International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 14, Issue 7, 2022, pp.-11469-11471.
Available online at https://bioinfopublication.org/pages/jouarchive.php?id=BPJ0000217

Research Article

DIETARY INCLUSION OF *MORINGA OLEIFERA* LEAF MEAL IMPROVES EGG FERTILITY AND HATCHABILITY IN JAPANESE QUAILS (*Coturnix coturnix* japonica)

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Received: July 03, 2022; Revised: July 26, 2022; Accepted: July 27, 2022; Published: July 30, 2022

Abstract: The study was conducted on 360 adult Japanese quails (270 layers and 90 males) for a period of 16 weeks. The study comprised of five treatments based on five variable inclusions of *Moringa oleifera* (*M. oleifera*) leaf meal and had an equal number of birds. The treatments T_0 (control), $T_{0.5}$, T_1, $T_{1.5}$, and T_2 corresponded to 0, 0.5, 1, 1.5, and 2% inclusion levels of *M. oleifera* leaf meal. The study disclosed percentage egg fertility, hatchability on total eggs set basis, and hatchability on fertile eggs set basis in the range of 81.71-88.89, 71.39-80.05, and 87.02-90.14, respectively in birds fed *M. oleifera* leaf meal based diets than the control diet (81.13, 70.14 and 86.50, respectively). The best level of inclusion was 1% in the study. The study thus affirms that the 1% level of inclusion of *M. oleifera* leaf meal can be recommended in the diets of layers for enhanced egg fertility and hatchability.

Keywords: *Egg, Fertility, Hatchability, Japanese quail, Layer, Moringa oleifera leaf meal*

Citation: Yadav A., *et al*., (2022) Dietary Inclusion of *Moringa oleifera* Leaf Meal Improves Egg Fertility and Hatchability in Japanese Quails (*Coturnix coturnix* japonica). International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 14, Issue 7, pp.- 11469-11471.

Academic Editor / Reviewer: Dr Payal Jain, Manoj Kumar Sharma

Introduction

A blend of ingredients, inclusive of cereals, by-products, plant-based protein sources, fats, vitamins, mineral mixtures, feed additives, and fatty acids are required to prepare the diets of poultry. These ingredients have their influence on the quality of eggs and growth of embryos. The growth of embryo depends on variety of factors, including age and strain of hen, size of egg, and nutrients and mineral contents in egg. Adequate consumption of omega-3 fatty acids is crucially important for hens as these are responsible in development of brain and retina of foetus [1]. Leucaena and cassava leaf meal are so far known to be rich in omega-3 fatty acids, and therefore, are supplemented commonly across the globe in the diets of poultry [2]. In past few years, the presence of omega-3 fatty acids in Moringa leaves has been reported by few scientists [3 and 4], and therefore, it can be postulated that the dietary inclusion of Moringa leaves may also influence the quality of eggs and growth of embryos. At present countable works have been conducted on the fertility and hatchability of chicken eggs in relation to feeding of Moringa leaves. The availability of such works is even scantier in Japanese quails. Based on this framework, the present study was designed to examine the effect of *Moringa oleifera* leaf meal on the fertility and hatchability of Japanese quail eggs.

Materials and methods

The study was conducted at Poultry Demonstration and Experimental Unit of College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, Chhattisgarh, India in the financial year 2020-21 to 2021-22. The study consisted of 360 adult Japanese quails, of which, 270 were layers and 90 were male Japanese quails. The birds were selected on the basis of resemblance in live weight, and distributed arbitrarily and uniformly in sex ratio of 3:1 in five different treatments of 3 replicates each. Apart from the basal diet, the birds in treatments: T_0 (control), $T_{0.5}$, T_1, $T_{1.5}$ and T_2 were fed 0, 0.5, 1, 1.5 and 2% levels of *M. oleifera* leaf meal, respectively.

The diet was isonitrogenous and isocaloric, and formulated as per ICAR [5], and fed twice daily with provision of clean drinking water round the clock. The experimental diet was formulated as in [Table-1]. Besides, the proximate composition of *M. oleifera* leaf meal is also presented in [Table-1]. The birds were maintained on floors. The effect of feeding *M. oleifera* leaf meal on the fertility and hatchability of eggs was noted during 16 weeks of experiment, which continued from 7th week to 22nd week of egg laying. The fertility and hatchability percentage of eggs were calculated as below. The data were analysed though one-way Analysis of Variance and Duncan's Multiple Range Test using IBM SPSS statistics software version 22. Completely randomised design was employed in the experiment.

Fertility (%)= [(Total number of eggs hatched + total number of eggs not hatched but found fertile after breaking the shell) / Total number of eggs set in incubator] × 100

Hatchability on total eggs set basis (%)= (Total number of chicks hatched)/(Total number of eggs set in incubator) × 100

Hatchability on fertile eggs set basis (%)= (Total number of chicks hatched)/(Total number of fertile eggs) × 100

Preparation of *Moringa oleifera* leaf meal

M. oleifera leaf meal was prepared from the leaves of mature Moringa trees, harvested every 30-45 days from the farm located at Veterinary College, Durg, Chhattisgarh and adjoining areas. The leaves, following harvesting, were dried in open shade and aerated place on the plastic sheets for 4-5 days. The leaves were cleared from any debris encountered during the process of harvesting and drying. The dried leaves were then grinded in a hammer mill to prepare leaf meal, and stored in airtight bags to prevent possible contamination and moisture absorption from the environment.

Results and discussions

The details of percentage egg fertility, and hatchability on total eggs set and fertile eggs set basis are given in [Table-2].

Table-1 *Feed composition (%) of Japanese quail diets and proximate composition (%) of Moringa oleifera leaf meal*

Ingredients	T_0	$T_{0.5}$	T_1	$T_{1.5}$	T_2
Maize	60.600	60.400	60.200	59.800	59.500
Soybean meal	27.400	27.100	26.800	26.600	26.400
Soybean oil	1.900	1.900	1.900	2.000	2.000
Limestone powder	7.800	7.800	7.800	7.800	7.800
Di-calcium phosphate	1.300	1.300	1.300	1.300	1.300
Methionine	0.100	0.100	0.100	0.100	0.100
Salt	0.500	0.500	0.500	0.500	0.500
TM. Premix	0.100	0.100	0.100	0.100	0.100
Vitamin Premix	0.150	0.150	0.150	0.150	0.150
Vitamin B complex	0.015	0.015	0.015	0.015	0.015
Choline Chloride	0.050	0.050	0.050	0.050	0.050
Toxin binder	0.050	0.050	0.050	0.050	0.050
Vitamin C	0.010	0.010	0.010	0.010	0.010
Moringa oleifera leaf meal	0.000	0.500	1.000	1.500	2.000
Total	100.00	100.00	100.00	100.00	100.00
CP (%)	18.60	18.59	18.59	18.60	18.60
ME (Kcal/Kg)	2850	2850	2850	2850	2850
Calcium (%)	3.00	3.00	3.00	3.00	3.00
Phosphorus (%)	0.32	0.32	0.32	0.32	0.32
Lysine (%)	1.00	1.00	1.00	1.00	1.00
Methionine (%)	0.40	0.40	0.40	0.40	0.40
Proximate composition (%) of *M. oleifera* leaf meal					
Dry matter	90.19				
Crude protein	30.21				
Crude fibre	8.12				
Ether extract	8.56				
Total ash	11.86				
Nitrogen free extract	41.25				

Egg fertility

The average fertility of eggs improved significantly at P≤0.05 in T_1 and $T_{1.5}$ while improved insignificantly (P≥0.05) in $T_{0.5}$ and T_2 in comparison to T_0. The egg fertility was higher in T_1 followed by $T_{1.5}$, T_2 and $T_{0.5}$ in comparison to T_0. The per cent increase in egg fertility in $T_{0.5}$, T_1, $T_{1.5}$ and T_2 was 0.71, 9.56, 3.93 and 1.22, respectively in comparison to T_0. The results suggest that the egg fertility improved in birds fed Moringa leaf meal based diets than control diet (T_0), however, it was found to reduce beyond 1% inclusion level of leaf meal, but was still on higher side than T_0.

The present study resembled with the findings of Tutubalang (2019) [2] and Alebachew, *et al.,* (2016) [6] where significant improvement in fertility was documented in Moringa leaf meal included treatments by 2.20% and 5.55-16.66%, respectively in comparison to control. A similar report was generated where fertility improved at 0.20, 0.40 and 0.60% inclusion level of Moringa leaf meal in the range of 6.00-10.01% in comparison to control [7]. The increase in fertility of eggs was credited to higher levels of zinc, selenium and vitamin-E in Moringa leaves. Zinc helps with the protection of genetic material structure or DNA chromatin in the sperm nucleus which is an important structure for successful fertility [8 and 9]. Besides, selenium improves the storage time of sperm in hen's oviduct leading to increase in chances of successful fertility [10]. The increase in fertility of eggs was also credited to the reduction in total sperm abnormalities as a result of protective action of Moringa leaf extract on testes [11]. Besides, the non-significant results in $T_{0.5}$ and T_2 in the present study is confirmed with the investigations of Ashour, *et al.*, (2020) [12] and Raphael, *et al.,* (2015) [13] where fertility remained similar in Moringa leaf meal included treatments and control.

Egg hatchability on total eggs set basis

The average egg hatchability on total eggs set basis was significantly higher in T_1 and $T_{1.5}$ at P≤0.05 while was insignificantly (P≥0.05) higher in $T_{0.5}$ and T_2 in comparison to T_0. The hatchability of eggs on total eggs set basis was more in T_1 followed by $T_{1.5}$, $T_{0.5}$ and T_2 as compared to T_0. The per cent increase in hatchability on total eggs set basis in $T_{0.5}$, T_1, $T_{1.5}$ and T_2 was 2.23, 14.12, 8.04 and 1.78, respectively in comparison to T_0. The results suggest that the egg hatchability on total eggs set basis improved with dietary inclusions of *Moringa oleifera* leaf meal, which however reduced beyond 1% inclusion level of leaf meal.

The result of present study is supported with the outcomes of Ashour, *et al.*, (2020) [12] and Tutubalang (2019) [2] who stated an increase in hatchability of total eggs set in Moringa leaf meal included treatments by 2.51 and 6.45%, respectively in comparison to control. A similar result is presented by Mousa, *et al.*, (2017) [7] and N'nanle, *et al.,* (2017) [14] where improvement in hatchability of total eggs set in Moringa leaf meal included treatments was in the range of 9.09-15.91 and 3.34-36.34%, respectively in comparison to control. The increase in hatchability of eggs was ascribed to the high availability of energy during hatching process and higher levels of selenium, zinc and vitamin-E in Moringa leaves [10, 8 and 9]. The enhanced hatchability was also due to higher levels of vitamin-C in Moringa leaves. This was confirmed by the investigation where an improvement in hatchability as a result of ascorbic acid supplementation to diets of indigenous Venda hens was reported [15].

Table-2 *Per cent average egg fertility, and hatchability on total eggs set basis (HTESB) and fertile eggs set basis (HFESB) in Japanese quails (Mean ± SE) under different dietary treatments*

Traits	T_0	$T_{0.5}$	T_1	$T_{1.5}$	T_2
Fertility	81.13^a±0.58	81.71^{ab}±0.87	88.89^c±0.77	84.32^b±1.27	82.12^{ab}±1.07
HTESB	70.14^a±0.46	71.71^a±0.53	80.05^c±0.39	75.78^b±1.24	71.39^a±0.80
HFESB	86.50^a±0.70	87.84^{ab}±0.66	90.14^c±0.74	89.89^{bc}±0.73	87.02^a±0.89

a, b and c Mean with different superscript differ significantly within rows (P≤0.05)

Egg hatchability on fertile eggs set basis

The average hatchability of eggs on fertile eggs set basis improved significantly at P≤0.05 in T_1 and $T_{1.5}$ while improved insignificantly (P≥0.05) in $T_{0.5}$ and T_2 in comparison to T_0. The values were higher in T1 followed by $T_{1.5}$, $T_{0.5}$ and T_2 in comparison to T_0. The per cent increase in hatchability of eggs on fertile eggs set basis in $T_{0.5}$, T_1, $T_{1.5}$ and T_2 was 1.52, 4.21, 3.92 and 0.60, respectively in comparison to T_0. The results suggest that the egg hatchability on fertile eggs set basis improved with inclusion of *Moringa oleifera* leaf meal in basal diets, which however declined above 1% inclusion of Moringa leaf meal.

The present results are in agreement with the outcome of Tutubalang (2019) [2] and Mousa, *et al.*, (2017) [7] where Moringa leaf meal included treatment had 4.29 and 0.54-3.34% improvement, respectively in hatchability per fertile eggs set as compared to control. In a parallel report, an improvement in hatchability per fertile eggs set in Moringa leaf meal included treatments was documented in the range of 2.34-17.87% in comparison to control [6]. The increase in hatchability of eggs was ascribed to the higher levels of selenium, zinc, vitamin-E and vitamin-C in Moringa leaves [8-10 and 15]. Besides, Ashour, *et al.*, (2020) [12] claimed no variations in the hatchability of fertile eggs set in Moringa leaf meal included treatments and control, which confirms the non-significant results in $T_{0.5}$ and T_2 in the present study. In contrast to the present study, a variable finding highlighted decline in hatchability in Moringa leaf meal treatments by 18.27-18.71% in comparison to control [13].

The authors of the present study hypothesize better utilization of nutrients in Moringa leaf meal for improvement in fertility and hatchability of eggs up to 1% inclusion level of leaf meal. Above 1% inclusion level, the improvement in fertility and hatchability was less which could be attributed to the higher body weight, egg weight and double egg yolk percentage of birds. Whereas, eggs in control (T_0) exhibited lowest fertility and hatchability across the treatments possibly due to lack of Moringa leaf meal in diet. The reasons are in agreement with the investigation where improvement in fertility, and hatchability on total eggs set basis was less beyond 0.40% inclusion of Moringa leaf meal [7]. This was attributed to more increase in egg weight beyond 0.40% inclusion of Moringa leaf meal. Besides, an observation resulted in less improvement in hatchability on total eggs set basis beyond 0.50% inclusion of Moringa leaf meal and ascribed it to high levels of saponins in Moringa leaf meal beyond 0.50% inclusion that reduce utilisation of egg yolk sac as energy source, thus, limiting the energy production required for hatching process, resulting in reduced hatchability [14]. In addition, less improvement in hatchability on fertile eggs set basis was also recorded beyond 5.00% inclusion of Moringa leaf meal [6].

The decline in hatchability beyond a level of inclusion was also reported by Raphael, *et al.,* (2015) [13], who believed negative correlation between body weight of birds, and fertility and hatchability of eggs to be the major reason for reduction in hatchability.

Conclusion

The percentage fertility and hatchability of eggs were better in birds fed Moringa leaf meal based diets than the control diet. Among variable levels of inclusions of *M. oleifera* leaf meal, the best results were obtained in 1% level. Hence, a 1% level of inclusion of *M. oleifera* leaf meal could be recommended in the diets of layers for maximum output in terms of next-generation chicks.

Application of research: *Moringa oleifera* is a non-conventional feed resource that can improve fertility and hatchability of eggs.

Research category: Livestock and Poultry Management

Abbreviations: *M. oleifera – Moringa oleifera*
HTESB-Hatchability on total eggs set basis
HFESB-Hatchability on fertile eggs set basis

Acknowledgement / Funding: Authors are thankful to Livestock Production Management Department; Department of Animal Genetics and Breeding; Department of Instructional Livestock Farm Complex; College of Veterinary Science and Animal Husbandry, Dau Shri Vasudev Chandrakar Kamdhenu Vishwavidyalaya, Durg, 491001, India

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Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Durg, Chhattisgarh, India

Cultivar / Variety / Breed name: Japanese quail (*Coturnix coturnix* japonica)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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