Original Article

Nutrient Digestibility Coefficients and Carcass Evaluation of Japanese Quails to Aqueous Administration of Egg Lime Molasses Mixture

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ABSTRACT

Background: Japanese quails are cheap and easy to maintain, and they have the potential to bridge the gap in animal protein consumption shortage; however, their performance is highly dependent on the efficiency of nutrient utilization.

Objectives: This study aimed to determine the effect of an egg-lime-molasses mixture (ELM) administration on Japanese quails' nutrient utilization and carcass parameters.

Methods: The study was conducted at the poultry unit of the Babcock University farmhouse, Ilishan-Remo, Ogun State, Nigeria, from January to March 2022. ELM was prepared by placing fresh chicken eggs in a bowl, after which one liter of lime juice and 500 g of molasses were added and covered tightly for 10 days at 27 °C with a relative humidity of 61%. The solution was then blended. Two-hundred-day-old Japanese quails were assigned to one of five treatments in a completely randomized design. The birds were subdivided into four replicates of 10 birds each. The control (T1) had no administration of ELM; T2, T3, T4, and T5 had inclusion levels of 10, 20, 30, and 40 mL, respectively, all in 500 mL of water. Food and water were provided ad libitum. Data on performance characteristics, apparent digestibility coefficients, and carcass parameters were collected and analyzed using SPSS software, version 22 using descriptive statistics and analysis of variance.

Results: The results revealed that ELM did not significantly affect performance characteristics and carcass parameters (P>0.05). The values for digestible crude protein were significantly higher (P<0.05) in the control (62.99%). However, the lowest values were observed among birds administered the lowest dosages (10 and 20 mL ELM with 56.36% and 54.38%, respectively). Birds administered the lowest dosages of ELM (10 mL) had significantly higher (P<0.05) digestible lipids (55.50%) and digestible ash (23.41%) values. The birds administered 20 mL ELM had significantly least (P<0.05) values for digestible lipids (25.50%) and digestible ash (2.58%), while significantly highest (P<0.05) values were observed for the same group of birds for digestible crude fiber (41.05%) and digestible carbohydrates (38.79%).

Conclusion: The inclusion of ELM in the water of Japanese quails did not alter their growth performance or carcass parameters.

Keywords: Apparent digestibility coefficients, Dressing percentage, Growth, Nutrient utilization, Performance

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Introduction

A quail is a bird of the order Galliformes, which are considered primitive birds, and most species in this order are medium-sized birds. Their body forms and behavioral characteristics resemble domestic chickens (Bacha & Bacha, 2012; Ahmad Alabdallah et al., 2021; Abd AL-Zahra Ali et al., 2023). The production of quail meat and eggs in Nigeria's poultry industry is significantly lower than that of broiler and layer chickens. The market potential for quail is considerably limited compared to chicken. Although chicken products can be marketed throughout Nigeria, the market for quails is highly restricted. Quail eggs have gained popularity in certain regions, but quail meat is not yet widely embraced in Nigeria due to its small size, resulting in smaller carcasses. Consequently, farmers are less interested in quail farming due to its narrower market scope (Redoy et al., 2017).

Eggs are a significant source of proteins. A raw, freshly laid egg consists of approximately 76.1% water, 12.6% protein, 9.5% fat, 0.7% carbohydrates, and 1.1% ash (USDA National Nutrient Database for Standard Reference, Release 1, 2018). Furthermore, eggs are abundant in essential minerals, such as phosphorus, calcium, and potassium, and contain moderate levels of sodium (142 mg per 100 g of whole eggs) (Réhault-Godbert et al., 2019). They also provide essential trace elements, such as copper, iron, magnesium, manganese, selenium, and zinc (Réhault-Godbert et al., 2019), with egg yolk being the primary contributor to the supply of iron and zinc. These minerals and micronutrients present in eggs are fascinating, as deficiencies in certain elements, such as zinc, magnesium, and selenium, have been linked to conditions, such as depression, fatigue, and the development of pathological diseases (Wang et al., 2018; Habibnezhad Arabi et al., 2021). Eggs offer not only a highly nutritious food source but also contain various bioactive compounds, including lipids, vitamins, proteins, and hydrolytic peptides (Kovacs-Nolan et al., 2005; Abeyrathne et al., 2013; Andersen, 2015; Giansanti et al., 2015; Chang et al., 2018;), which hold significant importance in animal health.

Lime juice can be used because it is a good source of organic acids, including citric and ascorbic acids (Holden et al., 2005). According to Holden et al. (2005), lime juice also included certain biomolecules, such as flavonoids and carotenoids. Humans' digestion has been reported to be improved by lime juice *(Holden et al., 2005;* Marchione, 2015). Ndelekwute and Enyenihi (2017) concluded that lime juice may be used to disinfect poultry feed and suggested adding 2.0% to broiler diets.

According to Habibu et al. (2014), molasses contains various natural substances, including sucrose, glucose, fructose, raffinose, and other non-sugar components. Molasses is the end product obtained during the production of sucrose and involves the repeated processes of juice evaporation, crystallization, and centrifugation from sugarcane or sugar beets (Curtin, 1983). Cane molasses, a dark and viscous liquid, is abundant in soluble carbohydrates, vitamins, minerals, and other compounds (Mangwanda et al., 2021). Its mineral contents include iron, zinc, copper, manganese, potassium, sodium, and calcium. Additionally, it contains various vitamins from the vitamin B complex, such as thiamine, riboflavin, niacin, pantothenic acid, biotin, and choline. However, molasses lacks vitamin C and has low phosphorus content (Curtin, 1983).

Sugarcane molasses plays a crucial role in livestock nutrition due to its nutritive value, appetizing properties, and physical characteristics of its sugar content. Nevertheless, toxicity associated with high doses of molasses has been reported (Geremew Kassa et al., 2024). In poultry, molasses is commonly used as a binding agent in dry diets and as an energy source. It has also been administered to chickens via drinking water, Reddy et al. (1998) and Ndelekwute et al. (2010) noted. *Habibu et al. (2014)* observed that birds with molasses in their drinking water experienced a significantly higher weight gain. Adamnezhad and Ghalehkandi (2018) reported that feed supplementation had beneficial effects on small intestine morphometry characteristics in Japanese quails. The study was premised Consistent with the assertion of Gholipour-Shoshod et al. (2023) that plants and plant materials can be used as beneficial additives in poultry nutrition to improve growth performance. In their study, Akintunde et al. provided a proximate analysis of an egg-lime-molasses mixture (ELM), revealing its composition (Akintunde et al., 2023a). The analysis indicated the presence of moisture (19.60%), crude protein (15.20%), lipids (5.50%), ash (14.60%), crude fiber (9.60%), carbohydrates (35.20%), fatty acids (4.40%), and energy (1060.30 Kcal/100 kg). Phytochemical screening demonstrated that ELM contains alkaloids, flavonoids, glycosides, saponins, steroids, phenols, terpenoids, tannins, and anthraquinones. Quantitative evaluation of the phytochemicals revealed the following concentrations in ELM: Alkaloids (8.46 mg/100 g), flavonoids (2.30 mg/100 g), glycosides (0.08 mg/100 g), saponin (5.25 mg/100 g), steroids (0.22 mg/100 g), phenols (0.09 mg/100 g), terpenoids (0.56 mg/100 g), tannin (8.34 mg/100 g), and anthraquinones (1.60 mg/100 g). The vitamin analysis showed the presence of vitamin A (3.20 mg/100 g), vitamin B1 (280 mg/100 g), vitamin

B2 (880 mg/100 g), vitamin B3 (340 mg/100 g), vitamin C (15.40 mg/100 g), and vitamin E (0.015 mg/100 g). Mineral analysis revealed the presence of calcium (29.95%), magnesium (4.08%), potassium (23.20%), sodium (0.38%), phosphorus (6.90%), chlorine (0.30%), manganese (1.44 ppm), iron (3.60 ppm), aluminum (5.35%), titanium (2.10 ppm), and silicon (22.70 ppm). Based on these results, ELM is rich in various nutrients and phytochemicals, enabling it to exhibit multiple biological activities and serve as a natural alternative to antibiotics, particularly in monogastric animal production (Akintunde et al., 2023a).

In a study on the growth pattern and physiological response of Japanese quails to an aqueous solution of egg lime molasses mixture, Akintunde et al. (2024) concluded that the aqueous administration of egg lime molasses solution in the diet of Japanese quails had no detrimental effects on the growth pattern and physiological response. Akintunde et al. (2023b), also in a study on the administration of ELM to spermiogramic parameters of Japanese quails, observed that the administration of ELM did not alter growth parameters; however, birds that received 20 mL per 500 mL of water had the best reproductive parameters. Herbs possess many antioxidants; thus, their use in poultry diets can improve the quality of the final products (Salehi et al., 2024).

Little work has been conducted on the effects of molasses feeding on poultry performance. Molasses aid in improving muscle and heart health. It is rich in nutrients and acts as a mild laxative. Too much molasses can cause diarrhea, which can be beneficial if poisoning or an intestinal issue is suspected (Rahiman & Pool, 2016; Mordenti et al., 2021). The level of molasses inclusion is usually limited due to the risk of soft feces or diarrhea, which has been related to high levels of potassium and sodium; hence, a mixture of eggs, lime, and molasses is required. However, paucity of information is available, particularly regarding the response of Japanese quails to the administration of egg-lime-molasses solution on nutrient utilization and carcass quality.

Materials and Methods

Experimental site

This study was conducted at the Poultry Unit of Babcock University Farm House, Ilishan-Remo, Ogun State, Nigeria. Ilishan-Remo is in the rainforest zone of Nigeria, with an annual rainfall of approximately 1500 mm and a mean temperature of 27 ˚C.

Preparation of egg lime molasses solution

First, eggs were placed in water to ensure their freshness. Then they were placed in a bowl, after which one liter of lime juice and 500 g of molasses were added to the same bowl, covered tightly, and left for 10 days at a temperature of 27 ˚C and relative humidity of 61%. At the end of 10 days, the eggshells dissolved into the solution, which was then blended.

Experimental treatments

Five dietary treatments were administered to the rats. T1, the control, was not administered the egg lime molasses solution: T2, T3, T4, and T5 had 10, 20, 30, and 40 mL per 500 mL of water, respectively.

Management of experimental birds and design

A total of 200 day old Japanese quails were purchased from a local farmer in Lagos State, Nigeria. Before the arrival of the quails, the pens where the birds stayed during the experiment were washed, disinfected alongside the drinkers, feeders, and other equipment, and left to air-dry for two weeks. One-hundred watt electric bulbs were installed in the cages to provide heat and illumination at night for continuous feed intake. Feed and water were provided ad libitum throughout the experimental period.

Data collection

Performance parameters

Feed intake: The feed intake was calculated weekly. This was done by subtracting the amount of feed left in the feeder from the initial amount of feed given on the previous day as the feed intake for the day (Equation 1).

1. Feed intake (g)=Feed offered (g)–Feed leftover (g)

$$\text{Average feed intake/animal} = \frac{\text{Feed offered in (g)} - \text{Feed leftover (g)}}{\text{Total number of birds in the group}}$$

Weight gain

The weights of all birds in each replicate were measured at the beginning of each weighing week using a digital scale. Weight gain of the birds was measured at the end of every week during the experimental period.

Table 1. Gross composition for experimental starter and finisher diets (g/100 kg)

Ingredient	Starter	Finisher
Maize	48.00	59.00
Soybean meal	33.00	30.00
Wheat offal	6.00	5.00
Fish meal	4.00	-
Palm oil	-	3.00
Vegetable oil	4.00	-
Meat-bone meal	2.50	-
Limestone	1.00	-
Dicalcium phosphate	0.50	1.50
Oyster shell	-	1.00
Salt	0.40	0.20
Methionine	0.20	0.20
Lysine	0.10	0.05
Vitamin/mineral premix	0.30	-
Avatec	-	0.05
%CP	15.20	20.00
ME (Kcal/Kg)	3 162.29	3 193.80

CP: Crude protein; ME: Metabolizable energy.

Feed conversion ratio: This was calculated by dividing the total feed intake by total body weight (Equation 2).

$$2.\ \text{Feed conversion ratio (FCR)} = \frac{\text{Feed intake (g)}}{\text{Body weight (g)}}$$

Apparent digestibility coefficient

A digestibility trial was conducted in which feed intake and fecal output were recorded for seven days. Feces samples were oven-dried in the laboratory and analyzed to determine the apparent digestibility coefficients using the appropriate formulae for proximate composition (McDonald et al., 1999).

Carcass and visceral organ evaluation

Four birds were randomly selected from each treatment group for the carcass evaluation. The selected birds were starved overnight and their live weights were recorded. The birds were de-feathered after scalding, and their plucked weights were recorded. The birds were then eviscerated, and the eviscerated weight was recorded.

Statistical analysis

The collected data were subjected to variance analysis according to the SAS (2002) procedure. Significant differences between treatment means were determined using Duncan's multiple-range test (Duncan, 1955).

Results

Table 2 presents the growth performance of Japanese quails administered varying levels of an egg-lime molasses solution. The results showed that aqueous administration of egg-lime molasses did not significantly influence ($P>0.05$) any growth parameters measured.

Table 3 presents the digestibility coefficients and total digestible nutrients of Japanese quail administered with varying egg lime molasses solution levels. Significant differences ($P<0.05$) were observed among all treatments for all parameters (digestible crude protein, digestible lipids, digestible ash, digestible crude fiber, digestible carbohydrate, and digestible dry matter).

Table 2. Performance parameters of Japanese quails to administration of ELM

Parameters	Mean±SE				
	T1	T2	T3	T4	T5
Initial live weight (g)	7.07±0.12	6.87±0.19	6.80±0.18	6.93±0.15	6.87±0.06
Live weight (g)	149.75±8.06	156.00±15.15	169.00±19.16	140.67±11.67	146.00±8.21
Total feed intake (g)	700.89±106.83	501.72±95.09	775.52±259.87	484.43±103.12	659.54±20.72
Weight gain (g)	157.55±1.69	155.40±6.13	168.77±6.09	158.53±3.56	159.15±5.56
Mortality (%)	1.00±0.41	1.75±0.75	0.25±0.05	2.00±0.41	1.00±0.41
FCR	4.44±0.64	3.18±0.53	4.58±1.48	3.02±0.62	4.16±0.17

(P<0.05).

FCR: Feed conversion ratio.

For digestible crude protein (54.38%), digestible lipid (25.5%), digestible ash (2.58%), and dry matter (5.19%), birds administered 0.40 mL ELM per 500 mL water had the lowest values (P<0.05). Also, the birds in this treatment (0.40 mL ELM/500 mL of water) had significantly highest values (P<0.05) for digestible crude fiber (41.05%) and digestible carbohydrates (38.79%). However, significantly higher values (P<0.05) were observed for digestible lipids and ash by birds administered 0.2 mL ELM per 500 mL of water. In contrast, the highest value (P<0.05) of 62.99% was observed for birds in the control group.

Table 4 presents the carcass evaluation and visceral organ characteristics of Japanese quails. Table 4 signified no significant difference (P>0.05) in all parameters obtained.

Discussion

The results indicated that ELM administration did not significantly affect the growth performance parameters. The results of this study were at odds with those of Rahim et al. (1999) and Ndelekwute et al. (2010), who found that giving chicken molasses reduced their feed intake while increasing their live weight, which was consistent with the report of Al-Abdaly et al. (2023) that the physiological response of chickens is significantly different from that of quails. Since Japanese quails were used in this study, along with the addition of chicken eggs and lime to the molasses used as the test component, there may be changes in the results based on species. However, the present study's results were consistent with those of Habibu et al. (2014), who claimed that the administration of molasses through drinking water had no

Table 3. Digestibility coefficients and total digestible nutrient of Japanese quails administered egg lime molasses solution at finisher phase

Parameters	T1	T2	T3	T4	T5
DCP (%)	62.99±0.28[e]	56.36±0.14[b]	54.38±0.14[a]	57.20±0.14[c]	60.03±0.14[d]
DL (%)	45.50±0.50[c]	55.50±0.50[d]	25.50±0.50[a]	31.50±0.50[b]	55.50±0.50[d]
DASH (%)	18.45±0.20[c]	23.41±0.00[d]	2.58±0.20[a]	23.21±0.20[d]	14.48±0.20[b]
DCF (%)	34.88±0.31[c]	21.30±0.31[a]	41.05±0.31[d]	28.70±0.31[b]	34.88±0.31[c]
DC (%)	29.35±0.56[a]	32.15±0.37[ab]	38.79±0.47[b]	31.68±0.47[ab]	30.75±0.47[ab]
DDM (%)	8.33±0.05[e]	7.49±0.05[c]	5.19±0.05[a]	6.24±0.05[b]	8.02±0.05[d]

[a, b, c, d, e] Significantly different within groups.

Abbreviations: DCP: Digestible crude protein; DL: Digestible lipids; DASH: Digestible ash; DCF: Digestible crude fiber; DC: Digestible carbohydrate; DDM: Digestible dry matter.

Table 4. Carcass evaluation of Japanese quails administered egg lime molasses solution at finisher phase

Parameters	T1	T2	T3	T4	T5
Live weight (g)	149.75± 8.06	156.00±15.15	169.00±19.16	140.67±11.67	146.00±8.21
Bled weight (g)	146.00±8.16	152.25±15.07	166.25±19.08	138.67±11.68	142.50±8.26
Defeathered (g)	131.97±3.42	129.88±11.34	151.95±16.48	133.13±13.01	130.86±5.83
Eviscerated (g)	115.72±2.08	115.07±10.86	133.00±12.36	117.00±12.10	116.50±4.09
Visceral organs (g)	16.25±2.73	14.81±2.86	18.95±4.54	16.13±2.04	14.36±2.53
Dressed weight (g)	101.99±2.79	103.08±10.61	123.50±10.82	106.00±12.34	106.00±3.03
Dressing Percent (%)	68.76±4.39	66.60±5.26	73.81±3.62	75.00±3.09	73.25±4.37

P>0.05=No significant difference.

impact on feed consumption. These outcomes were also consistent with those reported by Edache et al. (2015), who found no significant differences in Japanese quails-fed processed sweet potato meal diets. However, two years later, Olayinka et al. (2022) observations found significant differences in Japanese quails-fed diets with varying amounts of garlic meal. The results on growth performance were similar to those of the use of molasses in broiler diets, as reported by Khalid et al. (2007), who found that adding molasses had little to no negative effects on feed efficiency.

Additionally, according to Ndelekwute et al. (2019), lemon juice supplementation had no discernible effect on the feed-to-gain ratio of broiler chickens during the starter and finisher phases. The current study supports the results of Onibi et al. (2009) and Fadlalla et al. (2010), who found that garlic powder had no discernible impact on bird body weight gain and feed conversion ratio.

To evaluate the usefulness of diets for maximizing quail performance without affecting quail health, it is critical to determine the nutrient digestibility of quail diets. The results of the present study showed that the administration of ELM in drinking water significantly influenced the digestibility coefficients of Japanese quails. Birds administered 40 mL ELM/500 mL of water had the best digestibility coefficients for carbohydrates and fiber and the lowest protein, lipids, and ash values. These results are consistent with those of Hernandez et al. (2004), who demonstrated that including plant extracts in the diet improves the digestibility of nutrients throughout the digestive tract. The observed enhancement in total tract digestibility, particularly for carbohydrates, in Japanese quails supplemented with different levels of ELM can be attributed to the high energy content of molasses.

This result is consistent with the research conducted by Hildalgo et al. (2009) on vinasse, a byproduct of molasses fermentation. Dressing percentage is commonly used to assess carcass yield (Akintunde and Toye, 2014; Akintunde et al., 2021). Similarly, these results are consistent with those of Elsiddig et al. (2022), who reported no significant differences in the dressing percentage of broiler chickens across various groups that received different levels of molasses. Also, the results were consistent with those of Ghanim Kesab et al. (2023), who observed no significant differences in the carcass parameters of different strains of Japanese quails fed different levels of metabolizing energy. However, the results of this study differ from the findings of Yesilbag et al. (2022), who observed significant differences in the dressing percentage of quails fed different natural feed additives. The contrast could result from the mixture of egg, lime, and molasses and the variation in the mode of administration to the birds. The observed improvement in the total tract digestibility, especially for carbohydrates, may be attributed to the high energy values of molasses.

Conclusion

Including aqueous administration of egg lime molasses solution in the drinking water of Japanese quails did not alter the growth performance and carcass parameters, but administration of 20 mL per 500 mL of drinking water would be most appropriate for effective energy digestibility.

Ethical Considerations

Compliance with ethical guidelines

The use and care of animals followed the guidelines of the National Research Council (NRC) for research.

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Authors' contributions

Conceptualization, design of the experiments, data analysis, writing the original draft: Adeyinka Oye Akintunde; Management of experimental animals, data collection and data management: Adeyinka Oye Akintunde, Oluwaseyi Esther Ogundipe, and Samuel Inioluwa Akeju; Visualization, review, editing and final approval: Lois Chidinma Ndubuisi-Ogbonna, Oluwaseyi Esther Ogundipe, Oluwaseun Adetayo Adewole and Rufus Olusegun Animashaun.

Conflict of interest

The authors declared no conflict of interest.

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References

Abd Al-Zahra Ali, R., Rasmi Huwait, A. J., Issa Abed, R., & Faisal Majeed, M. (2023). The histopathological and oxidative stress profiles in Japanese Quails (Coturnix japonica) induced by dietary lead. *Archives of Razi Institute, 78*(2), 523-530. [DOI:10.22092/ARI.2022.359352.2407]

Abeyrathne, E. D., Lee, H. Y., & Ahn, D. U. (2013). Egg white proteins and their potential use in food processing or as nutraceutical and pharmaceutical agents-A review. *Poultry Science, 92*(12), 3292–3299. [DOI:10.3382/ps.2013-03391] [PMID]

Akintunde, A. O., & Toye, A. A. (2014). Nutrigenetic effect of graded levels of Moringa oleifera seed meal on performance characteristics and nutrient retention in local and exotic chickens. *International Journal of Moringa and Nutraceutical Research (IJMNR), 1*, 56-73. [Link]

Akintunde, A. O., Toye, A. A., & Ademola, A. A. (2021). Effects of dietary Moringa Oleifera seed meal on obesity, liver and kidney functional parameters of local and exotic chickens. *Aceh Journal of Animal Science, 6*(3), 97 - 103. [Link]

Akintunde, A. O., Ndubuisi-Ogbonna, L. C., Olorunfemi, O. A., Ladele, M. M., Shobo, B. A., & Adewole, S. A., et al. (2023). Nutritional and ethno-medicinal potentials of egg-lime-molasses mixture in livestock production. *Asian Journal of Dairy and Food Research, 42*(3), 298-306. [DOI:10.18805/ajdfr.DRF-285]

Akintunde, A. O., Ndubuisi-Ogbonna, L.C. Olorunfemi, O. A.,, Ladele, M. M. Ojo, O. A. & Adewumi, A., et al. (2024). Growth Pattern and Physiological Response of Japanese Quails to Administered Aqueous Solution of Egg Lime Molasses Mixture. Agricultural Science Digest, 44(3),, 523-529. [Link]

Akintunde, A. O., Ndubuisi-Ogbonna, L. C., Ladele, M. M., Olorunfemi, O. A., Ojo, O. A., Oyewumi, S. O., ... & Akinboye, O. E. (2023). Spermiogramic parameters of Japanese quails (Coturnix coturnix japonica) to aqueous administration of egg lime molasses mixture. *Ovozoa: Journal of Animal Reproduction, 12*(2), 57-67. [Link]

Ahmad Alabdallah, Z., Norezzine, A., Anatolyevich Vatnikov, Y., Alekseevich Nikishov, A., Vladimirovich Kulikov, E., & Ravilievna Gurina, R., et al. (2021). Influence of different genders of Japanese quail on the functional state of kidneys. *Archives of Razi Institute, 76*(3), 667-680. [DOI:10.22092/ari.2021.355522.1694] [PMID]

Al-Abdaly, Y. Z., Alfathi, M. Y., & Al-Mahmood, S. S. (2023). Comparison of azithromycin toxicity in chickens and quails. *Iranian Journal of Veterinary Medicine, 17*(4, 321-332. [DOI:10.32598/ijvm.17.4.1005354]

AAndersen C. J. (2015). Bioactive egg components and inflammation. *Nutrients, 7*(9), 7889–7913. [DOI:10.3390/nu7095372] [PMID]

Bacha Jr, W. J., & Bacha, L.M. (2012). *Color atlas of veterinary histology*. New Jersey: John Wiley & Sons. [Link]

Chang, C., Lahti, T., Tanaka, T., & Nickerson, M. T. (2018). Egg proteins: Fractionation, bioactive peptides and allergenicity. *Journal of the Science of Food and Agriculture, 98*(15), 5547–5558. [DOI:10.1002/jsfa.9150] [PMID]

Curtin, L. V. (1983). *Molasses - general considerations*. West Des Moines, Iowa: National Feed Ingredients Association. [Link]

Duncan, D. (1955) Multiple Range and Multiple F Tests. *Biometrics, 11*(1), 1-42. [DOI:10.2307/3001478]

Edache, J. A., Tulen, C. D., Muiduudtai, R. U., & Yisa, A. G. (2021). Performance and carcass values of Japanese quails (Coturnix coturnix japonica) fed processed sweet potato (Ipomea batatas) meal diets. *Nigerian Journal of Animal Production, 42* (2), 45-57. [DOI:10.51791/njap.v42i2.2618]

Elsiddig, A. E. A., Elobeid, E. A. E., Abdelbagi, A. A., & Amin, A. E. (2022). Using of sugar cane molasses in broiler chickens production. *Journal of the Faculty of Science and Technology, 9*(2), 55 - 68. [DOI:10.52981/jfst.vi9 (2).2882]

Fadlalla, I. M. T., Mohammed, B. H., & Bakhiet, A. O. (2010). Effect of feeding garlic on the performance and immunity of broilers. *Asian Journal of Poultry Science*, 4(4), 182-189. [DOI:10.3923/ajpsaj.2010.182.189]

Geremew Kassa, M., Asemu, A. M., Belachew, M. T., Satheesh, N., Abera, B. D., & Alemu Teferi, D. (2024). Review on the application, health usage, and negative effects of molasses. *CyTA-Journal of Food, 22*(1). [DOI:10.1080/19476337.2024.2321984]

Ghanim Kesab, Y., Nasser Waleed, R., & Mahmood Khaleel, M. (2023). Effect of different levels of metabolizing energy on productive performance of two grower quail strains. *Archives of Razi Institute, 78*(2), 619–626. [PMID]

Gholipour-Shoshod, A., Rahimi, S., Zahraei Salehi, T., Karimi Torshizi, M. A., Behnamifar, A., & Ebrahimi, T. (2023). Evaluating the competitiveness of medicinal plants with antibiotics to control salmonella enterica serovar typhimurium in broiler chickens. *Iranian Journal of Veterinary Medicine, 17*(2), 155-166. [DOI:10.32598/ijvm.17.2.1005233]

Giansanti, F., Leboffe, L., Angelucci, F., & Antonini, G. (2015). The nutraceutical properties of ovotransferrin and its potential utilization as a functional food. *Nutrients, 7*(11), 9105–9115. [DOI:10.3390/nu7115453] [PMID]

Habibu, B., Ikira, N. M., Buhari, H. U., Aluwong, T., Kawu, M. U., & Yaqub, L. S., et al. (2014). Effect of molasses supplementation on live weight gain, haematologic parameters and erythrocyte osmotic fragility of broiler chickens in the hot-dry season. *International Journal of Veterinary Science, 3*(4), 181-188. [Link]

Habibnezhad Arabi, S., Moslemi, H. R., & Ghafari Khaligh, S. (2021). Comparative study of micro ostrich eggshell and hydroxyapatite onthe healing of bone defect created in the rat calvarium. *Iranian Journal of Veterinary Medicine, 15*(1), 16-26. [DOI:10.22059/ijvm.2020.294423.1005054]

Hernández, F., Madrid, J., García, V., Orengo, J., & Megías, M. D. (2004). Influence of two plant extracts on broilers performance, digestibility, and digestive organ size. *Poultry Science, 83*(2), 169–174. [DOI:10.1093/ps/83.2.169] [PMID]

Hidalgo, K., Rodríguez, B., Valdivié, M., & Febles, M. (2009). Utilización de la vinaza de destilería como aditivo para pollos en ceba. *Revista Cubana de Ciencia Agrícola, 43*(3), 281-284. [Link]

Holden, J. M., Bhagwat, S. A., Haytowitz, D. B., Gebhardt, S. E., Dwyer, J. T., & Peterson, J., et al. (2005). Development of a database of critically evaluated flavonoids data: Application of USDA's data quality evaluation system. *Journal of Food Composition and Analysis, 18*(8), 829-844. [DOI:10.1016/j.jfca.2004.07.002]

Khalid Seham, Kh.,, &, Omer, M. I. (2007). The response of broiler chicks to different dietary molasses levels. *ALbuhuth, 11* (1).

Kovacs-Nolan, J., Phillips, M., & Mine, Y. (2005). Advances in the value of eggs and egg components for human health. *Journal of Agricultural and Food Chemistry, 53*(22), 8421–8431. [DOI:10.1021/jf050964f] [PMID]

Mangwanda, T., Johnson, J. B., Mani, J. S., Jackson, S., Chandra, S., & McKeown, T., et al. (2021). Processes, challenges and optimisation of rum production from molasses - A contemporary review. *Fermentation, 7*(1), 21. [DOI:10.3390/fermentation7010021]

Marchione, V. (2015). Ten health benefits of drinking lime juice. Available from: [Link]

McDonald, P., Edwards, R. A., Greenhalgh, J. F. D., Morgan, C. A., Sinclair, L. A., & Wilkinson, R. G. (1999). *Animal Nutrition.* Harlow, England: Addision Wesley Longman. [Link]

Mordenti, A. L., Giaretta, E., Campidonico, L., Parazza, P., & Formigoni, A. (2021). A review regarding the use of molasses in animal nutrition. *Animals: An Open Access Journal from MDPI, 11*(1), 115. [DOI:10.3390/ani11010115] [PMID]

Ndelekwute, E. K., Uzegbu, H. O., Igwe, I. R., Nosike, R. J., Odoemelam, V. U., & Inyang, U. O. (2010). Effects of administration of molasses through drinking water on growth and conformation parameters of meat-type chicken. *Animal Production Research Advances, 6*(1), 30-34. [Link]

Ndelekwute, E. K., & Enyenihi, G. E. (2017). Lime juice as a source of organic acids for growth and apparent nutrient digestibility of broiler chickens. *Journal of Veterinary Medicine and Surgery, 1*(1), 1-5. [Link]

Ndelekwute, E. K., Assam, E. D., Unah, U. L., Assam, E. M., & Okonkwo, A. C. (2020). Antibacterial action and dietary effect of lemon juice on nutrient digestibility and growth performance of broiler chickens. *Nigerian Journal of Animal Production, 46*(2), 102 - 110. [DOI:10.51791/njap.v46i2.17]

Olayinka, O. I., Bawa, G. S., Abeke, F. O., & Afolayan, M. (2022). Growth performance, nutrient digestibility and carcass quality of Japanese quail (Coturnix coturnix japonica) fed diets containing graded levels of garlic (Allium sativum) meal. *Nigerian Journal of Animal Science, 24*(1), 190-200. [Link]

Onibi, G. E., Adebisi, O. E., Fajemisin, A. N., & Adetunji, A. V. (2009). Response of broiler chickens in terms of performance and meat quality to garlic (Allium sativum) supplementation. *African Journal of Agricultural Research, 4*(5), 511-517. [Link]

Rahim, A. G. A., Eiman, A. T. E., El-Bagir, N. M., & Haseeba, S. A. (1999). Effects of feeding different levels of sugar cane molasses to broiler chicks: feed intake, body weight gain, efficiency of feed utilization and dressing percentage. *Sudan Journal of Veterinary Science and Animal Husbandry, 38(*1-2), 93-101. [Link]

Rahiman, F., & Pool, E. J. (2016). The effect of sugar cane molasses on the immune and male reproductive systems using in vitro and in vivo methods. *Iranian Journal of Basic Medical Sciences, 19*(10), 1125–1130. [PMID]

Reddy, J. S., Yadav, K. R., & Mandal, A. B. (1998). Performance of broilers fed molasses through mash or drinking water. *Indian Journal of Poultry Science, 33*(1), 31-35. [Link]

Redoy, M. R. A., Shuvo, A. A. S., & Al-Mamun, M. (2017). A review on present status, problems and prospects of quail farming in Bangladesh. *Bangladesh Journal of Animal Science, 46*(2), 109-120. [DOI:10.3329/bjas.v46i2.34439]

Réhault-Godbert, S., Guyot, N., & Nys, Y. (2019). The golden egg: Nutritional value, bioactivities and emerging benefits for human health. *Nutrients.* 11(3), 684. [DOI:10.3390/nu11030684] [PMID]

Salehi, F., Partovi, R. and Seifi, S. (2024). Effect of Dietary Supplementation of Silybum marianum and Artichoke (Cynara scolymus L.) on Japanese Quail's carcass characteristics, oxidative stability, and quality of breast meat. *Iranian Journal of Veterinary Medicine, 18*(1), 87-96. [DOI:10.32598/ijvm.18.1.1005318]

USDA. (2018). *National Nutrient Database for Standard Reference, Release 1. U.S. Department of Agriculture.* Beltsville, MD, USA: Food Group: Dairy and Egg Products.

Wang, J., Um, P., Dickerman, B. A., & Liu, J. (2018). Zinc, Magnesium, Selenium and Depression: A Review of the Evidence, Potential Mechanisms and Implications. *Nutrients, 10*(5), 584. [DOI:10.3390/nu10050584] [PMID]

Yesilbag, D., Abdullahoglu, E., Urkmez, E., Acar, A. B. D. U. L. L. A. H., Asmaz, D., & Kara, M. E. H. M. E. T. (2022). Evaluation of the effects of different natural dietary feed additives on performance and intestinal histomorphology in quails. J*ournal of the Hellenic Veterinary Medical Society, 73*(3), 4407-4416. [DOI:10.12681/jhvms.27265]

Zadeh Adamnezhad, H., & GhiasiGhalehkandi, J. (2018). Growth Performance and the Intestine Morphometry of Japanese Quail That Fed Diets Supplemented With Vitamin E and Selenium. *Iranian Journal of Veterinary Medicine, 12*(4), 323-334. [DOI:10.22059/ijvm.2018.253990.1004886]

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