

PERFORMANCE OF SILVER MONTAZAH HENS FED MASH OR PELLETTED DIETS CONTAINING CORN-WITH-COBS MEAL WITH OR WITHOUT ENZYME SUPPLEMENTATION

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ABSTRACT

A factorial experiment (4×2×2) was conducted to evaluate the response of laying hens to feeding experimental diets containing graded levels of corn-with-cobs meal (0, 10, 20 and 30%) with or without Kemzyme[®] supplementation (0 and 1 g/kg diet) in the form of mash or pellets. Thus, 16 isocaloric and isonitrogenous diets were formulated and used from 28 to 52 weeks of age. A total of 384 Silver Montazah laying hens were randomly chosen, individually caged in an open sided house and exposed to a daily photoperiod of 16 hr, and managed similarly. All hens were fed their respective experimental diets and had free access to water throughout the experimental period. The most important results obtained could be summarized as follows:

Dietary level of corn-with-cobs meal (CCM) had no significant effects on body weight change, feed consumption, egg weight, egg shape index and yolk index or serum total protein, albumin, calcium, inorganic phosphorus, or activity of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) in blood serum of hens. Increasing dietary level of CCM positively affected feed conversion, egg production rate and egg mass. In addition, Haugh units and serum and egg cholesterol were significantly increased when the level of CCM reached 30%. However, neither dietary enzyme supplementation nor diet form (mash vs. pellets) had significant effects on body weight change, feed consumption, feed conversion, egg production rate, egg weight, egg mass, shell thickness, egg shape index, yolk index, Haugh units or egg cholesterol, or serum levels of total protein, albumin, cholesterol, calcium, inorganic phosphorus, and activity of ALT and AST in blood serum. According to the obtained results, corn-with-cobs meal can be included up to 30% in diets of Silver Montazah laying hens, without compromising their productive performance or egg quality, with no need for pelleting the diets or adding exogenous enzymes.

Keywords: Corn-with-cobs meal, enzyme addition, diet form, laying performance.

INTRODUCTION

Compared with other cereal grains, corn (*Zea mays* L.) is the preferable primary energy source in poultry diets. The continuous increase in human population worldwide, particularly in developing countries, is often associated with increasing the relative prices of certain competitive animal and human feed- and foodstuffs, including corn, wheat, barley, rice and others. This necessitates an urgent need to look for cheaper or untraditional alternative feedstuffs. The whole corn-with-cobs meal, the ground product of the entire maize ear including the cobs, is an example of such feedstuffs which is efficiently used by ruminants, and there is almost no difference in the performance of feedlot animals receiving corn-with-cobs meal and animals feeding on shelled maize (FAO, 2004). For horses, corn-with-cobs meal

(which is also termed as corn-and-cob meal, corn ear or maize ear) is usually preferred to shelled maize as it is less likely to form a doughy mass in the stomach (FAO, 2004). It has been reviewed that the high fiber content of corn-with-cobs meal restricts its use as a feed ingredient in poultry diets; however, pigs can tolerate the incorporation of such feed ingredient up to 25-50% in their diets, depending on age (FAO, 2004). In harmony with the general nutritional aspect that the nutritive value of any feed ingredient is essentially affected by its chemical composition, Martínez *et al.* (2008) reported that chemical compositions of maize ear and corn are similar, but maize ear has higher fibre content than corn. They also found that inclusion of maize ear in the diet for fattening rabbits increases the digestible energy content, reduces the voluntary feed intake and improves feed conversion ratio.

According to the available sources of literature, very limited information is presented on the nutritive value of corn-with-cobs meal for poultry. In this regard, Scott *et al.* (1976) tabulated that corn-and-cob meal contains [on dry matter (DM) basis] 7.5% crude protein, 3.0% fat, 8.6% crude fiber, 0.04% calcium, 0.20% total P, 0.07% available P, 0.18% histidine, 0.18% lysine, 0.16% methionine, 0.16% cystine, 0.45% arginine, 0.45% phenylalanine, 0.45% glycine, 0.36% valine, 0.36% isoleucine, 0.36% threonine, 1.0% leucine and 0.09% tryptophan, and it has a metabolizable energy of 2840 kcal/kg DM. Recently, Martínez *et al.* (2008) reported that chemical composition of maize ear (DM basis) was as follows: 91.9% DM, 1.25% ash, 7.8% crude protein, 3.23% ether extract, 5.55% crude fiber, 18.0% neutral detergent fiber and 6.02% acid detergent fiber. The corresponding composition of corn cobs was as follows: 94.2, 1.94, 2.23, 0.471, 38.0, 86.1, 45.3 and 5.22% for DM, ash, crude protein, ether extract, crude fiber, neutral detergent fiber, acid detergent fiber and acid detergent lignin, respectively (Martínez *et al.*, 2008).

On the other hand, Longe and Ogedegbe (1989) fed growing pullets (from 9 to 21 weeks old) experimental diets containing graded amounts of maize cobs (5 to 20% of the diet) and found that ME intake was significantly reduced when the dietary level of maize cob exceeded 10%. They also found that protein intake was unaffected by dietary treatments but apparent nitrogen retention was significantly lower in pullets given the diet having 20% maize cob as compared to their control counterparts. Adeyemi and Familade (2003) fed laying hens on diets containing corn-cobs at levels of 5, 10, 15 and 20% of the total diet at the expense of maize. They found that hen-day production and feed per dozen eggs decreased with increasing dietary level of corn-cobs whereas egg weight and shell thickness were not significantly influenced by dietary treatments. In general, we must bear in mind that the nutritive value of a feedstuff for poultry can vary considerably depending upon its chemical composition and level of inclusion, composition and physical nature (i.e. particle size and texture) of the basal diet, type and age of the experimental birds and/or other factors.

Nowadays, most nutritionists formulate diets destined to poultry based completely on oil-seed meals, cereal grains and their by-products. Such plant feed ingredients naturally contain a variety of components (i.e.

antinutritional substances) that cannot be digested by monogastric animals because of the lack of or insufficiency of endogenous enzyme secretions. In addition to being unavailable to the animal, these components also lower the utilization of other dietary nutrients, leading to depressed performance. Recently, the inclusion of commercial enzymes into poultry diets has become a common practice, with different degrees of success depending upon the stress, health and nutritional status of the bird. The main targets for using feed enzymes are to increase digestibility (or availability) of nutrients, to break down the antinutritional factors, to achieve the least cost feed formulations and for environmental reasons (Bedford, 1996; Bedford and Morgan, 1996; Bedford and Partridge, 2003).

Therefore, the present study was carried out to evaluate the response of laying hens to feeding mash and pelleted diets containing graded levels of corn-with-cobs meal with or without enzyme supplementation.

MATERIALS AND METHODS

A 4×2×2 factorial experiment was carried out at Gimmizah Poultry Research Station, belonging to the Animal Production Research Institute, Ministry of Agriculture, Egypt. A total of 384 28-week-old Silver Montazah laying hens were randomly chosen and distributed into 16 equal experimental groups of 24 birds each (with 3 equal replications per treatment). Four isoenergetic (metabolizable energy of about 2700 kcal/kg) and isonitrogenous (crude protein of about 15%) experimental diets containing 4 levels of corn-with-cobs meal (CCM; 0, 10, 20 and 30%) were formulated as mash or pellets with or without Kemzyme[®] supplementation (0 and 1 g/kg diet). Thus, 16 experimental diets were prepared and used from 28 to 52 weeks of age. The experimental diets were formulated to meet the nutrient requirements of the local strains of laying hens, as indicated by several reports on the developed native chickens. Composition and proximate analysis of the experimental diets, used in this study, are presented in Table 1. Kemzyme[®] preparation contained alpha-amylase, β-glucanase, lipase, and cellulose. The hens were kept in individual cages in an open-sided laying house. All birds were exposed to a daily photoperiod of 16 hr and kept under the same hygienic and managerial conditions.

Daily records on hen-day egg production rate (EPR) and mortality of hens were maintained throughout the whole experimental period. Feed intake (FI), feed conversion (FC), EPR, egg weight (EW) and egg mass (EM) were determined, on a 28-d period basis, for the entire experimental period. Body weight change (BWC) and economic efficiency of production (EEP) were also estimated for the whole experimental period. EEP was calculated as 100 times net revenue divided by total costs. Net revenue (NR) was calculated as total revenues minus total costs. It also important to point out that total costs include purchasing price of pullet and total feed cost/pullet. Total revenues include sale price of spent hens and eggs. At 34 weeks of age, 6 blood samples were collected from the wing veins in non-heparinized test tubes. Blood sera were analyzed for the determination of concentrations of total

protein (TP; Henry *et al.*, 1964), albumin (AL; Dumas *et al.*, 1971), cholesterol (CH; Allain *et al.*, 1974), calcium (Ca; Tietz, 1987) and inorganic phosphorus (IP; Goldenberg and Fernandez, 1966) as well as activity of serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST; Reitman and Frankel, 1957) of laying hens. At the end of the experimental period (52 weeks of age), 15 eggs per treatment were collected and used for egg quality measurements. Egg quality was measured in terms of egg weight and its components (weights of egg shell, egg yolk and egg albumen), egg shape index (ESI), shell thickness (ST), yolk index (YI) and Haugh units (HU; Haugh, 1937). Egg yolk cholesterol (EYC) contents were also determined according to the method described by Ingr *et al.* (1987).

Table (1): Ingredients and nutrient composition of the experimental diets[§]

Ingredients %	Levels of corn-with-cobs meal (%)			
	0.00	10.0	20.0	30.0
Yellow corn	64.00	55.75	47.55	39.00
Soybean meal (44% CP)	17.25	17.25	17.25	17.20
Corn-with-cobs meal*	0.00	10.00	20.00	30.00
Wheat bran	6.50	4.25	2.00	0.00
Corn gluten meal (62% CP)	2.15	2.40	2.60	2.85
DL-Methionine	0.10	0.10	0.10	0.10
L-Lysine-HCl	0.10	0.10	0.10	0.10
Limestone	7.70	7.70	7.70	7.70
Dicalcium phosphate	1.60	1.60	1.60	1.60
Common salt	0.30	0.30	0.30	0.30
Vit. & Min. Premix**	0.30	0.30	0.30	0.30
Commercial vegetable oil	0.00	0.25	0.50	0.85
Total	100.00	100.00	100.00	100.00
Price/kg diet; P.T.	119	116	115	113
Calculated analysis (Air-dry basis: NRC, 1994)				
ME; kcal/kg	2701	2700	2699	2689
Crude protein (CP); %	15.00	15.00	15.00	15.00
Ether extract (EE); %	3.36	3.40	3.44	3.47
Crude fiber (CF); %	3.44	3.81	4.18	4.56
Ca; %	3.34	3.34	3.35	3.32
Non-phytate P; %	0.42	0.41	0.40	0.39
Lysine; %	0.79	0.76	0.73	0.69
Meth. & Cystine	0.62	0.62	0.60	0.58
Determined analysis (Dry matter basis: AOAC, 1990)				
Dry matter (DM); %	91.85	90.90	91.25	90.79
Ash; %	6.05	6.03	6.01	6.00
CP; %	16.03	16.30	16.18	16.37
EE; %	3.75	3.83	3.83	3.86
CF; %	3.97	4.40	4.62	5.08
NFE %	62.05	60.34	60.61	59.48

[§]: Pelleting and enzyme addition add 7 and 3 piasters to the price per kg diet illustrated above.

*: The nutrient composition of corn and cobs meal was calculated according to Scott *et al.* (1976).

** : Vitamin and Mineral Premix supplies each kg of the experimental diets with the following concentrations of nutrients: Vit. A, 10000 IU; Vit. D₃, 2000 IU; 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 chloride, 250 mg; Fe, 30 mg; Zn, 50 mg; Cu, 4 mg and Se, 0.1 mg.

A completely randomized block design in a factorial arrangement of treatments ($4 \times 2 \times 2$), 4 dietary levels of CCM (0, 10, 20 and 30%) with or without Kemzyme[®] addition (0 and 1 g/kg diet) in two diet forms (mash and pellets), was used. The statistical processing of data was performed by using multifactor analysis of variance of the general linear model procedure of the Statistical Analysis System (SAS, 1990). When the main effects were significant ($P \leq 0.05$), means were separated by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Productive performance of Silver Montazah laying hens:

Regardless of the effects of diet form and enzyme addition, EPR, total EM and FC (Table 2), NR and EEP of Silver Montazah (Table 3) were significantly ($P < 0.05$) affected by dietary level of corn-with-cobs meal (CCM) during the whole experimental period (28-52 weeks of age), while BWC, total FI and EW were not affected (Table 2). Hens fed the CCM-containing diets exhibited superior means of EPR, total EM and FC, NR and EEP compared with those of their control counterparts (Tables 2 and 3).

The best EPR was accomplished by hens fed the 30%-CCM-containing diets, followed by that of hens fed the 20%-CCM-diets, and then that of birds fed the 10%-CCM-diets, with no significant differences among them. The same trend of positive response was also observed in FC, total EM, NR and EEP of Silver Montazah laying hens. However, neither diet form (mash vs. pellets) nor enzyme addition had a significant effect on BWC, FI, FC, EPR, EW, EM and NR (Tables 2 and 3), but EEP was significantly increased due to enzyme addition (Table 3), regardless of the effects of other dietary factors. There were significant interactions ($P < 0.05$) between dietary CCM level and enzyme addition on FC, EPR and EM (Table 2), and NR and EEP (Table 3). The interactions between dietary CCM level and diet form were significant at $P < 0.05$ for FC, EPR, EM, NR and EEP (Tables 2 and 3). Enzyme addition by diet form interactions were only significant ($P < 0.05$) for FC, EM and EEP (Tables 2 and 3). The interactions among all dietary factors (*i.e.* ABC interactions) were significant for FC, EPR, EM, NR and EEP (Tables 2 and 3).

Since total feed intakes were approximately similar for all the experimental groups of Silver Montazah laying hens, the better productive performance (EPR, FC and EM) of hens fed the CCM-containing diets indicates that these hens could utilize their diets more efficiently than that did the control ones. The lack of significant differences in total FI among the different experimental groups of hens is an indication that CCM had no effect on the appetite of birds or palatability of diets. Also, it is interesting to note that inclusion of the CCM in the current the experimental diets increased their crude fiber contents only from 3.44 (in the control diet) to 4.56% (in the 30%-CCM-diet), which were in the normal range for laying hens. Unfortunately, no reports were found in the literature on the use of corn-with-cobs meal in laying hen diets.

Table (2): Laying performance of Sliver Montazah hens in response to feeding the experimental diets during whole experimental period (28-52 weeks of age).

Treatments ³	BWC (g)	FI (kg/hen)	FC (kg:kg)	EPR (%)	EW (g)	EM (kg/hen)
A: 1 (0.0 %)	504.89	20.279	5.51 ^b	50.93 ^b	44.94	3.678 ^c
2 (10 %)	514.53	20.235	5.32 ^a	52.62 ^a	44.92	3.803 ^b
3 (20 %)	507.65	20.300	5.30 ^a	52.96 ^a	44.96	3.830 ^b
4 (30 %)	514.16	20.405	5.28 ^a	53.41 ^a	44.97	3.863 ^a
SEM	3.19	2.354	0.12	3.02	0.18	0.210
Sig. level	NS	NS	*	*	NS	*
B: 1 (0 g)	508.35	20.311	5.38	52.21	44.95	3.773
2 (1 g)	512.26	20.299	5.32	52.74	44.95	3.813
SEM	0.89	3.112	0.10	4.00	0.18	0.182
Sig. level	NS	NS	NS	NS	NS	NS
C: 1 Mash	507.63	20.295	5.35	52.38	44.96	3.795
2 Pellet	512.99	20.317	5.33	52.58	44.94	3.812
SEM	1.01	3.001	0.09	2.51	0.15	0.153
Sig. level	NS	NS	NS	NS	NS	NS
AB: 1 (1x1)	503.12	20.335	5.56	50.65	44.93	3.655
2 (2x1)	514.58	20.228	5.35	52.30	44.91	3.779
3 (3x1)	505.73	20.284	5.32	52.71	44.96	3.813
4 (4x1)	510.00	20.398	5.35	52.96	44.01	3.809
5 (1x2)	506.66	20.222	5.46	51.20	44.97	3.703
6 (2x2)	514.47	20.242	5.32	52.65	44.94	3.804
7 (3x2)	509.58	20.316	5.27	52.85	44.95	3.852
8 (4x2)	518.33	20.417	5.28	53.48	44.94	3.870
SEM	1.02	2.015	0.15	2.46	0.18	0.172
Sig. level	NS	NS	*	*	NS	*
AC: 1 (1x1)	499.58	20.261	5.53	50.77	44.94	3.666
2 (2x1)	513.75	20.250	5.34	52.52	44.93	3.796
3 (3x1)	502.81	20.267	5.37	52.24	44.97	3.777
4 (4x1)	514.38	20.400	5.29	53.33	44.99	3.855
5 (1x2)	510.50	20.298	5.50	51.08	44.94	3.689
6 (2x2)	515.31	20.220	5.37	52.15	44.91	3.767
7 (3x2)	512.50	20.334	5.31	53.00	44.95	3.832
8 (4x2)	513.95	20.415	5.27	53.55	44.96	3.874
SEM	1.05	3.589	0.08	4.25	0.17	0.223
Sig. level	NS	NS	*	*	NS	*
BC: 1 (1x1)	504.79	20.313	5.42	51.91	44.95	3.750
2 (2x1)	510.46	20.275	5.31	52.83	44.96	3.820
3 (1x2)	511.92	20.310	5.35	52.53	44.95	3.796
4 (2x2)	514.06	20.324	5.34	52.64	44.93	3.807
SEM	0.89	2.445	0.16	4.00	0.19	0.128
Sig. level	NS	NS	*	NS	NS	*
BC: 1 (1x1x1)	497.70	20.319	5.59	50.38	44.92	3.632
2 (2x1x1)	501.46	20.255	5.40	51.85	44.90	3.749
3 (3x1x1)	512.91	20.279	5.33	52.54	44.97	3.801
4 (4x1x1)	514.58	20.363	5.32	52.90	45.03	3.825
5 (1x2x1)	500.00	20.213	5.47	51.15	44.93	3.697
6 (2x2x1)	505.62	20.254	5.28	53.08	44.97	3.839
7 (3x2x1)	508.54	20.261	5.26	53.27	44.97	3.849
8 (4x2x1)	520.20	20.410	5.25	53.79	44.95	3.887
9 (1x1x2)	508.54	20.353	5.53	50.93	44.95	3.677
10 (2x1x2)	511.87	20.214	5.32	52.49	44.92	3.796
11 (3x1x2)	516.25	20.263	5.29	53.00	44.94	3.830
12 (4x1x2)	514.37	20.382	5.26	53.55	44.99	3.874
13 (1x2x2)	511.45	20.242	5.46	51.30	44.94	3.707
14 (2x2x2)	513.54	20.102	5.27	52.73	44.91	3.811
15 (3x2x2)	511.45	20.381	5.31	53.08	44.97	3.837
16 (4x2x2)	516.45	20.425	5.27	53.51	44.92	3.874
SEM	1.18	4.021	0.17	4.85	0.18	0.321
Sig. level	NS	NS	*	*	NS	*

³: A, B and C refer to dietary level of corn-with-cobs meal, enzyme addition and diet form, respectively.

^{a-c}: For each of the main factors, means bearing common superscripts are not significantly different (P≤0.05).

NS: Not significant, *: Significant at P<0.05.

In this regard, however, Longe and Ogedegbe (1989) fed growing pullets (from 9 to 21 weeks old) experimental diets containing graded amounts of maize cobs (5 to 20% of the diet) and found that ME intake was significantly reduced when the dietary level of maize cob exceeded 10%. They also found that protein intake was unaffected by dietary treatments but apparent nitrogen retention was significantly lower in pullets given the diet having 20% maize cob as compared to their control counterparts. In a later study, Adeyemi and Familade (2003) fed laying hens on diets containing corn-cobs at levels of 5, 10, 15 and 20% of the total diet at the expense of maize. They found that hen-day production and feed per dozen eggs decreased with increasing dietary level of corn-cobs whereas egg weight and shell thickness were not significantly influenced by dietary treatments. Working with rabbits, Martínez *et al.* (2008) evaluated the nutritive value of maize ear (incorporated at 20 and 40% of the diet) for rabbits and found that the inclusion of maize ear in the diet increases the digestible energy content, reduces the voluntary feed intake and improves feed conversion on fattening rabbits.

According to the scientific literature, inconsistent responses of laying hens to feeding the enzyme-supplemented diets were observed. Several reports have indicated beneficial effects of enzyme addition to laying hen diets (e.g. Van der Klis *et al.*, 1997; Jackson *et al.*, 1999; Attia *et al.*, 2001; Jalal and Scheideler, 2001; Yakout *et al.*, 2003; El-Deek *et al.*, 2003), while some others failed to observe positive effects (Al Bustany and Elwinger, 1988; Francesch *et al.*, 1995; Senkoylu *et al.*, 2004). The insignificant effect of dietary enzyme supplementation on the productive performance of laying hens, observed in the present study, is in accordance with the results obtained by Al Bustany and Elwinger (1988), who found no significant effects on performance of laying hens when β -glucanase was added to barley-based diets. In line also with the present findings, Francesch *et al.* (1995) reported that there were no significant differences in rate of lay, daily feed intake and body weight gain of laying hens in response to feeding enzyme-supplemented diets. Recently, Senkoylu *et al.* (2004) observed no effect of enzyme addition on the productive performance of laying hens in one trial but feed conversion was improved in another trial due to enzyme supplementation.

On the other hand, Van der Klis *et al.* (1997) reported that production performance (except feed conversion ratio) was significantly improved by dietary supplementation of phytase. Jackson *et al.* (1999) concluded that β -mannanase is capable of increasing egg weight in commercial layers at early stages of production, and increasing egg production, particularly delaying the postpeak decline in productivity. Attia *et al.* (2001) reported that phytase and/or a multienzyme mixture (Optizyme) could overcome the negative effects of feeding rice bran-based diet on productive and reproductive performance of Norfa laying hens. Similarly, Jalal and Scheideler (2001) indicated that supplementation of phytase in normal; corn-soybean meal diets improved feed intake, feed conversion and egg mass while egg production and egg weight were not affected. In addition, Yakout *et al.* (2003) demonstrated that productive performance of Mandarah laying hens were

significantly improved in response to enzyme supplementation (Bio-Nutra[®]) to diets of different energy levels. Moreover, El-Deek *et al.* (2003) reported that addition of multi-enzyme mixture to 60% barley-containing diet improved egg production and egg mass.

These inconsistent responses of poultry species to dietary enzyme supplementation are expected and depend on the effectiveness of feed enzymes. The latter can vary considerably depending upon on a variety of factors relating to enzyme (*i.e.* type of enzyme preparation, its biological activity, level of addition, degree of specificity to substrate and its stability to feed processing or storage conditions), bird (*i.e.* age, breed or strain, nutritional, physiological and stress status) and diet (*i.e.* composition, form, physical features and method of processing); feeding programs and housing systems may also be involved.

In the present study, it was observed that Silver Montazah laying hens receiving their experimental diets in mash form performed approximately similar as did those given the pellets, suggesting no significant impact of diet form on the efficiency of feed utilization and thereby the productive performance. This insignificant effect of diet form (mash versus pellets) on hens' productivity, reported herein, is in line with the suggestion of McCracken (2002), who presented an excellent review on the effects of physical processing on the nutritive value of poultry diets and pointed out that laying hens can perform equally well whether their diet is supplies as mash or pellets. In addition, working with broiler chicks, McCracken *et al.* (1993) observed no significant differences in apparent metabolizable energy contents of a diet offered as mash or pellets after steam conditioning at 75°C for 1 min.

However, Almirall *et al.* (1997) found that feeding pelleted diets increased egg production and egg weight, and improved the food efficiency of laying hens in summer season. Similarly, Wahlström *et al.* (1999) reported that hens fed crumbled diet compared with mash diet had significantly superior feed conversion ratio, and higher body weight, egg weight and egg mass production, suggesting a higher nutritive value for the crumbled diet. Moreover, Zelenka (2003) indicated that steam pelleting increased apparent digestibility of all organic nutrients in 65-day-old Ross hybrid male chickens. With growing ducklings, Rabie (2004) found that birds fed on pellets exhibited higher means of live body weight, weight gain and feed conversion, and superior CP and EE digestibility compared with those fed on the mash diets.

Egg quality of Silver Montazah laying hens:

Irrespective of the effects of diet form and enzyme addition, hens fed the 10%- and 20%-CCM diets produced eggs of superior ST ($P<0.05$) as compared to those of the control birds, with no significant differences between them (Table 3). Also, hens fed the 30%-CCM diets produced eggs with ST that was not significantly different from that of the control birds. It was interesting to observe that hens fed the 30%-CCM diets produced eggs with the best mean of HU ($P<0.05$) compared with the other experimental groups, with no significant differences among them (Table 3).

Table (3): Egg quality and economic efficiency of 52-week-old Sliver Montazah laying hens in response to feeding the experimental diets

Treatments ^a	ST(mm×100)	ESI	YI	HU	NR (L.E.)	EEP (%)
A: 1 (0.0 %)	30.72 ^b	0.745	0.448	81.63 ^b	26.77 ^b	89.19 ^b
2 (10 %)	32.56 ^a	0.750	0.444	82.97 ^b	28.27 ^a	94.40 ^{ab}
3 (20 %)	32.32 ^a	0.752	0.445	81.82 ^b	28.50 ^a	94.97 ^{ab}
4 (30 %)	29.32 ^b	0.748	0.447	84.26 ^a	28.80 ^a	95.64 ^a
SEM	1.64	0.002	0.007	4.19	1.44	4.85
Sig. level	*	NS	NS	*	*	*
B: 1 (0 g)	30.99	0.748	0.447	82.30	27.87	90.90 ^b
2 (1 g)	31.46	0.749	0.445	83.04	28.29	94.25 ^a
SEM	1.63	0.003	0.004	4.08	1.68	5.01
Sig. level	NS	NS	NS	NS	NS	*
C: 1 Mash	31.17	0.747	0.453	82.19	28.04	93.57
2 Pellet	31.29	0.750	0.438	82.43	28.13	93.58
SEM	1.60	0.004	0.003	4.19	1.75	5.30
Sig. level	NS	NS	NS	NS	NS	NS
AB: 1 (1x1)	29.80	0.748	0.449	81.07	26.50	88.15
2 (2x1)	32.02	0.752	0.449	81.90	28.02	93.65
3 (3x1)	33.20	0.742	0.438	82.00	28.32	94.50
4 (4x1)	28.95	0.750	0.451	84.25	28.64	95.31
5 (1x2)	31.62	0.741	0.447	82.20	27.04	90.21
6 (2x2)	33.10	0.749	0.438	84.05	28.51	95.14
7 (3x2)	31.45	0.762	0.451	81.65	28.67	95.45
8 (4x2)	29.70	0.745	0.443	84.27	28.95	96.17
SEM	3.16	0.007	0.004	2.15	1.80	4.82
Sig. level	*	NS	NS	*	*	*
AC: 1 (1x1)	30.87	0.738	0.450	81.60	27.08	90.49
2 (2x1)	32.52	0.749	0.452	83.52	28.21	94.27
3 (3x1)	32.52	0.750	0.463	82.42	28.46	95.09
4 (4x1)	28.75	0.751	0.449	84.12	28.78	95.81
5 (1x2)	30.55	0.751	0.445	81.67	26.84	89.26
6 (2x2)	32.60	0.752	0.436	82.42	28.33	94.53
7 (3x2)	32.12	0.754	0.427	81.23	28.52	94.86
8 (4x2)	29.90	0.745	0.446	84.40	28.82	95.67
SEM	1.72	0.032	0.002	2.84	1.35	4.99
Sig. level	NS	NS	NS	*	*	*
BC: 1 (1x1)	30.88	0.748	0.451	82.62	27.65	92.24
2 (2x1)	31.45	0.746	0.455	83.21	28.43	94.89
3 (1x2)	31.10	0.748	0.442	81.98	28.10	93.56
4 (2x2)	31.48	0.752	0.434	82.87	28.15	93.60
SEM	3.12	0.021	0.011	3.41	1.91	4.21
Sig. level	NS	NS	NS	*	NS	*
BC: 1 (1x1x1)	30.05	0.741	0.447	80.60	26.32	87.72
2 (2x1x1)	30.90	0.751	0.464	82.90	27.73	92.71
3 (3x1x1)	32.85	0.746	0.444	84.25	28.10	93.83
4 (4x1x1)	29.75	0.753	0.451	82.75	28.43	94.72
5 (1x2x1)	31.70	0.735	0.454	82.60	27.08	90.49
6 (2x2x1)	34.15	0.748	0.439	84.15	28.69	95.82
7 (3x2x1)	32.20	0.754	0.481	80.60	28.83	96.35
8 (4x2x1)	27.75	0.748	0.446	85.50	29.13	96.89
9 (1x1x2)	29.55	0.756	0.451	81.55	26.68	88.59
10 (2x1x2)	33.15	0.753	0.435	80.90	28.32	94.59
11 (3x1x2)	33.55	0.739	0.433	79.75	28.55	95.17
12 (4x1x2)	28.15	0.746	0.452	85.75	28.86	95.90
13 (1x2x2)	31.55	0.747	0.440	81.80	27.01	89.93
14 (2x2x2)	32.05	0.751	0.437	83.95	28.34	94.46
15 (3x2x2)	30.70	0.769	0.421	82.71	28.50	94.56
16 (4x2x2)	31.65	0.743	0.439	83.05	28.77	95.44
SEM	2.85	0.015	0.004	4.02	1.82	3.89
Sig. level	*	*	*	*	*	*

^a: A, B and C refer to dietary level of corn-with-cobs meal, enzyme addition and diet form, respectively.

^{a-c}: For each of the main factors, means bearing common superscripts are not significantly different (P≤0.05).

NS: Not significant, *: Significant at P<0.05.

Dietary level of CCM had no significant effect on ESI and YI of eggs produced by 52-week-old Silver Montazah laying hens, regardless of the effects of other dietary factors (Table 3). However, neither dietary enzyme supplementation nor diet form (mash vs. pellets) had a significant effect on egg quality traits, measured in the present study, regardless of the effects of other dietary factors (Table 3).

There were significant interactions ($P < 0.05$) between dietary CCM level and enzyme addition on ST and HU whereas ESI and YI were not affected (Table 3). The interactions between dietary CCM level and diet form were also significant ($P < 0.05$) for ST and HU but ESI and YI were not affected. Enzyme addition by diet form interactions were only significant ($P < 0.05$) for HU while ST, ESI and YI were not affected. The interactions among all dietary factors (*i.e.* ABC interactions) were significant ($P < 0.05$) for ST, ESI, YI and HU (Table 3).

The lack of positive effects of dietary enzyme supplementation on egg quality traits of Silver Montazah laying hens is in accordance with the findings of Wu *et al.* (2005), who found that feeding enzyme-supplemented diets exerted no significant effect on most of egg quality parameters. In the meantime, Yakout *et al.* (2003) reported that enzyme supplementation had no effect on egg components but significantly improved egg weight. However, Roberts *et al.* (2006) reported a positive effect for using the commercial enzyme products in laying hen diets on shell thickness.

The insignificant effects of the physical form of the diet (mash versus pellets) on egg quality traits in the present study are in harmony with those reported by Deaton *et al.* (1989) who compared the performance of laying hens fed corn ground using a hammer mill or a roller mill, resulting in different particle size of grain, and obtained comparable performance (in terms of EPR, EW, FI and FC) and egg quality (egg break force) over three consecutive trials. In accord with the present results, Berto *et al.* (2007) evaluated the performance and egg quality of Japanese quails fed diets containing different corn and limestone particle sizes. They found that dietary treatments had no significant effects on quail performance or egg quality. Blood parameters of Silver Montazah laying hens:

It is interesting to point out that the determination of blood measurements was performed when the hens were at 34 weeks of age (during the peak production period) in order to mirror some indications on the metabolic and/or physiological status of the bird. Apart from the effects of diet form and enzyme addition, all blood serum parameters, measured herein, [total protein (TP), albumen (AL), total calcium (Ca) and inorganic phosphorus (IP) as well as serum activity of alanine aspartate aminotransferase (AST)] were not significantly affected by dietary CCM level, except for the level of serum cholesterol (CH) which was significantly ($P < 0.05$) higher in hens fed the 30%-CCM diets compared with the control birds (Table 4). Hens fed the 20%-CCM diets also exhibited an insignificant increase in serum CH as compared to the other experimental groups. Similarly, hens fed the 30%-CCM diets exhibited significantly ($P < 0.05$) higher level of egg yolk cholesterol (EYC) compared with their control counterparts.

Table (4): Blood serum parameters and egg yolk cholesterol of 34-week-old Silver Montazah laying hens in response to feeding the experimental diets

Treatments ^s	TP (g/dL)	AL (g/dL)	Ca (mg/dl)	IP (mg/dL)	CH (mg/dL)	EYC mg/g yolk	AST (U/L)	ALT (U/L)
A: 1 (0.0 %)	4.79	1.27	17.15	7.13	111.08 ^b	13.51 ^b	130.58	21.58
2 (10 %)	4.68	1.42	17.00	7.10	112.47 ^b	13.65 ^b	133.27	22.00
3 (20 %)	4.71	1.37	16.95	7.01	116.49 ^{ab}	14.28 ^{ab}	134.08	20.50
4 (30 %)	4.89	1.34	16.81	6.94	119.57 ^a	15.41 ^a	133.55	20.66
SEM	0.26	0.11	0.65	0.53	6.45	0.66	1.65	0.53
Sig. level	NS	NS	NS	NS	*	*	NS	NS
B: 1 (0 g)	4.81	1.35	17.85	7.08	117.16	14.02	132.86	21.69
2 (1 g)	4.94	1.43	17.90	7.02	116.45	13.41	132.30	20.86
SEM	0.19	0.09	1.58	0.60	4.50	0.49	1.12	0.40
Sig. level	NS	NS	NS	NS	NS	NS	NS	NS
C: 1 Mash	4.87	1.38	17.88	7.11	113.51	13.71	132.79	21.45
2 Pellet	4.97	1.34	17.75	7.05	113.30	13.20	132.50	20.87
SEM	0.19	0.08	1.71	0.15	4.53	0.49	1.10	0.38
Sig. level	NS	NS	NS	NS	NS	NS	NS	NS
AB: 1 (1x1)	4.79	1.34	17.78	7.18	118.05	14.30	132.00	21.50
2 (2x1)	4.74	1.39	17.71	7.14	117.61	14.02	134.00	22.66
3 (3x1)	4.76	1.43	17.69	7.19	112.38	13.25	133.83	20.16
4 (4x1)	4.81	1.37	17.72	7.16	119.27	14.22	131.33	21.66
5 (1x2)	4.85	1.43	17.73	7.13	113.10	13.50	129.16	21.66
6 (2x2)	4.81	1.41	17.75	7.17	107.33	13.00	131.83	20.66
7 (3x2)	4.89	1.42	17.70	7.19	109.77	14.30	134.33	20.83
8 (4x2)	4.94	1.39	17.72	7.18	115.71	13.08	134.66	20.16
SEM	0.37	0.17	2.27	0.35	8.65	0.93	2.34	0.76
Sig. level	NS	NS	NS	NS	*	NS	NS	
AC: 1 (1x1)	4.69	1.42	17.69	7.09	116.32	14.22	131.33	22.50
2 (2x1)	4.64	1.59	17.74	7.11	113.16	13.25	132.16	22.00
3 (3x1)	4.76	1.41	17.72	7.17	111.88	14.30	134.33	20.00
4 (4x1)	4.78	1.40	17.68	7.12	112.66	13.30	133.33	21.33
5 (1x2)	4.75	1.32	17.70	7.14	109.82	13.58	129.83	20.66
6 (2x2)	4.79	1.30	17.71	7.08	113.77	13.77	133.66	21.33
7 (3x2)	4.87	1.44	17.73	7.18	113.27	13.25	133.83	21.00
8 (4x2)	4.88	1.32	17.69	7.17	116.32	14.22	132.66	20.20
SEM	0.36	0.17	0.56	0.35	9.08	1.20	3.31	0.67
Sig. level	NS	NS	NS	NS	*	NS		
BC: 1 (1x1)	4.70	1.36	17.71	7.11	116.33	13.81	133.33	22.41
2 (2x1)	4.81	1.39	17.70	7.08	116.69	13.61	132.25	20.50
3 (1x2)	4.84	1.36	17.65	7.14	117.33	14.08	132.25	20.57
4 (2x2)	4.82	1.43	17.68	7.11	114.27	13.33	132.75	21.16
SEM	0.27	0.13	1.42	0.52	6.25	0.69	1.73	0.54
Sig. level	NS	NS	NS	NS	NS	NS	NS	*
BC: 1 (1x1x1)	4.66	1.39	17.64	7.13	124.66	15.44	133.66	23.00
2 (2x1x1)	4.70	1.42	17.65	7.07	115.00	13.66	132.00	23.33
3 (3x1x1)	4.81	1.49	17.68	7.09	111.77	13.16	137.33	20.33
4 (4x1x1)	4.84	1.41	17.67	7.13	113.88	13.00	130.33	23.00
5 (1x2x1)	4.82	1.41	17.65	7.17	117.99	13.01	129.00	22.00
6 (2x2x1)	4.63	1.45	17.68	7.07	111.33	12.83	132.33	20.66
7 (3x2x1)	4.76	1.34	17.70	7.09	112.00	15.44	131.33	19.66
8 (4x2x1)	4.83	1.49	17.65	7.11	111.44	13.16	136.33	19.66
9 (1x1x2)	4.80	1.32	17.68	7.16	109.38	12.12	130.33	20.00
10 (2x1x2)	4.79	1.43	17.69	7.13	120.22	14.38	136.00	22.00
11 (3x1x2)	4.72	1.38	17.62	7.12	113.00	13.33	130.33	20.00
12 (4x1x2)	4.56	1.48	17.64	7.11	124.66	15.44	132.33	20.33
13 (1x2x2)	4.71	1.45	17.70	7.09	118.21	14.00	129.33	21.33
14 (2x2x2)	4.78	1.41	17.59	7.15	113.33	13.16	131.33	20.66
15 (3x2x2)	4.80	1.39	17.62	7.13	117.55	13.17	137.33	22.00
16 (4x2x2)	4.79	1.42	17.71	7.12	117.99	13.01	133.00	20.66
SEM	0.52	0.21	2.80	0.14	12.01	1.12	3.18	1.25
Sig. level	NS	NS	NS	NS	*	*	*	*

^s: A, B and C refer to dietary level of corn-with-cobs meal, enzyme addition and diet form. respectively.

^{ab}: For each of the main factors, means bearing common superscripts are not significantly different (P<0.05).

NS: Not significant, *: Significant at P<0.05.

Hens fed the 20%-CCM diets also exhibited an insignificant increase in EYC as compared to the other experimental groups of hens. However, neither dietary enzyme supplementation nor diet form (mash vs. pellets) had a significant effect on blood parameters of Silver Montazah laying hens, measured in the present study, regardless of the effects of other dietary factors (Table 4). There were significant interactions ($P<0.05$) between dietary CCM level and enzyme addition on serum level of CH and activity of ALT in blood serum (Table 4). The interactions between dietary CCM level and diet form were also significant ($P<0.05$) for serum level of CH and activities of ALT and AST in blood serum. Enzyme addition by diet form interactions were only significant ($P<0.05$) for activity of ALT in blood serum. The interactions among all dietary factors (*i.e.* ABC interactions) were significant ($P<0.05$) for EYC and serum level of CH and activities of ALT and AST in blood serum (Table 4).

There is no clear explanation for the increased levels of serum and egg yolk cholesterol of hens fed the 30% CCM-containing diets as opposed to those of hens fed the control diet; this erratic observation may be resulted from a certain type of laboratory technical errors. On the other hand, means of all blood serum parameters, measured in the present study (including cholesterol) and egg yolk cholesterol, are comparable to those reported by Freeman (1984), Cerolini *et al.* (1990), Bragagnolo and Rodriguez-Amaya (2003) and Campbell (2004), regardless of the effect of dietary treatments.

CONCLUSION

Based on the obtained results, corn-with-cobs meal can be included up to 30% in diets of Silver Montazah laying hens, without compromising their productive performance or egg quality, with no need for pelleting the diets or adding exogenous enzymes.

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الأداء الإنتاجي لدجاج المنتزه الفضي المغذى علي علائق ناعمة أو مضغوطة تحتوي علي مجروش كيزان الذرة الكاملة ومدعمة أو غير مدعمة بالإنزيمات أمينة عبد المطلب السروي^١، محمود حسن ربيع^٢، سالم عبد العزيز درغام^٢ و محمد السيد غزلان^٢

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أجريت تجربة عاملية (٢×٢×٤) بهدف تقييم إستجابة دجاج البيض المغذى علي علائق ناعمة أو مضغوطة تحتوي علي مستويات متدرجة من مجروش كيزان الذرة الكاملة (صفر أو ١٠ أو ٢٠ أو ٣٠%) ومدعمة أو غير مدعمة بالمستحضر الإنزيمي كيمزاييم (بمعدل ١ جرام/كجم عليقة). تم إستخدام عدد ٣٨٤ دجاجة عمر ٢٨ أسبوعا تم توزيعها عشوائيا إلى ١٦ مجموعة تجريبية متساوية بكل منها ٣ مكررات وتم تسكينها في بطاريات ذات أقفاص فردية، وخضعت جميع الطيور لنفس ظروف الرعاية. تم تكوين ٤ علائق تجريبية متساوية في محتوياتها من الطاقة القابلة للتمثيل (حوالي ٢٧٠٠ كيلوكالوري/كجم) والبروتين الخام (١٥%)، وتم تقديم الغذاء والماء بحرية لجميع الطيور حتى نهاية التجربة عند عمر ٥٢ أسبوعا. وتم أخذ قياسات عن وزن الجسم وإنتاجية الطيور (إستهلاك الغذاء ومعدل إنتاج البيض ووزن البيضة وكثافة البيض ومعامل التحويل الغذائي) والكفاءة الإقتصادية وبعض صفات جودة البيض وبعض معايير سيرم الدم (مستوى البروتين الكلي والألبومين والكوليستيرول والكالسيوم الكلي والفسفور غير العضوي وكذلك نشاط إنزيمي الأنين أمينوترانسفيريز وأسبرتيت أمينوترانسفيريز في السيرم) كما تم تقدير الكوليستيرول في صفار البيض. وسنذكر تلخيص أهم النتائج المتحصل عليها فيما يلي: بصرف النظر عن تأثير الإضافة العلفية وشكل العليقة المقدمة، لم يكن لمستوى مجروش كيزان الذرة الكاملة في العليقة تأثير معنوي علي كل من التغير في وزن الجسم وإستهلاك الغذاء ووزن البيضة ودليل شكل البيضة ودليل الصفار أو مستويات سيرم الدم من البروتين الكلي، الألبومين، الكالسيوم، الفسفور غير العضوي أو نشاط إنزيمي الأنين أمينوترانسفيريز وأسبرتيت أمينوترانسفيريز في السيرم. أحدثت زيادة مستوى مجروش كيزان الذرة الكاملة في العليقة تأثيرا إيجابيا علي معدل التحويل الغذائي ومعدل إنتاج البيض وكثافة البيض، كما حدثت زيادة معنوية في جودة البيض (وحدات هوف) ومستويات الكوليستيرول في السيرم و صفار البيض عندما بلغ مستوى مجروش كيزان الذرة الكاملة في العليقة ٣٠%. كذلك لم يكن للإضافة الإنزيمية أو شكل العليقة المقدمة تأثير معنوي علي كل من التغير في وزن الجسم وإستهلاك الغذاء ومعدل التحويل الغذائي ومعدل إنتاج البيض ووزن البيضة وكثافة البيض وسماك القشرة ودليل شكل البيضة ودليل الصفار و وحدات هوف وكوليستيرول الصفار أو مستويات سيرم الدم من البروتين الكلي، الألبومين، الكوليستيرول، الكالسيوم، الفسفور غير العضوي أو نشاط إنزيمي الأنين أمينوترانسفيريز وأسبرتيت أمينوترانسفيريز في السيرم. ونستخلص من النتائج المتحصل عليها أنه يمكن إستخدام مجروش كيزان الذرة الكاملة في علائق الدجاج البيض حتى نسبة ٣٠% دون حدوث تأثيرات سلبية علي أدائها الإنتاجي أو جودة البيض مع عدم الحاجة إلى تصنيع عليقة في شكل محبيبات أو إضافة الإنزيمات إليها.