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EFFECT OF USIN GCANOLA MEAL TREATED BY CLAY ON LAYING HEN PERFORMANCE UNDER DESERT CONDITION

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ABSTRACT: A total number of 105 Lohman laying hens, 22 weeks of age were used to study the effect of using canola meal treated by clay on laying hen performance under desert condition. Hens were divided equally into seven treatment groups; three levels of CM (10, 15 and 20 %) and two levels of clay (0 and 2%), in addition to control group. Each group contains five replicates with 3 birds each.

Canola meal had a moderate levels of most amino acids but higher levels of methionine and arginine (1.50 and 30.21 mg/g) compared to amino acid of Soya bean meal (1.05 and 25.85 mg/g). Hens fed 20% CM with or without 2% clay recorded the lowest significant final body weight and body weight change (1589.00, 1593.33 and 69.33, 74.00 g), respectively. Hen fed 15% CM with 2% clay recorded higher egg production and egg mas (81.54% and 46.72 g/hen/day). Hens fed 20% CM without clay recorded the highest feed consumption value (111.6 g/hen/day). While, the control group recorded the best feed conversion ratio (2.39 g feed/g egg) followed by the group fed 15% with 2% clay (2.61 g feed/g egg). Hens fed diet containing 15% CM with 2% clay recorded the highest relative weight of yolk (22.01%). However hens fed 20% CM with 2% clay recorded the lowest value of yolk index (45.99%) and yolk color (7.80). Alanine transaminase (ALT) was increased significantly in hens fed 20% without or with 2% clay (41.00 and 39.33 I.U.L.). While, ALT was decreased ($p \leq 0.05$) in hens fed 10 and 15 % CM with 2% clay (24.33 and 25.00 I.U.L.). The results indicated that 15% CM with 2% clay in laying hen diets improved significantly egg production, egg mass, egg quality, digestion coefficients, blood characteristics, economic efficiency and relative economic efficiency under desert condition.

Key words: Canola meal-Egg quality-Digestion coefficients- Blood characteristics -Clay.

INTRODUCTION

It is now urgent to look for unconventional feedstuffs such as agro- industrial by-products to compensate the high cost of the conventional ones. Canola meal (CM) could be considered as a cheaper by–product and could successfully substitute soya ben meal in poultry diets as source of protein in poultry feeding. Crud protein of canola meal represented 34.93 % (El-Sheikh, 2016). The higher level of CM up to 10% in poultry rations showed a negative effect on poultry performance. The negative effects may be due to the anti-nutritional factors such as tannins (Thanaseelaan et al., 2007), which presented 1.5% (Newkirk et al., 2003a). Tannins are water soluble phenolic compounds with a molecular weight greater than 500 and with the ability to precipitate protein form aqueous solution. They occur almost in all vascular plants. Hydrolysable tannins (500-3000Da-Tannic acid) and condensed tannins (1000-20000Da-proanthocyanidins) are two different groups of these compounds (Frutos et al., 2004).

Dietary tannins inhibit the intestinal uptake and transport of simple sugars, amino acids and minerals (King et al., 2000; Song et al., 2002; Afsan et al., 2003; Johnston et al., 2005; Kim and Miller, 2005). Some additives may counteract some of these problems, for example clay are uptake tannins intake, allowing dietary ingredients to be digested and utilized more efficiently. A number of studies carried out in using clay in laying hen diet (Jin Soo Kim et al., 2011) reported that there were linear deceased in feed intake ($p \leq 0.01$) with increasing dietary clay level (0.0, 0.2 and 0.4%), improvement in FCR (($p \leq 0.05$) and egg production. Kermanshahi et al. (2011) found that egg production, egg weight, shell thickness and shell percent values were not significantly affected by clay levels (0.0, 1.5 and 3%). The objective of this work was to study effect of using canola meal treated by clay on egg production and egg quality of laying hen under desert condition.

MATERIALS AND METHODS

A total number of 105 Lohman laying hens, 22 weeks of age were used to study effect of using canola meal treated by clay on laying hen performance under desert condition. The present study was carried out at Siwa Oasis Research Station belonging to Desert Research Center (DRC), Egypt. Birds were divided equally into seven treatment groups' three levels of CM (10, 15 and 20 %) and two levels of clay (0 and 2%), in addition to control group. Each group contains five replicates with 3 birds each. Clay was mixed with canola meal then it mix with ingredients. The experimental diets (Table 1) were formulated to be iso-caloric (~2800 Kcal ME /kg diet) and iso-nitrogenous (~18.00% CP) to meet recommendations for Lohman laying hens. The birds were housed in wire cages of triple deck batteries. The hens were exposed to 15 h light /day during the experiment. Feed and water were provided ad libitum. Body weights were recorded at the beginning of the experiment (22 weeks of age) and at the end of the experiment (34 weeks of age). Clay contained 1.5 – 2.25% Na_2O, 2.5 – 3.5% MgO, 23-25% Al_2O_3, 45 – 56% SiO_2, 0,5 – 0.9% K_2O, 1.8 – 2.5% CaO, 6 – 8% Fe_2O_3, and 1 – 1.25% TiO_2.

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. Chemical analysis was carried out in the laboratories of the Animal and Poultry Production Department, Desert Research Center. At the end of the experiment treatment, three meals from each treatment groups were used and housed individually in metabolic cages to carry out digestibility trials in order to calculate nutrients digestibility coefficients. Feed intake and output of excreta were recorded for 3 days. Samples dried excreta and diets were used to chemical analyze dry matter, crude protein, crude fiber, ether extract, ash and fiber fraction according to A.O.A.C. (1990). The procedure of Jakobsen et al. (1960) was followed to determine the faecal nitrogen. Urinary organic matter was calculated according to Abou-Raya and Galal (1971).

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. Yolk color was determined with a commercially available "yolk color fan" according to the CIE standard colorimetric system (Yolk Colour Fan, the CIE standard colorimetric system, F. Hoffman-La Roche Ltd., Basal, Switzerland). Amino acid concentrations in canola meal and soya bean meal were determined according to Pellet and Young (1980).

At the end of the experiment, three blood samples from each treatment were withdrawn in test tubes, put horizontal for ten minutes to clot and centrifuged at 3000 rpm for 15 minutes to get or collect the serum, and preserved in deep freezer at -18°C until the time of analysis. Serum total protein and albumin, total lipid, urea, creatinine, alanine transaminase (ALT) and aspartate transaminase (AST) were determined by the colorimetric methods with commercial kits. Serum globulin was calculated by subtracting serum albumin from serum total protein.

Economic efficiency of egg production was calculated from the input-output analysis which was calculated according to the price of the experimental diets and eggs production during the year of 2014. The values of economic efficiency were calculated as the net revenue per unit of total cost.

Statistical Analysis:

Data were analyzed by the Computer Program, SAS (2003), using the General Linear Model (GLM) procedure. All the characteristics were performed in conformity by factorial analysis and one way analysis model. The significant differences among treatments means were separated 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: Y_{ijk} = observation, μ = overall mean, X_i = canola meal effect, Z_j = clay effect, $(X Z)_{ij}$ = interaction between canola meal and clay level, e_{ijk} = experimental errors.

b- one way analysis

$Y_{ij} = \mu + T_i + e_{ij}$

Where: Y_{ij} =Observed value of a given dependent variable, μ= Overall adjusted mean, T_i = Fixed effect of treatments, i= 1, 2....7. e_{ij} = Random error associated to each observation.

RESULTS AND DISCUSSION

Amino acid contents of canola meal and soya bean meal:

Amino acid of canola meal and soya bean meal are listed in Table (2). Data shows that CM had a moderate level of most amino acids but contain a higher levels of methionine and arginine (1.50 and 30.21 mg/g) compared to the same amino acids of soya bean meal (1.05 and 25.85 mg/g) respectively. The result contrary with that obtained by (Khajali and Slominski, 2012) who found that CM has a lower lysine and arginine content than soybean meal, while Newkirk et al. (2003b) and Bonnardeaux (2011) reported that CM containing high amount of sulfur amino acid. Prepress solvent extracted canola meal is characterized with lower and less consistent amino acid digestibility in broilers than soybean meal (Newkirk et al., 2003b; and NRC 1994). 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 and Kim et al., 2012).

Egg production:

Table (3) showed the effects of canola meal (CM), clay and their interactions on egg production of Lohman laying hens. Hens fed diet containing 10 and 15% CM recorded the highest ($p \leq 0.05$) final body weight and body weight change (1674.37, 1646.83 g and 144.20, 119.17 g), respectively. Final body weight and body weight changewere not significantly affected by clay. Interaction between CM and clay had a significant effect on final body weight and body weight change.Hens feed 20% CM with or without 2% clay recorded the lowest significant final body weight and body weight change (1589.00, 1593.33 and 69.33, 74.00 g), respectively. The results are in full agreement with that by Lee et al. (1991), Idrees (1998) and Naseem et al. (2006) who reported that canola meal can be used from 15 to 25% without any negative influence on growth of broiler chickens chicks. However, Franzon et al. (1998) reported that weight gain in broiler chickens was reduced with a higher canola meal level (30 to 40 %). Also, El- Sheikh (2016) found that hens fed diet containing 15% CM with 1 g microbial phytase / kg diet recorded the highest ($p \leq 0.05$) final body weight and body weight change.

The highest ($p \leq 0.05$) egg production (80.34%) and egg mass (45.74 g/hen/day) recorded by hens fed diet containing 15% CM compared to those fed 20 % CM (77.32 % and 45.12 g/hen/day). While, hen feed 10% CM recorded the highest value of egg weight (62.44 g). Results obtained Contrary with Perez-Maldonado and Barram (2004), Ciurescu (2009) and Janječić et al. (2009), who found that egg production, egg weight and body weights were not significantly affected when soybean meal was partially replaced with canola meal in layer diet. Egg production, egg weight and egg mass were not significantly affected by clay supplement (Table 3). Kermanshahi et al (2011) reported that egg production and egg weight did not significantly affected by increasing dietary clay level (0.0, 1.5 and 3.0%). While, Jin Soo Kim et al. (2011) concluded that increasing dietary clay level (0.0, 0.2 and 0.4%), improves the egg production. The interaction between CM level and clay supplementshow that, hen feed 15% CM with 2% clay recorded the highest egg production and egg mas (81.54% and 46.72 g/hen/day). However group feed 10 % CM without clay recorded the highest egg weight (62.97 g) followed by group feed 15% CM with 2% clay supplement (58.16 g). El- Sheikh (2016) found that hens fed diet containing 15% CM with 1 g microbial phytase /kg diet recorded the highest ($p \leq 0.05$) egg production and egg mass.

Hens fed diet containing 10% CM recorded the lower ($p \leq 0.05$) feed intake (105.5 g/hen/day) followed by hens feed 15% CM (107.6 g/hen/day). The best feed conversion ratio was recorded by hen feed 15% CM (2.72 g feed/g egg). However feed intake and feed conversion ratio were not significantly effect by clay supplement (Table 3). Kermanshahi et al. (2011) reported that feed consumption did not significantly affected by increasing dietary clay level (0.0, 1.5 and 3% clay diets). Also, Jin Soo Kim et al. (2011) reported that supplementation of clay on laying hen (0.0, 0.2 and 0.4%) had no significant effect on feed intake. Regarding to the interaction between CM level and clay, hens fed 20% CM without clay recorded the highest feed consumption value (111.6 g/hen/day). While, group fed control recorded the best feed conversion (2.39 g feed/g egg) followed by group fed 15% with 2% clay (2.61 g feed/g egg). The finding supported by Gawecki et al. (1986), Franzon et al. (1998) and Trappett (2001), observed that fed layers chicken on diets containing CM level up 20 to 40% had a better FCR values. However Rojas et al. (1985), Leeson et al. (1987) and Naseem et al. (2006) found that feed intake decreased when canola meal was used up to 15%. El- Sheikh (2016) found that hens fed diet containing 15% CM recorded the lower amount of feed intake and the best feed conversion compared with those supplied with 10 and 20% CM. It seem in fact that improved egg production as a result feeding canola meal along with in-feed clay may be due to clay had ability to uptake tannins intake, allowing dietary ingredients to be digested and utilized more efficiently especially simple sugars, amino acids and minerals.

Egg quality:

Results in table (4) showed that albumen wt., yolk wt. %, shell wt. %., shape index, shell thickness, Haugh unit and color yolk were not significantly affected by CM levels. Hen fed on diet containing 10% CM level recorded the higher yolk index value (49.67%). Gheisari and Ghayor (2014) feeding laying hen on rapeseed meal up to 20% did not effects on yolk weight and yolk weight ratio. Riyazi et al. (2009) found that Haugh units did not influenced by 10% dietary rapeseed meal but increased eggshell weight. Also, Najib and Al-khteeb (2004) observed significant increase in Haugh units with increasing the proportion of canola seed in diets of layers. All egg quality parameters were not significantly affected by clay supplement except yolk color had effect significantly by clay supplement. These results were agree with Jin Soo Kim et al. (2011) concluded that supplementation of clay level (0.0, 0.2 and 0.4%) had no effect on the egg and shell quality parameters in both experiments. Also, Kermanshahi et al. (2011) shown that shell thickness and the shell percent values did not significantly with increasing clay levels (0.0, 1.5 and 3.0% clay on diets) to the laying diet, respectively. Albumen wt. %., shell wt. %, shape index, shell thickness and Haugh unit did not significantly affected by the interaction between CM level and clay supplement. Hen fed on diet containing 15% CM with 2% clay recorded the highest yolk wt. % value (22.01%). However hen fed 20% CM with 2% clay recorded the lowest value of yolk index (45.99%) and yolk color (7.80). Also, El- Sheikh (2016) found that hens fed diet containing 15 % CM recorded the highest ($p \leq 0.05$) value of albumin weight followed by group fed 20% CM level. While, hens fed on diet containing 10% CM recorded the higher ($p \leq 0.05$) value of yolk wt. %, shell wt. %, and yolk index.

Digestion coefficients:

Digestion coefficients of OM, DM, CP, CF, EE and NFE are summarized in Table (5). Data show that digestibility coefficients values of OM, CP, EE and NFE were not significantly affected by CM level. While, DM and CFwere significantly influenced by CM levels. Hens fed on 15% CM recorded the best digestion coefficient of DM (76.78%) of all other CM levels groups. Hens fed on 20 or 15 % CM recorded higher values of CF (38.61 and 37.67%) respectively, compared to 10% CM (33.69%). Results obtained contrary with Zelenka (2003), Peric et al. (2015) and El-

Sheikh (2016). All digestion coefficients of DM, OM, CP, CF and NFE were not significantly affected by clay levels except digestion coefficients of EE was ($p \leq 0.05$) affected. The interaction between CM level and clay show that digestion coefficient of DM, OM and CP did not influenced. On the other hand, hens fed on diet containing 10% CM with 2% clay recorded the highest value of CF (39.00%) compared to the other group. while, hens fed on 15 % CM with 2% clay recorded the highest values of EE and NFE (91.74 and 83.18%), respectively.

Some blood serum characteristics:

Results of Table (6) showed that albumin, globulin, total lipid, creatinine and aspartic transaminase (AST) concentration were not significantly affected by CM levels, but it is noticeable that values increased numerically buy increasing CM level. However, total protein, urea and Alanine transaminase (ALT) concentration were recorded the higher ($p \leq 0.05$) values by increasing CM level up to 20%. The finding supported by Ahmed et al. (2015) who found that diets supplemented with CM at 5, 10 and 20% did not reveal a significant clear effect on serum total protein, albumin and globulin. While, serum creatinine had a higher ($p<0.05$)

compared to control Szymeczko et al. (2010) reported that using different levels of CM in broiler diet did not affect protein metabolism indices, total protein and albumin but concentration of creatinine was lower in birds fed the diets with the highest level of CM. On the other hand, Pearson et al. (1983) recorded higher plasma total protein and albumin in broilers fed diet supplemented with 500 g CM meal/kg of broiler diet. The most of blood serum characteristics did not affected by clay level except globulin and ALT has significantly affected. Regarded to the interaction between CM level and clay level noted that total protein, globulin, creatinine and (AST) were not significantly affected by dietary canola meal and clay supplement. While, urea and total lipid concentration were decreased ($p \leq 0.05$) in hens fed 10, 15, 20% canola levels with 2% clay supplement, values were 11.83,11.00, 11.83 and 641, 758, 733 mg /dl, respectively compared to the control (12.33 and 750 mg /dl). Alanine transaminase (ALT) was increased significantly in hen fed 20% without or with 2% clay (41.00 and 39.33 I.U.L.). While, ALT was decreased ($p \leq 0.05$) in hens fed 10 and 15 % CM with 2% clay (24.33 and 25.00 I.U.L.) compared to the control (25.33 I.U.L.). Ahmed et al. (2015) found that CM at a level of 5, 10 and 20% with enzyme supplementation decreased serum AST compared to the control. While, the level 5% showed lower serum ALT than the control.

Economic efficiency:

Results in Table (7) show that the best value for economic efficiency and relative economic efficiency had been recorded by hens fed on diet containing 15% canola meal with 2% clay (0.49 and 140%) followed by hens fed 10% CM without clay (0.40 and 114%) compared to the control (0.35 and 100%). Nascimento et al. (1998) reported that average diet cost decreased with increasing dietary canola meal and also found the largest gross margin (US $ / head) with 30% canola meal in diet. Also, El-Sheikh (2016) found that hen fed on diet containing 15% canola meal with 1 g microbial phytase / kg diet recorded the best economic efficiency and relative economic efficiency.

From the nutritional and economic efficiency stand points of view it could be concluded that 15 % CM with 2% clay improved significantly egg production, egg mass, egg quality, blood characteristics, economic efficiency and relative economic efficiency.

Table (1): Percentage composition, Chemical analysis and calculated analysis of the experimental diets

Ingredients (%)	control	experimental diet					
		1	2	3	4	5	6
Yellow corn	60.50	58.70	56.70	58.00	55.9	57.40	55.20
Soybean (44)%	22.00	14.00	11.40	9.50	7.30	4.80	2.40
Corn gluten (60)%	5.20	5.00	7.10	5.20	7.00	5.50	7.60
Canola meal	-	10.00	10.00	15.00	15.00	20.00	20.00
Plant oil	1.00	1.00	1.50	1.00	1.50	1.00	1.50
Clay	-	-	2.00	-	2.00	-	2.00
L-Lysine HCl	0.10	0.10	0.10	0.10	0.10	0.10	0.10
DL-Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Dicalcium phosphate	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Limestone	8.90	8.90	8.90	8.90	8.90	8.90	8.90
Premix**	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Chemical analysis:							
CP%	18.05	18.05	18.04	18.03	18.01	18.00	18.06
CF%	3.81	3.61	3.79	3.14	3.97	3.19	3.45
EE%	4.87	4.78	4.23	4.63	5.91	5.89	5.83
Calculated analysis:***							
ME(Kcal/kg)	2807	2803	2801	2803	2804	2809	2807
Ca%	3.58	3.56	3.51	3.54	3.57	3.56	3.57
Total P%	0.66	0.61	0.66	0.57	0.67	0.54	0.67
Available P%	0.44	0.42	0.41	0.40	0.40	0.39	0.38
Lysine%	0.88	0.85	0.77	0.78	0.73	0.73	0.86
Methionine&Cysteine%	0.60	0.58	0.53	0.55	0.51	0.53	0.49
Methionine%	0.42	0.37	0.38	0.34	0.35	0.31	0.33
Price L.E/ton	2837	2581	2670	2505	2540	2352	2439

* The price of one kg Canola meal (CM) = 1 L.E.

** Vit. and Min. Premix contents per Kg of diet: Vit. A, 12000 IU; Vit. D3, 2000 IU; Vit. E, 10 mg; Riboflavin, 4 mg; Pantothenic acid, 10 mg; Vit. B_{12}, 0.01 mg; Choline chloride, 500 mg; Vit. K, 2 mg; Vit. B_1, 1 mg; Vit. B_6,1.5 mg; Folic acid, 1 mg; Niacin, 20 mg; Biotin, 0.05 mg; Cu, 10 mg; I, 1 mg; Fe, 30 mg; Mn, 55 mg; Zn, 55 mg; and Se, 0.1 mg.

*** According to Tables of NRC (1994).

Table (2): Amino acids components of canola meal compared to Soya bean meal

Items	**Amino acids** (mg/g)																
	Aspartic acid	Threonine	Serine	Glutamic acid	Proline	Glycine	Alanine	Valine	Methionine	Cystine	Isoleucine	Leucine	Tyrosine	Phenylala-nine	Histidine	Lysine	Arginine
Canola meal	25.10	11.47	11.34	56.00	-	10.78	11.21	12.63	1.51	3.61	9.62	14.41	4.95	7.75	6.60	9.11	30.21
Soya bean meal	41.19	11.00	17.77	68.91	-	15.52	17.25	18.19	1.05	-	16.38	27.94	7.71	17.52	10.73	23.03	25.85

Table (3): Egg production of Lohman laying hens as affected by canola meal (CM), clay level and experimental treatments

Parameters / Treatments		Initial body wt. (g /hen)	Final body wt. (g / hen)	B.W. Changes (g / hen)	Egg production (%)	Egg wt. (g)	Egg mass (g / hen / day)	Fed consumption (g / hen / day)	Feed conversion (g feed/g egg)
CM	**10**	1527.67±41.66	1674.37^{a}±35.41	144.20^{a}±18.27	77.91^{b}±1.85	62.44^{a}±0.42	43.76^{b}±1.29	105.5^{b}±1.17	2.82^{ab}±0.11
	15	1527.67±30.52	1646.83^{a}±30.59	119.17^{ab}±12.96	80.34^{a}±1.14	57.82^{b}±0.49	45.74^{a}±1.23	107.6^{ab}±1.49	2.72^{b}±0.10
	20	1520.00±26.43	1591.17^{b}±25.57	71.17^{b}±8.50	76.04^{b}±1.89	56.17^{b}±1.26	42.25^{b}±1.54	111.1^{a}±1.59	3.07^{a}±0.12
Clay	**0**	1529.70±20.78	1641.74±18.28	112.08±14.28	77.66±1.82	60.73±1.81	43.63±0.78	108.6±1.36	2.86±0.10
	2%	1525.56±32.36	1633.13±21.13	105.91±9.41	78.53±1.30	56.89±0.49	44.21±0.77	107.5±0.68	2.69±0.06
Interaction									
Control	**0**	1528.33±56.83	1668.00^{a}±37.44	139.67^{a}±28.88	79.75^{ab}±1.43	57.94^{b}±0.42	45.30^{ab}±0.61	100.6^{d}±1.92	2.39^{c}±0.07
10 %	**0**	1523.00±43.26	1672.67^{a}±29.72	149.67^{a}±32.23	77.96^{b}±1.21	62.97^{a}±0.16	44.07^{ab}±0.37	103.6^{cd}±1.52	2.68^{abc}±0.12
	2%	1532.33±72.91	1676.07^{a}±65.66	138.73^{a}±18.45	77.86^{b}±1.03	55.92^{b}±0.80	43.44^{ab}±0.44	107.4^{bcd}±1.44	2.95^{ab}±0.17
15%	**0**	1531.33±36.47	1663.67^{a}±32.57	132.33^{a}±22.19	79.15^{ab}±1.03	57.47^{b}±0.64	44.77^{ab}±0.82	110.7^{ab}±1.12	2.84^{abc}±0.06
	2%	1524.00±50.26	1630.00^{ab}±52.69	106.00^{ab}±13.36	81.54^{a}±1.55	58.16^{b}±0.78	46.72^{a}±0.74	104.7^{bcd}±1.03	2.61^{bc}±0.17
20 %	**0**	1519.67±29.46	1589.00^{b}±30.09	69.33^{b}±11.70	75.87^{b}±1.75	55.75^{b}±2.54	42.03^{b}±0.42	111.6^{a}±1.46	3.12^{a}±0.20
	2%	1520.33±45.02	1593.33^{b}±42.47	74.00^{b}±12.70	76.20^{b}±1.30	56.58^{b}±0.79	42.74^{b}±0.67	110.5^{ab}±1.26	3.02^{ab}±0.16
Probabilities									
CM		NS	*	*	*	*	*	*	*
Clay		NS	NS	NS	NS	NS	NS	NS	NS
interaction		NS	*	*	*	*	*	*	*

$^{a, b}$....Means in the same column in each classification bearing different letters differ significantly ($p \leq 0.05$). NS = Not significant *= ($p \leq 0.05$)
CM = Canola meal

Table (4): Egg quality of Lohman laying hens as affected by canola meal (CM), clay level and experimental treatments

Parameters / Treatments		Egg weight (g)	Albumen wt.%	Yolk wt. %	Shell wt.%	Shape index	Yolk index	Shell thickness (mm)	Haugh unit	Yolk color
CM	**10**	60.44^{a}±0.66	65.26±0.61	21.14±0.40	13.59±0.29	79.82±0.51	49.67^{a}±0.62	0.474±0.01	85.29±0.75	8.30±0.14
	15	57.54^{b}±1.13	65.39±0.49	21.46±0.49	13.15±0.25	80.45±.48	48.20^{b}±0.48	0.488±0.01	85.68±0.77	8.30±0.01
	20	57.82^{b}±0.96	66.53±0.96	20.64±0.49	12.82±0.34	80.41±0.80	48.72^{b}±0.78	0.479±0.01	58.61±0.84	8.00±0.14
Clay	**0**	59.01±0.99	65.79±0.49	20.90±0.33	13.31±0.25	80.66±0.66	49.04±0.44	0.483±0.01	85.85±0.75	8.30^{a}±0.14
	2 %	58.19±0.60	65.67±0.61	21.26±0.43	13.07±0.26	79.80±0.39	48.03±0.63	0.478±0.01	85.20±0.49	7.60^{b}±0.11
Interaction										
Control	**0**	57.43±1.55	65.53±0.55	21.11^{ab}±0.32	13.34±0.41	79.01±0.53	46.17^{b}±0.89	0.474±0.01	83.95±1.15	8.80^{a}±0.25
10 %	**0**	60.37±1.36	64.47±0.83	21.85^{ab}±0.48	13.68±0.64	79.78±0.68	49.65^{a}±0.86	0.477±0.01	85.79±1.11	8.60^{ab}±0.10
	2%	60.52±0.32	66.05±0.81	20.44^{ab}±0.50	13.50±0.45	79.87±0.84	49.69^{a}±1.01	0.472±0.01	84.79±1.08	8.00^{cd}±0.22
15%	**0**	59.03±1.05	66.10±0.72	20.91^{ab}±0.57	12.98±0.37	80.40±0.89	47.99^{ab}±0.85	0.488±0.01	85.21±1.34	8.20^{bcd}±0.12
	2%	56.06±0.69	64.67±0.58	22.01^{a}±0.79	13.31±0.39	80.50±0.34	48.40^{ab}±0.56	0.487±0.01	86.14±1.86	8.40^{abc}±0.10
20 %	**0**	57.65±1.83	66.78±0.78	19.94^{b}±0.38	13.26±0.50	81.79±0.98	49.46^{a}±0.45	0.483±0.02	86.54±1.60	8.20^{bcd}±0.25
	2%	57.99±0.89	66.28±0.97	21.32^{ab}±0.84	12.39±0.41	79.02±0.70	45.99^{b}±1.01	0.475±0.01	84.67±0.44	7.80^{d}±0.12
Probabilities										
CM		*	NS	NS	NS	NS	*	NS	NS	NS
Clay		NS	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 ($p \leq 0.05$). NS = Not significant *= ($p \leq 0.05$)

CM = Canola meal

Table (5): Digestion coefficients of experimental diets as affected by canola meal (CM), clay levels and the experimental treatments

Treatments \ Parameter		DM%	OM%	CP%	CF%	EE%	NFE%
CM	**10**	72.77^{b}±1.10	78.23±0.98	89.74±0.42	33.69^{b}± 1.32	85.61 ± 1.54	76.22 ± 1.39
	15	76.78^{a}±0.95	80.88±1.25	90.62±0.47	37.67^{a}± 1.08	83.78 ± 1.85	80.12 ± 1.58
	20	72.95^{b}±1.20	78.60±1.18	90.09±0.46	38.61^{a}± 0.77	86.49 ± 0.85	77.05 ± 1.80
clay	**0**	74.53 ±1.00	79.71±0.95	90.31±0.35	37.13 ± 1.07	85.78^{b}± 0.99	78.31 ± 1.16
	2%	75.07 ±1.84	79.72±1.50	89.16±0.90	37.22 ± 1.53	88.97^{a}± 1.26	78.29 ±1.12
Interaction							
Control	**0**	71.39 ±2.11	78.76±1.82	88.00±0.52	31.13^{b}± 4.39	85.82^{ab}±2.33	78.59^{ab}± 2.57
10 %	**0**	72.55 ±1.70	77.83±1.56	89.82±0.55	33.82^{ab}±1.12	86.06^{ab}±1.16	75.63^{ab}± 2.07
	2%	75.38 ±0.56	79.87±0.94	89.05±0.57	39.00^{a}± 1.56	87.33^{ab}±2.42	78.59^{ab}± 1.64
15%	**0**	77.27 ±1.69	81.63±2.17	90.27±0.91	36.36^{ab}±1.61	84.47^{b}±2.77	81.13^{ab}± 2.62
	2%	71.74 ±1.23	77.54±1.22	90.16±0.31	37.27^{ab}±2.01	87.83^{ab}±1.71	72.72^{b}± 1.98
20 %	**0**	73.78 ±0.58	79.67±0.17	89.82±0.16	38.59^{ab}±1.63	86.82^{ab}±1.14	78.18^{ab}± 0.55
	2%	78.09 ±2.38	82.36±2.36	88.25±1.90	35.39^{ab}±1.75	91.74^{a}±2.14	83.18^{a}± 2.42
Probabilities							
CM		*	NS	NS	*	NS	NS
Clay		NS	NS	NS	NS	*	NS
Interaction		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) CM = Canola meal

Table (6): Some blood characteristics (Mean ± SE) of Lohman laying hens as affected by the experimental treatment

Treatments \ Parameter		Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Urea (mg/dl)	Total lipid (mg/dl)	Creatinine (mg/dl)	ALT (I.U./L)	AST (I.U./L)
CM	**10**	3.68^{b}	2.87	0.82	12.17^{ab}	719	0.39	28.83^{b}	57.33
	15	4.52^{a}	3.17	1.35	11.92^{b}	970	0.44	29.33^{b}	63.50
	20	4.04^{a}	3.05	0.99	13.42^{a}	1025	0.44	40.17^{a}	64.83
Clay	**0**	3.86	3.19	0.67^{b}	12.83	988	0.44	36.00^{a}	54.11
	2%	4.30	2.87	1.42^{a}	12.17	869	0.41	29.56^{b}	69.67
Interaction									
Contol	**0**	4.18	3.30^{ab}	0.88	12.33^{b}	750^{b}	0.67	25.33^{b}	50.66
10 %	**0**	3.62	3.12^{ab}	0.50	12.50^{b}	941^{ab}	0.44	33.33^{b}	38.66
	2%	3.74	2.61^{b}	1.11	11.83^{b}	641^{b}	0.33	24.33^{b}	76.00
15%	**0**	4.18	3.60^{a}	0.58	12.83^{ab}	1291^{a}	0.44	33.66^{b}	64.33
	2%	4.85	2.74^{b}	2.11	11.00^{b}	758^{b}	0.44	25.00^{b}	62.66
20 %	**0**	3.78	2.85^{b}	0.93	15.00^{a}	1208^{a}	0.44	41.00^{a}	59.33
	2%	4.29	3.25^{ab}	1.04	11.83^{b}	733^{b}	0.44	39.33^{a}	70.33
Probabilities									
CM		*	NS	NS	*	NS	NS	*	NS
Clay		NS	NS	*	NS	NS	NS	*	NS
interaction		NS	*	NS	*	*	NS	*	NS

[a, b] Means bearing different superscripts within the same row are significantly different ($p<0.05$).
ALT, alanine transaminase; AST, aspartic transaminase

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

Parameter	Control	Canola meal level %					
		10		15		20	
		0%	2%	0%	2%	0%	2%
Price /kg feed (L.E.)	2.837	2.581	2.670	2.505	2.540	2.352	2.439
Total feed intake/hen (kg)	8.450	8.702	9.022	9.299	8.795	9.374	9.282
Total feed cost / hen (L.E.)	23.97	22.45	24.09	23.29	22.34	22.05	22.64
Egg mass (kg/ hen)	3.805	3.701	3.648	3.760	3.924	3.530	3.567
Total revenue (L.E.)	32.34	31.46	31.01	31.96	33.35	30.01	30.32
Net revenue (L.E.)	8.37	9.01	6.92	8.67	11.01	7.96	7.68
Economicefficiency(Ec.E.)	0.35	0.40	0.29	0.37	0.49	0.36	0.34
RelativeEc.E.(%)	100	114	83	106	140	103	97

CM = Canola meal

1- Price of clay 1.5 L.E.
2- The price of one kg egg = 8.5 L.E.
3- Net revenue per unit of total feed cost
4- Relative economic efficiency % of the control, assuming that relative Ec. E. of the control = 100.

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الملخص العربى

تأثير استخدام كسب الكانولا المعامل بالطمى على أداء الدجاج البياض تحت الظروف الصحراوية

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استخدم فى هذه الدراسة 105 دجاجة لوهمان بياض عمر 22 اسبوع بهدف دراسة تأثير كسب الكانولا المعامل بالطمى على أداء الدجاج البياض تحت الظروف الصحراوية. قسمت الطيور إلى 7 مجاميع، 4 مجاميع من كسب الكانولا (0 و 10 و 15 و20%) ومجموعتان من الطمى (0 و 2%) بالإضافة إلى مجموعة الكنترول. كل مجموعة بها 5 مكررات بكل مكررة 3 طيور.

أهم النتائج المتحصل عليها

- أوضح تحليل الأحماض الأمينية لكسب الكانولا إحتواءة على كمية معتدلة من معظم الأحماض الأمينية مع إرتفاع مستوى الحمض الأمينى المثيونين والأرجنين (1,5 و 30,21 مجم/جم) مقارنة بكسب فول الصويا (1,05 و 25,85 مجم/جم).
- سجل معنوياً الدجاج المغذى على 15 % كسب كانولا مع إضافة 2% طمى أعلى إنتاج بيض وكتلة بيضة 81,54 % و 46,72 جم/ دجاجة/ يوم.
- سجل معنوياً الدجاج المغذى على 20 % كسب كانولا بدون أو مع إضافة 2% طمى أقل وزن جسم نهائى و تغير فى وزن الجسم (1589,00 و 1593,33 جم) و (69,33 و 74,00جم) على التوالى.
- سجل معنوياً الدجاج المغذى على20 % كسب كانولا بدون طمى أعلى كمية غذاء مأكول (111,6 جم/ دجاجة/ يوم). بينما سجلت مجموعة الكنترول أفضل معدل تحويل غذائى (2,39 جم غذاء /جم بيضة) تليها المجموعة المغذاة على 15 % كسب كانولا مع إضافة 2% طمى (2,61 جم غذاء / جم بيضة).
- سجل معنوياً الدجاج المغذى على 15% كسب كانولا أعلى نسبة مئوية لوزن الصفار (22,01%). بينما سجل معنوياً الدجاج المغذى على20 % كسب كانولا مع إضافة 2% طمى أقل قيم لدليل الصفار (45,99%) وأقل قيمة للون الصفار (7,80).
- سجل معنوياً الدجاج المغذى على20 % كسب كانولا بدون أو مع إضافة 2% طمى أعلى تركيز لسيرم ALT (41,00 و 39,33). بينما إنخفض معنوياً فى المجاميع المغذاة على 10 و 15 % كسب كانولا مع إضافة الطمى (24,33 و 25,00).

خلصت الدراسة إلى أن استخدام 15 % كسب كانولا مع إضافة 2% طمى فى علائق الدجاج البياض حسن معنوياً إنتاج البيض وكتلة البيضة وجودة البيضة و معامل هضم العناصر الغذائية وصفات الدم و الكفاءة الإقتصادية للدجاج البياض تحت الظروف الصحراوية.