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Effect of Feeding Artichoke Leaves Meal on Productive and Reproductive Performance of Mandarah Hens

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Abstract: The main target of this study was to evaluate the effect of feeding Artichoke Leaves Meal (ALM) on productive and reproductive performance of Mandarah hens. In this study, a total number of 300 Mandarah hens and 30 Mandarah cocks, 28 weeks of age were randomly distributed into 10 groups and fed on the experimental diets, six levels of ALM (2, 4, 6, 8, 10 and 12% of the diet) in comparison to three tested levels (50, 75 and 100 g/ton diet) of Artichoke Extract (AE), in addition to the basal diet. The results of this study showed that inclusion of Artichoke Leaves Meal (ALM) at 8% of the diet resulted in the highest, values, laying rate, egg mass and best feed conversion than the basal diet (control), while 12% ALM decreased feed intake, significantly as compared with the control and scored the least, numerically, egg mass. The improvements in laying rate, egg mass and feed conversion values, due to 8% ALM, compared to the control were 6.61%, 7.87% and 7.44%, respectively. None of the treatments had adverse effect on the change of body weight of the hen, however artichoke extract levels had no clear effect and may be not enough to cause remarkable effects on productive performance. Shell thickness values (mm) were improved by inclusion of AE or ALM, starting with 75 g/ton AE. There was a gradual, numerically, increase in yolk color score starting with 8% ALM. Artichoke leaves meal at 6,8 and 10% of the diet resulted in the highest fertility and hatchability percentages at the end of the experimental period. It could be concluded that AE at 75 g/ton or more or ALM up to 8% may have beneficial effect on semen quality. Digestibility coefficient of EE was improved by all levels of AE and by ALM up to 10% as compared to the control. Inclusion of Artichoke Leaves Meal (ALM) at 8, 10 and 12% of the diets decreased egg yolk total lipids significantly as compared with the control (232.01-237.94 vs. 264.44 mg/g). Artichoke Leaves Meal (ALM) at 8% decreased yolk total lipids, yolk cholesterol and yolk LDL, in comparison to the control by 10.02, 9.72 and 21.65%, respectively and increased HDL by 14.34%. It decreased serum cholesterol and serum LDL, in comparison to the control by 15.62 and 19.72%, respectively. Best net revenue, economic efficiency and relative economic efficiency values were for 8%, followed by 10% ALM. It is recommended to use 8% artichoke leaves meal to get best economic efficiency, productive, reproductive performance and low cholesterol eggs.

Key words: Artichoke, hens, cocks, productive, reproductive, cholesterol

Introduction

In Egypt, about 8617 faddens are cultivated with artichoke (*Cynara scolymus* L.), which produce about 7.84 ton/fadden (Agriculture Economic, 2003). Flower head of artichoke weights about 200 gm, while artichoke bracts weights 70-80 gm, about 37% of the flower head weight (El-Badry, 1995). Large amounts of artichoke bracts are produced annually as by products.

Artichoke (*Cynara scolymus* L.), an edible vegetable from the Mediterranean area, is a good source of natural antioxidants such as vitamin C, carotenoids, polyphenols, hydroxycinnamic acids and flavones (Temple, 2000; Jimenez *et al*., 2003). It is rich source of inulin and oligofructose, which belong to a class of carbohydrates known as fructans. Inulin and oligofructose are considered as functional food ingredients since they affect the physiological and biochemical processes in rats and human beings, resulting in better health and reduction in the risk of many diseases. Experimental studies have shown their use as bifidogenic agents, stimulating the immune system of the body, decreasing the pathogenic bacteria in the intestine, relieving constipation, decreasing the risk of osteoporosis by increasing mineral absorption, especially of calcium, reducing the risk of atherosclerosis by lowering the synthesis of triglycerides and fatty acids in the liver and decreasing their level in serum. These fructans modulate the hormonal level of insulin and glucagon, thereby regulating carbohydrate and lipid metabolism by lowering the blood glucose levels; they are also effective in lowering the blood urea and uric acid levels, thereby maintaining the nitrogen balance. Inulin and oligofructose also reduce the incidence of colon cancer. Oligofructose are non cariogenic as they are not used by Streptococcus mutans to form acids and insoluble glucans that are the main culprits in dental caries. Because of the large number of health promoting functions of inulin and oligofructose, these have wide applications in various types of foods like confectionery, fruit preparations, milk

desserts, yogurt and fresh cheese, baked goods, chocolate, ice cream and sauces. Inulin can also be used for the preparation of fructose syrups (Kaur and Gupta, 2002).

Stoev *et al.* (2002) found that water extract of artichoke had some beneficial protective effect against the growth inhibitory effect of ochratoxin A and associated pathomorphological changes. Grande *et al.* (2004) suggested that regular intake of bioactive compounds from Mediterranean wild plants, that is, wild artichoke; phenolic-rich extract contributes to maintenance of proper vasomotion and to the low incidence of atherosclerosis and endothelial dysfunction recorded in the Mediterranean area.

Kleessen *et al.* (2003) indicated that a small amount of fructan-rich Jerusalem artichoke, or topinambur (administered as 0.5% topinambur syrup) in broilers' drinking water has a beneficial effect on growth performance, led to a significant increase ($p<0.01$) in caecal counts of B. bacteriovorus, which parasitizes susceptible Gram negative pathogens, reduces bacterial endotoxin levels and suppresses potential pathogens in broilers' ceca. Inulin-type fructans are the simplest and most studied fructans and have become increasingly popular as prebiotic health-improving compounds (Van den *et al.*, 2006).

Inclusion of dehydrated artichoke leaves or wastes, as non-conventional feedstuffs in small species diets was studied. Bonomi (2001) reported that the replacement of lucerne meal with meal from dehydrated artichoke leaves at a rate of 4% of the total feed improved the growth rate and skin colour of broilers and the egg production of laying hens. Gul *et al.* (2001) investigated the possibility of using refuse parts of artichoke buds for silage making and the feeding value of the resulting silage. They found out that the nutrient contents and feeding energy value of the artichoke stalks with leaves are comparable with other silages. Meneses *et al.* (2007) revealed that the silage of crude by-product left after industrial processing of artichoke (*Cynara scolymus* L.) showed a good aptitude for ensilage, having a pleasant smell and good visual characteristics and can be used as animal feed.

Aforementioned studies revealed the efficacy of artichoke leaves in improving the skin colour of broilers and the egg production of laying hens. Also Artichoke Leaves Extract (ALE) has an inhibition effect on cholesterol biosynthesis and LDL oxidation, therefore it has been suggested as a harmless yet effective treatment option for hypercholesterolaemia (Lupattelli *et al.*, 2004; Pittler *et al.*, 2005). These results may indicate positive effects on egg quality (yolk color and cholesterol content). Hence, this work aimed to evaluate the effect of feeding Artichoke Leaves Meal (ALM) on productive and reproductive performance of Mandarah hens. Semen quality of Mandarah cocks was also investigated.

Materials and Methods

The present study was carried out at Sakha Animal Research Station, Animal Production Research Institute, Ministry of Agriculture, Egypt. The chemical analyses were carried out at Laboratories of the Animal Production Research Institute, Ministry of Agriculture, Egypt. The main target of this study was to evaluate the effect of feeding Artichoke Leaves Meal (ALM) on productive and reproductive performance of Mandarah hens and cocks.

A total number of 300 Mandarah hens and 30 Mandarah cocks, 28 weeks of age were randomly distributed into 10 groups of 30 hens and 3 cocks each and then subdivided into three replicates (10 hens +1 cock/replicate). Each group was fed on one of the 10 experimental diets, six levels of ALM (2, 4, 6, 8, 10 and 12% of the diet) in comparison to three tested levels (50, 75 and 100 g/ton diet) of Artichoke Extract (AE), in addition to the basal diet. The experimental period lasted 90 days. The experimental diets (Table 1) were formulated to be isonitrogenous (~16% CP) and isocaloric (~2700 Kcal ME/Kg diet) and to at least satisfy the nutrient requirements according to Agriculture Ministry Decree (1996). The birds were reared under the same managerial conditions in open-sided house on floor. Photoperiod was 17 hours daily. The birds were fed *ad libitum* and the water was available all the time. Artichoke leaves used in this study were obtained from Behairah governorate, the price of dried artichoke leaves was 150 LE/ton during the experimental period. Artichoke leaves meal contained, on air dry basis (as fed), 7.7% moisture, 9.5% CP, 1.5% EE, 28.0% CF, 6.9% ash, 46.4% NFE, 46.3% NDF, 32.2% ADF, 21.6% cellulose, 14.1% hemicellulose, 10.6% ADL. Its content of ME (2484 kcal/kg ALM) was determined using Scott *et al.* (1976) equation as follows: ME = 53+38 (% CP+2.25 × % EE + 1.1 × NFE). The active constituents of artichoke leaves (1.064% total flavonoids and 1.194% total phenolic content as cynarin), while artichoke extract (0.319% cynarin) were determined according to Constantinescue *et al.* (1967).

Feed Intake (FI), egg production (%) and egg weight were recorded. Thirty representative eggs from each treatment (10 from each replicate) were collected monthly throughout the experimental period in order to determine egg and shell quality. Shape index and yolk index were determined according to Romanoff and Romanoff (1949) as follows:

Shape index (%) = (width/length) × 100
Yolk index (%) = (height / diameter) × 100

Egg shell thickness, including shell membranes, was measured using a micrometer at the equator. Haugh unit score was applied from a special chart using egg weight and albumin height which was measured by using a micrometer according to Haugh (1937), Kotaiah and Mohapatra (1974) and Eisen *et al.* (1962). The egg

Table 1: Composition and calculated analysis of the experimental diets

		Artichoke extract (g/ton) AE			Artichoke leaves meal (ALM)					
Ingredients (%)	Control	50	75	100	2%	4%	6%	8%	10%	12%
Yellow corn	64.94	64.94	64.94	64.94	64.07	63.00	61.04	58.51	56.3	54.06
Soybean meal (44%)	23.50	23.50	23.50	23.50	23.10	23.19	23.16	23.32	23.26	23.20
Artichoke leaves meal	--	--	--	--	2.00	4.00	6.00	8.00	10.00	12.00
Wheat bran	1.74	1.74	1.74	1.74	1.00	--	--	--	--	--
Corn oil	--	--	--	--	--	--	--	0.40	0.70	1.00
Lime stone	7.63	7.63	7.63	7.63	7.63	7.59	7.58	7.54	7.51	7.50
Di calcium phosphate	1.51	1.51	1.51	1.51	1.51	1.52	1.52	1.52	1.52	1.52
NaCl	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Premix[1]	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
DL-Methionine	0.08	0.08	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.12
Total	100	100	100	100	100	100	100	100	100	100
Calculated analysis:										
Crude protein %	16.18	16.18	16.18	16.18	16.01	16.00	16.00	16.06	16.03	16.01
Metabolizable energy (Kcal ME /Kg diet)	2725	2725	2725	2725	2727	2731	2714	2718	2719	2719
Crude fibre %	3.26	3.26	3.26	3.26	3.70	4.13	4.64	5.16	5.67	6.17
Available Phosphors %	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Calcium %	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
Lysine %	0.81	0.81	0.81	0.81	0.80	0.80	0.80	0.80	0.80	0.79
Methionine %	0.34	0.34	0.34	0.34	0.35	0.36	0.35	0.36	0.36	0.36
Methionine+Cystine%	0.62	0.62	0.62	0.62	0.62	0.63	0.62	0.63	0.62	0.63

1. Each 3 kg of Vit. and Min. Mixture contains: Vit. A, 10000,000 IU; Vit. D_3, 2000,000 IU; Vit. E, 10,000 mg; Vit. k_3, 1000 mg; Vit. B_1, 1000 mg; Vit. B_2, 5000 mg; Vit. B_6, 1500 mg; Vit. B_{12}, 10 mg; Pantothenic acid, 10,000 mg; Niacin, 30,000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Choline, 250,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Copper, 10,000 mg; Iron, 30,000; Iodine, 1000 mg; Selenium, 100 mg; Cobalt, 100 mg; $CaCO_3$ to 3,000 gm

yolk visual color score was determined by matching the yolk with one of the 15 bands of the "1961, Roche Improved Yolk Color Fan". At the end of the experimental period three egg yolk samples from each treatment were separated from the broken eggs, calculated and extracted according to Folch *et al.* (1957). Total lipids, cholesterol, LDL, HDL were colorimetrically determined in both of blood serum and egg yolk, while AST, ALT, total protein, albumin and globulin were determined in blood serum using commercial kits, following the same steps as described by manufactures. At the end of the study, individual blood serum samples were taken from jugular vein of 3 hens within each treatment. Serum was separated for analysis.

A total of 1500 eggs (150 eggs×10 groups) were incubated monthly in a forced draft incubator for three times. Fertility, hatchability and chick hatching weight were recorded. Semen samples were collected between 10 and 11 AM at 40 weeks of age (at the end of the experiment, after 90 days) from three cocks of each group by abdominal massage technique according to the method of Burrows and Quinn (1937). Semen ejaculate volume was measured by tuberculin syringe graduated to nearest 0.01 mL percentage of sperm forward motion. Sperm abnormalities were determined according to Vontienhoven and Steel (1957).

Digestion coefficients of Dry Matter (DM), Organic Matter (OM), Crude Protein (CP %), Crude Fiber (CF %), Ether Extract (EE %) and Nitrogen Free Extract (NFE %) were determined at the end of the study using 3 hens from each group. Faecal nitrogen was determined according to the method outlined by Jakobsen *et al.* (1960), while the urinary organic matter fraction was calculated according to Abou-Raya and Galal (1971). Economic efficiency was calculated from the money out put-money in put analysis. The price of each kg of the experimental diets was calculated according to the price of ingredients in the local market at the time of experiment. Proximate analyses of feed and excreta were carried out following A.O.A.C. (1990).

Data from all the response variables were subjected to one way analysis of variance (SAS, 2000). Variables having a significant F-test ($P \leq 0.05$) were compared using Duncan's Multiple Range Test (Duncan, 1955).

Model:

$X_{ij} = \mu + T_i + e_{ij}$

Where: X_{ij} = Any observation

μ = Overall mean

T_i = Treatments (i = 1, 2,…and 10)

e_{ij} = Experimental error

Results and Discussion

Productive performance: Egg production was not influenced significantly ($P \leq 0.05$) by any of the treatments (Table 2). However, inclusion of Artichoke Extract (AE) or Artichoke Leaves Meal (ALM) resulted in higher laying rate than the basal diet (control), except ALM at 12%, which gave lower value (46.89 vs. 49.78%

Table 2: Effect of experimental treatments on productive performance parameters

Treatments	Egg production (%)	Egg weight (g)	Egg mass (g/d)	Feed intake (g/d)	Feed conversion (feed/egg mass)	Body weight change (%)
Control	49.78	49.49^{d}	24.64^{ab}	99.20^{a}	4.03	8.47
AE:						
50 g/ton	50.29	50.10^{a}	25.20^{ab}	96.76^{bc}	3.84	8.56
75 g/ton	50.37	49.57^{d}	24.97^{ab}	96.69^{bc}	3.87	8.58
100 g/ton	51.04	49.63^{cd}	25.33^{a}	98.22^{ab}	3.88	8.89
ALM:						
2%	52.18	49.71^{bcd}	25.94^{a}	98.05^{ab}	3.78	8.95
4%	51.52	50.06^{a}	25.80^{a}	98.00^{ab}	3.80	8.85
6%	52.41	49.86^{abc}	26.13^{a}	99.14^{a}	3.79	8.66
8%	53.07	50.09^{a}	26.58^{a}	99.19^{a}	3.73	8.81
10%	52.04	49.95^{ab}	25.99^{a}	99.20^{a}	3.82	8.65
12%	46.89	49.92^{ab}	23.41^{b}	94.78^{c}	4.05	8.78
SEM	±0.45	±0.04	±0.445	±0.31	±0.03	±0.192
P value	0.074	0.0001	0.050	0.002	0.562	0.835

a,b....= Means on the same column differently superscripted are significantly different ($P \leq 0.05$), SEM = Standard error for means

for the control). The highest numerically value was for 8% ALM (53.07%). In spite of the significant differences between the treatments, there was no clear trend to the treatments on egg weight, the values were very close and ranged between 49.49 and 49.57-50.1 g for the control and the treatments, respectively. Egg mass values (g/d) were not significantly different, however there was a gradual increase with increasing ALM level reaching maximum value at 8% (26.58 vs. 24.64 g for the control). There was no significant effect on feed intake due to ALM up to 10%, while 12% ALM decreased feed intake, significantly as compared with the control (94.78 vs. 99.2 g for the control). Inclusion of Artichoke Extract (AE) or Artichoke Leaves Meal (ALM) resulted in better feed conversion values than the basal diet (4.03), except ALM at 12%, which gave higher value (4.05) than the other treatment (3.73-3.88), the best value was for 8% ALM. None of the treatments had adverse effect on the change of body weight of the hen, all groups gained between 8.47 and 8.95% of the initial body weight. It could be concluded that inclusion of Artichoke Leaves Meal (ALM) at 8% of the diet resulted in the highest, numerically, laying rate, egg mass and best feed conversion than the basal diet (control), while 12% ALM decreased feed intake, significantly as compared with the control and scored the least, numerically, egg mass. The improvements in laying rate, egg mass and feed conversion values, due to 8% ALM, compared to the control were 6.61%, 7.87% and 7.44%, respectively. None of the treatments had adverse effect on the change of body weight of the hen. However artichoke extract levels had no clear effect and may be not enough to cause remarkable effects on productive performance. The results were supported by Alcicek *et al.* (2000) who suggested the suitability of globe artichoke silage made from artichoke stems with leaves for feeding animals in semi-arid zones. (Bonomi, 2001) concluded that 4% dehydrated artichoke leaves of the total feed improved the egg production of laying hens.

Egg quality

External egg quality: Shell weight (%) values did not reflect the effect of the treatments clearly, while shell thickness values (mm) were improved by inclusion of AE or ALM starting with 75 g/ton AE (Table 3). The differences between the control and the treatments were significant for 4, 8 and 12% ALM. The highest value was for 8% ALM (0.389 vs. 0.353 mm for the control). Shape index values (%) were not affected significantly by any of the treatments, the values ranged between 75.13 and 77.58%. The improvement in shell thickness due to inclusion of AE or ALM was supported by Kaur and Gupta (2002) who reported that artichoke (*Cynara scolymus* L.), is rich source of inulin and oligofructose which result in increasing mineral absorption, especially of calcium. Increased calcium absorption could be due to its increased availability by transfer of calcium from the small intestine into the large bowel and the osmotic effect of inulin and oligofructose that transfers water into the large intestine, thus allowing it to become more soluble (Carabin and Flamm, 1999). However, the exact mechanisms by which ingestion of non-digestible carbohydrates improves mineral absorption is not very clear (Kaur and Gupta, 2002).

Internal egg quality: There was no clear trend to either AE or ALM level regarding Haugh unit scores; however the values increased starting with 75 g/ton AE, as compared with the control (Table 3). Yolk color score of the control diet did not differ significantly than the diets including either AE or ALM. There was a gradual, numerically, increase in yolk color score starting with 8% ALM. The values were 7.20, 7.53 and 7.60 for 8, 10 and 12% ALM, respectively, while control group recorded 6.87; this improvement could be due to artichoke leaves content of carotenoids (Temple, 2000). The improvement in Yolk color score due to ALM was confirmed by the finding of Bonomi (2001) who reported that the replacement of lucerne meal with meal from

Table 3: Effect of experimental treatments on egg quality

Treatments	Items							
	External egg quality			Internal egg quality				
	Shell (%)	Shell thickness (mm)	Shape index (%)	Haugh unit score	Yolk color score	Yolk index (%)	Yolk (%)	Albumen (%)
Control	9.72^{cde}	0.353^{d}	76.48	70.27^{c}	6.87^{abc}	46.98	33.28	57.00
AE:								
50 g/ton	9.96^{bcde}	0.353^{d}	75.40	70.20^{c}	6.40^{c}	46.88	33.78	56.26
75 g/ton	10.63^{abc}	0.357^{cd}	75.13	80.47^{a}	6.93^{abc}	49.21	32.84	56.53
100 g/ton	10.87^{ab}	0.357^{cd}	77.03	76.33^{abc}	6.67^{bc}	49.09	35.20	53.94
ALM:								
2%	11.32^{a}	0.371^{abcd}	76.39	78.93^{ab}	7.07^{abc}	47.40	33.63	55.05
4%	10.08^{bcde}	0.380^{ab}	75.46	79.67^{ab}	6.73^{bc}	48.81	33.33	56.59
6%	9.40^{e}	0.371^{abcd}	77.58	74.73^{abc}	7.07^{abc}	49.21	34.25	56.36
8%	9.57^{de}	0.389^{a}	76.11	75.87^{abc}	7.20^{ab}	48.06	34.17	56.26
10%	10.39^{abcd}	0.363^{bcd}	75.45	73.20^{bc}	7.53^{a}	48.10	34.28	55.32
12%	10.48^{abcd}	0.377^{abc}	76.48	71.93^{c}	7.60^{a}	46.73	34.47	55.06
SEM	±0.11	±0.002	±0.29	±0.72	±0.08	±0.33	±0.22	±0.24
P value	0.0001	0.003	0.687	0.002	0.013	0.504	0.450	0.123

a, b....= Means on the same column differently superscripted are significantly different (P≤0.05), SEM = Standard error for means

Table 4: Effect of experimental treatments on reproductive performance of Mandarah hens

Treatments	Items								
	First hatch			Second hatch			Third hatch		
	Fertility	Hatchability	BW of hatched chicks (g)	Fertility	Hatchability	BW of hatched chicks (g)	Fertility	Hatchability	BW of hatched chicks (g)
	----------%----------			----------%----------			----------%----------		
Control	83.33	73.33	34.86	83.33	73.33	35.12	85.00	73.33	35.17
AE:									
50 g/ton	86.67	75.00	35.14	85.00	76.66	34.89	86.66	75.00	34.87
75 g/ton	88.33	75.00	35.04	86.67	75.00	35.16	90.00	78.33	35.04
100 g/ton	86.66	80.00	35.10	88.33	78.33	34.67	88.33	78.33	35.09
ALM:									
2%	88.33	81.66	35.10	83.33	76.66	34.91	88.33	76.66	34.84
4%	85.00	78.33	35.28	85.00	76.66	35.22	88.33	75.00	35.07
6%	88.33	80.00	34.94	85.00	78.33	34.74	90.00	81.66	35.21
8%	85.00	81.66	35.05	86.66	76.66	34.82	90.00	81.66	35.39
10%	86.66	81.66	35.01	86.66	81.66	34.98	90.00	80.00	34.94
12%	85.00	76.66	35.07	83.33	78.33	34.95	86.66	78.33	35.27
SEM	±0.79	±0.92	±0.036	±1.02	±0.88	±0.053	±1.08	±0.95	±0.064
P value	0.931	0.289	0.462	0.988	0.827	0.327	0.992	0.579	0.702

a,b....= Means on the same column differently superscripted are significantly different (p ≤ 0.05), SEM = Standard error for means

dehydrated artichoke leaves at a rate of 4% of the total feed improved the skin color of broilers. All treatments, with exception of 50 g/ton AE and 12% ALM, gave higher Yolk index values than the control. The differences were not significant. Both of AE at 100g/ton and ALM starting with 6% gave slightly higher yolk percentages than the control, without significant differences between the treatments. In contrast to the yolk percentage values, AE and ALM decreased albumin values without significant differences between the treatments. The slight increase in yolk percentages in relation to albumin percentages due to AE or ALM is revealed by Kraft (1997) who explained that the increased bile production due to the polyphenols in artichoke leaves extract mixes with and emulsifies fats to support fat digestion and fat metabolism.

Reproductive performance

Reproductive performance of mandarah hens: Table 4 represents percentages of fertility and hatchability, in addition to the weight of the hatched chicks as affected by the different treatments after 30 (first hatch), 60 (second hatch) and 90 (third hatch) days of feeding the experimental treatments. Fertility percentages were numerically higher for all artichoke treatments when compared with the control during the experimental periods. The values, after 90 days of feeding the experimental treatments were 86.66-90.00 vs.85.00% for the control without significant differences between the treatments. Hatchability percentages followed the same trend as that for fertility, the values, after 90 days of feeding the experimental treatments, were 75.00-81.66 vs.73.33% for the control without significant differences

Table 5: Effect of experimental treatments on semen quality of Mandarah cocks

	Item				
Treatments	Volume (ml)	Motility (%)	Life sperm (%)	Dead sperm (%)	Abnormal sperm (%)
Control	0.31	71.66	83.66	16.33	5.33
AE:					
50 g/ton	0.32	71.66	84.00	14.00	3.66
75 g/ton	0.32	75.00	84.00	16.00	3.00
100 g/ton	0.34	76.66	84.33	15.66	2.66
ALM:					
2%	0.32	75.00	84.00	16.00	2.33
4%	0.33	75.00	85.33	14.66	3.66
6%	0.35	76.66	84.66	15.33	2.33
8%	0.33	75.00	84.00	16.00	2.33
10%	0.32	73.33	84.33	15.66	2.66
12%	0.31	73.33	84.33	15.66	3.33
SEM	±0.003	±0.821	±0.66	±0.67	±0.28
P value	0.314	0.928	1.00	1.00	0.356

a, b....= Means on the same column differently superscripted are significantly different ($P \leq 0.05$), SEM = Standard error for means

between the treatments. Artichoke leaves meal at 6, 8 and 10% of the diet resulted in the highest fertility and hatchability percentages at the end of the experimental period. Body weight of the hatched chicks was not affected by the treatments during the experimental periods; the values after 90 days of feeding the experimental treatments were 34.84-35.39 vs.35.17 g for the control without significant differences between the treatments.

Semen quality of mandarah cocks: Table 5 shows the effect of the treatments on semen characteristics (ejaculate volume, motility, live sperms, dead sperms and the abnormal sperms). Inclusion of Artichoke Extract (AE) or Artichoke Leaves Meal (ALM), up to 10%, resulted in a slightly higher ejaculate volume than the basal diet (0.32-0.35 vs.0.31 mL). Motility (expressed as the percentage of motile spermatozoa with moderate to rapid progressive movement) was non-significantly higher for groups fed on diets containing AE at 75 g/ton or more or ALM up to 8%, as compared with the control. Also the percentages of abnormal sperms decreased numerically due to AE or ALM inclusion when compared with the control. Percentages of both live and dead sperms seemed not affected by the treatments. It could be concluded that AE at 75 g/ton or more or ALM up to 8% may have beneficial effect on semen quality. Improving the percentages of fertility, hatchability and semen quality in artichoke treatments (ALM), may be due to ALM contents of Cynarin (1.19%) and Fllavonoids (1.06%) which have been classified as antioxidants (Wang *et al*., 2003). The importance of the antioxidants in this regard was explained by Kelso *et al.* (1996) and Aitken (1994) who reported that avian spermatozoa are characterized by the presence of high concentrations of polyunsaturated fatty acids within the phospholipids. The presence of such polyunsaturated fatty acids requires an efficient antioxidant system to protect sperm membranes against peroxidative damage.

Nutrient digestibility: The effect of treatments on the nutrients digestibility coefficients of CP, CF, EE and NFE are summarized in Table 6. Nutrient digestibility coefficients of CP, CF and NFE were not affected significantly by the treatments, while digestibility coefficient of EE was improved by all levels of AE and by ALM up to 10% as compared to the control; the difference was significant between the control and both of 2 and 6% ALM. Increasing artichoke leaves meal level to 12% gave, numerically, lower values of nutrients digestibility coefficients than the control. This may be due to increasing crude fiber by increasing artichoke leaves meal level.

Improving the digestibility coefficient of EE due to AE or ALM inclusion was supported by Kraft (1997) who revealed that the increased bile production due to the polyphenols in artichoke leaves extract mixes with and emulsifies fats to support fat digestion and fat metabolism. The results were on the same trend with Bonanno *et al.* (1994) who incorporated Dried Artichoke Bracts (DAB) in New Zealand White rabbit diets at 15 or 30% for 56 days experimental period and found that only 30% DAB in the diet decreased digestive utilization and energy value of the diet.

Biochemical parameters

Some constituents of egg yolk extract: Egg yolk content of total lipids was not affected significantly by AE levels or by up to 6% ALM, (Table 7), while 8, 10 and 12% ALM decreased egg yolk total lipids significantly as compared with the control (232.01-237.94 vs. 264.44 mg/g). Yolk cholesterol started to be affected significantly by 6% ALM, where there was a gradual decrease from 14.44 to 13.82 mg/g by increasing ALM levels from 6 to 12% of the diet. Yolk LDL start to decrease significantly by 4% ALM as compared with the control (7.35-8.09 vs. 9.47 mg/g), while the useful HDL values were numerically higher than the control and the other treatments starting with 8% ALM. Artichoke Leaves Meal (ALM) starting with 8% decreased yolk total lipids, yolk

Table 6: Effect of experimental treatments on nutrient digestibility

	Item					
Treatments	DM (%)	OM (%)	CP (%)	CF (%)	EE (%)	NFE (%)
Control	77.50	76.60	80.37	21.83	73.83^{bc}	73.86
AE:						
50 g/ton	77.50	77.00	81.33	21.73	75.83^{ab}	73.97
75 g/ton	77.40	77.67	80.90	21.83	76.00^{ab}	73.87
100 g/ton	77.10	77.50	82.60	21.50	77.23^{ab}	75.16
ALM:						
2%	77.67	76.93	82.27	21.10	77.63^{a}	75.27
4%	77.50	76.33	80.73	22.20	77.10^{ab}	73.53
6%	77.93	76.80	82.30	23.57	77.57^{a}	74.83
8%	78.40	78.33	82.63	22.70	77.20^{ab}	75.86
10%	77.10	76.90	81.83	23.66	76.73^{ab}	74.80
12%	76.60	76.83	78.80	24.03	71.73^{c}	69.66
SEM	±0.455	±0.494	±0.541	±0.358	±0.44	±0.52
P value	0.537	0.183	0.914	0.665	0.016	0.384

a,b....= Means on the same column differently superscripted are significantly different (P ≤ 0.05), SEM = Standard error for means

Table 7: Effect of experimental treatments on some constituents of egg yolk extract

	Items			
	Total lipids	Cholesterol	L.D.L.	H.D.L.
Treatments	(mg/g)			
Control	264.44^{a}	15.84^{a}	9.47^{a}	5.37
AE:				
50 g/ton	264.08^{a}	15.80^{a}	9.39^{a}	5.40
75 g/ton	261.27^{a}	15.32^{ab}	9.03^{ab}	5.65
100 g/ton	254.55^{abc}	15.25^{ab}	8.28^{abcd}	6.05
ALM:				
2%	258.06^{ab}	15.31^{ab}	8.78^{abc}	5.83
4%	244.65^{abc}	14.78^{abc}	8.09^{bcd}	6.00
6%	242.43^{abc}	14.44^{bc}	7.65^{cd}	6.06
8%	237.94^{bc}	14.30^{bc}	7.42^{d}	6.14
10%	232.01^{c}	14.18^{bc}	7.59^{cd}	6.35
12%	232.97^{c}	13.82^{c}	7.35^{d}	6.29
SEM	±2.880	±0.157	±0.177	±0.106
P value	0.010	0.009	0.004	0.421

a,b....= Means on the same column differently superscripted are significantly different (p ≤ 0.05), SEM = Standard error for means

cholesterol and yolk LDL, in comparison to the control. For example 8% ALM decreased these values by 10.02, 9.72 and 21.65%, respectively, while increased HDL by 14.34%.

Blood serum constituents: Results of serum constituents as affected by different treatments are shown in Table 8. Neither Artichoke Extract (AE) nor Artichoke Leaves Meal (ALM) at the studied levels had no significant effect on serum constituents, except serum cholesterol and serum LDL, which start to decrease significantly at 6% or more as compared with the control. It could be concluded that artichoke extract and artichoke leaves meal at the studied levels had no adverse effects on liver functions (AST and ALT) or serum constituents. Artichoke Leaves Meal (ALM) at 8% decreased serum cholesterol and serum LDL, in comparison to the control by 15.62 and 19.72%, respectively.

The results were supported by El-Sayaad *et al.* (1995) who found that incorporation of Artichoke Bracts (AB) in New Zealand White rabbits diets up to 20%, for 9 weeks, had no significant effect on blood components. The non adverse effect on liver function enzymes (AST and ALT) was supported by Pecht (1996) who reported that a preparation made from artichokes, encourages the functioning of liver and kidneys. The decrease in blood lipids and cholesterol due to artichoke, was explained by Gebhardt (1998) and Pittler *et al.* (2005) who revealed that cynarine (1.5-di-caffeoyl-D-quinic acid), which is the principal active component of Artichoke Leaves Extract (ALE) inhibits the incorporation of 14C-labelled acetate into the nonsaponifiable lipid fraction and thus reduce cholesterol biosynthesis or it may have indirect inhibitory effects exerted at the level of HMGCoA reductase, a key enzyme in cholesterol biosynthesis. It can concluded that decrease of total lipids, LDL and cholesterol in blood serum led to decrease the same components in egg yolk.

Economical evaluation: The economic efficiency of the different formulated diets as affected by different treatments is shown in Table 9. Results indicated that Artichoke Extract (AE) or Artichoke Leaves Meal (ALM) at the studied levels improved net revenue, economic efficiency and relative economic efficiency compared to the control group. Best net revenue, economic efficiency and relative economic efficiency values were for 8%, followed by 10% ALM. ≥ From economic point of view, it is recommended to use 8% artichoke leaves meal to get best net revenue, economic efficiency and relative economic efficiency. These results were in agreement with Hammad and Abd El-Maksoud (2005) who concluded that dietary crude fiber level of 7%, which was higher than maximum CF level in this experiment (Table 1), increased laying performance and economic efficiency. The results of this study and the previous studies showed that dehydrated artichoke leaves meal may be comparable or utilized better than other sources of fiber in the diet as reported by Mesini (1996).

Table 8: Effect of experimental treatments on blood serum constituents

Treatments	Items								
	AST	ALT	Total protein	Albumin	Globulin	Total lipids	Cholesterol	L.D.L.	H.D.L.
	(U/L)		(g/dl)				(mg/dl)		
Control	52.27	22.56	6.03	3.55	2.48	1.072	180.8^{a}	72.0^{a}	56.3
AE:									
50 g/ton	51.93	23.02	6.64	3.46	3.17	1.073	180.9^{a}	71.6^{a}	56.5
75 g/ton	58.84	23.74	6.12	3.15	2.97	1.055	177.1^{ab}	69.8^{ab}	57.0
100g/ton	59.41	23.85	6.76	3.75	3.01	1.010	169.5^{abc}	66.6^{ab}	57.7
ALM:									
2%	57.29	24.18	6.47	3.37	3.09	0.998	176.0^{ab}	68.2^{ab}	58.4
4%	50.91	24.34	6.45	3.64	2.81	0.993	167.0^{abcd}	63.5^{ab}	62.9
6%	56.01	22.87	6.00	3.17	2.83	0.956	160.1^{bcde}	59.7^{b}	62.0
8%	48.11	24.68	6.26	3.26	3.00	0.966	152.5^{cde}	57.8^{b}	59.7
10%	56.69	22.45	5.39	2.69	2.70	0.901	148.0^{e}	58.6^{b}	58.3
12%	55.84	22.76	5.31	2.66	2.65	0.893	149.0^{de}	58.0^{b}	57.7
SEM	±1.345	±0.493	±0.189	±0.165	±0.095	±0.028	±2.721	±1.386	±1.789
P value	0.709	0.991	0.803	0.914	0.905	0.897	0.001	0.039	0.999

a,b....= Means on the same column differently superscripted are significantly different ($p \leq 0.05$), SEM = Standard error for means

Table 9: Economical evaluation of dietary treatments during the experimental period (90 days)

Items	Control	AE			ALM					
		50 g/ton	75 g/ton	100 g/ton	2%	4%	6%	8%	10%	12%
Price/ kg feed (L.E.)	1.20	1.21	1.22	1.23	1.19	1.17	1.16	1.14	1.13	1.12
Total feed intake/hen (kg)	8.93	8.71	8.70	8.84	8.82	8.82	8.92	8.93	8.93	8.53
Total feed cost/hen (L.E)	10.72	10.54	10.61	10.85	10.50	10.32	10.35	10.18	10.10	9.55
Total number of eggs/hen	44.80	45.27	45.33	45.93	46.97	46.37	47.17	47.77	46.83	42.20
Total price of eggs /hen (L.E.)[1]	13.44	13.58	13.60	13.78	14.09	13.91	14.15	14.33	14.05	12.66
Net revenue / hen (L.E.)[2]	2.72	3.04	2.99	2.93	3.59	3.59	3.80	4.15	3.95	3.11
Economical Efficiency (E.E.)	0.25	0.28	0.28	0.27	0.34	0.35	0.37	0.41	0.39	0.33
Relative EE[3]	100	112	112	108	136	140	148	164	156	132

1- The price of the egg = 30 P.T., 2- Net revenue per unit of total feed cost, 3- Relative economic efficiency % of the control

Conclusion: It could be concluded that, the artichoke leaves meal can be used at 8% of layer diet to get best economic efficiency, productive, reproductive performance and low cholesterol eggs.

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