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EFFECT OF DIETARY CORN GLUTEN FEED AND PHYTASE SUPPLEMENTATION TO LAYING HENS DIETS

By

El-Deek, A. A., Mona Osman, and Mona Mahmoud

Poultry Production Department, Faculty of Agriculture, El-Shatby 21545.

Alexandria University, Alexandria – Egypt

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ABSTRACT: *This trial was conducted to evaluate the use of corn gluten feed (CGF) as a feed ingredient in laying hens diets in terms of chemical composition, amino acids content, metabolizable energy (ME). In addition, the productive performance and economical efficiency of Hy-Line White Laying hens (W-36) were also determined. A total of 144 hens were distributed into six equal groups of 24 birds in 6 replicates of 4 hens each. Hens were housed in similar environmental, managerial and hygienic conditions. The first group was fed on basal diet (control), whereas other groups were fed on diets containing dietary CGF at 0, 4, 8, 12, 16 and 20% with phytase addition, which was incorporated at 300 FTU/kg. Diets were formulated to be iso-nitrogenous (18.5% CP) and iso-caloric (2,850 kcal/kg).*

Main results could be summarized as follows:

1. *Evaluation of CGF indicated a ME value of 1850 kcal/kg.*
2. *Hens fed dietary CGF up to 20% with phytase showed no deleterious effects on egg production, egg weights, feed consumption, feed conversion ratio and egg mass, and egg quality parameters. The opposite was true with yolk index, Haugh units, breaking force and dry shell weight which were significantly ($P \leq 0.05$) decreased by feeding CGF (20%).*
3. *Yolk total lipids and cholesterol were not significantly affected by any of the dietary treatments.*

4. *Calcium and phosphorus excretion reduction could be achieved by feeding CGF (20%) with phytase when compared to that of the control (6.16 vs. 5.93% for Ca, and 2.20 vs. 1.95% for P).*
5. *Feeding cost was reduced by incorporating CGF up to 16% plus phytase by about 3.87% than that of the control.*

It could be concluded that CGF at 16% with phytase might be suitable as untraditional feed ingredient for laying hens diets. Also, in addition to the fact that CGF has a moderate protein and low energy contents, phytase supplementation could be a helpful tool that may plays an important role regarding potential pollution hazards.

INTRODUCTION

A considerable attention has been paid to use unconventional feedstuffs which could be used as cheap sources of energy and protein in formulating poultry diets. The increment of corn gluten feed production, a co-product of the wet milling industry, and its potential as a feedstuff for poultry may be a feasible solution to minimize the problem of feed cost which represents 65% of the total production costs.

It is well known that phosphorus from plant source is only 30-40% available (Perney *et al.*, 1993) as well as large portion of the phosphorus is organically bound in the form of phytate which can complex with several cations such as Ca, Mg, Zn, Fe, K and Cu as well as amino acids (Fretzdorff *et al.*, 1995 and Ravindran *et al.*, 1998). Because of the low amount of endogenous phytase secreted by the gastrointestinal tracts of birds, the use of phytate P is negligible (Sebastian *et al.*, 1998). So, nutritionists provide a margin of safety for phosphorus (P) by incorporating microbial phytase into poultry diets in order to enable assimilation of the phosphorus found in feed ingredients and diminishes the amount of phosphate in the manure and subsequently released to the environment (Wodzinski and Ullah, 1996) without compromising production performance (Keshavarz, 2000).

Early reports in this regard, Punna and Roland (1999) revealed that supplemental phytase at 300 units /kg diet was effective to overcome all the adverse effects of 0.1% nonphytate phosphorus on performance during the growing and laying periods. Carlos and Edwards (1998) reported that the use of 600 unit phytase /kg of a low - P layer diet (0.33% total P) significantly improved egg production and its specific gravity. Van der Klis *et al.*, (1996) and Parsons (1999) reported that all signs of P deficiency were alleviated in the presence of 100 unit phytase/ kg diet in long - term experiments. Also, Um and Paik (1999) reported that egg production performance of hens fed diets containing 0.37, 0.24 and 0.12% non-phytate phosphorus (NPP) plus 500 unit phytase/kg diet was greater or equal to that of the control group that was fed diet of 0.37% NPP without phytase.

Boling *et al.*, (2000) revealed that diets supplemented with phytase supported optimal egg production without adverse effect. Jalal and Scheideler (2001) reported that supplementation of corn soybean meal diets for laying hens with phytase at 250 or 300 unit/ kg improved feed conversion ratio, egg mass and elicited a favorable effected shell quality and egg components for hens fed a low non - phytate phosphorus (0.1%). Additionally, Keshavarz (2003) reported that level of supplementary phytase (300 unit phytase /kg diet) was more effective than that of the lower level (150 units) in restoring the performance of laying hens fed low - P diets (0.25, 0.20 or 0.15%) as compared with that of the control (0.45% P diet). Moreover, Lim *et al.*, (2003) found that supplementation of microbial phytase at level 300 FTU/kg can improve egg production and decrease the number of broken and soft eggs produced as well as P excretion.

The present trial was conducted to investigate the influence of dietary CGF supplemented diets, and phytase addition on productive performance, egg quality parameters, manure contents of Ca and P and economic efficiency of laying hens.

MATERIALS AND METHODS

The current trial was carried out at the 20-million eggs project, Ministry of Agriculture and completed at the Poultry Research Center, Faculty of Agriculture, Alexandria University, through out the successive years of 2000/ 2001.

Corn Gluten Feed Evaluation:

Proximate analysis of CGF, purchased from National Company for Maize Products was determined according to the methods of (AOAC, 1985). Amino acids profile was performed by ion-exchange chromatography (Spackman *et al.*, 1958 and Spitz, 1973). Metabolizable energy (**ME**) of the tested material was conducted by the method of Vorha *et al.*, (1982) as follows:

$$ME = ME\ (kcal/g)\ basal\ diet + \frac{ME\ (Kcal/g)\ tested\ diet - ME\ (Kcal/g)\ basal\ diet}{(g.\ tested\ material/\ g\ tested\ diet)}$$

Experimental design and diets:

One hundred forty four, 32-weeks of age, Hy- Line W-36® White Laying Hens were used in 27- week experiment. Hens were randomly distributed into six equal groups of 24 hens each (six replicates of four birds each) and housed in 55 x 40 x 50 cm wire cage in a light and temperature controlled house. General management was followed according to the breeder management guide. Experimental diets were formulated utilizing 6 dietary levels (0, 4, 8, 12, 16 and 20%) of CGF as one of the diets ingredients plus phytase[2] "Natuphos®" which was supplemented at (300 FTU/Kg).

Experimental diets were formulated to contain almost the same protein and ME values as the control diet. Composition and calculated analysis of experimental diets are shown in (Table 1). Feed consumption was provided according to flock management guide and water was provided *ad libitum* throughout the production period (32 to 59 weeks of age).

Performance and Egg Quality Parameters:

Individual body weights were recorded at the beginning and at the end of the experiment. Eggs were daily collected and individually weighed. Mortality was also recorded daily. Egg mass was calculated by multiplying egg production by average egg weight. Feed consumption was monthly determined and feed conversion ratio was calculated for each interval and for the whole experimental period (32 to 59 weeks of age).

Egg quality measurements were performed at 43, 51 and 59 weeks of age on egg produced through three days, where three fresh eggs per replicate were randomly collected. Shape and yolk index were determined according to Romanoff and Romanoff (1949). Egg shell thickness was measured using a micrometer to the nearest 0.01 mm at the equator. Egg yolk visual color score was determined by matching the yolk with one of the 15 bands of the 1961, Roche Improved Yolk Color Fan. Shell weight per unit of surface area (SWUSA) was then calculated according to the equation of Carter (1975). SWUSA (mg/cm^2) = (SW "mg" x 1000)/ SA "cm^2". Surface area (SA) was calculated by the equation of Nordstrom and Ousterhout (1982) as follow: SA (cm^2) = 2.978 x (fresh egg weight$^{0.7056}$).

Yolk total lipids and cholesterol were determined by using commercial kits according to the method of fisher and Leveille (1957) and Allain *et al.*, (1974). Fatty acids of yolk were carried out by gas liquid chromatography (GLC) according to the procedure of Radwan (1978).

[2] Natuphos® a product of BASF, 100 Campus Drive 07932 Florham Park, NJ

At the end of the experiment at 59 weeks of age, three pooled samples of excreta voided from each group were taken to determine Ca and P contents according to the AOAC, (1985) procedure. Also, feeding cost/ egg was calculated for each treatment and relative feeding cost was calculated in relation to the control treatment.

Analysis of variance was performed using SAS software computer program (SAS, 1996) and Duncan's new multiple range test (1955) to test means differences if a significant probability value was obtained.

RESULTS AND DISCUSSION

Corn Gluten Feed Evaluation:

Results of the chemical composition of CGF showed that moisture and crude fiber content were about 1.1 fold over the NRC (1994) analysis. However, dry matter, crude protein and fat were lowered by 1.1, 14.3 and 20% than those of NRC (1994), respectively (Table 2). These differences in the chemical composition may be related to the proportion of germ, if any, added back to the bran during the wet milling process (Castanon *et al.*, 1990). It is worth noting that the low protein content (18%) in CGF was associated with higher concentration of nitrogen free extract (53%).

These results were in agreement with findings of Wu, (1996) who suggested that nutrients composition of CGF played an important part in the nutritional potential of formulating hens diets. The ME value reported herein (1850 kcal/kg) was higher than that reported by (Matterson *et al.*, 1965), while it was lower than that of Bayley *et al.*, (1971) which was 2067 kcal/kg and NRC (1984) being 1944 kcal/kg. Results of Castanon *et al.*, (1990) suggested that CGF has a moderate protein content and low energy level that may be suitable as an ingredient for laying hen diets.

Amino acids content of CGF (Table 2) indicated that Glycine, Iso-leucine, Phenylalanine, Lysine, Tryptophan, and Valine were higher than those of NRC (1994). Whereas, Methionine, Arginine and Histidine were slightly lower. These variations might be a result of the difference in protein content of various lots processed that contain different proportion of germ, gluten meal and/or bran.

Laying Hens Performance:

Hens viability during studied production period from 32 to 59 weeks for all experimental groups was very good, as mortality was zero.

Results of body weigh. gain, egg production, weights, mass, feed consumption and feed conversion ratio for all different experimental groups are presented in (Table 3). Although each CGF dietary inclusion level plus phytase supplementation had no significant effects on body weights and/ or gains, a slight increase was noted in this respect. This result is in agreement with those reported by Carlos and Edwards, (1998); Um and Paik, (1999) and Metwally, (2006) who reported an improvement in growth performance due to incorporate microbial phytase into laying hens diets.

Increasing CGF inclusion levels up to 20% plus phytase addition decreased values of egg production, weights, and egg mass, which were not significant reductions. Current results positively correlate with findings of Castanon *et al.*, (1990) who revealed that CGF inclusion had no negative effect on egg production as compared to those given the control diet. Also, no significant difference was observed in egg production percent of hens fed phytase supplemented diets (Metwally, 2006).

The negative response of feed consumption as laying hens were fed the 20% CGF diet plus phytase altered those values of feed conversion ratio, but without any significance. So, it could be concluded that dietary CFG inclusion with phytase addition might have a neutral effect on hen's appetite. These findings support those of (Gordon and Roland, 1998; Carlos and Edwards, 1998; Um and Paik, 1999; Jalal and Scheideler, 2001; and Metwally 2006) who reported beneficial effects of dietary supplementation with phytase on feed intake and feed conversion ratio of laying hens.

Egg Quality Traits:

As noted from (Tables 4 & 5), there were no significant effects noted on wet and/ or dry egg components (percent of yolk, albumen and shell) except that of the dry shell percent, which was decreased with both age and dietary CGF inclusion levels plus phytase increasing as compared to that of the control group. Along following a similar manner, all values of egg shape index, yolk color, shell thickness, SWUSA, specific gravity, yolk total cholesterol and lipids were affected by dietary treatments. The opposite was true with yolk index and shell breaking force, which was affected by increasing CGF dietary levels up to 20% with phytase supplementation.

There are inconsistencies in literature regarding dietary phytase supplementation effect on egg shell quality. Several investigators reported a beneficial effect of dietary phytase supplementation on egg shell quality (Carlos and Edwards, 1998; Punna and Roland, 1999; and Metwally, 2006), whereas other reports suggested no beneficial effect (Coon and Lesske, 1999; and Parsons, 1999). On the other hand, an adverse effect was recorded as a result of dietary phytase supplementation (Um and Paik, 1999).

In regard to differences between the fatty acids composition of yolk in (Table 6), it is clear that feeding CGF up to 20% significantly increased ($P \leq 0.05$) palmetic and linoleic acids concentrations of egg yolk compared with those of the control, while the opposite was true with the all other fatty acids determined. This suuports results of Sim and qui, (1995) who reported that yolk lipids composition synthesis on a combination of liver lipids synthesis, hepatic uptake and the incorporation of lipids components from diets.

Calcium and phosphorus composition of manure:

None of CGF inclusion levels with phytase addition (Table7) significantly changed Ca and P content of manure. These results are well coordinated with those of (Um and Paik 1999; Keshavarz. 2000 and El-Husseiny *et al.*, 2006) who reported that retention of Ca and P were greater ($P \leq 0.05$) in phytase supplemented groups. A reduction of P is particularly important in relation to potential environmental P pollution of hen's manure by using microbial phytase in layer diets without compromising production performance.

Economical evaluation:

Economical evaluation for different CGF diets to laying hens diets with phytase supplementation is shown in (Table 9). It is clear that hens of the control group consumed more feed, thus it had the highest feed cost. Consequently, feeding diets containing CGF up to 16% plus phytase supplementation is beneficial to improve the relative feeding cost/ egg by about 3.87% compared to that of the control group.

Table (1). Composition and chemical analysis of the experimental diets.

Ingredients	Corn gluten feed (%)					
	0	4	8	12	16	20
Corn yellow	53.00	48.92	44.84	40.76	36.68	32.60
Soybean meal (44%)	31.70	30.86	30.02	29.18	28.34	27.50
Corn gluten feed	---	4.00	8.00	12.00	16.00	20.00
Vegetable oil	3.96	4.88	5.80	6.72	7.64	8.56
Bone meal	2.70	2.70	2.70	2.70	2.70	2.70
Limestone	7.48	7.48	7.48	7.48	7.48	7.48
L-Lysine	---	---	---	---	---	---
DL-Methionine	0.158	0.159	0.160	0.160	0.161	0.162
Premix[1]	0.300	0.300	0.300	0.300	0.300	0.300
NaCl	0.503	0.503	0.503	0.503	0.503	0.503
Sand	0.199	0.198	0.197	0.197	0.196	0.195
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated values, (%):						
Crude protein	18.510	18.510	18.510	18.500	18.500	18.500
M.E. kcal/kg	2,851	2,851	2,851	2,851	2,851	2,851
Ca.	3.530	3.540	3.540	3.550	3.550	3.560
Available P.	0.496	0.496	0.496	0.496	0.496	0.496
Total P.	0.722	0.733	0.743	0.753	0.763	0.773
Methionine	0.460	0.460	0.460	0.460	0.460	0.460
Lysine	1.030	1.030	1.020	1.020	1.020	1.020
Fat	6.312	7.352	8.390	9.430	10.470	11.510
Fiber	2.960	3.220	3.480	3.730	3.990	4.250

[1]Vitamins and minerals premix provides per kilogram of diet: 5,500 IU vitamin A, 11.0 IU vitamin E, 1.1 mg menadione (as menadione sodium bisulfite), 1,100 ICU vitamin D3, 4.4 mg riboflavin, 12 mg Ca pantothenate, 44 mg nicotinic acid, 191 mg choline chloride, 12.1 µg vitamin B12, 2.2 mg vitamin B6, 2.2 mg thiamin (as thiamin mononitrate), 0.55 mg folic acid, 0.11 mg d-biotin. Trace mineral (mg per kilogram of diet). 60 mg Mn, 50 mg Zn, 30 mg Fe, 5 mg Cu, 3 mg Se.

Table (2). Chemical composition and amino acids content[1] of corn gluten feed.

Composition, %	CGF[2]	NRC[3]
Dry matter	89	90
Moisture	11	10
Crude protein	18	21
Crude fiber	9	8
Crude fat	2	2.5
Ash	7	---
Nitrogen free extract	53	---
ME (Kcal/Kg)	1,850	1,750
Amino Acids:		
Arginine	0.8	1.01
Glutamic acid	4.3	---
Glycine	1.0	079
Histidine	0.6	0.71
Isoleucine	1.3	0.65
Leucine	2.7	1.89
Lysine	0.8	0.63
Methionine	0.3	0.45
Phenylalaninie	1.0	0.58
Threonine	0.8	0.89
Tryptophan	0.2	0.10
Valine	1.3	0.05

[1]g/100 g true protein [2]CGF: Corn gluten feed [3]NRC (1994)

Table (3): Effect of feeding different levels of (CGF) plus phytase on production traits of Hy-Line White laying hens from 32-59 weeks of age.

Period (Wks)	CGF[1] (%)					
	0	4	8	12	16	20
Body weights (g.)						
32	1138.88±0.6	1140.46±0.8	1140.83±0.7	1141.67±0.7	1141.08±0.9	1140.430±0.6
59	1296.90±7.2	1297.95 ±9.1	1299.89±9.7	1299.95±7.1	1297.77±10.8	1299.01±7.5
Weight gains (g.)						
32-59	158.02±4.3	157.49±9.1	159.06±7.8	158.28±7.2	156.69±8.1	158.58±6.1
Feed consumption (g.)						
32-47	100.5±2.2	99.9±2.0	99.7±2.1	99.7±2.1	99.3±2.0	99.1±1.9
48-59	101.2±2.1	100.2±2.2	99.8±2.0	99.4±1.9	99.0±2.0	98.1±1.8
Feed conversion ratio						
32-47	1.90±0.2	1.86±0.2	1.96±0.1	1.91±0.2	1.93±0.1	1.91±0.2
48-59	2.16±0.2	2.03±0.2	2.12±0.3	2.08±0.2	2.03±0.2	2.17±0.2
Egg production (%)						
32-47	81.49±0.8	81.59±1.6	80.52±1.6	82.39±0.8	82.19±1.4	81.94±1.0
48-59	77.31±1.8^{ab}	81.25±0.9^{a}	77.22±2.2^{ab}	78.82±2.2^{ab}	80.28±1.3^{ab}	74.91±1.1^{b}
Egg weights (g.)						
32-47	63.33±0.7	64.49±0.6	62.03±0.8	62.08±0.6	61.39±0.8	62.23±0.7
48-59	60.46±0.8	60.86±0.6	61.02±0.7	60.96±0.7	61.06±0.7	60.44±0.7
Egg mass (g./ hen/ day)						
32-47	51.58±0.5	52.62±0.9	49.99±1.5	51.13±0.6	50.49±1.4	50.96±0.6
48-59	46.74±1.2	49.47±0.7	47.18±1.7	47.99±1.7	49.06±1.2	45.28±1.1

^{abc}Means within a row with no common superscripts differ significantly ($P \leq 0.05$).

[1] CGF: Corn gluten feed

Table (4): Effect of feeding different levels of (CGF) plus phytase on egg quality traits of Hy-Line White laying hens from 32-59 weeks of age.

Traits	Period (Wks)	CGF[1], (%)					
		0	4	8	12	16	20
Egg shape index	43	73.67±0.7	73.57±1.2	75.79±0.9	75.16±0.6	74.14±0.3	74.65±1.6
	51	73.34±0.9	74.36±0.8	75.77±0.6	75.18±0.8	73.68±0.8	73.55±1.9
	59	73.66±0.7	73.57±1.2	61.82±0.9	75.16±0.6	74.14±0.8	74.65±1.6
Egg w. (g)	43	61.50±1.6	62.33±1.1	60.37±1.1	60.53±0.7	61.83±1.4	61.13±0.9
	51	61.62±1.6	60.33±0.91	61.98±1.04	61.20±1.5	58.97±1.9	60.78±1.3
	59	64.00±1.2	63.83±0.6	61.82±0.9	60.67±0.8	61.78±1.5	61.90±0.9
Yolk color	43	9.0±0.0^{a}	8.83±0.2^{ab}	8.33±0.2^{b}	8.83±0.2^{ab}	9.33±0.2^{a}	9.00±0.3^{a}
	51	8.17±0.5	7.50±0.6	7.17±0.7	8.00±0.6	8.33±0.6	8.00±0.5
	59	9.00±0.0^{a}	8.83±0.2^{ab}	8.33±0.2^{b}	8.83±0.2^{ab}	9.33±0.2^{a}	9.00±0.3^{a}
Yolk index	43	46.28±1.0^{a}	42.93±0.9^{ab}	41.75±2.9^{ab}	41.39±0.7^{b}	43.87±0.8^{ab}	41.44±0.9^{b}
	51	45.44±0.9	43.99±1.1	41.33±3.2	42.88±1.0	42.45±0.6	42.01±0.8
	59	46.25±1.0^{a}	43.00±1.0^{ab}	41.85±1.2^{ab}	41.39±0.7^{b}	43.87±0.8^{ab}	41.00±0.9^{b}
Yolk w. wet (%)	43	26.96±0.6^{a}	25.65±0.6^{ab}	24.20±0.6^{b}	24.17±0.7^{b}	25.23±0.8^{ab}	26.25±0.6^{ab}
	51	26.39±0.7^{ab}	27.58±0.8^{a}	25.37±1.0^{ab}	24.24±0.9^{b}	26.13±0.7^{ab}	27.15±0.6^{a}
	59	25.89±0.6	25.08±0.8	23.64±0.7	24.12±0.7	25.30±1.1	25.95±0.8
Yolk w. solids (%)	43	12.10±0.2^{a}	11.55±0.4^{a}	10.17±0.4^{b}	10.20±0.5^{b}	11.14±0.4^{ab}	11.62±0.5^{a}
	51	11.60±0.4^{ab}	12.17±0.5^{ab}	11.47±0.5^{ab}	10.78±0.4^{b}	11.50±0.5^{ab}	12.52±0.6^{a}
	59	12.07±0.2^{a}	11.52±0.4^{a}	10.14±0.4^{b}	10.17±0.5^{b}	11.11±0.4^{ab}	11.59±0.5^{a}
Total cholesterol (mg/g yolk)	43	18.30±0.5	18.50±0.5	18.65±0.2	18.79±0.8	18.86±0.6	19.01±0.5
	51	17.16±0.6	17.85±0.0	18.55±0.6	18.95±0.8	18.55±0.6	18.95±0.9
	59	16.74±0.0^{b}	18.55±0.5^{ab}	18.53±0.5^{ab}	18.48±0.4^{ab}	18.95±0.9^{a}	17.98±0.2^{ab}
Total lipids (mg/g yolk)	43	2.77±0.4	3.01±0.3	3.49±0.5	2.34±0.1	2.67±0.3	3.66±0.6
	51	2.76±0.4	3.01±0.3	3.50±0.4	2.35±0.1	2.70±0.2	3.65±0.5
	59	2.46±0.4	2.69±0.2	3.19±0.5	2.03±0.1	2.36±0.3	3.35±0.6

[abcd] Means within a row with no common superscripts differ significantly ($P \leq 0.05$).

[1] CGF: Corn gluten feed

Table (5): Effect of feeding different levels of corn gluten feed to Hy-Line White laying hens at 43, 51 and 59 weeks on Haugh units, albumin w. wet, and albumin w. solids percents, shell thickness (mm), SWUSA, breaking force, specific gravity, shell w. wet, and shell w. dry percents

Traits	Period (Wks)	CGF[1], (%)					
		0	4	8	12	16	20
Albumin w. wet (%)	43	61.75±0.7	62.95±1.1	64.33±0.6	64.62±0.6	63.33±0.9	62.94±0.9
	51	61.07±0.9	59.03±1.6	61.75±1.3	58.50±4.0	59.11±2.4	61.39±1.2
	59	63.24±0.9	63.81±1.2	65.13±1.0	64.68±0.7	63.24±1.3	63.38±1.1
Albumin w. solids (%)	43	21.72±1.3	22.97±1.2	22.53±0.8	22.82±0.5	22.90±1.4	22.20±1.0
	51	21.87±1.0	19.82±0.9	21.77±1.3	20.58±2.3	18.83±2.3	18.23±2.7
	59	24.19±1.3	24.46±1.2	23.97±1.1	22.94±0.8	22.83±1.6	22.95±1.2
Shell thickness (mm)	43	0.32±0.01^{c}	0.33±0.01^{bc}	0.36±0.01^{a}	0.35±0.01^{ab}	0.34±0.01^{ab}	0.34±0.01^{bc}
	51	0.33±0.01	0.34±0.02	0.35±0.01	0.35±0.01	0.32±0.01	0.33±0.01
	59	0.32±0.01^{c}	0.33±0.01^{bc}	0.36±0.01^{a}	0.35±0.00^{ab}	0.34±0.01^{ab}	0.34±0.01^{bc}
SWUSA	43	95.45±3.5	96.58±4.2	96.39±3.3	94.29±2.1	96.81±2.7	91.06±4.8
	51	94.19±3.3	99.39±3.4	101.52±2.3	92.44±3.8	95.00±2.3	91.29±4.6
	59	92.91±4.3	94.89±3.9	95.04±4.4	94.23±2.7	96.87±2.7	90.26±4.7
Breaking force	43	34.50±2.1^{a}	30.17±1.2^{ab}	23.33±2.1^{c}	29.17±2.3^{abc}	29.67±1.7^{abc}	24.67±1.0^{bc}
	51	33.50±1.1^{a}	29.17±1.2^{ab}	24.33±1.1^{c}	28.12±1.2^{abc}	28.21±1.1^{abc}	25.27±1.8^{bc}
	59	34.50±2.1^{a}	30.17±1.2^{ab}	23.33±2.1^{c}	29.17±2.3^{abc}	29.67±1.7^{abc}	24.67±1.8^{bc}
Specific gravity	43	1.078±0.0^{b}	1.082±0.0^{a}	1.078±0.0^{b}	1.081±0.0^{ab}	1.079±0.0^{ab}	1.078±0.0^{b}
	51	1.081±0.0	1.078±0.0	1.079±0.0	1.081±0.0	1.079±0.0	1.078±0.0
	59	1.081±0.0	1.082±0.0	1.078±0.0	1.082±0.0	1.079±0.0	1.078±0.0
Shell w. wet (%)	43	11.29±0.4	11.39±0.5	11.46±0.3	11.21±0.3	11.44±0.3	10.80±0.6
	51	11.14±0.4	11.83±0.4	11.98±0.2	10.97±0.5	11.39±0.3	10.86±0.6
	59	10.87±0.5	11.11±0.5	11.23±0.5	11.19±0.3	11.45±0.3	10.67±0.6
Shell w. dry (%)	43	5.05±0.3	5.18±0.3	5.03±0.3	4.88±0.2	5.17±0.2	4.68±0.3
	51	4.98±0.3^{ab}	5.24±0.3^{ab}	5.54±0.2^{a}	4.79±0.2^{ab}	4.81±0.2^{ab}	4.68±0.3^{b}
	59	6.24±0.0^{a}	6.03±0.1^{a}	5.41±0.1^{c}	5.42±0.13^{c}	5.69±0.1^{b}	5.45±0.1^{c}

^{abc} Means within a row with no common superscripts differ significantly ($P \leq 0.05$)

[1] CGF: Corn gluten feed

Table (6): Effect of corn gluten feed (CGF) supplemented with phytase on yolk fatty acids profile (%) at 59 weeks of age.

Fatty acids	Corn gluten feed (%)					
	0	4	8	12	16	20
14:0	0.455±0.0^{c}	0.397±0.0^{e}	1.123±0.0^{a}	0.477±0.0^{b}	0.426±0.0^{d}	0.372±0.0^{f}
16:0	20.206±0.0^{f}	20.822±0.0^{e}	29.49±0.0^{a}	25.551±0.0^{d}	27.076±0.0^{c}	27.506±0.0^{b}
16:1	3.973±0.0^{a}	2.867±0.0^{b}	1.749±0.0^{f}	2.187±0.0^{c}	1.877±0.0^{e}	1.892±0.0^{d}
18:0	13.337±0.0^{a}	11.638±0.0^{b}	10.302±0.0^{f}	11.492±0.0^{c}	11.010±0.0^{d}	10.549±0.0^{e}
18:1	40.204±0.0^{a}	38.124±0.0^{c}	38.203±0.0^{b}	35.571±0.0^{e}	32.258±0.0^{f}	36.342±0.0^{d}
18:2	20.907±0.0^{e}	25.355±0.0^{b}	18.662±0.0^{f}	23.539±0.0^{c}	25.945±0.0^{a}	22.590±0.0^{d}
20:0	0.919±0.0^{c}	0.798±0.0^{c}	0.467±0.0^{f}	1.182±0.0^{b}	1.409±0.0^{a}	0.749±0.0^{e}

[abcdef] Means within a row with no common superscripts differ significantly ($P \leq 0.05$).

14:0 Myrestic acid   18:0 Stearic acid   16:0 Palmetic acid
18:2 Linoleic acid   16:1 Palmitoleic acid   18.1 Oleic acid
20:0 Arachidic acid

Table (7): Effect of corn gluten feed (CGF) supplemented with phytase to Hy-Line White laying hens at 59 week on Ca and P (%) of manure contents in the experiment.

Items	Corn gluten feed (%)					
	0	4	8	12	16	20
Ca	5.93±0.0	5.93±0.3	5.97±0.1	5.92±0.6	5.90±0.2	5.89±0.0
P	1.90±0.1	1.87±0.2	1.89±0.0	1.88±0.1	1.80±0.0	1.86±0.1

[ab] Means within a row with no common superscripts differ significantly ($P \leq 0.05$) .

Table (8): Average feeding cost/ egg as affected by corn gluten feed (CGF) supplementation as a feed ingredient plus phytase in laying hens diets during 32 to 59 weeks of age period.

Traits	Corn gluten feed (%)					
	0	4	8	12	16	20
Egg mass h/period	9.70	10.05	9.56	9.76	9.78	9.51
Feed/egg/ period	19.74	19.62	19.54	19.50	19.42	19.36
Total feeding cost (L.E.)	15.06	14.91	14.79	14.69	14.59	14.49
Feeding cost/egg (L.E.)	1.55	1.48	1.55	1.51	1.49	1.52
Relative feeding cost/egg (L.E.)	100	95.48	100	97.42	96.13	98.06

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الملخص العربي

تأثير اضافة علف جلوتين الذرة و انزيم الفايتيز الى اعلاف الدجاج البياض

أحمد أحمد الديك، منى عثمان و منى محمود

تم تقييم علف جلوتين الذرة كمادة علفية فى اعلاف الدجاج البياض و ذلك من خلال التحليل الكيماوى، محتوى الأحماض الأمينية، الطاقة الميتابوليزمية و الكفاءة الإجمالية من للبروتين و نسبة البروتين الصافية. بالإضافة الى التأثير على الأداء الإنتاجى و الصفات المصاحبة و الكفاءة الإقتصادية لدجاجات الهاى لاين التجارية حيث استخدم عدد ١٤٤ دجاجة فى التجربة حيث قسمت الدجاجات الى ٦ مجاميع تجريبية مكونة من ٦ مكررات بكل مكررة ٤ دجاجات. استخدم علف جلوتين الذرة بمستويات صفر، ٤، ٨، ١٢، ١٦ أو ٢٠% كمصدر للبروتين مع/ بدون الفايتيز بمستوى ٣٠٠ وحدة. كانت العلائق متساوية فى محتواها من الطاقة و البروتين. اوضحت نتائج التجربة التالى:

١. اوضح التقييم الكيماوى لعلف جلوتين الذرة احتواؤه على طاقة ميتابوليزمية ١٨٥٠ كيلو كالورى/ كجم.
٢. الدجاجات المغذاه على غذاء جلوتين الذرة لم تتأثر سلبيا عند التغذية حتى مستوى ٢٠% وذلك من خلال صفات انتاج البيض ووزن البيض واستهلاك العلف والكفاءة التحويلية للعلف و كتلة البيض و صفات جودة البيضة. العكس تم الحصول عليه لصفات معامل الصفار وقوة كسر القشرة و وزن القشرة الجافة والتى انخفضت كلها عند التغذية على ٢٠% من علف جلوتين الذرة.
٣. لم تتأثر دهون البيضة ومستوى الكوليسترول معنويا باى من المعاملات المستخدمة.
٤. عند التغذية على غذاء جلوتين الذرة بمستوى ٢٠% فان اخراج الكالسيوم والفوسفور بالزرق انخفض فى وجود الفايتيز مقارنة بالكنترول (بنسبة ٥.٩٣ و٦.١٦ % للكالسيوم) و (٢.٢٠ و ١.٩٥ % للفوسفور) على التوالى.
٥. انخفضت تكلفة العلف عند التغذية على علف جلوتين الذرة بمستوى ١٦% بنسبة ٣.٨٧% مقارنة بالكنترول.

ومن هذه النتائج يمكن القول بان احلال علف جلوتين الذرة حتى ١٦% من كسب فول الصويا مع اضافة الفايتيز من الممكن اعتباره حل مناسب لإستخدام مواد علف غير تقليدية فى اعلاف الدجاج البياض.ومع احتواؤه على نسب ملائمة من البروتين ومستويات منخفضة من الطاقة فان اضافة الفايتيز من الممكن اعتبارها وسيلة جيدةلزيادة الاستفادة منه والتى قد تلعب دورا مهما ايضا خاصة بالنسبة لتلوث البيئة.