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EVALUATION OF CORN GLUTEN FEED AS A FEED INGREDIENT FOR LAYING HENS

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ABSTRACT: *This study was designed to evaluate corn gluten feed* ***(CGF)*** *in term of chemical composition, protein efficiency ratio* ***(PER)*** *and net protein ratio* ***(NPR)*** *and to investigate the partial replacement effect of CGF on commercial laying hens performance, as well as economical efficiency. One hundred and forty four Hy-Line White layers at 32 weeks old were randomly divided into six equal groups of 24 hens in 6 replicates. The first group served as the control, whereas other groups were fed dietary CGF at 4, 8, 12, 16 and 20%, respectively. Diets were iso-nitrogenous and iso-caloric (18.5% CP and 2.850 kcal/kg, respectively). Main results could be summarized as follow:*

1. *Corn gluten feed analysis showed a 89% dry matter, 18% crude protein, 2% ether extract, 9% crude fiber, 7% ash and 53% nitrogen free extract. The metabolizable energy was 1850 kcal/kg and PER and NPR values were 2.49 and 2.97, respectively.*
2. *Dietary CGF can be incorporated in laying hens diets up to 20% without affecting egg production and could be safely fed without any adverse effect on egg weight or egg mass.*
3. *Feed consumption was decreased with increasing CGF inclusion level. This reduction was significant at 16 and 20% CGF inclusion levels, respectively.*
4. *Dietary inclusion of CGF up to 16% had improved feed conversion ratio* ***(FCR)*** *throughout experimental period.*
5. *No adverse effect were noted on egg shape and yolk index, Haugh units and yolk color, and yolk, albumen and shell relative weights, due to increasing dietary CGF up to 20% as compared to the control.*

[1] Rev. By Prof. Dr. M.Osman

6. *Total cholesterol and total lipids of yolk were almost similar while, feeding CGF up to 20% significantly increased most fatty acids composition of egg yolk.*
7. *Dietary CGF inclusion in all experimental diets had no significant effect on Ca and P excretion in the manure.*
8. *Using corn gluten feed in laying hens diets from 32 to 59 weeks of age reduced feed cost/ kg egg by 7.24% for the 4% CGF fed group, and this reached 15.13% for those fed the 20% CGF diet as compared to the contrl and other dietary treatments.*

From nutritional and economical points of view, CGF could be incorporated successively up to 20% in commercial laying hens diets without adversely affecting egg production parameters, egg quality and/ or economical efficiency.

INTRODUCTION

Corn is one of the richest sources of dietary energy for poultry feeding. According to the published statistics, corn forms the greatest share in Egyptian imported feedstuffs owing to its use in producing certain products for human, animal and poultry consumption. Accordingly, there is an urgent need to search for alternative feedstuffs or by-products which could be used as cheap sources of energy to replace yellow corn grains in the formulated poultry diets.

The production of corn gluten feed (CGF) in Egypt, a co-product of the wet milling industry has been steadily increasing during the last years. This product contains on the average 22% crude protein, 2.0% ether extract and 9.0% crude fiber (Cooley, 1970). Also, Castanon *et al.*, (1990) yield values of 20.3% crude protein, 2.3% ether extract, 0.70% lysine, 0.43% methionine, 0.51% cystine and 0.31% tryptophan. Wu, (1996) found that CGF contains 20% crude protein, 3% crude fat, 8% crude fiber and 7% ash. Along the same line, Matterson *et al.*, (1965) determined the ME value of CGF by clearly 1.589 kcal/g. of DM for chicks. Bayley *et al.*, (1971) reported this value by about 2.067 kca/g of DM for chick and 2.311 kcal/g for adult male turkey, respectively. According to NRC (1984), the ME value of CGF represented by 1.750 kcal/kg while, ranging between 1.912 to 2.772 kcal/g as reported by Sibbald (1986), and 1.944 kcal/kg as published by Castanon (1988).

Although, using CGF in poultry feeding has not been encouraged because of higher fiber levels which reduce digestibility and availability of nutrients, the incorporation of CGF at 7.5% into turkey breeder diets improved the productive performance, fertility and hatchability percentage (Hillman *et al.*, 1973). Brake and Thaxton (1979) reported that a pullet grower dietary regimen with CGF yielded superior performance during 20 weeks post-molt compared to that of the ground corn. Also, Owings *et al.*, (1988) demonstrated that CGF can be used successfully on a nutritional basis up to 10% of the diet without negatively influencing growth performance and feed efficiency. Castanon *et al.*, (1990) indicated that a proportion of 25% CGF or less can be included in a layer diet without affecting egg production detrimentally.

So, the present study aimed to shed some light on the proximate analysis of CGF as an alternative feedstuff in laying hens diets. Also, to investigate the effect of dietary CGF partial replacement on productive performance, egg quality measurements and economical efficiency of Hy-line White laying hens during 32 to 59 weeks of age.

MATERIALS AND METHODS

The following trail was conducted at the 20-Million Egg Project; Ministry of Agriculture, and completed at the Poultry Research Center, Faculty of Agriculture, Alexandria University.

Corn gluten feed evaluation:

Proximate analysis of CGF, obtained from National Company for Maize products was determined according to (AOAC, 1990). Amino acids profile was performed by ion-exchange chromatography (Spackman *et al.*, 1958; and Spitz, 1973). The metabolizable energy (**ME**) of the tested material was conducted according to Vorha *et al.*, (1982) as follows:

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

Protein efficiency ratio (**PER**) and net protein ratio (**NPR**) were estimated according to the procedure described by Willis and Baker (1980). Calculations of PER was reported as grams of gain per grams of protein intake, while NPR was computed as follows:

$$\frac{(Weight\ gain\ of\ chicks\ fed\ the\ tested\ diet - Weight\ loss\ of\ chicks\ fed\ N\text{-}free\ diet)}{Amount\ of\ the\ protein\ consumed}$$

Experimental Design and Diets:

One hundred and forty four, 32-week of age, Hy- Line White Laying Hens were used in a 27- weeks 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 cages in LTC house under similar management and hygienic conditions. General management was as described in the flock management guide. Experimental diets were formulated including 6 CGF levels (0, 4, 8, 12, 16 and 20%) as one ingredient of diets. Ingredients composition and calculated analysis of experimental diets are shown in (Table 1). Hens were fed according to flock management guide, while water was provided *ad libitum* throughout the studied production period of 32 to 59 weeks of age.

Individual body weights were recorded at 32, 43, 51 and 59 weeks of age. Eggs were collected daily, and were individually weighed weekly. Mortality was also recorded daily. Egg mass was calculated by multiplying egg production by average egg weight. Feed intake was calculated monthly, while feed conversion ratio was calculated for each period.

Egg quality measurements were performed at 43rd, 51st and 59th weeks of age on eggs produced through three days period using three eggs/ replicate. Shape and yolk index were measured according to Romanoff and Romanoff (1949). Egg shell thickness was measured using a micrometer to the nearest 0.01 mm at the equator. Shell weight per unit of surface area (**SWUSA**) was calculated according to Paganelli *et al.*, (1974). Haugh units score was applied from a special chart using egg weight and albumen height which measured by using a micrometer according to Kotaiah and Mohapatra (1974). Egg yolk color score was measured by matching the yolk with one of the 15 bands of a 1961 Roche Improved Yolk Color Fan. Also, yolk total lipids and cholesterol were determined using commercial kits according to (Fisher and Leveille 1957, and Allain *et al.*, 1974). Yolk fatty acids were determined by gas liquid chromatography according to the procedure of Radwan (1978).

At the end of the experiment (59 weeks of age), three pooled samples of excreta were voided from each experimental group for Ca and P analysis according to AOAC, (1990). The relative economic efficiency of egg production was calculated according to costs of experimental diets and egg produced as follow:

$$\text{Relative feeding cost/ kg egg} = \frac{\text{Supplemented group feeding cost}}{\text{Un-supplemented group feeding cost}}$$

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

RESULTS AND DISCUSSION

Corn Gluten Feed evaluation:

Chemical composition of CGF (Table 2) shows that moisture and crude fiber were represented by 1.1 fold over those of the NRC (1994). While, dry matter, crude protein and fat were lower by 1.1, 14.3 and 20% than those of NRC (1994), respectively. 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 protein content (18%) in CGF was associated with higher concentration of nitrogen free extract (53%).

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

Amino acid content of CGF (Table 2) indicated that glycine, iso-leucine, phenylalanine, lysine, tryptophan and valine were higher than those reported by the NRC (1994). Whereas, methionine, arginine and histidine were slightly lower. These variations might be due to difference in protein content of various lots processed which contain different proportions of germ, gluten meal and/or bran.

Results of PER and NPR are shown in (Table 3). CGF should be used in combination with other protein sources to cover amino acid limitation and benefits from higher contents of lysine and tryptophan. These results are well correlated with those of Castanon *et al.*, (1990) who indicated that the superior protein quality of CGF may be attributed to its relatively high concentration of tryptophan and lysine. Therefore, CGF should be used in combination with other protein sources that are limited in lysine and tryptophan contents.

Laying Hens performance:

Hens viability during the studied production period 32 to59 weeks of age was very good. with no mortalities meaning 100% viability for all experimental group fed the CGF diets (*Data not reported*).

As presented in (Table 4), body weights and weight gains measured through experimental periods at (32 and 59 weeks of age) for hens fed dietary CGF included up to 20% in layers diets. Obtained data of feeding 16% CGF diets showed a statistically similar manner ($P \geq 0.05$) to those of the control group. This trend changed and decreased significantly ($P \leq 0.05$) by feeding the 20% CGF diet. This reduction was a reflection of reducing nutrients availability in with CGF at 20% inclusion level. It may be due to the negative influence of phytic acid on the solubility of protein (Fretzdorff *et al.*, 1995).

These results are in agreement with previous findings of Owing *et al.*, (1988) who reported a successful utilization of CGF that can be included on a nutritional basis up to 10% of the diet without negatively influencing growth performance.

Egg production. weights and mass data of hens fed diets with CGF inclusion up to 20% from 32 to 59 weeks of age are presented in (Table 4). It is clear that there was a steady non-significant increase as a result of feeding diets with CGF up to 20%. This numerical increase was 5.67% over the control. This finding is supported by results of Hillman *et al.*, (1973) who found that 7.5% CGF in turkey breeder diets increased egg production yield. Castanon *et al.*, (1990) indicated that a proportion of 25% CGF or less can be included in a layer diet without affecting egg production dramatically. However, egg weights and mass values were significantly increased ($P \leq 0.05$) by dietary CGF. Hens fed 16% CGF diet achieved the heaviest egg weight as compared to that of the control, followed by the 20% CGF diet of 64.41 and 64.05, respectively for 32 to 47 weeks of age period. Whereas, during the same period the greatest ($P \geq 0.05$) egg mass value was obtained from feeding the 20% CGF diet.

It appears that lysine content of CGF might be related to maintain optimum performance. As our result positively agree with reports of Scheideler (1996) and Yakout (2000) who indicated that a daily lysine intake is required through the peak production to obtain maximum layer performance. On the other hand, Castanon *et al.*, (1990) reported that CGF supplementation to laying hens diets had a negative effect on egg weights.

Dietary CGF inclusion significantly decreased ($P \leq 0.05$) feed consumption, and also improved ($P \leq 0.05$) feed conversion ratio (Table 4). Overall mean for feed consumption for those hens fed 16 or 20% CGF diets were significantly lower than those fed the control diet. Accordingly, birds fed 20% CGF diet exhibited superior feed conversion ratio as compared to those fed the control diet. This improvement might be due to the presence of unsaturated fatty acids mixture especially linoleic acid, which have been reported to be essential for laying hen performance (Murray *et al.*, 1993).

Egg Quality Parameters:

Results of egg quality traits and egg components data for hens at 59 weeks of age are presented in (Tables 5 and 6). It is clear that dietary CGF up to 20% did not significantly affect egg shape, yolk index, shell thickness, SWUSA, breaking force and egg shell gravity. An exception was noted with Haugh units, which was significantly decreased ($P \leq 0.05$) as compared with the control group.

Although there was a tendency to increase wet and dry egg yolk values as hens were fed on 20% CGF when compared to those of the control group, dry albumen and shell percentages followed the opposite trend with no significant differences noted among treatments.

These findings especially yolk solids percent strongly agree with results of Shafer *et al.*, (1998) who explained that albumen and yolk components respond independently to nutritional changes as a result of a unique protein synthesis mechanism for each one.

Presented in (Table 5) are egg yolk cholesterol and total lipids values. Although dietary treatments insignificantly affected these parameters at 51^{st} and 59^{th} weeks of age, average yolk total lipids and cholesterol values were decreased due to feeding increasing dietary CGF levels up to 20%. This superiority may encourage the use CGF in laying hens diet without any deleterious effects on yolk total lipids and cholesterol at least after peak production until 43 weeks f age. After this, according to our findings there was no significant affects on yolk lipids or cholesterol up till 59^{th} weeks of age. This finding supports the result of Sim and Qui. (1995) who reported that yolk lipids synthesis depends on a combination of the liver lipid synthesis, hepatic uptake and the incorporation of lipid components from the diet. These process might be affecting lipid synthesis more at younger than older age.

Increasing CGF inclusion up to 20% significantly elevated ($P \leq 0.05$) myrestic, palmetic, stearic, linoleic and arachidic acids in the egg yolk over those of the control group(Table 7). The opposite was true with palmitoleic and oleic acids which were significantly decreased ($P \leq 0.05$) as compared to those of the control.

Manure Ca and P Composition:

Results for manure Ca and P excretion are listed in (Table 8). It is noted that increasing dietary CGF inclusion up to 20% did not significantly affect Ca and P of the manure. This might be related to the reduced feed consumption while increasing the CGF dietary inclusion. Corresponding results of Allan and Wood (1994) were positively correlated with our results, stating that Ca absorption could be inversely related to that of feed intake. Further research is needed to clarify this area of manure P excretion because of the existing relation with the environmental pollution potentiality.

Economic Efficiency:

Data obtained for economic efficiency are summarized in (Table 9). Due to the lower prices of the studied material compared to that of the yellow corn and soybean meal. CGF containing diets were therefore cheaper than the control one. This was reflected in turn on economic efficiency values. It seems that CGF 20% inclusion decreased cost/kg egg by 15.13% as compared to that of the control.

It could be stated that CGF inclusion up to 20% in laying hens diet as an ingredient of laying hens diets would have a positive effect on productive performance of laying hens, and also egg quality. It might play a role in reducing the ever-increasing cost of poultry rations.

Table (1): Composition and chemical analysis of experimental diets given to Hy-Line White laying hens throughout studied production period (32-59 weeks)

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
DL-Methionine	0.16	0.16	0.16	0.16	0.16	0.16
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30
NaCl	0.30	0.30	0.30	0.30	0.30	0.30
Sand	0.20	0.20	0.20	0.20	0.20	0.20
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 utilized in experimental diets compared with NRC analysis

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). Evaluation of protein quality of corn gluten feed

Treatment	Weight gain	Feed intake	Gain per feed	PER[1]	NPR[2]
N-free diet	- 6.4±0.9	72.5±3.5	-0.093±0.01	---	---
CGF[3]	28.1±1.3	123.9±5.1	0.227±0.05	2.49±0.09	2.97±0.17

[1]PER: Protein efficiency ratio [2]NPR: Net protein ratio.

Table (4): Performance of White Hy-Line laying hens fed diets with graded levels of corn gluten feed.

Period (Wks)	CGF[1] (%) 0	4	8	12	16	20
Body weights (g.)						
32	1140.21±0.8	1139.70±0.8	1140.50±0.9	1140.13±0.8	1139.46±0.7	1139.04±0.96
59	1303.3^{a} ±12.5	1304.69^{a} ±13.8	1318.9^{a} ±11.9	1308.58^{a} ±9.7	1312.64^{a} ±11.1	1295.4^{b} ±10.0
Weight gains (g.)						
32-59	163.10^{b} ±16.2	165.10^{b} ±17.2	178.4^{a} ±16.9	168.51^{b} ±13.7	173.18^{a} ±13.3	156.01^{c} ±12.7
Feed consumption (g.)						
32-47	101.7^{a} ±2.0	100.4^{a} ±2.1	99.0^{a} ±2.1	98.4^{ab} ±1.9	97.9^{b} ±1.9	97.4^{b} ±1.7
48-59	105.3^{a} ±3.0	103.1^{a} ±2.9	99.9^{b} ±2.8	100.1^{ab} ±2.9	99.5^{b} ±3.0	98.8^{b} ±2.5
Feed conversion ratio						
32-47	2.10^{a} ±0.2	2.00^{a} ±0.2	1.89^{b} ±0.2	1.95^{ab} ±0.1	1.89^{b} ±0.1	1.86^{b} ±0.1
48-59	2.40^{a} ±0.5	2.40^{a} ±0.5	2.05^{abc} ±0.4	2.18^{b} ±0.4	2.13^{b} ±0.3	1.98^{c} ±0.2
Egg production (%)						
32-47	80.10±1.3	80.69±1.2	81.18±0.9	81.35±0.39	80.56±1.8	81.91±1.6
48-59	73.56^{ab} ±2.4	73.28^{b} ±4.2	80.32^{a} ±1.3	73.10^{ab} ±2.3	75.97^{ab} ±1.6	81.39^{a} ±2.0
Egg weights (g.)						
32-47	61.22^{b} ±1.2	63.61^{ab} ±0.4	64.53^{a} ±0.8	62.18^{ab} ±1.0	64.41^{a} ±0.7	64.05^{a} ±0.7
48-59	59.49^{b} ±0.7	61.48^{ab} ±1.2	60.69^{ab} ±0.5	62.81^{a} ±0.7	61.67^{ab} ±0.3	61.23^{ab} ±0.5
Egg mass (g./ hen/ day)						
32-47	49.02±1.1	51.32±0.9	52.36±0.6	50.59±1.0	51.87±1.1	52.45±1.0
48-59	43.72±1.8	43.29±2.9	48.73±0.9	45.93±1.4	46.82±1.1	49.89±1.5

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

[1] CGF: Corn gluten feed

Table (5): Egg quality traits of White Hy-Line laying hens fed diets with graded levels of corn gluten feed.

Traits	Period (Wks)	CGF[1], (%)					
		0	4	8	12	16	20
Egg shape index	43	74.26±1.2	75.15±1.7	77.09±0.9	75.49±1.5	75.48±0.6	75.66±0.8
	51	74.90±1.2^{ab}	75.21±1.5^{ab}	77.39±0.8^{a}	73.99±1.2^{b}	74.12±0.6^{b}	76.41±1.3^{ab}
	59	72.56±1.5	75.15±1.7	77.09±0.9	75.49±1.5	75.48±0.6	75.66±0.8
Egg w.(g)	43	61.50±0.9	62.50±1.3	61.70±0.8	63.35±2.1	62.65±1.7	61.20±0.5
	51	60.17±1.6^{ab}	59.97±1.9^{ab}	60.78±1.1^{ab}	65.02±1.8^{a}	58.27±2.2^{b}	61.55±0.9^{ab}
	59	62.95±1.3^{b}	62.20±1.1^{ab}	63.85±0.9^{a}	62.95±2.36^{ab}	63.55±1.7^{ab}	62.98±0.9^{ab}
Yolk color	43	8.83±0.3^{ab}	7.83±0.3^{c}	8.17±0.4^{bc}	7.83±0.2^{c}	8.83±0.2^{ab}	9.50±0.2^{a}
	51	7.50±0.8	7.17±0.6	7.83±0.5	7.67±0.2	7.67±0.6	8.17±0.9
	59	8.33±0.7^{ab}	7.83±0.3^{b}	8.17±0.4^{b}	7.83±0.2^{b}	8.83±0.2^{ab}	9.50±0.2^{a}
Yolk index	43	41.95±0.9^{c}	42.58±1.4^{c}	43.92±1.1^{bc}	44.29±1.9^{b}	44.31±1.0^{b}	46.17±1.4^{a}
	51	41.63±0.8	42.46±1.2	44.19±0.9	45.65±2.2	43.09±1.3	46.14±1.6
	59	42.80±0.8	42.58±1.4	43.92±1.1	44.29±1.9	44.31±1.0	46.17±1.4
Yolk w. wet(%)	43	24.63±0.1	25.93±0.7	26.63±0.4	24.87±0.8	23.98±0.7	25.63±0.3
	51	25.76±0.7	27.34 ±1.1	26.64±0.4	25.21±0.9	27.53±1.6	25.84±0.7
	59	24.28±0.6^{ab}	26.04±0.7^{a}	25.72±0.4^{ab}	25.15±1.3^{ab}	23.63±0.6^{b}	24.94±0.6^{ab}
Yolk w. solids (%)	43	10.72±0.2^{bc}	11.75±0.4^{ab}	11.99±0.2^{a}	11.29±0.5^{abc}	10.57±0.4^{c}	11.25±0.2^{abc}
	51	12.37±1.3	11.92±0.4	11.62±0.3	12.75±0.6	11.90±0.3	11.72±0.4
	59	10.79±0.2^{bc}	11.72±0.4^{ab}	11.96±0.2^{a}	11.26±0.5^{abc}	10.54±0.4^{c}	11.22±0.2^{abc}
Total cholesterol (mg/g yolk)	43	17.81±0.1^{ab}	17.46±0.5^{ab}	16.92±0.1^{ab}	17.49±0.4^{a}	17.03±0.0^{ab}	16.94±0.1^{b}
	51	19.47±0.4	18.97±0.1	19.10±0.0	19.95±0.2	19.38±1.4	17.56±0.5
	59	17.44±0.6	16.43±0.4	16.98±0.8	17.15±0.1	17.44±0.5	15.78±0.7
Total lipids (mg/g yolk)	43	3.76±0.0^{a}	2.99±0.0^{b}	3.17±0.0^{ab}	3.29±0.1^{ab}	3.11±0.4^{ab}	3.13±0.1^{ab}
	51	3.66±0.1	3.00±0.0	3.19±0.1	3.29±0.1	2.92±0.6	2.73±0.3
	59	3.40±0.1	2.69±0.0	2.87±0.1	2.98±0.1	2.71±0.5	2.62±0.2

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

[1] CGF: Corn gluten feed

Table (6): Egg quality traits, Haugh units, SWUSA, breaking force, and specific gravity of White Hy-Line laying hens fed diets with graded levels of corn gluten feed.

Traits	Period (Wks)	CGF[1], (%)					
		0	4	8	12	16	20
Haugh units	43	105.02±5.5^{a}	96.83±2.6^{ab}	95.88±2.5^{b}	89.99±0.7^{b}	95.46±1.8^{b}	89.76±0.9^{b}
	51	103.43±6.2^{a}	93.76±1.6^{ab}	95.17±2.1^{ab}	94.92±2.9^{ab}	91.24±2.1^{b}	89.59±0.9^{b}
	59	102.97±6.9^{a}	96.85±2.6^{ab}	95.38±2.5^{ab}	90.14±0.7^{b}	95.28±1.8^{ab}	89.33±1.1^{b}
Albumin w. wet, (%)	43	64.08±0.2	63.33±0.9	62.08±0.8	64.63±0.9	64.96±1.0	63.22±0.8
	51	59.79±2.8	60.01±1.3	58.54±2.0	59.53±1.4	58.20±2.9	61.12±1.9
	59	64.72±0.9	63.15±1.1	63.38±0.5	64.25±1.7	65.46±0.9	64.23±0.9
Albumin w. solids, (%)	43	23.10±0.4	23.30±1.2	22.02±0.9	24.70±1.8	24.45±1.6	22.40±0.7
	51	11.25±1.2^{d}	15.80±0.6^{c}	18.05±1.9^{bc}	23.12±0.9^{a}	19.20±1.9^{bc}	22.15±0.9^{ab}
	59	24.48±1.3	22.98±1.1	24.15±0.7	24.29±2.4	25.34±1.6	24.17±1.1
Shell thickness (mm)	43	0.34±0.01^{ab}	0.32±0.01^{b}	0.35±0.01^{a}	0.35±0.01^{a}	0.34±0.01^{ab}	0.34±0.01^{ab}
	51	0.34±0.01^{ab}	0.32±0.01^{b}	0.35±0.01^{a}	0.35±0.01^{a}	0.32±0.01^{ab}	0.33±0.01^{ab}
	59	0.35±0.01^{a}	0.32±0.01^{b}	0.35±0.01^{a}	0.36±0.01^{a}	0.34±0.01^{ab}	0.34±0.01^{ab}
SWUSA[2]	43	95.41±2.4	91.23±3.0	95.55±3.4	89.42±2.5	93.82±4.9	94.10±6.3
	51	96.72±2.2	89.87±2.6	95.63±3.1	91.07±2.0	92.23±4.6	92.03±3.5
	59	93.59±3.5	91.59±3.5	93.16±2.7	90.01±3.3	92.89±4.87	92.17±5.8
Breaking force	43	26.33±0.6^{abc}	23.00±1.0^{d}	24.00±0.8^{cd}	28.33±1.6^{abc}	32.33±3.8^{a}	30.00±1.0^{ab}
	51	26.00±0.5^{bcd}	22.00±1.0^{d}	23.39±1.0^{cd}	27.90±2.0^{bc}	32.10±3.5^{a}	32.15±1.0^{a}
	59	25.83±0.9^{bc}	23.00±1.0^{c}	24.00±0.8^{c}	29.00±1.5^{ab}	32.33±4.0^{a}	30.00±1.0^{ab}
Specific gravity	43	1.078±0.0^{b}	1.078±0.0^{b}	1.078±0.0^{b}	1.078±0.0^{b}	1.082±0.0^{a}	1.078±0.0^{b}
	51	1.078±0.0	1.078±0.0	1.078±0.0	1.078±0.0	1.078±0.0	1.078±0.0
	59	1.078±0.0^{b}	1.078±0.0^{b}	1.078±0.0^{b}	1.078±0.0^{b}	1.082±0.0^{a}	1.078±0.0^{b}
Shell w. wet, (%)	43	11.29±0.2	10.74±0.3	11.29±0.4	10.50±0.3	11.06±0.6	11.15±0.8
	51	11.52±0.2	10.73±0.3	11.36±0.4	10.61±0.3	11.10±0.6	10.89±0.4
	59	11.01±0.4	10.81±0.4	10.89±0.3	10.60±0.5	10.90±0.6	10.83±0.7
Shell w. dry, (%)	43	5.65±0.3	5.43±0.3	5.72±0.2	5.37±0.2	5.43±0.3	5.38±0.4
	51	5.04±0.2	4.53±0.2	5.01±0.2	4.99±0.2	4.56±0.3	4.81±0.3
	59	5.87±0.1	5.62±0.1	5.83±0.0	5.62±0.2	5.73±0.1	5.59±0.2

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

[1]CGF: Corn gluten feed [2]SWUSA: Shell weight per unit of surface area

Table (7): Effect of feeding different levels of corn gluten feed for Hy-Line White laying hens at 59 weeks on yolk fatty acids component (%).

Fatty acids[1]	CGF[2], (%)					
	0	4	8	12	16	20
14:0	0.278±0.0^{f}	0.391±0.0^{b}	0.473±0.0^{a}	0.365±0.0^{c}	0.305±0.0^{e}	0.342±0.0^{d}
16:0	30.513±0.0^{c}	25.672±0.0^{e}	28.503±0.0^{d}	25.316±0.0^{f}	30.922±0.0^{b}	30.971±0.0^{a}
16:1	2.714±0.0^{a}	2.495±0.0^{b}	1.828±0.0^{c}	1.753±0.0^{d}	1.804±0.0^{c}	1.543±0.0^{f}
18:0	8.668±0.5^{d}	8.606±0.0^{d}	11.492±0.0^{a}	9.642±0.0^{c}	10.515±0.0^{b}	9.866±0.0^{bc}
18:1	46.847±0.0^{a}	36.9125±0.0^{c}	36.572±0.0^{e}	36.824±0.0^{d}	37.206±0.0^{b}	36.426±0.0^{f}
18:2	9.865±0.0^{f}	24.943±0.0^{a}	19.947±0.0^{d}	24.84±0.0^{b}	17.858±0.0^{e}	20.169±0.0^{c}
20:0	0.616±0.0^{f}	0.9825±0.0^{d}	1.187±0.0^{c}	1.262±0.0^{b}	1.393±0.0^{a}	0.686±0.0^{e}

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

[1]**Fatty acids**: 14:0 Myrestic acid, 16:0 Palmetic acid, 16:1 Palmitoleic acid, 18:0 Stearic acid, 18:1 Oleic acid, 18:2 Linoleic acid, 20:0 Arachidic acid

[2] **CGF**: Corn gluten feed

Table (8): Effect of feeding different levels of corn gluten feed on Ca and P (%) in manure for Hy-Line White laying hens at 51 week of age

Traits	CGF[1], (%)					
	0	4	8	12	16	20
Ca	6.17±0.0	6.12±0.1	6.14±0.0	6.16±0.3	6.17±0.9	6.16±0.1
P	2.19±0.4	2.09±0.2	2.10±0.1	2.16±0.3	2.17±0.2	2.20±0.0

[1] CGF: Corn gluten feed

Table (9): Economic evaluation as affected dietary levels of corn gluten feed for Hy-Line White hens during (32 to 59) weeks of age

Traits	CGF[1], (%)					
	0	4	8	12	16	20
Egg mass, kg/ hen/ period	**9.16**	**9.36**	**9.96**	**9.52**	**9.74**	**10.06**
Feed/egg (period)	**20.25**	**19.89**	**19.48**	**19.42**	**19.33**	**19.21**
Total feeding cost (LE.)	**13.96**	**13.23**	**13.31**	**13.20**	**13.09**	**12.96**
Feeding cost/egg	**1.52**	**1.41**	**1.34**	**1.39**	**1.34**	**1.29**
Cost/egg	**100.00**	**92.76**	**88.16**	**91.45**	**88.16**	**84.87**

[1] CGF: Corn gluten feed

REFERENCES

A.O.A.C. (1990). *Association of official analytical chemists (1985). Official method of analysis. 15th ed. Published by the A.O.A.C, Washington, D.C., USA.*

Allain, C. C.; Poon, L. S. and Richmond, W. (1974). *Fu P.C. Clin Chem., 20: 470.*

Allan L. H., and Wood, R. J. (1994). *Calcium and phosphorus. Pp. 144-163. In: Modern Nutrition in Health and disease. Ed R.S. Goodhardt and M.E. Shils, ed Lea and Febiger, Philadelphia. P analysis Anal Biochem. 56: 66-73.*

Bayley, H. S.; Summers, J. D. and Slinger, S. J. (1971). *A nutritional evaluation of corn wet milling by-products with growing chicks, turkey poult, adult roosters, turkeys, rats and swine. Cereal Chem. 48:27-33.*

Brake, J. and Thaxton, P. (1979). *Physiological change in caged layers during a forced molt. 2. Gross change in orans. Poultry Sci. 58: 707-716.*

Castanon , F.; Han, Y. and Parsons, C. M. (1990). *Protein quality and metabolizable energy of corn gluten feed. Poultry Sci. 69:1165-1173.*

Castanon, F. (1988). *Nutritional evaluation of corn gluten feed by poultry. M.S. Thesis, University of Illinois, Urbana-Champaign, IL.*

Cooley, M. L. (1970). *Feed ingredient guide. In P fost, H.B. and C.E. Swinehard (Ed.). Feed Manufacturing Technology. American Feed Manufacturing Association. Chicago.*

Duncan, D. B. (1955). *Multiple range and multiple F-test, Biometrics 11:1-42.*

Fisher, H. and Leveille, G. A. (1957). *Observations on the cholesterol, linoleic and linolenic acid content of eggs as influenced by dietary fats. J. Nutrition 63:119-129.*

Fretzdorff, B.; Brummer, J. M.; Rocken, W.; Dreiner, R.; Konietzny, U. and Jany, K. D. (1995). *Reducktion des phytinsaure- Gehaltes bei der Herstellung Von Backearen Getreidenahrmitteln. AID-Verbraucherdients. 40: 12-20.*

Hillman, R. I.; Kienholz, E. W. and Shroder (1973). *The effect of corn gluten feed in chicken and turkey breeder diets. Poultry Sci. 52:2309 (Abst.).*

Kotaiah, T. and Mohapatra, S. C. (1974). *Measurement of albumen quality. India Poult. Ganzette 59: 507-508.*

Matterson, L. D.; Potter, L. M.; Stutz, M. W. and Singsen, E. P. (1965). *The metabolizable energy of feed ingredients for chickens. Pages 3-11 in: University of Connecticut Agricultural Experiment station Research report No. 7, University of Connecticut, Storrs, CT.*

Murray, R. K.; Granner, D. K.; Mayes, P. A. and Rodwell, V. W. (1993). *Textbood harper's biochemistry. Pages 232-240, twenty- third edition, Appleton and longe, Norwalk Connecticut los Altos, California.*

NRC (1984). *Nutrient requirements for domestic animals. Nutrient requirements of Poultry 8th Ed. National Academy of Sciences, Washington, DC.*

NRC (1994). *Nutrient requirements of Poultry, 9th rev. ed. National Academy Press. Washington, D.C.*

Owings, W. J.; Sell, L.; Ferket, P. and Hasiak, R. J. (1988). *Growth performance and carcass composition of turkey hens fed corn gluten feed. Poultry Sci. 67:585-589.*

Paganelli, C. V., Olsozwoka, A., and Ar. A. (1074). *The avian egg: surface area, volume and density. The condor. 76: 319-325.*

Radwan, S. S. (1978). Coupling of two-dimensional thin layer chromatography with gas chromatography for the quantitative analysis of lipids classes and their constituent fatty acids. J.Chromatog. Sci. 16: 538-542.

Romanoff, A. L. and Romanoff, A. L. (1949). *The avian egg. John Wiley and Sons, Inc., New York.*

SAS (1996). *User's guide : Statistics. SAS Institute Inc., Cary, NC.*

Scheideler, S. E. (1996). *Hisex White Leghorn lysine requirement for optimum body weight and egg production and egg weight. Poultry Science. 75:341 (Abstr.).*

Shafer, J. B., Carey, J. B., Prochaska, J. F. and Sams, A. R. (1998). *Dietary methionine intake effects on egg component yield, composition, functionality and texture profile analysis. Poultry Sci. 77: 1056-1062.*

Sibbald, I. R. (1986). *The T.M.E. system of feed evaluation: methodology, Feed composition data and bibliography. Animal Research Centre Contribution 85-91, Research Branch, Agric. Canada, Attawa, Ontario, Canada.*

Sim, J. S. and Qui, G. H. (1995). *Designing poultry products using flaxseed. Pages 315-333 in: Flax. S.C. Cunnane and L.U. Thompson, ed. Flaxseed in Human Nutrition. AOCS Press, Champaign, IL.*

Spackman, D. H.; Stein, W. H. and Moore, S. (1958). *Automatic recording apparatus for use in the chromatography of amino acids. Analyt. Chemist. 30:1190.*

Spitz, H. D. (1973). *A new approach for sample preparation of protein hydrolyzates for amino acid analysis. Anal. Biochem. 56: 66-73.*

Vorha, P.; Chami, D. B. and Oyawoye (1982). *Determination of metabolizable energy by fast method. Poultry Sci. 61:766-769.*

Willis, G. M. and Baker, D. H. (1980). *Evaluation of turfgrass clippings as a dietary ingredient for the growing chick. Poultry Sci. 59: 404-411.*

Wu, Y. V. (1996). *Neutral sugar contents of corn gluten meal and corn gluten feed. Poultry Sci. 75: 103-107.*

Yakout, H. M. (2000). *Response of laying hens to practical and low protein diets with ideal TSAA: lysine rations: Effects on egg production, components, nitrogen and nitrogen excretion. Ph. D. Thesis, Faculty of Agriculture, Alexandria University.*

الملخص العربي

تقييم الجلوتفيد كمادة علفية فى علائق الدجاج البياض

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إستهدفت هذه التجربة تقييم الجلوتفيد كمادة علفية فى للدجاج البياض الهاى لاين التجارية عند عمر ٣٢ الى ٥٩ اسبوع. وذلك من خلال التحليل الكيماوى، قياس الطاقة الممثلة و الكفاءة الكلية للبروتين و نسبة البروتين الصافية. بالإضافة الى التأثير على الأداء الإنتاجى و الصفات المصاحبة له من جودة بيض و محتواه من الأحماض الدهنية الكلية و الكوليسترول و محتوى الزرق من الكالسيوم و الفوسفور و الكفاءة الإقتصادية للإنتاج. استخدم عدد ١٤٤ دجاجة فى التجربة قسمت الدجاجات الى ٦ مجاميع تجريبية مكونة من ٦ مكررات بكل مكررة ٤ دجاجات. استخدم الجلوتفيد بمستويات صفر، ٤، ٨، ١٢، ١٦ أو ٢٠% فى العلائق. نتائج تجربة التغذية اوضحت التالى:

١. احتوى الجلوتفيد على ٨٩% مادة جافة، ١٨% بروتين خام، ٢% دهون، ٩% الياف و ٧% رماد و ٥٣% مستخلص خالى من النيتروجين. فى حين ان الطاقة الممثلة كانت ١٨٥٠ كيلو كالورى/ كجم. كذلك فان الكفاءة البروتين ونسبة البروتين الصافية كان ٢.٤٦ و ٢.٩٧ على التوالى.

٢. لم تتأثرصفات انتاج البيض سلبيا فى الدجاجات المغذاه على الجلوتفيد عند التغذية حتى مستوى ٢٠%.

٣. استهلاك العلف انخفض عند التغذية على مستوى ٢٠% من الجلوتفيد فى حين ان الكفاءة التحويلية للعلف لم تتأثر معنويا بالمعاملات الغذائية خلال مدة التجربة.

٤. الدجاجات المغذاه على الجلوتفيد لم تتأثر سلبيا عند التغذية حتى مستوى ٢٠% وذلك لصفات معامل الصفار و وحدات هيو فى حين ان العكس كان صحيح بالنسبة لقوة كسر القشرة أو كثافة القشرة.

٥. دهون البيضة ومستوى الكوليسترول لم تتأثر معنويا باى من المعاملات المستخدمة فى حين ان معظم الأحماض الدهنية للصفار ازدادت بالمعاملة حتى ٢٠% جلوتفيد.

٦. عند التغذية على الجلوتفيد بمستوى ٢٠% فان اخراج الكالسيوم والفوسفور لم تتأثر معنويا.

٧. انخفضت تكلفة العلف عند التغذية على الجلوتفيد بمستوى ٤% بنسبة ٧.٢٤% مقارنة بـ١٣.١٥ % عند التغذية على الجلوتفيد بمستوى ٢٠%.

من وجهه نظر غذائية واقتصادية فان اضافة الجلوتفيد بنسبة ٢٠% لاعلاف الدجاجات البياضة التجارية لن يكون له اية اثار سلبية على صفات انتاج البيض وجودة البيضة والكفاءة الإقتصادية.