of feeding of Moringa Leaf Powder on feed intake (g/bird/day)

Source of variation	**Age (week)**								
	3rd					4th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	13.15	4.38	1.68	4.07	24.67	8.22	11.02	4.07
Error	**8**	20.84	2.60			5.97	0.75		
Total	**11**								

Appendix XI

Analysis of variance for effect of feeding of Moringa Leaf Powder on feed intake (g/bird/day)

Source of variation	Age (week)								
	5th					6th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	34.92	11.64	1.52	4.07	1.67	0.56	0.06	4.07
Error	**8**	61.33	7.67			76.00	9.50		
Total	**11**								

Appendix XII

Analysis of variance for effect of feeding of Moringa leaf powder on feed intake (g/bird/day)

Source of variation					
	Total feed intake				
	df	SS	MSS	F cal	F tab
Treatment	**3**	14786.69	4928.90	3.42	4.07
Error	**8**	11524.19	1440.52		
Total	**11**				

Appendix XIII

Analysis of variance for effect of feeding of Moringa leaf powder on weekly feed conversion ratio

Source of variation	Age (week)								
	1st					2nd			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	9.00	3.00	0.94	4.07	2.35	0.78	2.06	4.07
Error	**8**	25.49	3.19			3.04	0.38		
Total	**11**								

Appendix XIV

Analysis of variance for effect of feeding of Moringa leaf powder on weekly feed conversion ratio

Source of variation	Age (week)								
	3rd					4th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	1.86	0.62	1.61	4.07	2.23	0.74	3.20	4.07
Error	**8**	3.07	0.38			1.86	0.23		
Total	**11**								

Appendix XV

Analysis of variance for effect of feeding of Moringa leaf powder on weekly feed conversion ratio

Source of variation	Age (week)								
	5th					6th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	8.39	2.80	1.45	4.07	4.64	1.55	0.88	4.07
Error	**8**	15.44	1.93			14.11	1.76		
Total	**11**								

Appendix XVI

Analysis of variance for effect of feeding of Moringa leaf powder on weekly feed conversion ratio

Source of variation	Age (week)				
	Overall FCR				
	df	SS	MSS	F cal	F tab
Treatment	**3**	2.71	0.90	59.38	4.07
Error	**8**	0.12	0.02		
Total	**11**				

Appendix XVII

Analysis of variance for effect of feeding Moringa leaf powder on age at first egg(days), body weight at first egg (g) and weight of first egg(g)

Source of variation	**Age (week)**												
	Age at first egg (days)					Body weight at first egg (g)				Weight of first egg (g)			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	16.92	5.64	7.52	4.07	2518.00	839.33	18.15	4.07	0.04	0.01	0.00	4.07
Error	**8**	6.00	0.75			370.00	46.25			32.00	4.00		
Total	**11**												

Appendix XVIII

Analysis of variance for effect of feeding Moringa leaf powder (*Moringa oleifera*) on egg production (HDEP%)

Source of variation	**Age (week)**								
	7th					8th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	40.44	13.48	3.37	4.07	105.75	35.25	8.81	4.07
Error	**8**	32.00	4.00			32.00	4.00		
Total	**11**								

Appendix XIX

Analysis of variance for effect of feeding Moringa leaf powder (*Moringa oleifera*) on egg production (HDEP%)

Source of variation	Age (week)								
	9th					10th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	118.17	39.39	9.85	4.07	110.49	36.83	9.21	4.07
Error	**8**	32.00	4.00			32.00	4.00		
Total	**11**								

Appendix XX

Analysis of variance for effect of feeding Moringa leaf powder (*Moringa oleifera*) on egg production (HDEP%)

Source of variation	Age (week)								
	11th					12th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	62.32	20.77	5.19	4.07	65.69	21.90	5.47	4.07
Error	**8**	32.00	4.00			32.00	4.00		
Total	**11**								

Appendix XXI

Analysis of variance for effect of feeding Moringa leaf powder (*Moringa oleifera*) on egg production (HDEP%)

Source of variation	Age (week)								
	13th					14th			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	46.73	15.58	3.89	4.07	102.34	34.11	8.53	4.07
Error	**8**	32.00	4.00			32.00	4.00		
Total	**11**								

Appendix XXII

Analysis of variance for effect of supplementation MOLP on digestibility during growth of Japanese quail

Source of variation	Age (week)												
	DMI					Dig. DMI				DM Dig. Cof.			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	15.75	5.25	1.31	4.07	7.47	2.49	0.70	4.07	5.49	1.83	0.46	4.07
Error	**8**	32.00	4.00			28.47	3.56			32.00	4.00		
Total	**11**												

Appendix XXIII

Analysis of variance for effect of supplementation MOLP on digestibility during growth of Japanese quail

Source of variation	Age (week)												
	CPI					Dig. CPI				CP Dig. Cof.			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	0.90	0.30	0.30	4.07	0.31	0.10	0.19	4.07	6.92	2.31	1.03	4.07
Error	**8**	8.00	1.00			4.47	0.56			18.00	2.25		
Total	**11**												

Appendix XXIV

Analysis of variance for effect of supplementation MOLP on digestibility during growth of Japanese quail

Source of variation	Age (week)												
	CFI					Dig. CFI				CF Dig. Cof.			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	0.04	0.01	0.46	4.07	0.00	0.00	0.20	4.07	3.11	1.04	0.66	4.07
Error	**8**	0.23	0.03			0.03	0.00			12.50	1.56		
Total	**11**												

Appendix XXV

Analysis of variance for effect of supplementation MOLP on digestibility during growth of Japanese quail

Source of variation	**Age (week)**											
	EEI					Dig. EEI				EE Dig. Cof.		
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	0.66	0.22	12.93	4.07	0.38	0.13	9.41	4.07	4.00	1.33	0.26	4.07
Error	**8**	0.14	0.02			0.11	0.01			40.50	5.06		
Total	**11**												

Appendix XXVI

Analysis of variance for effect of supplementation MOLP on digestibility during growth of Japanese quail

Source of variation	**Age (week)**												
	NFEI					Dig. NFEI				NFE Dig. Cof.			
	df	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab	SS	MSS	F cal	F tab
Treatment	**3**	2.67	0.89	1.15	4.07	0.39	0.13	0.23	4.07	35.47	11.82	6.21	4.07
Error	**8**	6.20	0.77			4.46	0.56			15.24	1.90		
Total	**11**												

Plagiarism Report

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