IJAS Iranian Journal of Applied Animal Science

Productive Performance of Laying Hens Fed Different Levels of Distillers Dried Grains with Solubles with or without Certain Feed Additives

Research Article

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Received on: 8 Oct 2015
Revised on: 8 Dec 2015
Accepted on: 31 Dec 2015
Online Published on: Jun 2016

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Online version is available on: www.ijas.ir

ABSTRACT

The objective of this work was to evaluate the inclusion of distillers dried grains with solubles (DDGS) as substitution for soybean meal in Hisex Brown laying hen diets with or without enzyme or vitamin E supplementation on productive performance. A total number of 180 Hisex Brown laying hens at 26 weeks of age were randomly divided into 15 treatment groups in a 5 × 3 factorial design experiment, included five levels of DDGS substitution rates for soybean meal (0, 25, 50, 75 and 100%) and three levels of feed additives (without, 250 mg enzyme/kg diet or 200 mg vitamin E/kg diet) through 26-38 weeks of age. The results indicated that increasing DDGS substitution level more than 50% decreased ($P \leq 0.01$) averages of feed consumption and feed conversion, egg number and mass. All of these traits gave satisfactory results when hens fed 25 or 50% DDGS substituted by soybean meal. Enzyme or vitamin E supplementation significantly ($P \leq 0.01$) decreased both of feed consumption and egg mass. It could be concluded that DDGS was successfully substituted for soybean meal in laying hen diets up to 50% without adverse effects on the performance of laying hens.

KEY WORDS DDGS, egg production, enzyme, vitamin E.

INTRODUCTION

Distillers dried grains with solubles (DDGS) is a by-product obtained from the milling process of corn for ethanol production (Aines *et al.* 1986). DDGS is an excellent feed ingredient for use in poultry diets and contains approximately 85% of the energy value in corn, has moderate levels of protein and essential amino acids, and is high in available phosphorus (Pahm *et al.* 2009; Adedokun *et al.* 2008). The United States is a leader in corn production holding approximately 50% of the total grain corn in the world. Corn DDGS contain all the nutrients from grain in a concentrated form (Babcock *et al.* 2008) except for the majority of the starch, which has been utilized in the fermentation process. Therefore, it can be a rich source of crude protein, amino acids, phosphorus and other nutrients in poultry diets (Świątkiewicz and Koreleski, 2008). Distillers dried grains with solubles are higher in nonstarch polysaccharides (NSP), crude protein, crude fat and minerals than the parent grain. However monogastric do not digest feedstuffs high in NSP efficiently. As a result, the metabolizable energy of DDGS is lower than in corn (2820 *vs.* 3420 kcal/kg, based on moisture content) as reported by Wang *et al.* (2007) and NRC (1994). Roberson *et al.* (2005) concluded that up to 15% of DDGS can be used in laying hen diets without reducing egg production. However, supplementing monogastric diets with exogenous enzymes may improve the available energy of DDGS by degrading the fiber content and increasing the digestibility of other components. Amylase improves starch digestion, xylanase reduces gut viscosity and breaks down cereal cell walls and protease affects soybean meal anti-nutritional factors and storage proteins (Graham and Aman, 1991; Muramatsu *et al*. 1991). Vitamin E is an indispensable cellular antioxidant (Puthpongsiriporn *et al*. 2001; Brigelius-Flohé *et al*. 2002) and may help the immune response in chickens by protecting lymphocytes, macrophages, and other cells against oxidative damage (Franchini *et al*. 2002; Leeson, 2007). The present study was designed to evaluate the inclusion of DDGS in Hisex Brown laying hen diets with or without enzyme or vitamin E supplementation on their productive performance.

MATERIALS AND METHODS

The present study was conducted at Poultry Research Farm, Poultry Department, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. All experimental procedures were carried according to the Local Experimental Animal Care Committee and approved by the ethics of the institutional committee of the Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt.

A 5 × 3 factorial design experiment was performed included five levels of DDGS (0, 5.5, 11, 16.5 and 22% substituted for the same percent of soybean meal which represents 0, 25, 50, 75 and 100%, respectively in the diet) and three levels of certain feed additives (without, 250 mg enzyme/kg diet or 200 mg vitamin E/kg diet) through 26-38 weeks of age (each 4 weeks were considered as a separated period). A total number of 180 Hisex Brown laying hens, at 26 weeks old (Initial weight was 1663 g) were randomly divided into 15 treatment groups, each of 12 hens (4 replicates/treatment and 3 hens/replicate). Each replicate was housed in one layer cage with dimensions of 40 × 40 × 40 cm. Hens of all experimental groups had nearly the same initial average body weight (1650 g) at the start of the experiment. Fifteen isocaloric-isonitrogenous diets were formulated to cover the nutrient requirements of laying hens from 26-38 weeks of the age according to NRC (1994). DDGS was incorporated in the diets at five levels (0, 5.5, 11.0, 16.5 and 22.0%) and replacement rates (0.0, 25.0, 50.0, 75.0 and 100.0%) of soybean meal. The chemical composition of DDGS used in the present study is as follows: 89.05% dry matter; 95.38% organic matter; 4.62% ash; 27.23% crude protein; 11.27% ether extract; 7.45% crude fiber and 38.48% nitrogen free extract. The composition and chemical analysis of the experimental diets are shown in Tables 1 and 2. Each level of DDGS was fed with or without enzyme or vitamin E supplementation. The enzyme used in this study was "Gallazyme" (containing beta-glucanse 2300 u/g; xylanase 20000 u/g; cellulase-complex 3000 u/g; alpha-amylase 400 u/g; protease 200 u/g) and was added at level of 250 mg/kg diet. Vitamin E (dl-α-tocopherole acetate, 50% concentration) was supplemented at level of 200 mg/kg diet. Feed additives were purchased from Multivita Company, 6th of October city, Egypt. Birds were fed *ad libitum* and the fresh water was available all the time during the experimental period. Hens were maintained on a 17-7 h light-dark cycle throughout the experiment. Feed consumption was recorded weekly then feed conversion (g feed/g egg) was calculated. Eggs were collected for each replicate every day. Egg number and egg weight were daily recorded for each replicate within each group, then egg mass was calculated for each 4 weeks (average egg weight×egg production). Vaccinations and medical program were done according to the stages of age under supervision of a veterinarian. Data were statistically analyzed on 5 × 3 factorial design basis according to Snedecor and Cochran (1982) using SPSS® software statistical analysis program (SPSS, 1999).

RESULTS AND DISCUSSION

Data presented in Tables 3 and 4 revealed that DDGS levels had significant (P≤0.01) effects on both feed consumption and feed conversion at all periods studied. Data showed an increase in daily feed consumption as increasing the substitution of DDGS up to 50%, while feed conversion averages were negatively affected (P≤0.01) when soybean meal was substituted by DDGS. Regarding feed additives (enzyme or vitamin E), it is clear that hens fed diet without feed additives had the highest (P≤0.01) feed consumption followed by hens fed diet supplemented with enzyme then those supplemented by vitamin E. Feed conversion ratios did not significantly differ by dietary enzyme or vitamin E supplementation. The interaction among DDGS levels and feed additives had a significant (P≤0.01) effect on feed consumption of Hisex Brown laying hens only during period of 26-30 weeks of age. However, the interaction among them was significant on feed conversion ratio during all periods studied.

Results in Tables 5 and 6 indicated that DDGS inclusion levels above 50% significantly (P≤0.01) decreased egg number and egg mass of Hisex brown laying hens during all the experimental periods studied. The interaction among DDGS levels and feed additives was significant (P≤0.01) on egg number and egg mass of hens throughout the interval period.

It is noticeable in our study, that the highest feed consumption was observed in the group of hens fed 5.50% DDGS (25% replacement rate). While, the lowest feed consumption was recorded for hens fed the diet contained 22% DDGS (100% replacement rate) during all the experimental periods studied and this was associated with the depression in feed conversion ratio. It could be suggested that high levels of DDGS which needed more amounts of corn gluten to cover the nutrient requirements of NRC (1994) led to a decrease in diet palatability.

Table 1 Composition of the experimental diets

Items	Distillers dried grains with solubles (DDGS) substitution for soybean meal (%)				
	0	25	50	75	100
Ingredients (%)					
Yellow corn (8.5%)	60.58	59.46	58.30	57.20	56.02
Soybean meal (44%)	22.00	16.50	11.00	5.50	0.00
DDGS (27.40%)	0.00	5.50	11.00	16.50	22.00
Corn gluten meal (62%)	4.92	6.39	7.85	9.31	10.77
Di calcium phosphate	1.85	1.83	1.80	1.75	1.70
Limestone	8.17	8.19	8.23	8.27	8.34
Vitamins premix[1]	0.15	0.15	0.15	0.15	0.15
Minerals premix[2]	0.15	0.15	0.15	0.15	0.15
Salt	0.30	0.30	0.30	0.30	0.30
DL-methionine	0.12	0.10	0.09	0.07	0.05
L-lysine HCl	0.04	0.13	0.23	0.32	0.42
Soybean oil	1.72	1.30	0.90	0.48	0.10
Total	100	100	100	100	100

[1] Layer vitamins premix: each 1.5 kg consists of vitamin A: 12000000 IU; vitamin D_3: 2000000 ICU; vitamin E: 10 g; vitamin K: 328 mg; vitamin B_1: 1000 mg; vitamin B_2: 5000 mg; vitamin B_6: 1500 mg; vitamin B_{12}: 10 mg; Biotin: 50 mg; Pantothenic acid: 10 g; Niacin: 30 g and Folic acid: 1000 mg.
[2] Layer minerals premix: each 1.5 kg consists of Mn: 60 g; Zn: 50 g; Cu: 10 g; I: 1000 mg; Si: 100 mg and Co: 1000 mg.

Table 2 Chemical analysis (calculated and determined) of the experimental diets

Chemical analysis	0	25	50	75	100
Calculated[1]					
Crude protein (%)	18.00	18.00	18.00	18.00	18.00
Metabolizable energy (kcal/kg diet)	2850	2850	2851	2851	2852
Calcium (%)	3.64	3.64	3.64	3.64	3.64
Nonphytate P (%)	0.45	0.45	0.45	0.45	0.45
Lysine (%)	0.84	0.84	0.84	0.84	0.84
Methionine + cystine (%)	0.75	0.75	0.75	0.75	0.75
Crude fiber (%)	2.94	3.05	3.16	3.27	3.37
Determined[2]					
Crude protein (%)	18.16	18.26	17.91	17.76	18.01
Crude fat (%)	5.17	5.54	5.52	5.49	5.80
Moisture (%)	9.93	10.79	10.89	10.77	10.45
Ash (%)	5.46	5.04	4.95	5.16	5.30

[1] Calculated according to NRC (1994).
[2] Analyzed according to AOAC (2003).

Level of dietary crude fiber increased linearly with increasing dietary DDGS, so that, diets contained higher levels of fiber occupied more space in the crop which resulted in a less feed consumption (Myer and Cheeke, 1975).

Similar results were obtained by Pescatore *et al.* (2010), Deniz *et al.* (2013) and Abd El-Hack *et al.* (2015) who showed a significant reduction in feed consumption of hens fed high levels of corn DDGS. Contrarily, Romeo *et al.* (2010) postulated that feed consumption in laying hens was not changed by dietary inclusion of DDGS. With regard to feed additives (enzyme or vitamin E), it is clear that hens fed diet without feed additives had the best (P≤0.01) feed consumption followed by hens fed diet supplemented with enzyme then those supplemented by vitamin E. Puthpongsiriporn *et al.* (2001) and Yoruk *et al.* (2006) mentioned that feed consumption of laying hens treated with vitamin E (25, 45 or 65 IU/kg diet) or multi-enzymes was not significantly affected.

Feed conversion ratios were not significantly differed by dietary enzyme or vitamin E supplementation.

The interaction among DDGS levels and feed additives had a significant (P≤0.01) effect on feed consumption of Hisex Brown laying hens only during period of 26-30 weeks of age.

However, the interaction among them was significant on feed conversion ratio during all periods studied. Masa'deh (2011) and Jiang *et al.* (2013) found insignificant differences due to the interaction effect among DDGS and enzymes on feed consumption or feed conversion of laying hens. Declined laying performance with 20% DDGS may be attributed to the low palatability and high concentration of fibrous constituents, so the hens were not fully able to meet their energy and amino acid requirements (Deniz *et al.* 2013). The high content of crude fiber and sulfur, and low palatability of DDGS could be a reason for decreased egg production and egg mass (Shalash *et al.* 2010).

Table 3 Feed consumption and feed conversion ratio (Mean±SE) for Hisex laying hens as affected by DDGS levels and feed additives

Items	Feed consumption (g/day)			Feed conversion ratio (g feed/g egg mass)		
	26-30 wk	30-34 wk	34-38 wk	26-30 wk	30-34 wk	34-38 wk
DDGS effect (%)	**	**	**	**	**	**
0	109.17±0.74[b]	101.67±1.64[b]	103.56±1.71[b]	1.65±0.03[c]	1.56±0.026[d]	1.61±0.025[d]
25	113.07±0.59[a]	114.37±1.71[a]	113.95±1.43[a]	1.75±0.04[bc]	1.74±0.032[c]	1.75±0.034[c]
50	109.90±0.66[b]	111.16±1.97[a]	110.62±1.74[a]	1.66±0.04[c]	1.76±0.033[c]	1.76±0.037[c]
75	109.19±0.36[b]	103.40±3.06[b]	106.09±2.43[b]	1.84±0.04[ab]	1.88±0.025[b]	1.92±0.029[b]
100	87.48±0.70[c]	84.23±1.36[c]	90.39±1.19[c]	1.93±0.09[a]	1.99±0.070[a]	2.10±0.052[a]
Feed additives effect	*	**	**	NS	NS	NS
Without	107.89±0.80[a]	107.77±3.05[a]	109.54±2.30[a]	1.74±0.03	1.82±0.041	1.87±0.049
Enzyme (250 mg/kg diet)	105.88±0.43[ab]	102.46±2.62[b]	104.72±2.30[b]	1.80±0.06	1.78±0.055	1.80±0.050
Vitamin (200 mg/kg diet)	103.51±0.47[b]	98.66±2.49[c]	100.50±1.72[c]	1.76±0.04	1.76±0.038	1.81±0.040

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
* (P≤0.05) and ** (P≤0.01).
DDGS: distillers dried grains with solubles.
NS: non significant.

Table 4 Feed consumption and feed conversion ratio (Mean±SE) for Hisex laying hens as affected by the interaction among DDGS levels and feed additives

Items		Feed consumption (g/day)			Feed conversion ratio (g feed/g egg mass)		
		26-30 wk	30-34 wk	34-38 wk	26-30 wk	30-34 wk	34-38 wk
Interaction effect		**	NS	NS	**	**	**
0% DDGS	Without	114.33±1.63[a]	107.33±3.61	109.74±3.51	1.68±0.05[cde]	1.59±0.048[fgh]	1.65±0.032[fgh]
	Enzyme	98.03±0.07[e]	98.70±0.73	100.92±0.56	1.57±0.04[e]	1.57±0.067[gh]	1.61±0.071[gh]
	Vitamin E	115.14±0.35[a]	99.00±0.30	100.04±0.46	1.70±0.02[cde]	1.52±0.003[h]	1.58±0.007[h]
25% DDGS	Without	115.96±0.45[a]	119.66±0.85	117.12±0.82	1.62±0.02[de]	1.74±0.016[cdefg]	1.71±0.034[efgh]
	Enzyme	115.91±1.35[a]	113.93±1.65	116.15±1.91	1.86±0.06[bc]	1.70±0.046[defgh]	1.76±0.044[defg]
	Vitamin E	107.33±2.34[bc]	109.51±3.36	108.59±1.92	1.78±0.07[bcde]	1.77±0.089[cdef]	1.78±0.093[def]
50% DDGS	Without	117.49±0.59[a]	117.40±1.91	116.55±1.02	1.75±0.03[bcde]	1.82±0.071[cde]	1.83±0.031[cde]
	Enzyme	112.01±0.93[ab]	109.51±2.60	110.12±2.84	1.63±0.04[de]	1.66±0.005[efgh]	1.67±0.014[efgh]
	Vitamin E	100.19±0.39[de]	106.57±3.35	105.18±1.64	1.59±0.08[de]	1.81±0.035[cde]	1.79±0.096[def]
75% DDGS	Without	114.51±0.35[a]	108.95±4.46	111.80±3.26	1.86±0.07[bc]	1.94±0.029[bc]	1.99±0.023[b]
	Enzyme	108.11±0.28[bc]	107.49±1.23	108.41±0.63	1.73±0.05[bcde]	1.79±0.035[cdef]	1.79±0.014[def]
	Vitamin E	104.93±0.24[cd]	93.76±5.91	98.07±4.48	1.95±0.06[b]	1.91±0.028[bcd]	1.98±0.003[bc]
100% DDGS	Without	77.15±0.39[g]	85.53±3.68	92.51±3.01	1.80±0.09[bcd]	2.02±0.080[ab]	2.21±0.058[a]
	Enzyme	95.34±0.87[e]	82.67±1.10	88.03±0.55	2.23±0.14[a]	2.17±0.124[a]	2.18±0.066[a]
	Vitamin E	89.95±0.72[f]	84.48±2.05	90.62±1.69	1.77±0.09[bcde]	1.80±0.093[cde]	1.91±0.061[bcd]

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
* (P≤0.05) and ** (P≤0.01).
DDGS: distillers dried grains with solubles.
NS: non significant.

The latter author added that the high protein and low starch contents in diets consist of DDGS, forced gluconeogenesis pathway to solely rely on converting amino acids to glucose, and the high fat content would become major way of supplying energy through fatty acid oxidation (Sun *et al.* 2012). So, these changes could have influenced poultry metabolism over time, and ultimately might have affected laying performance (Shalash *et al.* 2010). Świątkiewicz *et al.* (2013) suggested that DDGS may be incorporated up to a concentration of 200 g/kg in the diet of laying hens without any negative effects on egg performance. Moreover, supplementation of xylanase and phytase, as well as inulin and chitosan, can positively affect the performance of layers given diets with a high concentration of DDGS. Sun *et al.* (2012) concluded that up to 50% of DDGS could be included in the layer's diet without affecting egg weight,feed intake, egg mass, feed efficiency and egg production. Hassan and Al Aqil (2015) reported that DDGS can be safely added in the diets as an alternative source of protein and energy up to 20% without negative effects on productive performance characteristics of Hisex laying hens from 30 to 42 weeks of age. Our results agreed with those reported by Roberson *et al.* (2005), Bregendahl and Roberts (2006) and Abd El-Hack *et al.* (2015). In contrast, Cheon *et al.* (2008) and Masa'deh (2011) found that increasing levels of DDGS up to 20 and 25% did not cause negative effects on egg production. In the present study, egg number was not significantly affected by dietary enzyme or vitamin E supplementation throughout all the experimental periods studied.

Table 5 Egg number and mass (Mean±SE) for Hisex laying hens as affected by DDGS levels and feed additives

Items	Egg number (egg/hen/month)			Egg mass (g/month)		
	26-30 wk	30-34 wk	34-38 wk	26-30 wk	30-34 wk	34-38 wk
DDGS effect (%)	**	**	**	**	**	**
0	27.80±0.27[a]	27.67±0.36[a]	27.70±0.33[a]	1988.40±28.86[a]	1958.56±30.10[a]	1930.39±29.02[a]
25	27.33±0.69[a]	27.59±0.32[a]	27.52±0.39[a]	1949.75±57.98[a]	1984.02±35.05[a]	1960.38±38.23[a]
50	27.69±0.48[a]	26.77±0.49[a]	27.00±0.48[a]	1997.16±35.20[a]	1898.48±42.37[a]	1893.32±39.88[a]
75	26.40±0.47[a]	24.70±0.57[b]	25.12±0.53[b]	1786.38±46.26[b]	1656.90±51.25[b]	1664.57±48.47[b]
100	20.73±0.84[b]	19.85±0.64[c]	20.26±0.56[c]	1377.34±51.40[c]	1280.87±39.86[c]	1300.35±31.93[c]
Feed additives effect	NS	NS	NS	NS	**	**
Without	26.20±0.82	25.47±0.81	25.65±0.80	1872.64±71.88	1799.70±69.30[a]	1784.46±68.50[a]
Enzyme (250 mg/ kg diet)	26.08±0.87	25.47±0.89	25.73±0.82	1802.85±64.12	1771.39±75.64[a]	1777.17±68.08[a]
Vitamin (200 mg/ kg diet)	25.70±0.53	25.01±0.56	25.18±0.52	1783.93±51.79	1696.21±54.96[b]	1687.78±50.79[b]

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
** (P≤0.01).
DDGS: distillers dried grains with solubles.
NS: non significant.

Table 6 Egg number and mass (Mean±SE) for Hisex laying hens as affected by the interaction among DDGS levels and feed additives

Items		Egg number (egg/hen/month)			Egg mass (g/month)		
		26-30 wk	30-34 wk	34-38 wk	26-30 wk	30-34 wk	34-38 wk
Interaction effect		**	**	**	**	**	**
0% DDGS	Without	28.44±0.42[a]	28.31±0.26[a]	28.35±0.26[a]	2046.29±31.03[abc]	2024.99±6.48[ab]	1999.55±28.67[ab]
	Enzyme	27.33±0.62[abc]	27.22±1.07[ab]	27.25±0.94[ab]	1885.20±50.68[bcd]	1901.95±85.61[bcd]	1893.90±77.42[bcd]
	Vitamin E	27.63±0.14[ab]	27.48±0.07[ab]	27.52±0.09[ab]	2033.72±16.72[abc]	1948.74±5.21[abc]	1897.72±7.19[bcd]
25% DDGS	Without	28.56±0.08[a]	27.84±0.26[ab]	28.02±0.21[a]	2153.64±8.78[a]	2071.75±23.11[a]	2060.54±26.83[a]
	Enzyme	28.00±0.59[ab]	28.25±0.28[a]	28.19±0.25[a]	1873.09±35.18[bcd]	2010.80±27.18[ab]	1980.63±16.32[abc]
	Vitamin E	25.45±1.72[bcd]	26.66±0.73[ab]	26.36±0.95[abc]	1822.53±120.22[d]	1869.51±71.16[bcd]	1839.97±82.35[cd]
50% DDGS	Without	28.11±0.34[ab]	27.51±0.73[ab]	27.66±0.60[ab]	2016.04±16.80[abc]	1938.85±46.83[abc]	1917.49±25.63[abcd]
	Enzyme	28.11±0.51[ab]	27.15±0.68[ab]	27.39±0.61[ab]	2068.42±28.31[abc]	1983.51±44.54[ab]	1979.73±35.21[abc]
	Vitamin E	26.86±1.34[abc]	25.66±1.02[bc]	25.96±1.09[bc]	1907.03±89.58[bcd]	1773.07±85.86[de]	1782.75±94.04[de]
75% DDGS	Without	26.45±0.55[abc]	24.49±0.74[cd]	24.98±0.63[cd]	1854.56±61.35[cd]	1690.22±65.93[e]	1686.84±56.93[e]
	Enzyme	27.93±0.45[ab]	26.56±0.36[ab]	26.90±0.24[ab]	1884.82±52.52[bcd]	1807.80±16.68[cde]	1817.65±3.83[de]
	Vitamin E	24.83±0.57[cd]	23.05±0.92[de]	23.50±0.83[de]	1619.76±54.63[e]	1472.68±70.69[f]	1489.20±66.01[f]
100% DDGS	Without	19.45±0.83[e]	19.18±0.30[f]	19.25±0.41[f]	1292.66±55.40[f]	1272.68±18.85[gh]	1257.88±28.74[g]
	Enzyme	19.00±1.36[e]	18.17±0.89[f]	18.94±0.59[f]	1302.75±99.03[f]	1152.89±55.93[h]	1213.93±31.00[g]
	Vitamin E	23.73±0.82[d]	22.21±0.78[e]	22.59±0.42[e]	1536.62±59.01[e]	1417.04±48.27[fgh]	1429.24±28.28[f]

The means within the same column with at least one common letter, do not have significant difference (P>0.05).
** (P≤0.01).
DDGS: distillers dried grains with solubles.
NS: non significant.

In agreement with our results, Grobas *et al.* (2002), Amiri *et al.* (2006) and Mahrose *et al.* (2012) postulated that egg number of laying hens was not influenced significantly by different levels of dietary vitamin E. Egg mass was significantly (P≤0.01) varied due to enzyme or vitamin E supplementation at all periods studied. The best egg mass averages accompanied with diets had no additives and then diets supplemented with enzyme. Our results are in disagreement with those of Świątkiewicz *et al.* (2013) who found that the addition of feed enzymes significantly (P≤0.05) increased daily mass of eggs in the first phase of the laying cycle. The interaction among DDGS levels and feed additives was significant (P≤0.01) on egg number and egg mass of hens throughout the interval period. The present results agreed with those reported by Masa'deh (2011), Jiang *et al.* (2013) and Abd El-Hack *et al.* (2015) who found insignificant increase in egg number or egg mass due to this interaction.

CONCLUSION

In conclusion; the results of the current study provide relevant information to egg producers and nutritionists on the use of DDGS as a valuable dietary ingredients. Also, the results showed that DDGS could be successfully substituted for soybean meal in laying hen diets up to 50% without adverse effects on their performance, but still here is a need to investigate this substitution effects on egg quality traits.

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