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EFFECT OF FEEDING LINSEED MEAL-CONTAINING DIETS WITH OR WITHOUT ENZYME SUPPLEMENTATION ON PRODUCTIVE AND REPRODUCTIVE PERFORMANC OF MAMOURAH HENS.

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ABSTRACT

The present study was designed to evaluate the productive and reproductive performance of Mamourah laying hens fed linseed meal-containing diets with or without enzyme supplementation. A total number of 270 Mamourah pullets were randomly divided into nine experimental groups fed experimental diets containing linseed meal at levels of zero (served as a control diet), 2.5, 5.0, 7.5 and 10.0% with or without Kemzyme supplementation (added at g/kg). All experimental diets were formulated to be isonitrogenous and isocaloric. The obtained results can be summarized as follows: Birds fed the 10% linseed meal-containing diets with supplemental enzyme consumed the least amount of feed even though, linseed meal-containing diets had no deleterious effects on the performance of Mamourah laying hens for egg production, egg weight and feed conversion, further improvements in these criteria were achieved by the dietary supplementation with enzyme. Feeding the linseed-containing diets resulted in a significant increases in egg yolk percentage and egg color score, while no significant differences were observed in percentages of egg shell and albumen or Haugh unit compared with those of the control group. Data showed that egg fertility and chicks weight at hatch of birds fed the linseed meal-containing diets were significantly superior to those of the control group, while hatchability percentages were not significantly affected. In the present study there were a significant reduction in concentrations of egg yolk cholesterol and total lipids of birds fed diets containing linseed meal with or without enzyme. The same response was observed for levels of plasma cholesterol and total lipids. Panel test; using fresh or stored eggs, demonstrated that odor intensity and egg flavor of normal eggs were not significantly affected by feeding the different dietary treatments. In conclusion, taking the economical aspect into account, linseed meal could be safely used with or without enzyme supplementation up to 10.0% in Mamourah laying hen diets without any adverse effects on their productive and reproductive performance or egg quality.

INTRODUCTION

Flax or linseed (*Linum usitatissiumum* L.), a commonly oil seed crop, is a potentially valuable source of protein and energy for both ruminant and monogastric animals. It is also an excellent source of ω-3 fatty acids (Bhatty, 1995). Linseed may be processed by mechanical expeller or solvent extraction and the residual linseed meal can be used as an animal and poultry feed ingredient. Linseed meal is an important feedstuff for ruminants, in particular dairy cows, but its use in poultry feeds is limited because of its relatively high fiber content and the presence of various antinutritional factors, including mucilage, pyridoxine antagonist (linatine) and cyanogenic glycosides; primarily linamarin (Bhatty, 1995).

Expeller linseed meal contains about 33.0-34.3% crude protein, 5.4-10.0% crude fat, 7.2-8.8% crude fiber and metabolizable energy between 2350 and 3120 kcal/kg (Abou-Raya, 1967; Abbas *et al.*, 1990; Barbour and Sim, 1991; Marley, 1995; Sayed, 2002 and Abdou, 2003).

Linseed and linseed meal contains substantial amounts of mucilage (a water dispersible polysaccharide) amounted to 80 g/kg in seeds and 173 g/kg in expeller meal (Bhatty and Cherd-Kiatgumchai, 1990 and Marley, 1995) which has a high water-absorptive capacity and can increase the viscosity of digesta leading to a reduced nutrient availability (Antoniou and Marquardt, 1981; Fengler and Marquaredt, 1988; Bhatty, 1995; Kratzer and Vohra, 1996; Simon, 1998 and Rodriguez *et al.*, 2001).

Dietary supplementation with specific fungal or microbial enzyme preparations capable of hydrolyzing the soluble non-starch polysaccharides (NPS) has been shown to alleviate the adverse effects of increased digesta viscosity resulting in improvements in nutrient digestion and absorption and thus improved broiler performance (Petterson and Aman, 1989; Brenes *et al.*, 1993 and Danicke *et al.*, 2000). Mucilage of linseed meal consists of neutral and acidic polysaccharide components (Muralikrishna *et al* 1987; Fedeniuk and Biliaderis, 1994). Because of this structural component it might be hypothesized that the use of multienzyme preparation might result in a decrease in the intestinal viscosity caused by the inclusion of linseed meal and consequently an improved nutrient utilization (Ortiz *et al.*, 2001). Improving the utilization of linseed meal by enzyme supplementation may permit its inclusion at a higher level in poultry feeds as a source of n-3 fatty acids accumulated in eggs and meat, thereby such foods could be more healthy for humans (Kratzer and Vohra, 1996; Krasicka *et al.*, 2000; Mattews *et al.*, 2000; Lopez-Ferrer *et al.*, 2001; Rebole *et al.*, 2002). Moreover, there are numerous publications in the current literature on the possibility of modifying yolk lipid composition through using dietary or non-dietary manipulations (Hargis, 1988; Caston and Leeson, 1990; Jiang *et al.*, 1992). Certainly, in the last two decades, the consumer's perception that human foods that are low in cholesterol and high in polyunsaturated fatty acids (n-3 and n-6 fatty acids) are healthier.

Historically, linseed meal has not been a satisfactory feedstuff for poultry. It could satisfactorily replace the protein equivalent of soybean meal up to 2 or 3 % of the diet, but higher levels caused noticeable reduction in gain and feed efficiency in broiler and pullets (Ewing, 1963; McDonald *et al.*, 1988; Raya *et al.*, 1991 and Richter *et al.*, 1998a). However, Marley, 1995; Nam *et al*, 1997 and Sayed, 2002 observed no effect on growth, feed intake or feed utilization of broilers fed 5-10% linseed meal in their diets. Scheideler and Froning (1996) indicated that laying hens could tolerate up to 15% dietary flaxseed without affecting laying rate during the peak production period. Moreover, Richter *et al.* (1998b) showed that addition of enzyme mixture containing β-glucanase, xylanase and α-amylase to linseed meal containing-diet improved egg production and feed conversion of laying hens. Generally, the susceptibility of broilers to linseed meal seems to be higher than that shown by laying hens (Roth-Maier *et al.*, 1988).

Therefore, this study was designed to evaluate the productive and reproductive performance of Mamourah laying hens fed linseed meal-containing diets with or without enzyme supplementation. The study aimed also at investigating the effects of feeding such experimental diets on the sensory quality of eggs.

MATERIALS AND METHODS

The present study was carried out at El-Gimmizah Poultry Research Station, Ministry of Agriculture, Egypt. Expeller linseed meal, obtained from the local market, was ground to fine particles and used.

A total number of 270 28-week-old Mamourah pullets were housed in individual laying cages (45×30×42 cm) and subjected to a daily photoperiod of 14 h light: 10h darkness. Hens were randomly divided into nine experimental groups (30 birds each) and fed their respective corn-soybean meal diets containing linseed meal at levels of 0 (control), 2.5, 5.0, 7.5 or 10 % (at the expense of soybean meal) without or with enzyme supplementation (except for the control) from 28 to 52 weeks of age. The crude enzyme preparation (kemzyme) used (1.0 g/kg diet) is a commercial enzyme mixture containing α-amylase, β-glucanase and lipase. Birds fed a free access to feed and water throughout the experimental period. Experimental diets were formulated to be nearly isonitrogenous and isocaloric, and their composition was calculated according to the tabulated data of NRC (1994), except for that of linseed meal which was quoted from Mariey (1995). The productive performance of pullets was evaluated as change in body weight, egg production, egg weight, daily egg mass, daily feed intake and feed conversion ratio on a 28-day period basis. When the birds were 36 weeks of age, an egg quality test was performed to examine certain traits of egg quality, including egg components (relative weights of shell, yolk and albumen, yolk index, Haugh units (Haugh, 1937) and yolk color score by using the Roche yolk color fan. Egg yolk lipids and cholesterol were also determined according to the procedures of Folch *et al* (1957) and Elkine and Rogler (1990) respectively. Blood samples were collected from five birds per treatment into heparinized tubes and plasma was isolated by centrifugation at 3000 rpm for 15 minutes and used for the determination of total lipids (Frings and Dunn, 1970), cholesterol (Allain *et al.*, 1974) and triglycerides (Fossati and prencipe, 1982) using the specific kits. At 36 weeks of age, all settable eggs per treatment were collected and incubated. Fertility percentage was estimated as a percentage of fertile eggs to the number of eggs set. Incubated eggs were weighed at 0 and18 days of incubation for the determination of egg weight loss percentage. Individual weights of hatched chicks were also recorded. At the end of study (52 weeks of age) a panel test was carried out on boiled fresh eggs or eggs stored for 14 days at 5° C. On day 0 and 14 of storage, ten eggs were randomly selected from each treatment and cooked for sensory evaluation according to the method of Caston *et al.* (1994). Characteristics examined were intensity of the normal egg flavor, the perception of normal or off-flavors, and yolk color.

Data were analyzed using SPSS Program (SPSS, 1997) through one-way analysis of variance. Significantly different means were identified by Duncan new multiple range test (Duncan, 1955).

Table 1: Composition and calculated analysis of the experimental diets.

Ingredients	Control	2.5	5	7.5	10
Corn yellow grain	61.41	61.0	59.0	59.50	59.00
Soybean meal (44%)	24.0	21.3	20.75	18.25	16.50
Linseed meal	-----	2.50	5.00	7.50	10.00
Wheat bran	5.00	5.00	4.00	4.00	3.50
Limestone	6.50	6.65	7.00	6.50	6.50
premix*	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30
DI-calcium phosphate.	2.00	2.00	2.00	2.00	2.00
Methionine	0.14	0.15	0.15	0.15	0.15
Vegetable oil	0.35	0.80	1.50	1.50	1.75
Calculated analysis:**					
Crude Protein, %	16.65	16.50	16.50	16.30	16.30
M.E (kcal / kg)	2690	2699	2700	2720	2720
Calcium, %	3.10	3.10	3.10	3.00	3.00
Available P., %	0.49	0.48	0.47	0.47	0.47
Lysine, %	0.83	0.80	0.78	0.78	0.78
Methionine, %	0.41	0.40	0.42	0.41	0.41
Methionine+Cystine, %	0.69	0.70	0.70	0.70	0.71
Chemical analysis:**					
Crude Protein, %	16.2	16.0	16.2	16.2	16.2
Crude Fiber, %	3.58	3.57	3.61	3.70	3.75
Ether Extract, %	2.70	2.80	2.90	3.00	3.10

*** Premix at 0.30 of the diet supplies, the following per kg of the diets: Vit. A 10000 I.U, Vit.D3 2000 I. U, Vit. E 10 mg, Vit. K 1 mg, Vit.B1 1 mg, Vit.B2 5 mg, Vit.B6 1.5 mg, Vit.B12 0.01 mg, Folic acid 0.35 mg, Biotin 0.05 mg, Pantothenic acid 10 mg, Niacin 30 mg, Choline 250 mg, Fe 30 mg, Zn 50 mg, Cu 4 mg, I 1 mg and Se 0.1 mg.**

**** according to NRC 1994**

- Diets from 2 to 5 were formulated to contain no or kemzyme preparation (kg / ton).

RESULTS AND DISCUSSION

Body weight:

The data of live body weight are presented in Table 2. Results indicated that there were no significant differences in final body weight and body weight gain of Mamourah pullets in response to feeding linseed meal-containing diets compared with the control one. These results are in disagreement with those obtained by Caston *et al.* (1994) who reported that body weight of laying hens fed 10 and 20% dietary flaxseed were significantly lighter than that of the control group. This inconsistent response may be attributed to differences in hens breed or in type and level of linseed meal used. The slightly higher body weight gain of birds fed linseed meal-diets plus enzyme supplementation may be brought about through breaking down their

polysaccharides and eliminating the negative impact of mucilage on nutrient digestibility and utilization of metabolizable energy. Alzueta *et al.* (2002) indicated that feeding the demucilaged linseed meal significantly improved digestibility of fat and major fatty acids as well as efficiency of apparent metabolizable energy in broiler chickens and this was associated with a marked reduction in digesta viscosity.

Table (2): Effect of feeding experimental diets containing different levels of linseed meal on body weight and weight gain of Mamourah laying hens from 28 to52 weeks of age.

Item / Treatment		Initial body weight (g)	Final body weight (g)	Weight gain (g)
Linseed meal %	0.0	1620.83	1736.67	115.83
	2.5	1522.50	1637.50	115.00
	5.0	1605.83	1722.00	116.25
	7.5	1583.33	1690.00	106.67
	10.0	1600.00	1700.00	100.00
Linseed meal % + enzyme	2.5	1543.75	1637.50	144.56
	5.0	1588.33	1722.00	142.92
	7.5	1614.17	1690.00	124.16
	10.0	1595.83	1700.00	116.67
Standard error		16.14	14.83	20.08

Laying hens performance:

Data presented in table 3 showed that egg production rate, egg weight, daily egg mass, feed intake and feed conversion were significantly affected by feeding linseed meal-diets without or with enzyme supplementation. It was observed that there were no significant differences in daily feed intake of hens fed the linseed meal-diets with or without enzyme supplementation, with the exception that a significantly lower value was recorded for hens fed the highest level of linseed meal (10%) in the absence or presence of enzyme supplementation, compared with their control counterparts. Birds fed the 10% linseed meal diet with enzyme supplementation had the lowest value of daily feed intake (97.86 g/hen) while the highest value (104.68 g) was recorded for the control group. These results agree with the findings of Richter *et al* (1998a) who observed a significant reduction in feed intake of laying hens fed linseed meal-containing diets. Also, similar results were obtained by Scheideler *et al.* (1994) and Yannak-Poulos *et al.*(1999) who found that hens fed 5% whole linseed meal or 5-15% ground linseed meal consumed significantly less feed compared with the control group. It is note worthy that birds fed linseed meal at a level of 10% of the diet achieved egg production rate, daily egg mass and feed conversion similar to those of the control group. In line with the present results, Richter *et al.* (1998a) reported that feeding 4%-linseed cake-diet did not influence egg production of laying hens. Enzyme supplementation in the present study, resulted in significantly higher egg production rate and daily egg mass regardless of the dietary level of linseed meal. Similar results were observed by Richter *et al.* (1998b) who

found a significant improvement in egg production rate of hens fed enzyme supplemented-diets. In addition, Scheideler *et al.* (1994) observed a significant improvement in egg production rate when laying hens were fed experimental diets containing 5% whole linseeds or 5-15% ground linseed.

Table (3): Means and standard error of egg production % (hen / day) egg weight, egg mass, feed intake and feed conversion of Mamourah laying hens as affected by the different dietary treatments.

Treatment \ Item		Egg/hen/ day %	Egg weight (gm)	Egg mass (gm/ hen/day)	Feed intake gm/hen/ day	Feed conversion gm/hen/day
Linseed meal %	0.0	65.29^{cd}	47.08^{e}	30.84^{d}	104.68^{a}	3.394^{c}
	2.5	66.67^{bc}	48.24^{cd}	32.21^{bc}	103.68^{ab}	3.219^{b}
	5.0	65.07^{cd}	49.41^{ab}	32.26^{bc}	103.14^{ab}	3.197^{b}
	7.5	63.39^{d}	49.95^{a}	31.69^{cd}	103.16^{ab}	3.255^{b}
	10.0	63.50^{d}	48.98^{bc}	31.19^{cd}	102.07^{ab}	3.272^{cb}
Linseed meal % + enzyme	2.5	70.02^{a}	47.91^{de}	33.60^{a}	103.00^{ab}	3.065^{a}
	5.0	69.64^{a}	48.22^{cd}	33.61^{a}	102.64^{ab}	3.053^{a}
	7.5	67.86^{b}	49.19^{abc}	33.41^{a}	102.18^{ab}	3.058^{a}
	10.0	67.60^{b}	48.61^{bcd}	32.91^{ab}	97.87^{c}	2.968^{b}
Standard error		0.631	0.314	0.368	0.708	0.44

a-d: Means with different superscripts in the same column are significantly different.

Analysis of variance showed that birds fed 5-10% linseed meal containing-diets without or with enzyme supplementation laid significantly heavier eggs than did their control counterparts. The increase in egg weight for hens fed the linseed meal-diets may by attributed to heavier egg yolks as indicated in Table 4. In this regard, Yannak-Poulos *et al.* (1999) and Tserveni-Gousi (2001) found that egg weight was significantly higher for hens fed diets containing 5 or 10% ground flaxseed.

Table (4): Means and standard error of egg quality traits for eggs of Mamourah laying hens as affected by the different dietary treatments.

Treatments \ Item		Shell %	Yolk %	Albumen %	Yolk Index	Haugh units	Yolk color
Linseed meal %	0.0	13.18	30.65^{b}	56.39	46.88	84.76	4.6^{d}
	2.5	13.55	32.14^{a}	54.72	46.83	84.57	5.3^{c}
	5.0	13.25	32.20^{a}	55.11	46.81	84.65	5.4b^{c}
	7.5	13.59	32.19^{a}	54.20	46.77	84.44	6.0^{ab}
	10.0	13.28	32.08^{a}	55.12	46.76	84.58	6.4^{a}
Linseed meal % +Enzyme	2.5	13.45	32.60^{a}	54.72	46.82	84.78	5.1^{c}
	5.0	13.40	32.22^{a}	54.70	46.95	84.66	5.4^{bc}
	7.5	13.12	32.18^{a}	54.65	46.81	84.51	5.5^{bc}
	10.0	13.50	32.89^{a}	54.76	46.92	83.68	6.1^{a}
Standard error		0.269	0.613	0.639	0.504	1.18	0.20

a-d: Means with different superscripts in the same column are significantly different.

However, Balnave (1970, 1971) found that linoleic acid content of the vegetable oils was responsible for the improvement of egg weight. This may reflect a synergistic effect between linolenic and linoleic acids leading to an improvement in egg weight.

Feed conversion was significantly ($P<0.05$) better for pullets fed the diets-containing linseed meal up to 7.5% without enzyme supplementation compared with that of the control group, while feed conversion value of pullets fed the diet containing 10% linseed meal was not significantly different from that of the control group. Also, birds fed linseed meal-diets with enzyme supplementation had significantly ($P<0.05$) better values of feed conversion compared with those fed the control diet. Since no differences were observed in feed intake of hens fed the experimental diets containing linseed meal up to 7.5%, the significant improvement in feed conversion achieved by hens fed such diets may be due, at least in part, to an improvement in daily egg mass, regardless of enzyme supplementation. These results agree with the findings of Richter *et al.* (1998b) who observed that addition of enzyme mixture containing β-glucanase to linseed cake-diet improved feed conversion of laying hens. On the other hand, improved egg production and daily egg mass of hens fed the linseed meal-diets plus enzyme were also contributing factors for the improvement of feed conversion achived by these hens.

Egg quality traits:

Results given in Table 4 showed that feeding linseed meal-containing diets with or without enzyme supplementation resulted in significant increases in yolk percentage and yolk color score compared with those of the control group. On the other hand, no significant differences were observed in percentages of egg shell and albumen or Haugh unit due to feeding the experimental diets. These results are in line with those obtained by Caston *et al.* (1994) who reported that shell weight was not affected by the level of ground flaxseed in the diets. Also, Tserveni-Gousi, (2001) found that dietary flaxseed with or without enzyme addition had no significant effect on Haugh unit or albumen weight compared with those of the control group. The same author (Tserveni-Gousi, 2001) reported that hens fed dietary flaxseed produced heavier eggs and egg yolks compared with those of the control group. In accordance with the present results, Yannak-Poulos *et al.* (1999) and Tserveni-Gousi (2001) reported that feeding experimental diets containing 5-10% ground flaxseed achieved a significant increase in yolk color score.

Egg fertility and hatchability:

Data presented in Table 5 showed no significant differences among different dietary treatments in egg weight loss or hatchability percentages. The fertility of eggs produced by birds fed the linseed meal-containing diets (from 5-10%) with or without enzyme supplementation were significantly superior to those of the control group, whereas birds fed the 2.5% linseed meal-diets were not significantly different from those of the control group. No clear explanation could be offered for the observed improvement of egg fertility of hens fed the linseed meal-diets compared with that of the control group. The present results also showed that hatch weight of chicks for birds

fed linseed meal-diets with or without enzyme supplementation was significantly higher compared with that of the control group.

Table (5): Means and Standard error of rate of hatching egg weight (g),egg weight loss (%), fertility %, hatchability % and hatched chicks weight (g) for eggs produced by Mamourah laying hens as affected by the different dietary treatments.

Treatments \ Item		Egg weight (g)	Egg weight Loss %	Fertile eggs (%)	Hatchability (%)	Hatch weight of chick
Linseed meal %	0	51.75	15.95	94.08^{cd}	94.95	30.65^{c}
	2.5	51.21	15.18	94.90^{bc}	95.50	31.70^{a}
	5.0	51.85	15.85	97.68^{a}	95.70	31.76^{a}
	7.5	51.50	15.68	97.18^{a}	95.20	32.58^{a}
	10.0	51.51	15.31	97.76^{a}	95.31	32.25^{a}
Linseed meal % +Enzyme	2.5	51.17	15.15	94.20^{c}	95.80	31.20^{b}
	5.0	51.30	15.30	95.23^{b}	95.40	31.30^{b}
	7.5	51.76	15.46	97.30^{a}	95.65	31.66^{ab}
	10.0	51.40	15.25	97.25^{a}	95.35	32.25^{a}
Standard error		0.285	0.235	0.260	0.250	0.29

a-d: Means with different superscripts in the same column are significantly different.

Selected blood parameters:

Blood plasma levels of cholesterol and triglycerides were significantly lower ($P<0.05$) in birds fed the experimental diets containing linseed meal with or without enzyme supplementation (Table 6). The same response was observed for total lipids concentration of hens fed diets containing 5 to 10% linseed meal either with or without enzyme supplementation. The lowest plasma cholesterol and triglyceride levels were recorded for hens fed the 10% linseed meal-diet followed by those fed 7.5, 5.0 and 2.5% linseed meal-diets either without or with enzyme supplementation. However, the lowest values of total lipids were measured for hens fed the10% linseed meal without or with enzyme supplementation followed by those fed 7.5 and 5.0% linseed meal, respectively. In this respect, gummy substances or polysaccharides can act as hypocholesterolemic agents through binding with the bile salts in the intestinal tract, shortening intestinal transit time of digesta and/or increasing fecal sterol excretion (Khalil, 1994). The current results are in harmony with those reported by Cunnane *et al.* (1989), Ferrier *et al.* (1992) and Farrell (1994), who found that feeding experimental diets containing varying levels of ground flaxseed resulted in a significant reduction in plasma cholesterol and triglycerides. Also, Qota *et al.* (2002) observed a significant decrease in plasma cholesterol and triglyceride in response to feeding linseed meal-diets to broiler chicks. On the contrary, Raya *et al.* (1991b) found no significant differences in concentrations of plasma total lipids and cholesterol of broiler chicks due to a complete dietary substitution of linseed meal for soybean meal.

Table (6): Means and standard error of levels of blood plasma cholesterol, triglycerides and total lipids, and concentrations of egg yolk cholesterol and total lipids of Mamourah laying hens as affected by the different dietary treatments.

Treatments \ Item		Blood plasma			Egg yolk	
		Cholesterol mg/100ml	Triglyceride mg/100ml	Total lipids mg/100ml	Total lipids mg/g yolk	Cholesterol mg/g yolk
Linseed meal %	0.0	186.2^{a}	325.0^{a}	1443.6^{a}	290.0^{a}	14.6^{a}
	2.5	160.0^{b}	291.0^{b}	1418.6^{a}	269.3^{b}	13.0^{b}
	5.0	134.4^{c}	282.5^{b}	1312.4^{b}	242.0^{d}	11.6^{cd}
	7.5	114.4^{d}	250.5^{c}	1325.0^{b}	225.2^{e}	10.2^{e}
	10.0	109.6^{d}	233.5^{c}	1256.2^{b}	211.6^{f}	10.3^{e}
Linseed meal % + Enzyme	2.5	157.0^{b}	292.5^{b}	1431.2^{a}	275.2^{b}	13.3^{b}
	5.0	137.0^{c}	277.5b	1331.2^{b}	257.4^{c}	12.3^{c}
	7.5	127.0^{c}	273.5^{b}	1337.4^{b}	242.0^{d}	11.2^{cd}
	10.0	117.6^{d}	251.0^{c}	1262.4^{b}	227.0^{e}	10.3^{e}
Standard error		3.70	1.74	12.81	3.77	0.26

a-f : Means with different superscripts in the same column are significantly different.

Yolk total lipids and cholesterol:

There were significant ($P<0.05$) reductions in yolk cholesterol and total lipids as the level of dietary linseed meal increased (Table 6). The percent reductions of yolk cholesterol relative to that of the control group exhibited by birds fed 2.5, 5.0, 7.5 and 10% linseed meal-diets without enzyme addition were 10.9, 20.5, 30 and 35%, but with dietary supplemental enzyme these birds showed relative reductions in yolk cholesterol of 8.9, 15.3, 23.5 and 29%, respectively. Yolk total lipids were reduced by about 7.1, 16.5, 22.5 and 27.0% and 5.1, 11.3, 16.5 and 21.7% in eggs of hens fed 2.5, 5.0, 7.5 and 10% linseed meal-diets without or with enzyme supplementation compared with the control group. These reductions in yolk total lipids and cholesterol contents may be related to their lower levels in blood plasma of hens fed the linseed meal-containing diets.

Sensory evaluation:

The effect of feeding linseed meal-containing diets on sensory qualities of fresh and stored eggs are presented in Table 7. Data from the panel test using fresh or stored eggs demonstrated that odor intensity or flavor of normal egg (fresh or stored) was not significantly affected by feeding the different dietary treatments. However, panelists were not able to distinguish between eggs from hens fed linseed meal with or without enzyme and those produced by the control hens. The results in the literature regarding the effect of dietary linseed meal on odor intensity or flavor of normal egg are contradictory, Jiang *et al.* (1992), Caston *et al.* (1994) and Scheideler *et al.* (1994) found that eggs from hens fed 10% whole linseeds or 10-15% ground linseed had lower flavor desirability scores than eggs from hens fed the control diets. Data in Table 7 also showed that dietary linseed meal with or without enzyme supplementation had a significant ($P<0.05$) positive effect on yolk color for fresh and stored eggs. Similar results were obtained by Jiang *et al.* (1992) who found that egg yolk from hens fed flaxseed-diets had the highest color values. On the other hand, Tserveni-

Gousi (2001) reported that the inclusion of flaxseed into laying hen diets reduced the off-flavor and improved the color and flavor of boiled eggs.

Table (7): Means and standard error of scores of panel test characteristics of eggs produced by Mamourah laying hens as affected by the different dietary treatments.

Treatment \ Item		Yolk odor intensity		Flavor		Yolk color	
		Fresh	Stored	Fresh	Stored	Fresh	Stored
Linseed meal %	0	4.21	4.35	5.20	5.10	5.10^{b}	5.33^{c}
	2.5	4.12	4.25	5.16	5.10	5.33^{b}	5.80^{bc}
	5.0	3.95	4.08	5.13	5.00	5.70^{ab}	6.20^{ab}
	7.5	4.05	4.18	5.13	4.96	5.90^{ab}	6.40^{ab}
	10.0	4.13	4.26	5.16	4.96	6.00^{a}	6.80^{a}
Linseed meal % + Enzyme	2.5	4.02	4.13	5.16	5.03	5.60^{ab}	6.20^{ab}
	5.0	4.12	4.25	5.16	4.86	5.80^{ab}	6.20^{ab}
	7.5	4.00	4.08	5.10	4.90	5.80^{ab}	6.40ab
	10.0	4.09	4.18	5.06	4.90	5.90^{ab}	6.60^{a}
Standard error		0.140	0.140	0.03	0.05	0.172	0.172

a-c : Means with different superscripts in the same column are significantly different.

Economical efficiency :

Results given in Table 8 showed that economic efficiency of birds fed the linseed meal-containing diets with or without enzyme supplementation were approximately similar to that of the control group.

Table (8): Economic efficiency of Mamourah laying hens as affected by the different dietary treatments.

Treatment / Item	Linseed meal (%) without enzyme					Linseed meal % with enzyme			
	0	2.5	5.0	7.5	10.0	2.5	5.0	7.5	10.0
Total feed cost/hen L.E	26.25	26.40	26.30	26.30	26.00	26.63	26.54	26.44	25.53
Total No. of egg/hen	110.0	112.0	109.3	106.5	106.6	117.6	117.0	114.0	113.5
Total revenue /hen L.E	33.0	33.6	32.8	32.0	32.0	35.3	35.1	34.2	34.0
Net revenue/hen L.E	6.75	7.20	6.50	5.70	6.00	8.66	8.56	7.76	8.47
Economic efficiency%	25.7	27.2	24.7	21.5	22.6	32.5	32.2	29.3	33.1

1-Total feed cost /hen L.E= Feed intake x price of kg feed.

2- Total revenue /hen L. E= total No .of egg /hen x price of an egg at time of experiment=30Pt.

In conclusion, taking the economical aspect into account, linseed meal could be safely used with or without enzyme supplementation up to 10.0% in laying hen diets without any adverse effects on their productive and reproductive performance or egg quality.

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تأثير التغذية على علائق تحتوى على كسب بذرة الكتان مع أو بدون أنزيمات على الأداء الإنتاجى والتناسلي لدجاج المعمورة البياض

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أجريت هذه التجربة لتقييم تأثير التغذية على علائق تحتوى كسب بذرة الكتان مع أو بدون إنزيم على الأداء الإنتاجى والتناسلي لدجاج المعمورة البياض.تم استخدام عدد 270دجاجة عمر 24أسبوع وزعت عشوائيا إلى 9مجموعات بكل منها 30دجاجة، وغذيت على علائق تجريبية مختلفة تحتوي على مستويات متدرجة من كسب بذرة الكتان (صفر أو 2.5 أو 5.0 أو 7.5 أو 10.0%) في وجود أو عدم وجود إضافة الإنزيم (كيمزايم معدل 1جم/ كجم عليقة). وتم تكوين جميع العلائق التجريبية بحيث تكون ذات محتويات متساوية تقريبا من الطاقة والبروتين.

أهم النتائج يمكن تلخيصها كالتالي:

1- استهلكت الطيور التي غذيت على العلائق المحتوية على 10% كسب بذرة الكتان + الإنزيم أقل كمية من الغذاء عند مقارنتها بباقي المجموعات.
2- لم يكن للتغذية على العلائق التي تحتوى على كسب بذرة الكتان تأثيرات سيئة على الأداء الإنتاجى لدجاج المعمورة فيما يتعلق بإنتاج البيض، وزن البيض وكفاءة التحويل الغذائي بينما أدت الإضافة الإنزيمية إلى حدوث بعض التحسينات في القياسات السابقة.
3- كانت هناك زيادة معنوية فى كل من النسبة المئوية لوزن الصفار ولون الصفار في المجموعات التي غذيت على العلائق المحتوية على كسب بذرة الكتان بينما لم يلاحظ أي اختلافات معنوية فى النسب المئوية لوزن القشرة، والبياض ووحدات هوف بالمقارنة بمجموعة الكنترول.
4- كانت هناك زيادة معنوية فى كل من النسبة المئوية لخصوبة البيض ووزن الكتكوت عند الفقس للطيور التى غذيت على العلائق التي تحتوى على كسب الكتان عن تلك التى غذيت على عليقة الكنترول،بينما لم تتأثر النسبة المئوية للفقس بالمعاملات المختلفة.
5- حدث انخفاضا معنويا فى تركيزالكوليستيرول والدهون الكلية فى صفار البيض للطيور التى تغذت على العلائق المحتوية على كسب بذرة الكتان مع أو بدون إضافة الأنزيم, كما لوحظت أيضا نفس الاستجابة لمستويات كل من الكوليستيرول والدهون الكلية فى بلازما الدم.
6- أوضحت نتائج اختبارات التذوق سواء للبيض الطازج أو المخزن عدم تأثر رائحة أو طعم البيض بالمعاملات الغذائية المختلفة.

عموما مع الأخذ فى الإعتبار الناحية الاقتصادية يمكن استخدام كسب بذرة الكتان حتى مستوى10% فى علائق دجاج المعمورة البياض دون حدوث أي تأثيرات سلبية على جودة البيض أو الأداء الإنتاجى أوالتناسلي للدجاج.