Egyptian J. Nutrition and Feeds (2017), 20 (2) Special Issue: 203-212

EFFECT OF USING MORINGA OLEIFERA LEAF MEAL AS FEED ADDITIVES ON JAPANESE QUAIL DURING LYING PERIOD

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SUMMARY

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

Keywords: *Moringa oleifera leaf meal, egg production, egg quality, hatchability, Japanese quail.*

INTRODUCTION

Moringa oleifera is one of the plants that can be utilized in the preparation of poultry feeds. The plant apart from being a good source of vitamins and amino acids, it has medicinal uses (Makkar and Becker., 1999). Natural medicinal products originating from herbs and spices have also been used as feed additives for farm animals (Guo, 2003). Kakengi et al. (2005) observed that, Moringa oleifera leaf meal contains 86% DM, 29.7l% C.P., 22.5% CF, 4.38% EE, 27.9% calcium, 0.26% phosphorus and negligible amount of tannin (1.23g/kg).

Murro *et al*. (2003) reported that, 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 (Kout el Kloub *et al*., 2015). Plant products have been used for centuries by humans as food and to treat ailments. Moringa oleifera is a plant that posses 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 (Siddhuraju and Becker, 2003; and Anhwange *et al*.,2004). The antioxidant compounds (phenols,Vitamin C, E, β carotene, zinc, selenium, flavonoids) in *Moringa oleifera* have been reported (in some studies) 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 onto the meat surface or active packaging (Valeria and Williams., 2011).

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 (Gaia, 2005). Walter *et al*. (2011) assured that *Moringa oleifera* and *Moringa stenopetala* methanol and n-hexane 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 oleifera such as: fluoride, (quercetin and kaercetin) 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 (Siddhuraju and Becker, 2003). Atawodi, (2010) found that Moringa oleifera contained Polyphenols like ellagic acid, gallate, methylgallate, catechol, kaempferol quercetin. Moringa oleifera is a highly valued food plant characterized by a multipurpose use. Anwar *et al*. (2007) and Kout Elkloub *et al*. (2015) reviewed the use of this tree in Japanese quail diets. Dietary supplementation of Moringa formulated diets for broilers was effective in enhancing the oxidative stability of chicken meat (Qwele *et al.*, 2013). 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 (Zanu *et al*., 2012).The purpose of this study was to evaluate the effect of Moringa oleifera leaf meal (MOLM) in the Japanese quail diet on their productive performance.

MATERIALS AND METHODS

The experimental work was carried out at El – Fayoum Poultry Research Station, Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, Egypt.

Moringa oleifera leaf meal:

Moringa oleifera leaf meal (MOLM) used in this study was obtained from the Horticultural crops technology section at the National Research Center.

Experimental Design and Management of birds:

A total number of 180 birds of Japanese quail-56 days old were having nearly equaled live weights (g) were distributed randomly into four treatment groups, three replicates per each, each replicate containing 10 females and 5 males. Birds were fed on diet containing 20 % CP and 2900 Kcal ME .Table 1 shows composition and calculated analysis of diets. Dietary treatments were designed to contain 0.0 (control), 0.2, 0.4and 0.6% *Moringa oleifera* leaves meal as growth promoters in Japanese quail diets. All birds received feed and water *ad libitum*.

Egg performance:

During the experimental periods, 9-12, 13-16, and 17-20 weeks of age, egg numbers were recorded and weighed daily. Egg production percent were calculated by dividing egg number on number of live female quail. Feed intake was determined per replicate and feed conversion ratio was calculated as gram feed consumption divided by gram egg mass per hen per day**.**

Egg quality parameters:

A total number of 30 eggs per each treatment were taken after 20 wks of age to determine the interior and exterior egg quality parameters:
Egg shape index = width / length x 100 (by using a digital caliper), shell thickness shell thickness with membranes was determined using a digital micrometer as an average of 3(narrow, medial, broad) to the nearest 0.001mm. Internal quality unit (IQU) was calculated according to the equation derived by Kondaiah *et al*.(1983) as follows:
$IQU=100 \log(H+4.18- 0.8989*W^{0.6674})$.
Where H = albumen height in mm and W = egg weight in g.

Some blood traits:

At the end of the experimental period (20 weeks of age) 3 chicks of each group were randomly taken.

Blood samples were collected from wing vain of each bird in two heparinized test tubes. Blood of the first tube was used to evaluate the hemoglobin concentration (Hb), hematocrit % (Ht), total erythrocytes count (RBCs), and total leucocytes count (WBCs). Mean Corpuscular Volume (MCV) was calculated = Ht × 10/ RBC's, Mean Corpuscular Hemoglobin (MCH) was calculated = Hb × 10/ RBC's and Mean Corpuscular Hemoglobin Concentration (MCHC) = HbX100/ Ht. All measurements conducted according to Clark *et al. (*2009). While the second blood tube was centrifuged at 3000 rpm for 20 minutes. The separated plasma was stored at -20°C until assayed for blood traits included determine total protein, albumin, globulin, cholesterol, and liver enzymatic activity (GOT and GPT) using commercial kits.

Reproduction performance:

Eggs were daily collected from each treatment (60 eggs) during the last week and storage at 15°C. Eggs set in setter up to 14 day of incubation and transferred to hatchery for hatching on day 15 of incubation. On day 17 "the end of incubation period" un-hatched eggs were broken to determine unfertile eggs, dead and deformed (Abnormalities) embryos. Fertility, hatchability per total and fertile eggs, dead and deformed embryos percent were calculated.

***Statistical Analysis*:**

Obtained data were statistically analyzed using linear models procedure described in SAS users guide (SAS, 1999). Differences among means were tested using Duncan's multiple range tests (Duncan's, 1955). One – way analysis model was applied for experiment:

$$Y_{ij} = \mu + T_i + E_{ij}$$

Where: Y_{ij} = Observations, μ= The overall mean, Ti =Effect of $i^{th\ treatments}$ and E_{ij} = Experimental error.

RESULTS AND DISCUSSION

Production performance:

Feed consumption, feed conversion:

The results in Table (2), demonstrate production performance of Japanese quail as affected by different levels of MOLM. In the first period (9-12) week, results showed that there were no significant difference of FC, but there were significant improvement among all levels of MOLM for FCR compared to the control. In the second period (13-16) week, the results showed that there were no significant differences between all treatments for FC and a level of 0.4% MOLM achieved the best FCR compared to other treatments. In the third period (17-20) week there were no significant difference between all treatments for FC and FCR. For the overall period (9-20) week results showed that the level of 0.4% followed by 0.2% MOLM has achieved the best FCR compared to control, however increase the levels of MOLM up to 0.6% had negative FCR. This may be due to the presence of phytates which is an anti-nutritional factor. Phytates was reported to reduce bioavailability of minerals in non- ruminant animals (Reddy *et al*., 1982) and decline digestibility of starch and protein (Thompson, 1993).These results were in harmony with the finding of Teteh *et al*. (2016) who reported that supplementation of 1.2% MOLM had insignificantly effect on FC but level 1% improved FCR. Also, results agree with Kout Elkloub *et al*. (2015) who reported that supplementation of MOLM at levels 0.2, 0.4 and 0.6% resulted the best significant feed conversion ratio (FCR) at 0.2% MOLM in all periods. Kaijage *et al.* (2015) and Abou-Elezz, *et al.* (2012) reported that *Moringa oleifera* fresh leaves had lower feed intake and better feed conversion ratio.

This improvement in FCR may be attributed to rich content of nutrients in MOLM (Kakengi et al., 2005) and antimicrobial properties of Moringa (Fahey *et al*., 2001). Decreasing feed consumption with increasing MOLM level agree with Raphael *et al.* (2016) who reported that feed intake and Feed conversion ratio decreased with increasing level of MOLM.

Egg production:

Results in Table 3 showed that egg production percent was significantly influenced by MOLM supplementation; all levels achieved higher egg production percentage compared to control. For all periods of egg production, 0.4% and 0.2% MOLM recorded higher egg production percent values but 0.4% and

0.6% recorded higher average egg weight. On the other hand higher egg mass ranged between 0.4 and 0.6% levels. However the level 0.4% MOLM recorded the highest egg mass. Most egg production parameters depressed by increasing MOLM up to 0.6% but remained higher than control treatment. Improving egg weight by *Moringa oleifera* leaf meal supplementation agree with Raphael *et al.* (2016) who reported that the relation between egg weight and inclusion of *Moringa oleifera* leaf meal in the diet was very high. Also agree with Ebenebe *et al.* (2013) who showed that Moringa oleifera leaf meal at levels of 2.5, 5, 7.5% supplementation, resulted significantly ($P \leq 0.05$) better egg production at 5% level. Moreover the results agree with Abou-Elezz, *et al. (2012)* who 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 the 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).

Egg quality:

The results for egg quality are shown in Table 4. Supplementation of MOLM at levels of 0.2% and 0.4% were decreased albumin% compared to control and 0.6%. All levels of MOLM were significantly improved internal quality unit. Decreasing albumin weight% may be due to there was negative correlation between egg weight and albumen percent (Abou-Elezz *et al.,* 2012). Yolk index% decreased by MOLM treatments compared to control, but yolk weight percent and yolk color insignificantly increased. This observation agrees with (Wubalem, 2016) who reported that yolk index% is implying relatively lower concentrations of cholesterol. Results demonstrated egg shape index, shell weight percent were no significant, but all MOLM levels recorded lower shell thickness than control treatment.

The decline in egg shell quality may be due to egg quality measured during chronic heat stress month “during May” where Lin *et al.* (*2004)* found decreased in egg shell thickness from heat-stressed hens. These results agree with Ebenebe *et al*. (2013) who showed that Moringa oleifera leaf meal at levels of 2.5, 5, and 7.5% did not show any significant difference with egg width, shell thickness and egg shape index. Teteh *et al*. (2016) reported that supplementation MOLM at level 1% achieved better significantly yolk ratio compared to control. The result indicated that inclusion of Moringa at lower levels 0.2, 0.4% improved egg production and egg quality but higher level 0.6% was lower productivity and poorer egg quality indices.

Hematological parameters:

Data of hematological parameters including WBCs, RBCs, Hb, Ht, MCV, MCH and MCHC are given in Table (5). From the present results it's noted that there were of all levels of MOLM had significantly ($P \leq 0.05$) higher WBCs, RBC, Hb and Ht than control treatment. On the other hand all levels of MOLM recorded significantly lower MCV than control treatment. While no significantly among all treatment. Improving of RBC, Hb and Ht may be due to diets containing *Moringa oleifera* leaf meal recorded higher RBC which may be due to existence of saponins in MOLM. Saponins have hemolytic action against RBC (Ologhobo *et al.*, 2014).

The data of the present study demonstrated that *Moringa oleifera* had no harmful effects on hematological parameters. In this respect Ologhobo *et al.* (2014) reported that the inclusion of *Moringa oleifera* in broiler diets up to 5% was possible without negatively affecting hematological indices. Regardless reducing significantly MCV values with all levels of MOLM supplementation, these levels improved Macrocytic anemia where *Moringa oleifera* excellent source of vitamin B (Dhakar *et al.,* 2011). Increasing significantly white blood cells by *Moringa oleifera* supplementation agree with Olugbemi *et al. (*2010) who demonstrated that *supplemented diet with 10% Moringa oleifera leaf led to increase in white blood cells.*

Plasma constituents:

The results of the estimated blood plasma parameters at 20 weeks old as affected by dietary *Moringa oleifera* leave meal are presented in Table 6. Total plasma protein and globulin were significantly increased by using 0.2 and 0.4% MOLM. On the other hand 0.2, 0.4% MOLM recorded the lowest A/G ratio. Plasma albumin significantly decreased with all levels of MOLM compared to control. Regarding globulin, the results agree with Hedau *et al. (*2010) who reported that serum globulin levels significantly increased in groups treated with *Moringa oleifera*. Increasing globulin may be due to dietary supplementation of

Moringa oleifera might have increased immune ability (Du *et al.,* 2007). Decreasing A/G ratio attributed to increasing globulin that confirm denominator of the ratio. The significant improvement in plasma lipid profile was achieved by MOLM supplementation. Total lipid, cholesterol and LDL which contained relatively high cholesterol content" decreased significantly but HDL "classified as good cholesterol" increased significantly by MOLM supplementation. Improvement of total lipid was agreement with El-Sheikh *et al.* (2015) who indicated that low dose of Moringa leaves powder in layers diets reduced lipid content.

On the other hand *Moringa oleifera* inclusion in layer diets was active in cholesterol reduction in serum **(**El-Sheikh *et al.,* 2015). Improvement cholesterol parameters may be due to *Moringa oleifera* contained hypocholesterolemic agent such phytoconstituent, β-sitosterol (Kumar, *et al.,* 2010). This result is also supported by the works of Olugbemi *et al*. (2010) who reported that Moringa leaves had a beneficial effect on the immune responses and improve intestinal health of broilers. Concept of the liver enzymes and total antioxidant capacity, supplemented control diet with 0.2, 0.4% MOLM significantly decreased ($P \leq 0.05$)liver enzymes. The concentrations of total antioxidants capacity values, in plasma were high in 0.6% followed by 0.4% MOLM compared to control group. Results in harmony with Kout Elkloub et al. (2015) who reported that supplementation MOLM demonstrated that total antioxidant capacity was significant on 0.6 and 0.4% MOLM. Also Results of total antioxidant capacity agree with (Mousa *et al.,* 2016). The significant increase in TAC may be due to *Moringa Oleifera* hold antioxidant enzymes that reduced lipid peroxidation and decrease free radicals (Ogbunugafor *et al.,* 2011). Significant decrease in GPT and GOT with *Moringa Oleifera* supplementation reported by Annongu *et al* (2013) may attribute to *Moringa oleifera* have relative hepatic architectural improvements and induced liver damage (Bahr and Farouk 2016).

Reproduction performance:

Fertility, hatchability, clears; dead and deformed percent were affected significantly by MOLM supplementation (Table 7). Diet supplemented with all levels of MOLM presented significantly ($P \leq 0.05$) the most excellent fertility, but level 0.4% improved hatchability per total egg, while level 0.6% improved hatchability per fertile egg. Clear and dead percent in contrast, control presented the worst values, while deformed no effect to all treatment. Increasing fertility with all levels agree with Raphael *et al.* (2016) who reported that fertility tends to increase with increasing level of *Moringa oleifera leaf* meal in the diets. Increasing fertility percent may be due to *Moringa Oleifera* leaf extract significantly enhanced the sperm parameters and protect testes from different toxic substances (Akunna *et al.,* 2012) and exhibited a reduction in total sperm abnormalities (El-wassimy *et al.,* 2014). Supplementation of plant containing selenium improved fertility and hatchability (Alebachew *et al.,* 2016) and contain either higher levels of zinc and vitamin E, which can improve hatchability (Wubalem, 2016).

CONCLUSION

It could be concluded that *Moringa oleifera* leaf meal (MOLM) improved egg production performance, egg quality, immune organs and blood constituents, and reproductive performance. The best level occurred by 0.4% in Japanese quail diets**.**

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تأثير إستخدام مسحوق أوراق المورينجا أوليفيرا كإضافات غذائية على السمان اليابانى خلال فترة إنتاج البيض

محمد عبد العظيم محمد موسى ، قوت القلوب مصطفى السيد مصطفى ، ريرى فوزى حسين شطا ، حنان عبد الرحيم حسن الغنيمى ، صباح فاروق يوسف

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تهدف هذه الدراسة الى تقييم تاثيرات مسحوق اوراق المورينجا اوليفيرا فى علائق السمان اليابانى (خلال فترة انتاج البيض) على الاداء الانتاجى للسمان الياباني وقياسات جودة البيض والخصوبة والفقس ومكونات الدم. تم استخدام ١٢٠ انثى / ٦٠ ذكر سمان يابانى عمر ٥٦ يوم حتى ٢٠ اسبوع من العمر. قسمت عشوائيا الى ٤ معاملات تجريبية وكل مجموعة تحتوى على ٣ مكررات بكل مكررة ١٠ اناث / ٥ ذكور. غذيت كتاكيت السمان علي اربع علائق تجريبيه تحتوي على ٤ مستويات من مسحوق المورينجا صفر – ٠.٢ – ٠.٤ – ٠.٦ % خلال فترة التجربة (١٢ اسبوع). اظهرت النتائج ان اضافة مستوى ٠.٤% سجل اعلى نسبة انتاج بيض يلية مستوى ٠.٢% ومستوى ٠.٤ ، ٠.٦% سجلا اعلى متوسط وزن بيض خلال الفترات المختلفة وان معظم قياسات جودة البيض خصوصا لون الصفار تحسنت مع كل المستويات ولكن لا توجد اى اختلافات معنوية بالمقارنة بالكنترول. مستويات ٠.٤ ، ٠.٦% حققت معنوية عالية بالنسبة لكرات الدم البيضاء والحمراء والهيموجلوبين والهيماتوكريت بالمقارنة بالكنترول. زيادة مسحوق المورينجا حتى ٠.٦% حسن معنويا بدرجة عالية للبروتين الكلى والجلوبيولين والكوليسترول عالى الكثافة ومضادات الاكسدة الكلية وخفض معنويا للدهون الكلية والكوليسترول والكوليسترول منخفض الكثافة. كل مستويات المورينجا حسنت الخصوبة ولكن مستوى ٠.٤% حسن الفقس بالنسبة للبيض الكلى بينما مستوى ٠.٦% حسن الفقس بالنسبة للبيض المخصب. بصفة عامة يمكن استخدام مسحوق ورق المورينجا حتى مستوى ٠.٦% واضافتها لعليقة السمان اليابانى يمكن ان يكون لها تاثيرات ايجابية على انتاج البيض وجودة البيض والخصوبة والفقس.

Table (1): The composition and calculated analysis of diet.

Ingredients	%	Calculated values	%
Yellow corn	57.00	CP%	20
Soybean meal 44%	27.80	ME.KCal/Kg	2900
Corn gluten 62%	5.50	Ca %	2.50
Soy oil	2.00	Avail. P%	0.30
Dicalcium phosphate	1.15	Meth. %	0.42
Limestone	5.80	Lysine%	0.98
Salt Nacl	0.40		
Premix (V&M.) *	0.30		
DL.Methionine	0.05		
Total	100		

**Each 3 kg contains: 15000.000 IU Vit. A, 4000.000 IU Vit. D_3, 50000 mg Vit. E, 4000 mg Vit. K_3, 3000mg Vit. B_1, 8000mg Vit. B_2, 5000mg Vit. B_6, 16000mg pantothenic acid, 20mg Vit. B_{12},2000mg folicacid,4500mgniacin,200mg biotin,7500mg zinc,5000mg choline,15000mg copper, 150mg cobalt,1000mg iodine,150mg selenium,100000mgmanganese, 30000mg iron, carrier caco3 add to 3 kg.*

Table (2): Effect of *Moringa oleifera* leaf meal supplementation on feed consumption and feed conversion ratio

Treatments	FC	FCR	FC	FCR	FC	FCR	FC	FCR
	Period 1(9-12) weeks		Period 2(13-16) weeks		Period 3(17-20) weeks		Overall (9-20) weeks	
Cont.	32.76	4.48 ^{a}	30.71	3.22 ^{a}	33.04	3.4	32.17	3.69 ^{a}
0.2%	29.27	2.79 ^{b}	31.91	2.84 ^{a}	31.67	2.63	30.95	2.75 ^{bc}
0.4%	31.86	2.83 ^{b}	30.40	2.36 ^{b}	31.17	2.45	31.14	2.55 ^{c}
0.6%	32.90	3.34 ^{b}	33.44	2.99 ^{a}	32.95	3.10	33.10	3.14 ^{b}
SEM	±1.28	±0.38	±1.74	±0.12	±.33	±0.33	±.0.75	±.0.14

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05) FC=feed consumption (g/hen/day) ,FCR=feed conversion ratio(g feed /g egg), Cont= control, 0.2%= 2.gm Moringa oleifera leaf meal/1kg diet, 0.4%= 4gm Moringa oleifera leaf meal/1kg diet, 0.6%= 6gm Moringa oleifera leaf meal/1kg diet.

Table (3): Effect of *Moringa oleifera* leaf meal supplementation on egg production

Treat.	Period 1(9-12) weeks			Period 2 (13-16) weeks			Period 3 (17-20) weeks			Overall (9-20) weeks		
	EP%	EM	EW	EP%	EM	EW	EP%	EM	EW	EP%	EM	EW
Cont.	57.14^{b}	7.42^{b}	13.01^{b}	72.14^{c}	9.60^{c}	13.30^{b}	74.05^{c}	9.82^{c}	13.2 ^{c}	67.78^{b}	8.94^{c}	13.19^{b}
0.2%	81.16^{a}	10.51^{a}	12.98^{b}	83.72^{ab}	11.24^{b}	13.43^{b}	88.91^{ab}	12.05^{ab}	13.55^{bc}	84.60^{a}	11.26^{ab}	13.32^{b}
0.4%	83.43^{a}	11.47^{a}	13.71^{a}	92.69^{a}	12.84^{a}	13.87^{a}	91.74^{a}	12.93^{a}	14.08^{a}	89.29^{a}	12.41^{a}	13.89^{a}
0.6%	71.27^{ab}	10.07^{a}	14.20^{a}	78.73b^{c}	11.18^{b}	13.90^{a}	77.48^{bc}	10.73^{bc}	13.8 ^{ab}	75.83^{b}	10.66^{b}	13.99^{a}
SEM	±5.23	±0.78	±0.18	±2.93	±0.47	±0.09	±3.63	±0.54	±0.11	±.2.68	±.0.45	±.0.11

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05), EP%=egg production%, EM=Egg mass/hen/day, EW=egg weight (g),

Table (4): Effect of *Moringa oleifera* leaf meal supplementation on egg quality.

Treat.	Egg shape index	Albu.%	Albumin height (mm)	Internal quality unit	Yolk quality			Shell quality		
					Yolk index%	Yolk color	Yolk%	Shell%	Shell thickness mm	Egg surface area
Cont	81.30	62.48^{a}	5.21	63.40^{b}	49.70^{a}	4.83	29.03	8.94	0.255^{a}	24.77^{ab}
0.2%	80.87	60.53^{b}	5.56	68.22^{a}	48.64^{ab}	5.10	30.71	8.76	0.244^{ab}	23.93^{b}
0.4%	80.61	60.28^{b}	5.90	70.33^{a}	48.42^{ab}	5.13	30.55	9.17	0.247^{ab}	24.47^{ab}
0.6%	80.24	61.56^{a}	5.68	67.21^{a}	47.37^{b}	5.07	29.58	8.86	0.241^{b}	25.12^{a}
SEM	±0.45	±0.30	±0.21	±2.21	±0.52	±0.10	±0.48	±0.13	±0.004	±0.34

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05).

Table (5): Effect of *Moringa oleifera* leaf meal supplementation on hematological parameters.

Treatments	WBCs (10^3/mm^3)	Hemoglobin(Hb)(g/dl)	RBCs (10^6/mm^3)	Hematocrite (Ht) %	MCV	MCH	MCHc
Cont.	248.87^{b}	15.30^{b}	3.12^{b}	44.43^{b}	142.14^{a}	48.96	34.10^{b}
0.2%	260.33^{ab}	17.03^{a}	3.51^{a}	47.67^{a}	135.46^{b}	48.39	35.96^{ab}
0.4%	263.40^{a}	17.30^{a}	3.58^{a}	47.73^{a}	133.37^{b}	48.43	36.26^{a}
0.6%	264.53^{a}	17.97^{a}	3.58^{a}	48.93^{a}	136.69^{b}	50.20	36.67^{a}
SEM	±3.72	±0.91	±0.05	±1.31	±2.73	±1.65	±1.21

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05).WBCs= white blood cell count, RBCs=Red blood cell count, MCV= Mean Corpuscular Volume, MCH= Mean Corpuscular Hemoglobin, MCHC= Mean Corpuscular Hemoglobin Concentration

Table (6): Effect of *Moringa oleifera* leaf meal supplementation on plasma constituents.

Treat.	Plasma protein profile				Plasma lipid profile				Liver enzymes		TAC
	Total protein	Albumin	globulin	A/G	Chole.	HDL	LDL	Total lipid	GOT	GPT	
Cont.	4.66^{bc}	1.34^{a}	3.31^{c}	0.40^{a}	134.5^{a}	68.4^{bc}	66.10^{a}	880.0^{a}	89.0^{a}	41.6^{a}	0.16^{c}
0.2%	5.42^{a}	0.85^{b}	4.57^{a}	0.19^{c}	105.7^{c}	71.7^{b}	34.01^{b}	562.3^{b}	77.3^{c}	30.6^{c}	0.21^{c}
0.4%	5.20^{ab}	1.15^{ab}	4.05^{b}	0.28^{b}	93.64^{d}	64.9^{c}	28.65^{c}	479.6^{c}	81.6^{b}	32.6^{c}	0.34^{b}
0.6%	4.37^{c}	1.26^{ab}	3.11^{c}	0.41^{a}	118.6^{b}	81.7^{a}	36.88^{b}	450.0^{d}	85.6^{a}	36.3^{b}	0.45^{a}
SEM	±0.18	±0.13	±0.16	±0.03	±1.81	±1.87	±1.56	±3.16	±1.04	±0.73	±0.02

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05),
A/G= Albumin/globulin, chole.= cholesterol, TAC=total antioxidants capacity (mmol/l)

Table (7): Effect of *Moringa oleifera* leaf meal supplementation on hatchability parameters.

Treatments	Fertility%	Hatch.t.egg%	Hatch.f.egg%	Clear%	Dead %	Deformed%
Cont.	83.33^{b}	73.33^{b}	88.41^{b}	16.67^{a}	6.67^{a}	3.33
0.2%	90.00^{a}	80.00^{b}	88.89^{ab}	10.00^{bc}	6.67^{a}	3.33
0.4%	91.67^{a}	85.00^{a}	91.36^{ab}	8.33^{c}	3.34^{b}	3.33
0.6%	88.33^{a}	8١.٦6^{ab}	92.78^{a}	11.67^{b}	1.67^{b}	5.00
SEM	±1.99	±1.03	±1.17	±0.63	±0.97	±0.91

a, b, c Means in the same column with different superscripts are significantly different (p≤0.05).
Hatch.t. egg%= hatchability per total eggs ; Hatch.f. egg%= hatchability per fertile eggs.