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UTILIZATION OF DRY CORN GRAINS DISTILLATION BY-PRODUCT WITH SOLUBLE (DDGS) AS AN ALTERNATIVE NON-CONVENTIONAL FEED STUFF IN LAYING HEN DIETS

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SUMMARY

A total of 105 Dokki-4 laying hens, 24 weeks of age were used to study utilization of dry corn grains distillation by-product with soluble (DDGS) as an alternative non-conventional feed stuff in laying hen diets. Hens were divided equally into seven treatment groups, three levels of DDGS (20, 25 and 30 %) without or with enzyme (1g enzyme/kg diet), in addition to8 control group. Each group contains five replicates with 3 birds each. Egg production and egg weight were recorded and egg mass was calculated daily during 24 to 36 weeks of age. Random samples of 5 eggs from each treatment were collected weekly to measure egg quality. Results showed that proximate analysis for DDGS yielded values of 93.72% for dry matter (DM), 21.74% for crude protein (CP), 6.74% for ether extract (EE), 6.54 % for crude fiber (CF) and 5.93% for ash. Hens fed diet containing 20 % DDGS recorded the highest ($P \leq 0.05$) egg production, egg weight, egg mass, lowest feed consumption and the best feed conversion ratio (FCR), values were 76.32%, 43.15g, 32.91g/ hen/ day, 99.02g/ hen /day and 3.06 g feed/g egg, respectively. Supplementation of enzyme to diets containing DDGS had significant effect on egg production, egg weight, egg mass, feed consumption and FCR. Concerning to the interaction between DDGS level and enzyme supplied, hen fed 20 % DDGS with enzyme recorded values similar to hen feed control diet. Albumen wt. %, yolk wt. %, shell wt. %, shape index and yolk index, were not affected by DDGS level, on the other hand Haugh unit and shell thickness were insignificantly affected by DDGS level. The interaction between DDGS level and enzyme supplied effect on egg quality except shell thickness had not. The best value for economical efficiency and relative economical efficiency had been recorded by hen fed on control diet (0.50 and 100%) followed by 20% DDGS with 1 g enzyme / kg diet (0.45 and 90 %). The present study show that DDGS could be used in layer diets up to 20% with 1 g enzyme / kg diet without adverse effect on performance of laying hens and egg quality.

***Keywords**: DDGS, laying hens production, egg quality and enzyme.*

INTRODUCTION

The trend of research in recent years has been to search for alternatives to traditional feedstuff such as corn and soybean meal with untraditional feed stuff to reduce production costs in the poultry industry, Distiller's dried grains with soluble (DDGS) are considered as a by-product of agro-processing that can be used as an unconventional feedstock for poultry feed. Youssef *et al*. (2009) suggested that DDGS could be considered a conventional feed stuff as alternative of energy and protein in poultry diets with other feed components. However, previous studied had reported that, DDGS can be used up to 15% in layer feeds without adversely affect while, inclusion of 20% negatively affected laying rate and egg weight (Swiatkiwicz and Koreleski, 2006). Also, Roberts *et al.* (2007a) found that using 10 % DDGS in laying hens diets had no negative effects on egg production or egg quality parameters. Shalash *et al.* (2010) reported that DDGS can be successfully fed at levels up to 10 % in laying hen diet without adverse effect on laying performance. Ghazalah *et al*. (2011) found that higher levels of corn DDGS negatively affected egg quality and productive performance. Abd El-Hack *et al.* (2015) and Abd El-Hack and Mahgoub (2015) showed that increasing DDGS level up to 22% in Hi sex Brown laying hens diets declined ($P \leq 0.05$) the number of egg produced and depressed egg weight, egg mass and feed intake, also, feed conversion ratio was negatively affected compared to diets that did not contain DDGS. Distiller's dried grains with soluble are higher level in the non-starch polysaccharides (NSP), crude fiber, crude protein, fats and minerals. However, NSP have a negative affect energy density (dilution effect), entrapping of nutrients, increasing the viscosity of digesta and constitute complex formation with minerals, thereby forming a component difficult to digest (Classen and Bedford, 1999 and Simon, 2000). Moreover, supplementing exogenous enzymes in poultry diets may improve the available energy of DDGS by analysis the fiber content and increasing the digestibility of other components. Several studies have demonstrated the positive effects of enzyme additives on feed intake, egg production, egg weight, egg mass and egg-specific gravity when added to laying hen diets (Francesch *et al.,* 1995; Pan *et al.,* 1998; Jaroni *et al*., 1999 and Ghazalah *et al.,* 2011). Thus the objective of this work was to study utilization of DDGS as an alternative untraditional feed stuff in laying hen diets.

MATERIALS AND METHODS

The present study was carried out at Siwa Oasis Research Station, Desert Research Center (DRC), Egypt. A total of 105 *Dokki-4* laying hens, 24 weeks of age were used to study utilization of dry by-

Table (1): Percentage compositions and calculated analysis of the experimental diets.

Ingredient (%)	Experimental diet						
	1	2	3	4	5	6	7
Yellow corn, ground	62.0	55.4	55.3	53.5	53.4	51	50.9
Soybean meal (44%)	20.0	10	10	5.9	5.9	3.8	3.8
Corn gluten meal (60%)	4.0	4	4	5	5	4.6	4.6
Distillation of corn grains with soluble (DDGS)	-	20.00	20.00	25.00	25.00	30.00	30.00
Wheat bran	3.4	-		-		-	-
Commercial enzyme	-	-	0.1	-	0.1	-	0.1
Premix**	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Limestone	8.9	8.9	8.9	8.9	8.9	8.9	8.9
Di-calcium phosphate	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DL-Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-Lysine HCl	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Calculated analysis:***							
ME(Kcal/kg)	2716	2724	2720	2730	2726	2708	2705
Crude protein %	17.08	17.07	17.06	17.09	17.09	17.08	17.07
Crude fiber %	3.19	3.77	3.77	3.91	3.90	4.15	4.15
Ether extract %	2.8	4.11	4.10	4.48	4.48	4.81	4.81
Calcium %	3.38	3.38	3.38	3.38	3.38	3.38	3.38
Total phosphorus %	0.55	0.51	0.51	0.50	0.50	0.50	0.50
Available phosphorus %	0.30	0.27	0.27	0.26	0.26	0.25	0.25
Lysine%	0.80	0.64	0.64	0.58	0.58	0.55	0.55
Methionine & cystine%	0.60	0.43	0.43	0.37	0.37	0.33	0.33
Methionine%	0.40	0.44	0.44	0.46	0.46	0.46	0.46
Price L.E/ton****	4928	4710	4806	4689	4785	4612	4708

** The price of one kg DDGS = 1 L.E.*
*** Vit. and Min. Premix contents per Kg of diet: 12000 IU. Vit. A, 2000 IU. Vit. D3, 10 mg Vit. E, 4 mg Riboflavin, 10mg Pantothenic acid, 0.01 mg Vit. B_{12}, 500 mg Choline chloride, 2 mg Vit. K, 1 mg. Vit. B_1, 1.5 mg Vit. B_6 1 mg Folic acid, 20 mg Niacin, 0.05 mg Biotin, 10 mg Cu, 1 mg I, 30 mg Fe, 55 mg Mn, 55 mg Zn and 0.1 mg Se.*
**** According to NRC (1994).*
***** According to the local market price of the experimental time (2018).*

products for distillation of corn grains with soluble (DDGS) as an alternative non-conventional feedstuff in laying hen diets. Hens were divided equally into seven treatment groups, three levels of DDGS (20, 25 and 30 %) without or with enzyme (1g enzyme/kg diet), in addition to control group. Each gram of the enzyme mixture (kemzyme) contained 400 units α-amylase, 300 units xylanase, 1250 units B-glucanase, 450 units protease. Each group contains five replicates with 3 birds each. The experimental diets were formulated to be isocaloric (~2700 Kcal ME /kg diet) and isonitrogenous (~17.00% CP) as listed in Table (1). Hens were housed in wire cages of triple deck batteries. Feed and water were provided *ad libitum*.

Body weights were recorded at the beginning of the experiment (24 weeks of age) and at the end of the experiment (36 weeks of age). Body weight changes were calculated as the difference between the initial and final body weight. Egg weight and egg number were recorded daily to calculate the egg mass (g/hen/day). Feed consumption was recorded biweekly, while feed conversion value (g feed /g eggs) were calculated as the amount of feed consumed divided by egg mass.

Egg quality parameters were measured using 35 eggs (5 eggs/each treatment group). These involved yolk, albumen and shell weight percentage. Egg shell thickness was measured in mm using a micrometer. Egg shape index was calculated according to Romanoff and Romanoff (1949) as an egg diameter divided by an egg length. Yolk index was calculated according to Funk *et al*. (1958), as yolk height divided by yolk diameter. Haugh unit was calculated according to Eisen *et al*. (1962) using the calculation chart for rapid conversion of egg weight and albumen height. Amino acid concentrations in DDGS were determined according to Pellet and Young (1980).

Economic efficiency of egg production was calculated from the input-output analysis which was calculated according to the price of the experimental diets and egg production during the year of 2018.The values of economical efficiency were calculated as the net revenue per unit of total cost.

A procedure General Linear Model was used to analyzing data by the Computer Program, SAS (2003). All the characteristics were performed in conformity by factorial analysis and one way analysis model to compare the difference between means by Duncan's Multiple Range-Test (Duncan, 1955).

Model applied was:

a- factorial analysis $Y_{ijk} = \mu + X_i + Z_j + (XZ)_{ij} + e_{ijk}$.

Where: Yijk = observation, µ = overall mean, Xi = DDGs effect, Zj = enzyme supplied effect, (X Z)ij = interaction between DDGs and enzyme supplied level, eijk = experimental errors.

b- one way analysis $Y_{ij} = \mu + T_i + e_{ij}$.

Where: Yij =observed value of a given dependent variable, µ= overall adjusted mean, Ti = fixed effect of treatments, i= 1, 2....7. eij = random error associated to each observation.

RESULTS AND DISCUSSION

Chemical analysis of DDGS:

Chemical analysis of DDGS on DM basis % is presented in Table (2). The results of proximate analysis for DDGS yielded values of 93.72% for dry matter, 21.74% for crude protein (CP), 6.74% for ether extract (EE), 6.54 % for crude fiber (CF), 5.93% for ash, analyzed data showed that the moisture

Table (2): Chemical composition of DDGS (% on dry matter basis).

Item	Moisture	DM	OM	CP	CF	EE	NFE	Ash
DDGS	6.28	93.72	94.06	21.74	6.54	6.74	59.05	5.93

content of DDGS (6.28%) may be indicating the ability to store as un- traditional feed stuff for a long time without any deleterious effects. DDGS had a higher level of crude protein (21.74%) this mean that DDGS might be considered as a promising source of protein in poultry feed comparable with soya bean meal. The results of proximate analysis for DDGS in present study differs with obtained by Batal and Dale (2006), Shalash *et al.* (2009a, b) and Ghzalah *et al.* (2011) this in fact that chemical composition of DDGS varied according to processing procedures which may lead to large variations in the nutritional value of DDGS (Cromwell *et al.*,1993). Also, differences in the protein content of the corn grain used to produce DDGS and because of differences in residual starch content (diluting the concentrations of protein and other nutrients) caused by differences in fermentation efficiency Shalash *et al.* (2010).

Amino acid of DDGS:

Amino acid of DDGS and soya bean meal are listed in Table (3). Data shows that soya bean meal had a higher level of amino acids than DDGS, but DDGS had a moderate level of most amino acids and a higher level of methionine compared to soya bean meal (1.10 vs. 1.05 mg/g). The results agree with that obtained by Shalash *et al.* (2009a, b). Some amino acids, especially lysine can be turned to biologically unavailable lysine derivatives (un-reactive lysine) during heat processing as well as prolonged storage of feedstuffs (Kim and Mullan, 2012 a and b).

Table (3): Amino acids components of DDGS compared to soya bean meal.

Amino acid	DDGS (mg/g)	Soya bean meal (mg/g)
Aspartic acid	23.08	41.19
Threonine	8.29	11.00
Serine	10.16	17.77
Glutamic acid	43.07	68.91
Proline	16.29	-
Glycine	11.21	15.52
Alanine	14.84	17.25
Valine	13.85	18.19
Methionine	1.10	1.05
Cystine	2.58	-
Isoleucine	11.29	16.38
Leucine	25.42	27.94
Tyrosine	5.55	7.71
Phenylalanine	12.54	17.52
Histidine	7.65	10.73
Lysine	10.74	23.03
Arginine	14.49	25.85

Final body weight and body weight change:

Final body weight and body weight change were not significantly affected by both DDGS levels and enzyme supplied or the interaction between DDGS level and enzyme supplement. (Table 4). These finding are in agreement with Lumpkins *et al.* (2005) who observed that hens fed the commercial diet with 15% DDGS showed no significant effects on live body weight. Roberts *et al.* (2007a, b) reported no negative effects on body weight in Hi-Line W-36 laying hen when feeding on 10% of maize DDGS within 23-58 weeks of age. Also, Jiang *et al.* (2013) found that the effects of DDGS supplementation on body weight and any production parameter were not significant. In this respect, Abd El-Hack (2015) noticed that replacing soybean meal in the diet by DDGS up to 75% (16.5% DDGS in the diet) did not exert any detrimental ($P \leq 0.05$) effect on final body weight and body weight change during the whole experimental period (22- 42 weeks of age).

Table (4): Body weight change of local laying hens as affected by DDGS, enzyme and experimental treatments.

Treatments	Parameters	Initial body wt. (g /hen)	Final body wt. (g / hen)	B.W. Changes (g / hen)
DDGS	20	1420.50	1475.00	54.50
	25	1425.25	1450.75	25.50
	30	1415.74	1463.23	47.49
Enzyme	0	1411.78	1461.77	49.99
	1g/kg diet	1416.56	1456.11	48.46
Interaction				
Control	0	1424.33	1445.00	20.67
20 %	0	1413.00	1461.33	48.33
	1g/kg diet	1416.00	1465.67	49.67
25%	0	1412.67	1439.00	26.33
	1g/kg diet	1419.00	1448.00	29.00
30 %	0	1422.67	1471.33	48.66
	1g/kg diet	1418.33	1457.67	39.34
Probabilities				
DDGS		NS	NS	NS
Enzyme		NS	NS	NS
Interaction		NS	NS	NS

NS = Not significant. *DDGS = Distiller dried corn grains with soluble.*

Egg production:

Egg production, egg weight, egg mass, feed consumption and FCR were significantly affect by DDGS levels, enzyme supplied and their interactions (Table 5). Hens fed diet containing 20 % DDGS recorded the highest ($P \leq 0.05$) egg production, egg weight, egg mass, lowest feed consumption and the best FCR, values were 76.32%, 43.15g, 32.91g/ hen/ day, 99.02g/ hen /day and 3.06 g feed/g egg, respectively. It is worth noticing that from the present study increasing DDGS level 20 up to 30% decreased egg production, egg weight and egg mass. This may be due to DDGS high fiber content such as non-starch poly saccharide. These results disagree with Lumpkins *et al*. (2005) who roberted that laying hens fed the basal diet with 15% DDGS did not show any significant effect on hen-day egg yield, egg weight and feed intake. While, Swiatkiwicz and Koreleski (2006) observed no impact on egg production when *Lohmann* brown hens were fed DDGs up to 20% during phase one (26-43 week of age). However, egg production, egg weight and feed intake were negatively affected when hens fed 20% DDGS compared to other DDGS treatments during phase two of production (44-68 week of age). Pineda *et al*. (2008) recommended that laying hens could be fed on high level of DDGS, without adverse effects on egg production but advised that all nutrients should be considered when formulating diets containing DDGS. Loar *et al*. (2010) found that feeding up to 32% DDGS in diets of second-cycle layers had no detrimental effects on egg production. Similar results were obtained by Masa'deh (2011), who stated that increasing DDGS level from 0-25% for White Leghorn type hens did not negatively affect egg production and feed intake while, egg weight and egg mass were decreased. On the other hand, Deniz *et al*. (2013) found that the inclusion of 20% DDGS significantly ($P \leq 0.05$) depressed laying rate, egg weight, egg mass, feed intake and FCR of laying hen compared to those fed diets without DDGS supplementation. Some studies by Abd El-Hack *et al*. (2015) and Abd El-Hack and Mahgoub (2015) showed that increasing DDGS level up to 22% in Hi sex Brown laying hens diets declined ($P \leq 0.05$) the number of egg produced and depressed egg weight, egg mass, feed intake and FCR was negatively affected compared to diets that did not contain DDGS. Youssef *et al.* (2017) found that DDGS inclusion in the diet had insignificant impact on rate of laying and egg mass, egg weight, feed consumption and FCR as compared to the control group during the whole experimental period (28-48 wks of age). Shalash *et al*. (2009, 2010) and Ghazalah *et al*. (2011) reported that inclusion of 20% DDGS in the laying hen diets yielded the worst FCR compared with the 0% DDGS ($P<0.05$). Recently Abd El-Hack *et al*. (2019) suggested that the inclusion of 18% DDGS was associated with the worst ($P \leq 0.001$) egg production and the lowest daily feed intake also, the best FCR was recorded in the control, while the worst was recorded in the 18% DDGS group.

Table (5): Egg production and feed intake of local laying hens as affected by DDGS, enzyme and experimental treatments.

Treatments \ Parameters		Egg production (%)	Egg wt. (g)	Egg mass (g / hen / day)	Fed consumption (g / hen / day)	Feed conversion (g feed/g egg)
DDGS	20	76.32^{a}	43.15^{a}	32.91^{a}	99.02^{c}	3.06^{c}
	25	73.89^{b}	42.18^{b}	31.17^{b}	101.88^{b}	3.32^{b}
	30	70.87^{c}	41.01^{c}	29.03^{c}	105.25^{a}	3.72^{a}
Enzyme	0	71.21^{b}	41.47^{b}	29.50^{b}	104.18^{a}	3.60^{a}
	1g/kg diet	76.17^{a}	42.75^{a}	32.57^{a}	99.92^{b}	3.13^{b}
Interaction						
Control	0	78.72^{a}	43.88^{a}	34.52^{a}	93.42^{e}	2.74^{a}
20 %	0	74.36^{bc}	42.58^{b}	31.62^{bc}	100.02^{cd}	3.22^{c}
	1g/kg diet	78.28^{a}	43.72^{a}	34.20^{a}	98.02^{d}	2.90^{de}
25%	0	71.64^{c}	41.38^{c}	29.64^{d}	104.26^{b}	3.56^{b}
	1g/kg diet	76.12^{ab}	42.98^{b}	32.70^{b}	99.50^{cd}	3.08^{cd}
30 %	0	67.62^{d}	40.46^{d}	27.24^{e}	108.26^{a}	4.02^{a}
	1g/kg diet	74.12^{bc}	41.56^{c}	30.82^{cd}	102.24^{bc}	3.42^{b}
Probabilities						
DDGS		***	***	***	**	***
Enzyme		**	***	***	**	***
Interaction		***	***	***	***	***

a, b ....Means in the same column in each classification bearing different letters differ significantly (P≤0.05).
*NS = Not significant *= (P≤0.05) **= (P≤0.001) DDGS = distiller dried corn grains with soluble.*

Supplementation of enzyme preparations to diets containing DDSGs had significant effect on egg production, egg weight, egg mass, feed consumption and FCR, hen fed diet inclusion enzyme supported recorded the highest (P ≤ 0.05) values of egg production (76.17%), egg weight (42.75g), egg mass (32.57g) and lowest feed consumption (99.92g/hen/day) and the best FCR (3.13g feed/g egg), respectively. Several studies demonstrated that mixture enzyme supplementation to layer feeds have been reported to improve layers performance including FCR (Benabdeljelil and Arbaoui, 1994; Vukic Vranjes and Wenk, 1995; Shalash *et al.*, 2009 a,b; Shalash *et al.* 2010 and Ghazalah *et al.*, 2011). Also, Nelson (1989) who stated that laying performance was improved by adding multi enzyme preparations containing variety of enzyme. Recently Abd El-Hack *et al.* (2019) observed that exogenous enzyme mixture supplementation did not significantly affect egg production or FCR.

Regarding to the interaction between DDGS level and enzyme supplied, hen fed 20 with enzyme supplied recorded values similar to hen feed control diet, values were (78.28 vs. 78.72% for egg production, 43.72 vs. 43.88g for egg weight, 34.20 vs.34.52 g/hen/day for egg mass, 98.02 vs. 93.42g/hen/day for feed consumption and 2.90 vs. 2.74 g/feed/g egg for FCR. These results agree with (Shalash *et al.*, 2009a,b) who reported that there was an increase in broiler body weight at 28 and 42 day when they fed diet containing 12% DDGS supplemented with radish root extract enzyme. In addition Shalash *et al.* (2010) found that enzyme addition to DDGS diets stimulated the utilization of DDGS levels even with the high levels 15 or 20%. Also, Ghazalah *et al.* (2011) reported that corn DDGS should be included in layers diet at less than 15.45% of total dietary level, supplemented with Avizyme 1500® in order to improve egg productive performance. Abd El-Hack *et al.* (2017) reported that the interaction between DDGS and enzyme had a statistically significant effect (P ≤ 0.05 or 0.01) on feed efficiency and egg output. Abd El-Hack *et al.* (2019) observed that the interaction effect of DDGS and exogenous enzyme mixture was significant (p ≤ 0.01) for the majority of egg characteristics. Improvement in egg production by enzyme supplementation in fact that mixture enzyme is malty enzyme which improve enhancement the nutritive value of DDGS diets for laying hens. Improve the digestibility of NSP, fibers, or other components reported by Mahrose et *al.* (2016).

Egg quality measurements:

Egg quality measurements are shown in table (6). Albumen wt. %, yolk wt. %, shell wt. %, shape index, yolk index, had not significant by DDGS level, on the other hand haugh unit and shell thickness were significantly affected by DDGS level. Hens fed diet containing 20 recorded the highest (P ≤ 0.05) value of haugh unit (93.39), while hens fed diet containing 25 recorded the highest (P ≤ 0.05) value of shell thickness (0.447), these finding contrary with obtained by Lumpkins *et al.* (2005), Swiatkiwicz and Koreleski (2006) and Jung and Batal (2009) reported no significant differences in haugh units, egg shell thickness or shell breaking strength between hens fed a basal diet or diets contain different inclusion levels of DDGS. Masa'deh (2011) found no significant differences in haugh units among the levels of DDGS. Abd El-Hack and Mahgoub (2015) observed that the best yolk index and shell thickness were obtained from hens fed the basal diet or diets included 5 and 10% DDGS compared with those fed 15% DDGS. Youssef *et al.* (2017) found that Egg quality traits were insignificantly affected due to feeding DDGS, whereas yolk color was significantly increased by feeding 20% DDGS diet as compared to the control. Enzyme supplied by 1 g / kg diet significantly affected shape index (72.68) compared to those received 0 enzyme supplied (70.24). On the other hand albumen wt. %, yolk wt. %, shell wt. %, yolk index, haugh units and egg shell thickness had not significant by Enzyme supplied.

Table (6): Egg quality* of local laying hens as affected by DDGS, enzyme and experimental treatments.**

Treatments	Parameters	Egg weight (g)	Albu-men wt.%	Yolk wt. %	Shell wt.%	Shape index	Yolk index	Haugh unit	Shell thickness
DDGS	20	44.23^{a}	51.99	36.01	12.01	70.68	34.30	93.39^{a}	0.420^{b}
	25	44.22^{a}	52.75	34.98	12.26	71.42	34.15	90.60^{b}	0.447^{a}
	30	41.26^{b}	51.95	35.91	12.14	72.29	36.35	91.97^{ab}	0.440^{ab}
Enzyme	0	42.75	52.30	35.38	12.32	70.24^{b}	34.15	92.22	0.442
	1g/kg diet	43.72	52.16	35.89	11.95	72.68^{a}	35.72	91.75	0.430
Interaction									
Control	0	40.17^{c}	51.73	35.96	12.31	70.63	31.73	92.52	0.385^{c}
20 %	0	42.54^{bc}	52.68	35.29	12.03	70.60	33.27	94.35	0.412^{bc}
	1g/kg diet	45.91^{a}	51.29	36.72	11.99	70.75	35.33	92.42	0.428^{ab}
25%	0	45.14^{ab}	53.08	34.60	12.32	70.35	34.39	90.03	0.449^{ab}
	1g/kg diet	43.30^{abc}	52.43	35.36	12.21	72.47	33.92	91.18	0.446^{ab}
30 %	0	40.57^{c}	51.16	36.23	12.61	69.77	34.78	92.28	0.464^{a}
	1g/kg diet	41.95^{bc}	52.75	35.59	11.67	74.80	37.91	91.66	0.416^{bc}
Probabilities									
DDGS		**	NS	NS	NS	NS	NS	*	*
Enzyme		NS	NS	NS	NS	*	NS	NS	NS
Interaction		**	NS	NS	NS	NS	NS	NS	**

[a, b] *....Means in the same column in each classification bearing different letters differ significantly (P≤0.05).*
*NS = Not significant   *= (P≤0.05)   **= (P≤0.001)   DDGS = distiller dried corn grains with soluble.*
[***] *Egg quality means of samples (5 egg all treatment).*

Concerning the interaction between DDGS level and enzyme supplied had not significant effect on the most egg quality except shell thickness was significant affect. These results agreed with those reported by Shalash *et al.* (2010) observed that supplementation of enzyme preparations to diets containing DDGS had no significant effect on egg weight, yolk weight, shell weight, yolk index and egg shape index. Also, Ghazalah *et al.* (2011) found that shell weight %, shell thickness, haugh units and albumen index were insignificant affect by DDGs with Avizyme supplementation, while shape index, yolk index and yolk color were significant affect. Also, Abd El-Hack *et al.* (2017) found that enriching layer diets with 250 mg enzyme/kg diet did not affect many egg quality criteria, although it had a positive effect on egg shell percentage. Recently, Abd El-Hack *et al.* (2019) found that that all egg quality criteria (excluding shell thickness and shell percentage) were significantly (P ≤ 0.01) affected by the interaction between DDGS and exogenous enzyme mixture.

Economical efficiency (EE):

Results of economical efficiency (EE) and relative economical efficiency (REEg) estimated for the different treatments during experiment are shown in Table (7). The best value for (EE) and (REE) had been recorded by hen fed on control diet (0.50 and 100%) followed by 20 and DDGS with 1 g enzyme / kg diet (0.45 and 90 %). Obtained results agreed with Ghazalah *et al.* (2011) Hens fed diet containing 50% DDGS as substitution for soybean meal with Avizyme supplementation were economically the best treatment which had economical and relative efficiency values of 0.50 and 116.32%, respectively. Also, Masa'deh (2011) found that feeding laying hens on 30% DDGS saved $31.16/ Mt and $28.58/Mt for phase I and II compared to the control group which received diets without DDGS.

Table (7): Economical efficiency of Local laying hens as affected by the experimental treatments.

Parameters	Control	Distiller dried corn grains with soluble levels %					
		20		25		30	
		0 g / kg diet	1 g / kg diet	0 g / kg diet	1 g / kg diet	0 g / kg diet	1g / kg diet
Price /kg feed (L.E.)	4.928	4.71	4.806	4.689	4.785	4.612	4.708
Total feed intake/hen (kg)	7.847	8.402	8.234	8.758	8.358	9.094	8.059
Total feed cost / hen (L.E.)	38.67	39.57	39.57	41.07	39.99	41.94	37.94
Egg mass (kg/ hen)	2.900	2.656	2.873	2.490	2.747	2.288	2.589
Total revenue (L.E.)	58.00	53.12	57.46	49.80	54.94	45.76	51.78
Net revenue (L.E.)	19.33	13.55	17.89	8.73	14.95	3.82	13.84
Economical efficiency (Ec.E.)	0.50	0.34	0.45	0.21	0.37	0.09	0.36
Relative Ec.E. (%)	100	69	90	43	75	18	73

1-price of kg enzyme 150 L.E.
2-The price of one kg egg = 20 L.E.
3-Net revenue per unit of total feed cost
4-Relative economical efficiency % of the control, assuming that relative Ec.E. of the control = 100.

CONCLUSION

In conclusion the result show that, DDGS could be used in layer diets up to 20% with 1 g enzyme / kg diet without adverse effect on performance of laying hens and egg quality.

REFERENCES

Abd El-Hack, M.E. (2015). Enzymes drying to be used in low-cost animal fodder production for existing Biotechnology Company. Ph.D. Thesis, Faculty of Agriculture, Zagazig University, Egypt.

Abd El-Hack, M. E., Alagawany, M., Mayada R. F. and Kuldeep Dhama (2015). Use of maize distiller's dried grains with solubles (DDGS) in laying hen diets: trends and advances. Asian J. of Anim. and Vet. Advances 10 (11): 690-707.

Abd El-Hack, M.E.; Chaudhry, M.T.; Mahrose, K.M.; Noreldin, A.; Emam, M and M. Alagawany (2017) The efficacy of using exogenous enzymes cocktail on production, egg quality, egg nutrients and blood metabolites of laying hens fed distiller's dried grains with solubles. J. Anim. Physiol. Anim. Nutr. 726 - 735.

Abd El-Hack, M.E. and S. Mahgoub (2015). Mitigating harmful emissions from laying hens manure and enhancing productive performance through feeding on DDGS with or without *Bacillus* spp. Proceedings of the International Conference Industrial waste and Wastewater Treatment and Valorization, May 21-23, President Hotel, Athens, Greece.

Abd El-Hack M. E., Mahrose K. M., Faten A. M. Attia, Swelum A. A., Taha A. E., Shewita R. S., Ussein E. O. S. H, and A N. Alowaimer (2019). Laying performance, physical, and internal egg quality criteria of hens fed distillers dried grains with solubles and exogenous enzyme mixture. Animals, 9, 150; doi: 10. 3390/ ani 9040150 *www.mdpi.com/journal/animals*.

Batal, A.B. and N.M. Dale, (2006). True metabolizable energy and amino acid digestibility of distillers dried grains with solubles. J. Appl. Poult. Res., 15: 89-93.

Benabdeljelil, K. and M.I. Arbaoui, (1994). Effects of enzyme supplementation of barley based diets on hen performance and egg quality. Anim. Feed Sci. Technol., 48: 325-334.

Classen, H. L. and M.R. Bedford (1999). The use of enzyme to improve the nutritive value of poultry feeds. In: "Recent Developments in Poultry Nutrition". (Gransworthy P. C. and J. Wisemean, 2nd ed.), Nottingham University Press.

Cromwell, G.L., K.L. Herkelman and T.S. Stahly (1993). Physical, chemical and nutritional characteristics of distillers dried grains with solubles for chicks and pigs. J. Anim. Sci., 71: 679-686.

Deniz, G., H. Gencoglu, S.S. Gezen, I.I. Turkmen, A. Orman and C. Kara (2013). Effects of feeding corn distiller's dried grains with solubles with and without enzyme cocktail supplementation to laying hens on performance, egg quality, selected manure parameters and feed cost. Livestock Sci., 152: 174-181.

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

Eisen E. J., Bohren B. B. and H. E. Mckean (1962). The haugh unit as a measure of egg albumen quality. Poult. Sci., 41: 1461-1468.

Francesch, M., A.M. Perez-Vendrell, E. Estevez-Gracia and J. Brufau, (1995). Enzyme supplementation of a barley and sun flower based diet on lying hen performance. J. Appl. Poult. Res., 4: 32-40.

Funk, E. M.; Froning, G.; Grottes, G.; Forward, R. and J. Kinder (1958). Quality of eggs laid by caged layers. Worlds Poult. Sci., J., 14:207.

Ghazalah, A.A., M.O. Abd-Elsamee and E.S. Moustafa (2011). Use of distillers dried grains with solubles (DDGS) as replacement for soybean meal in laying hen diets. Int. J. Poult. Sci., 10: 505-513.

Jaroni, D., S.E. Scheideler, M. Beck and C. Wyatt (1999). The effect of dietary wheat middlings and enzyme supplementation. 1. Late egg production efficiency, egg yields and egg composition in two strains of Leghorn hens. Poult. Sci., 78: 841-847.

Jiang, W., L. Zhang and A. Shan (2013). The effect of vitamin E on laying performance and egg quality in laying hens fed corn dried distillers grains with solubles. Poult. Sci., 92: 2956-2964.

Jung, B. and A. Batal (2009). The nutrient digestibility of high-protein corn distillers dried grains and the effect of feeding various levels on the performance of laying hens. J. Applied Poult. Res., 18: 741-751.

Kim J.C. and B.P. Mullan (2012b). Quantification of the variability in the amino acid and reactive lysine content of soybean meal and development of A NIR calibration for rapid prediction of reactive lysine content. South Perth, WA 6151: Livestock Industries Innovation, Department of Agriculture and Food, 3 Baron-Hay Court.

Kim J. C., Mullan B. P. and J. R. Pluske (2012a). Prediction of apparent, standardized, and true ileal digestible total and reactive lysine contents in heat-damaged soybean meal samples. J. Anim. Sci.; 90 Suppl. 4:137–9.

Loar, II R.E., M.W. Schilling, C.D. McDaniel, C.D. Coufal, S.F. Rogers, K. Karges and A. Corzo (2010). Effect of dietary inclusion level of distillers dried grains with solubles on layer performance, egg characteristics and consumer acceptability. J. Applied Poult. Res., 19: 30-37.

Lumpkins, B.S., A.B. Batal and N.M. Dale (2005). Use of distillers dried grains plus solubles in laying hen diets. J. Appl. Poult. Res., 14: 25-31

Mahrose, K.; Abd El-Hack, M.; Attia, A. and M. El-Hindawy (2016). Productive performance of laying hens fed different levels of distillers dried grains with solubles with or without certain feed additives. Iranian J. Appl. Anim. Sci., 6, 407–413.

Masa'deh, M.K. (2011). Dried distillers grain with solubles in laying hen and pullet rations. Ph.D. Thesis, Faculty of The Graduate College, Animal Science Department, University of Nebraska-Lincoln, USA.

NRC (1994). National Research Council. Nutrient Requirements of Poultry. 9 th rev. ed. Nat 1. Acad. Press. Washington.

Nelson, C.E. (1989). Maximizing animal productivity through dry Kemzyme brand enzyme. Kemin Industries, Inc. Publication. No. 02236, pp: 1-12.

Pan, C.F., Igbasan F.A, Guenter W. and R.R. Marquardt (1998). The effects of enzyme and inorganic phosphorus supplements in wheat- and rye-based diets on laying hen performance, energy and phosphorus availability. Poult. Sci., 77: 83-89.

Pellet, P. L. and V. R. Young (1980). "Nutritional evaluation of protein foods." Published by the United Nation University. pp.189.

Pineda, L., S. Roberts, B. Kerr, R. Kwakkel, M. Verstegen and K. Bregendahl (2008). Maximum dietary content of dried distiller's grains with soluble in diets for laying hens: Effects on nitrogen balance, manure excretion, egg production and egg quality. Iowa State University Animal Industry Report 2008, Iowa State University. (http://www.ans.iastate.edu/ report/air/).

Roberson, K.D., J.L. Kalbfleisch, W. Pan and R.A. Charbeneau (2005). Effect of corn distiller's dried grains with solubles at various levels on performance of laying hens and egg yolk color. Int. J. Poult. Sci., 4: 44-51.

Roberts, S.A., H. Xin, B.J. Kerr, J.R. Russell and K. Bregendahl (2007a). Effects of dietary fiber and reduced crude protein on ammonia emission from laying-hen manure. Poult. Sci., 86: 1625-1632.

Roberts, S.A., H. Xin, B.J. Kerr, J.R. Russell and K. Bregendahl (2007b). Effects of dietary fiber and reduced crude protein on nitrogen balance and egg production in laying hens. Poult. Sci., 86: 1716-1725

Romanoff, A. L. and A. J. Romanoff (1949). In"The Avian egg"John Wiley and Sons; Inc., New York, U.S.A.

SAS (2003). Statistical Analysis System, User's Guide, Statistics, SAS Institute Carry, North Carolina.

Shalash, S.M., M.A. Sayed, E. Hoda El-Gabry, A. Nehad Ramadan and S. Manal Mohamed (2009b). Nutritive value of distillers dried grains with soluble and broiler performance at starter period. Int. J. Poult. Sci., 8: 783-787.

Shalash, S.M., S. Abou El-Wafa, M.N. Ali, M.A. Sayed, E. Hoda El-Gabry and M. Shabaan (2009a). Novel method for improving the utilization of corn dried distillers grains with soluble in broiler diet. Int. J. Poult. Sci., 8: 545-552.

Shalash, S.M.M., S.A. El-Wafa, R.A. Hassan, N.A. Ramadan, M.S. Mohamed and H.E. El-Gabry (2010). Evaluation of distillers dried grains with solubles as feed ingredient in laying hen diets. Int. J. Poult. Sci., 9: 537-545.

Simon, O. (2000). Non starch polysaccharides (NSP) hydrolyzing enzyme as feed additions. Male of action in the gastro intestinal tract. *Lohman* Information, 23: 7-13.

Swiatkiwicz, S. and J. Koreleski (2006). Effect of maize distillers dried grains with soluble and dietary enzyme supplementation on the performance of laying hens. J. Anim. Feed Sci., 15: 253-260.

Vukic Vranjes, M. and C. Wenk (1995). Influence of dietary enzyme complex on the performance of broilers fed on diets with and without antibiotic supplementation. Br. Poult. Sci., 36: 265-275.

Youssef A. Attia, R.A. Hassan, A. E. Abd-El-Hamid and W. S. Selim (2017). Utilization of different levels of distillers dried grains with solubles (DDGS) in local laying hen diets Egypt. Poult. Sci. Vol (37) (ii): 545-558.

Youssef, A.W., M.M. El-Moniary and A.H. Abd El-Gawad (2009). Evaluation of distiller dried grains with soluble (DDGS) as a feedstuff in poultry diets. Am.-Eurasian J. Agric. Environ. Sci., 5: 540-544.

الإستفادة من المنتجات العرضية الجافة لتقطير حبوب الاذرة بالسوائل كخامة علفية غير تقليدية فى علائق الدجاج البياض

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استخدم فى هذه الدراسة 105 دجاجة دقي4 بياض عمر 24 أسبوع بهدف دراسة الإستفادة من المنتجات العرضية الجافة لتقطير حبوب الاذرة بالسوائل (DDGS) كخامة علفية غير تقليدية فى علائق الدجاج البياض. تم تقسيم الدجاج إلى سبع مجموعات متساوية كما يلى: 4 مجاميع من المنتجات العرضية الجافة (0 و 10 و 15 و20%) ومجموعتان من الإنزيم (0 و 1جم إنزيم /كجم عليقة) بالإضافة إلى مجموعة المقارنه. كل مجموعة بها 5 مكررات بكل مكرر3 طيور. تم تسجيل إنتاج ووزن البيض يوميا وتم حساب كتلة البيض يوميا خلال 24 إلى 36 أسبوع من العمر. تم جمع 5 بيضات من كل معامله لقياس جودة البيضة. أوضحت النتائج أن التحليل الكيماوي كان 93,72 % للمادة الجافه و 21,74% للبروتين الخام و 6,74 % للمستخلص الدهنى و 6,54 للالياف الخام و 5.93 % للرماد. سجل الدجاج المغذى على 20% DDGS أعلى إنتاج البيض ووزن البيض وكتلة البيضة واقل كمية غذاء مأكول وأفضل معدل تحويل غذائى كانت القيم 76,32% و 43,15جم و 32,91جم لكل دجاجة يوميا و 99,02 جم دجاحة يوميا و 3.06 جم غذاء لكل جم بيض على التوالى. إضافة الإنزيم الى العلائق المحتويه على DDGS اثرت معنويا على إنتاج البيض ووزن البيض وكتلة البيضه وكمية الغذاء المأكول و معدل التحويل الغذائي. بالرجوع الى التداخل بين DDGS والإنزيم المضاف وجد أن الدجاج المغذى على 20 % DDGS مع 1 جم إنزيم سجل قيم مشابهه للدجاج المغذى على الكنترول. لم يتأثر معنويا وزن البياض ووزن الصفار ووزن القشرة ودليل الشكل ودليل الصفار بمستوى DDGS فى العليقة. على الجانب الأخر تأثر معنويا Haugh units وسمك القشرة بمستوى DDGS فى العليقة. التداخل بين DDGS والإنزيم المضاف لم يؤثر معنويا على معظم مقاييس جودة البيضة ما عدا تأثر معنويا سمك القشرة. سجل الدجاج المغذي على عليقة مقارنه أفضل كفاءه إقتصادية وعائد إقتصادى (0.50 و100%) يتبعه الدجاج المغذى على 20 % DDGS مع اضافة 1 جم إنزيم لكل كجم علف (0.45 و 90%) على التوالى. خلصت الدراسة إلى انه من الوجهه الغذائية والاقتصادية يمكن استخدام DDGS حتى مستوى 20 % مع إضافة 1جم إنزيم / كجم عليقة بدون اى تأثيرات سلبية على أداء الدجاج البياض وجودة البيضة.