Egypt. Poult. Sci. Vol. (38)(III): (755-772) (2018) **(1805-1026)**

Egyptian Poultry Science Journal

http://www.epsj.journals.ekb.eg/

ISSN: 1110-5623 (Print) – 2090-0570 (Online)

EFFECT OF USING DIFFERENT GUAR MEAL LEVELS AND β–MANNANASE SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE OF GOLDEN MONTAZAH LAYING HENS.

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Received: 10/07/2018 Accepted: 06/08/2018

ABSTRACT: This experiment was carried out to evaluate the effect of dietary guar meal levels with or without β-mannanase on layer performance. One hundred and sixty eight 22-week-old Golden Montazah pullets divided randomly into seven treatment groups each group had 24 pullets divided into three replicates with 8 pullets per each. The 1st group fed on corn - soybean meal diet and served as control group. The 2nd, 4th and 6th groups fed on diets contain 5%, 10% and 15% guar meal respectively without β-mannanase. The 3rd, 5th and 7th groups fed on diets contain 5%, 10% and 15% guar meal with 250 mg/kg β-mannanase respectively. The experiment was extended for three months to estimate production performance. At the end of the experiment egg quality was assayed and slaughter assay was conducted. The following results were obtained:-

Adding 10% guar meal had no harmful effects on egg production performance, however increasing guar meal up to 15% retarded clearly egg production performance compared with control. Remarkable improvements in production performance were observed when β-mannanase supplemented to guar diets.

Significant improvement in shell weight percent and shell thickness were observed by increasing guar level up to 15% with or without β-mannanase compared with control treatment, in contrast significant decrease was observed in albumen weight. Neither guar meal levels nor β-mannanase supplementation influenced liver, gizzard, heart and spleen weight percent. All guar meal treatments with or without β-mannanase recorded significantly (P≤ 0.05) lower abdominal fat percent than control treatment. Increasing guar meal than 5% increased significantly (P≤ 0.05) thymus weight percent but supplemented β-mannanase decreased significantly (P≤ 0.05) thymus weight percent.

The best relative economic efficiency value recorded for diet that contains 5% guar meal with β-mannanase.

Key words: guar meal - β-mannanase - egg production - performance.

INTRODUCTION

Guar bean "Cyamopsis tetragonoloba" is a source of guar gum and guar meal produced after gum extraction. Many author insert guar meal in layer diets where Rao, et al. (2015) use 10% guar meal without harm effect in layer performance. Increasing guar meal to 15% or 20 delayed layer performance (Saeed et al., 2017 and Hassan, 2013) Guar meal possesses many advantages, relatively inexpensive where it had half price of soybean meal (Shahbazi, 2012 a). Protein percent in guar meal reach to 50% depended on hull and germ percent where hull and germ compose 21% and 44% respectively from the entire guar bean (Ehsani and Torki 2010). Moreover guar meal holds saponin which possesses antibacterial effects and can use as an antibiotic alternative (Hassan, 2008). Saponin also has antiprotozoal effect through interacting with cholesterol in cell membrane and killing protozoa so it has anticoccidial activity (Abbas, et al., 2012). The upper appropriate limit of guar meal in poultry diets is dependent on age of bird (Shahbazi, 2012 a).

Guar meal may possess many flaws, where it contains anti-nutritive trypsin inhibitor (Saeed, et al., 2017) that found at low level compared with processed soybean meal (Conner, 2002). Recently Saeed et al. (2017) reported that trypsin inhibitor in guar meal can moderate by heat treatment. Guar meal either contains galactomannan which present in large quantity in hull after gum extraction and known as guar gum (Lee et al., 2005). Galactomannan play important role as prebiotic when it found in diets in a small amount but large amount from galactomannan represent the main anti-nutritional agent in guar meal (Gutierrez, et al., 2007). Galactomannan built from 65% mannose and 35% galactose units (Kok et al., 1999), where it increases intestinal viscosity (Gutierrez, et al., 2007) and causes diarrhea (Lee et al., 2003 b).

Galactomannan may possess beneficial effects where it increase macrophage activity and decrease gastrointestinal pathogenic bacteria as salmonella enteritidis (Zhang, 2005) especially when β-mannanase insert in diets (Lee et al., 2003a). Beta-mannanase supplementation overcame harm effects of guar meal (Mohayayee and Karimi, 2012), possesses ability to hydrolyze galactomannan, reduce intestinal viscosity (Lee et al., 2003a), enhance growth, and improve feed conversion (Gharaei et al. 2012). Benefit of β-mannanase dependent on concentration of guar meal in diet (Latham et al. 2017).

The aim of this study was to evaluate the effect of using different guar meal levels with or without β-mannanase supplementation to layer diets on productive performance, egg quality and organs weight percent of Golden Montazah layers.

MATERIALS AND METHODS

Experimental design and procedure:

One hundred and sixty eight 22-week-old Golden Montazah pullets that reached 5% egg production were distributed randomly into seven treatment groups. Each group had 3 replicates of 8 pullets that housed in individual cages. The first group performed control treatment and fed corn-soybean meal diet without guar meal. Groups 2, 4 and 6 fed diets contain 5%, 10% and 15% guar meal respectively (Table, 1) without beta -mannanase. Groups 3, 5 and 7 fed previous guar levels in the same order with 250 mg β-mannanase per kilogram. Hens received 16 hrs continuous light during the period guar meal - β-mannanase - egg production - performance.

from 5am to 8pm for three month. Diets were prepared weekly to preserve β-mannanase from degradation and hens fed ad libitum. Egg collected and weighed daily to the nearest decigram. At the end of experiment ten fresh eggs from each replicate were chosen to evaluate egg quality while one hen from each replicate was picked for slaughter.

Productive performance and egg quality:

Egg production percent (EP%), egg mass per hen per day (EM) and average egg weight (AEW) were calculated according to Murugesan and Persia (2013). Feed intake recorded individually by subtraction feed residual at week end from feed offered during this week. Feed conversion was calculated via dividing daily feed intake by EM.

Ten freshly laid eggs from each replicate were gathered at the last three days of the experiment. Egg weighed then length and width diameters measured using vernier caliper then eggs were broken to evaluate inner egg quality. Shape index, egg component percent, yolk index, yolk color, Haugh unit and shell thickness were assayed. Haugh unit calculated according to (Haught, 1937) equation.

Slaughter test and plasma collection

At the end of this experiment, one bird from each replicate was slaughtered, bled, feathers removed and eviscerated. After evisceration carcass, immune organs and other organs were weighed and proportioned to live body weight.

During bleeding one blood samples from each hen collected in test tubes contain EDTA. Blood samples centrifuged (3500 rpm for 15 minutes) to obtain plasma. Total proteins (TP), albumins (Alb), aspartate transaminase (AST) and alanine transaminase (ALT) were measured in plasma using Spectrum – diagnostics kits, Schiffgraben 41, Hannnover, Germany. Globulins (Glb) were calculated by subtracting albumins from total proteins and Albumin Globulin ratio (A/G ratio) was calculated.

Economic efficiency of different experimental diets was calculated for the overall period of egg production from the input of feed intake and output of egg production which were calculated according to the market prices of diets and eggs. Control diet was used as standard for calculating relative economic efficiency of other treatments.

Statistical analysis

Compare means, one way ANOVA procedure of statistical software package (SPSS, 2007) version 16 was used to achieve treatments effect. To detect enzyme and guar effects, "univariate model" general linear model procedure of (SPSS, 2007) was used after exclude control treatment. Post Hoc multiple comparisons for observed means procedure of (SPSS, 2007) was used to compare means at F-test ($P \leq 0.05$) according to (Duncan, 1955).

RESULTS AND DISCUSSION

Production performance

Egg production

Experimental treatments showed significant effect on EP% and EM during different egg production periods (Table, 2). Using 5% and 10% guar meal with β-mannanase recorded significantly ($P \leq 0.05$) higher EP% and EM than control treatment for all months and overall period. Increasing guar meal levels to 15% without β-mannanase decreased EP% and EM significantly ($P \leq 0.05$) compared with control treatment for all months and overall period. Average egg weight significantly affected by experimental treatments during the first month and overall egg production period.

Using 15% guar level without β-mannanase decreased significantly (P≤ 0.05) AEW compared with control treatment during the first month and overall egg production period.

Regarding guar meal level, after the first month of egg production both EP% and EM decreased significantly (P≤ 0.05) by increasing guar level than 10%. In the same manner increasing guar level than 10% decreased significantly (P≤ 0.05) AEW during the first and overall period and insignificantly during the second and third month of egg production. Diets with β-mannanase recorded significantly (P≤ 0.05) higher EP% and EM during different months and overall period than diets without β-mannanase.

Desirable results of increasing guar meal level up to 10% on EP% and EM agree with Saeed et al. (2017) who reported that 10% guar meal can supplement to diets with no harmful effects on poultry production performance. Furthermore guar meal can add to layer diets with higher rate of egg production such white leghorn up to 10% without harm effect on EP, EM and AEW (Rao, et al., 2015). In contrast, Gutierrez et al. (2007) reported that layers possess high production rate can get guar level up to 5% not more without negative effects on laying performance. On the other hand decreasing performance of egg production by increasing guar meal level up to 15% is in full agreement with Saeed et al. (2017) who reported that 15% declined layer performance moreover Rao, et al. (2015) reported that 15% can decrease EP, EM and AEW. In addition Hassan (2013) reported that feeding 20.0% guar meal lowered significantly EP% and EM of laying hens.

The significant decrease in EP% and EM of hens that received diet contains 15% guar meal without β-mannanase may be due to increasing whole anti-nutrients galactomannan and saponin in diet. In spite of using galactomannan as prebiotic, it is indigestible nutrient and in the absence of β-mannanase the large amount of galactomannan in guar meal increase intestinal viscosity (Gutierrez, et al., 2007) and cause diarrhea (Lee et al., 2003 b). Saponin percent in guar meal was 4.8 from dry matter (Hassan, et al., 2010). So the whole saponin in diets that contains 10 and 15% guar meal were about 4.8 and 7.2 gm/kg diet respectively. Whitehead, et al. (1981) reported that supplemented more than 5 g saponin/kg diet decreased egg production performance.

Significant improvement of EP% and EM by β-mannanase supplementation during different months and overall period agree with Ehsani and Torki (2010) who reported that β-mannanase has useful effects on egg production performance. Moreover Saeed et al. (2017) suggested that guar meal addition to poultry diets can maximize production performance by β-mannanase supplementation.

Feed intake and feed conversion

Treatments, β-mannanase supplementation and guar level addition had significant effects on feed intake during different months and overall periods (Table, 3). Regarding treatment effect, 10% guar meal with β-mannanase recorded significantly (P < 0.05) the highest feed intake during 1st, 2nd and overall period.

Regarding guar meal level, increasing guar meal level more than 10% decreased significantly (P < 0.05) feed intake during the 2nd, 3rd months and overall period. The results agree with Rao et al. (2015) who reported that layers can consume guar meal up to 10% without negative effect on feed intake. We can suppose that anti-nutrient saponin is a malefactor that may cause decrease in feed intake, where using 15% guar meal gets 7.2 gm saponin/kg diet. Whitehead et al. (1981) reported that feed intake decreased by feeding more than 5gm saponin /kg diet. This may be due to saponin may possess ability to slow intestinal motility and prolonged digestion process (Shimoyamada et al., 1998). Significant increase in feed intake by β-mannanase supplementation during different months and overall period, may be due to increasing egg mass (Table, 2) which required more feed to cover egg production.

Feed conversions of diets contain 5%, 10% and 15% guar meal levels with or without β-mannanase did not differ significantly ($P < 0.05$) compared with control diet during different months and overall period (Table, 3). Nevertheless using 15% guar meal during the 1st, 2rd months and overall period of egg production downgraded significantly ($P < 0.05$) feed conversion compared with using 5% guar. On the other hand β-mannanase supplementation improved significantly feed conversion during 1st month and over all period and numerically during the 2nd and 3rd months of egg production.

The results of guar meal levels agree with Kamran, et al. (2002) and Gharaei, et al. (2012) who observed adverse effect on feed conversion when guar meal level increased than 10%. Depressing feed conversion by increasing guar meal level may be due to saponin conjugated with protein to form indigestible compound that identified as saponin-protein complex (Potter et al., 1993) and reduce digestibility of protein (Shimoyamada et al., 1998).

Beta-mannanase supplementation recorded 9.45% relative improvement in feed conversion during overall experimental period where the improvement were12.8%, 4.6% and 9.5% during 1st, 2nd, and 3rd month of egg production respectively. The results agree with (Lee, et al., 2005) who reported that supplemented β-mannanase to guar meal diets improved feed/gain ratio by about 8 to 10%. Moreover supplemented β-mannanase to diet that contains anti-nutritional galactomannan decreased intestinal viscosity and improving feed conversion (Dhawan and Kaur 2007). This improvement in agreement with Caldas, et al. (2018) and may be due to β-mannanase hydrolyzed galactomannan into to mannose and galactose (El-Masry, et al., 2017 and Kurakake, et al., 2006). Mannose has ability to competitive exclusion where it competes with glycoprotein in intestine and prevents colonization and salmonella from attachment with intestinal sites (Berge and Wierup, 2012). So mannose protects glycoprotein from consuming by colonization and salmonella and save it for birds. Nutrients availability in general, increased by minimized pathogenic bacteria population (Hashemi and Davoodi, 2010). Moreover β-mannanase decreased intestinal viscosity where increasing intestinal viscosity decreased enzyme activity (Smits et al., 1997).

From productive performance results (Table, 2 and 3) especially β-mannanase results, we can suppose that galactomannan that known as guar gum participate mainly in decreasing productive performance when guar level increased more than 10% and saponin play other part.

Egg quality

All external and internal egg quality parameters significantly affected by experimental treatments on the other hand, guar meal level has a significant effect on all egg quality parameters except for shape and yolk index (Table, 4). In contrast β-mannanase supplementation has only significant effect on shape index.

Regarding effect of treatments on egg component percent, increasing guar meal level to 15% with or without β-mannanase decreased significantly ($P < 0.05$) albumen weight percent so shell and yolk weight percentage increased significantly ($P < 0.05$).

Regarding effect of guar level on improvement shell quality the results agree Rao, et al. (2015) who reported that guar meal may be able to add with harmless effects on egg shell quality. This is may be due to guar contains saponin that improve significantly ($P < 0.05$) shell thickness (Hou, et al., 2009).

In regard to insignificant effects of β-mannanase supplementation on most egg quality parameters, the results agree with (Soleymani et al., 2011) who reported that β-mannanase did not influence egg quality while we cannot explain significant result of shape index. Decreasing shell thickness by β-mannanase supplementation in agreement with Shahbazi (2012 b).

Plasma proteins and liver enzymes:

Neither blood plasma proteins (TP, Alb, and Glb) nor liver enzymes (AST and ALT) influenced significantly by treatments, guar level and β-mannanase supplementation (Table, 5). In general all guar treatments recorded numerically higher total proteins values compared with control treatments. Regarding insignificant effect of guar meal level

Insignificant effect of guar meal level on TP, Alb, and Glb agree with Shivajirao (2017). From plasma AST and ALT we can suppose that liver function may not be affect by guar meal level where liver enzymes remained around normal range. Moreover most experimental treatments recorded numerically lower AST and ALT compared with control treatment and this may be due decreasing incidence of fatty liver where guar meal reduced liver fat content (Zhang, 2005).

Insignificant effects of β -mannanase on plasma proteins, albumin and globulins were in agreement with Mehri, et al., (2010) and Shivajirao, (2017). In regard to insignificant values of liver enzymes in response to β –mannanase supplementation, the results agree with El-Masry, et al. (2017).

Organs weight percent (% live body weight):

Experimental treatments influenced significantly carcass, abdominal fat and thymus weight percent but, had no significant effect on other organs weight percent. On the other hand neither β-mannanase supplementation nor guar meal level influenced significantly carcass composition except for thymus weight percent and abdominal fat (Table, 6).

Regarding effect of treatments on abdominal fat the results agree with Patel and McGinnis (1985) who reported that abdominal fat weight percent of diets with different guar meal levels were significantly lower than control treatment. Decreasing abdominal fat may be due to guar gum "galactomannan" in guar meal decreased liver fat and serum cholesterol (Patel, et al., 1981) and saponin in guar meal decreased plasma cholesterol by creating saponin- cholesterol insoluble complexes in digestive tract (Abdulkarimi et al., 2011).

The significant increase in thymus weight by increasing guar meal levels up to 10% may be due to guar meal contains large amount of arginine that increase twofold than arginine in soybean meal (Mohayayee and Karimi, 2012) and arginine possess ability to increased thymus weight percent (Abdukalykova, and Ruiz-Feria 2006). In contrast decreasing thymus weight percent by increasing guar level than 10% may be due to increasing diet saponin content where saponin in a high dose significantly decreased thymus weight (Hiai, et al., 1987).

Decreasing thymus weight percent by β-mannanase supplementation agree with Zou, et al. (2006). Moreover the relative decrease in thymus weight percent by β-mannanase supplementation was about 27%, this result was in agreement with Ferreira et al. (2016).

Relative economic efficiency:

The best relative economic efficiency value recorded for diet that contains 5% guar meal with β-mannanase followed by 10% guar meal without β-mannanase then 10% guar meal with β-mannanase diets (Table, 7). Control diet recorded the lowest relative economic efficiency value.

It could be recommended to insert guar meal in layer diets up to 10% not more with β-mannanase enzyme to improve productive performance.

Table (1): Composition and calculated analysis of experimental diets

	Composition			
Ingredient	**control**	**5% guar meal**	**10% guar meal**	**15% guar meal**
Yellow corn	62.15	61.93	61.80	61.65
Soya bean meal 44%	18.45	16.15	13.83	11.55
Corn gluten meal 60%	5.90	4.03	2.15	0.27
Guar meal	0.00	5.00	10.00	15.00
Wheat bran	3.17	2.61	2.05	1.48
Limestone	7.85	7.85	7.85	7.85
Di Calcium Phosphate	1.64	1.55	1.40	1.24
Vitamins and minerals premix*	0.3	0.3	0.3	0.3
DL Methionine	0.02	0.06	0.10	0.14
sodium chloride	0.32	0.32	0.32	0.32
sodium bicarbonate	0.10	0.10	0.10	0.10
choline chloride	0.10	0.10	0.10	0.10
Total composition	100	100	100	100
calculated analysis Nutrient				
crude protein	17.00	17.00	17.00	17.00
Metabolizable energy	2,750	2,750	2,750	2,750
Crude fiber	3.45	3.38	3.50	3.45
Crude fat	2.95	3.05	3.22	3.30
Lysine	0.78	0.78	0.78	0.78
Methionine	0.34	0.34	0.34	0.34
Methionine +cysteine	0.66	0.66	0.66	0.66
Calcium	3.40	3.40	3.40	3.40
Available Phosphorous	0.42	0.42	0.42	0.42
chloride	0.18	0.18	0.18	0.18
Sodium	0.20	0.20	0.20	0.20

*Supplied each kg of diet: Vit. A, 12000 IU; Vit. D3, 2200 IU; Vit. E, 10 mg; Vit K3, 2 mg; Vit. B1, 1 mg; Vit. B2 5 mg; B6 1.5 mg; B12 10 mcg; Nicotinic acid 30 mg; Folic acid 1 mg, Pantothenic acid 10 mg; Biotein 50 mcg; Choline 250 mg; Copper 10 mg; Iron 30 mg; Manganse 60 mg; Zinc 50 mg; Iodine 1 mg; Selenium 0.1 mg; Cobalt 0.1 mg

Table (2): Effect of treatments, guar meal levels and β-mannanase on egg production parameters.

Items	Egg production percent				Egg mass per hen per day (g)				Average egg weight (g)			
	1st month	2nd month	3rd month	Overall period	1st month	2nd month	3rd month	Overall period	1st month	2nd month	3rd month	Overall period
Treatments effect												
Control	39.58^{c}	54.86^{b}	64.58^{c}	53.01^{c}	17.01^{c}	25.23^{b}	31.78^{c}	24.67^{b}	42.70^{a}	45.49	49.05	45.75^{a}
5%GM without β-m	41.25^{bc}	55.97^{b}	65.42^{b}	54.21^{bc}	17.46^{c}	25.85^{b}	32.71^{b}	25.34^{ab}	42.51^{a}	45.75	49.29	45.85^{a}
5% GM with β-m	45.42^{ab}	62.36^{a}	69.17^{a}	58.98^{ab}	18.52^{ab}	28.66^{a}	34.46^{a}	27.21^{a}	40.91^{ab}	45.59	49.19	45.23^{a}
10% GM without β-m	40.69^{bc}	54.86^{b}	66.53^{b}	54.03^{bc}	16.28^{cd}	24.02^{bc}	33.31^{ab}	24.54^{b}	40.56^{ab}	43.53	48.58	44.22^{ab}
10% GM with β-m	47.08^{a}	62.36^{a}	70.56^{a}	60.00^{a}	19.39^{a}	27.07^{ab}	34.87^{a}	27.11^{a}	41.32^{ab}	43.29	48.60	44.40^{ab}
15% GM without β-m	38.33^{d}	50.42^{c}	61.81^{d}	50.19^{d}	15.29^{d}	22.23^{c}	29.98^{d}	22.50^{c}	39.83^{b}	44.01	47.49	43.77^{b}
15% GM with β-m	45.14^{b}	51.81^{c}	64.44^{c}	53.86^{c}	18.12^{b}	23.27^{c}	31.46^{bc}	24.35^{b}	39.65^{b}	44.45	48.09	44.15^{ab}
SE±	1.24	1.37	1.81	0.99	0.52	0.66	0.98	0.53	0.27	0.19	0.27	0.21
P. values	0.038	0.012	0.002	0.017	0.042	0.009	0.024	0.029	0.008	NS	NS	0.036
Guar meal levels effect												
5% GM	43.33	59.17^{a}	67.29^{a}	56.60^{a}	17.99	27.25^{a}	33.59^{a}	26.28^{a}	41.71^{a}	45.67	49.24	45.54^{a}
10% GM	43.89	58.61^{a}	68.54^{a}	57.01^{a}	17.84	25.54^{b}	34.09^{a}	25.82^{a}	40.94^{ab}	43.41	48.59	44.31^{ab}
15% GM	41.74	51.11^{b}	63.13^{b}	51.99^{b}	16.70	22.75^{c}	30.72^{b}	23.39^{b}	39.74^{b}	44.23	47.79	43.92^{b}
SE±	2.38	2.51	3.65	1.89	0.98	1.20	1.97	1.02	0.51	0.31	0.53	0.41
P. values	NS	0.009	0.023	0.004	NS	0.001	0.021	0.016	0.027	NS	NS	0.038
β-mannanase effect												
Without β-m	40.09^{b}	53.75^{b}	64.58^{b}	52.81^{b}	16.35^{b}	24.03^{b}	32.00^{b}	24.13^{b}	40.96	44.43	48.45	44.62
With β-m	45.88^{a}	58.84^{a}	68.06^{a}	57.59^{a}	18.68^{a}	26.33^{a}	33.59^{a}	26.20^{a}	40.63	44.44	48.63	44.56
SE±	2.38	2.05	2.98	1.55	0.80	0.98	1.61	0.84	0.42	0.25	0.44	0.33
P. values	0.031	0.034	0.012	0.023	0.029	0.036	0.044	0.002	NS	NS	NS	NS

[a,b,..] Means within the same column with different superscripts are significantly differ ($P \leq 0.05$)

NS: not significant. GM: guar meal β-m: β-mannanase (250 mg /kg)

Table (3): Effect of treatments, guar meal levels and β-mannanase on feed intake and feed conversion.

Items	Feed intake				Feed conversion			
	1st month	**2nd month**	**3rd month**	**Overall period**	**1st month**	**2nd month**	**3rd month**	**Overall period**
Treatments effect								
Control	78.06^{bc}	88.11^{c}	98.56^{ab}	88.24^{b}	4.89^{ab}	3.91	3.15	3.98
5%GM without β-m	82.33^{bc}	88.67^{c}	97.00^{b}	89.33^{b}	5.08^{ab}	3.74	3.36	4.06
5% GM with β-m	78.06^{bc}	91.33^{b}	99.83^{a}	89.74^{b}	4.52^{b}	3.30	3.23	3.68
10% GM without β-m	74.50^{c}	88.33^{c}	97.44^{b}	86.76^{c}	5.67^{a}	3.80	3.50	4.32
10% GM with β-m	93.39^{a}	96.72^{a}	100.44^{a}	96.85^{a}	4.89^{ab}	3.61	2.99	3.83
15% GM without β-m	78.78^{bc}	83.00^{d}	94.61^{c}	85.46^{c}	5.88^{a}	4.19	3.86	4.64
15% GM with β-m	87.89^{b}	86.72^{cd}	93.83^{c}	89.42^{b}	5.10^{ab}	4.29	3.47	4.26
SE±	1.32	1.34	1.76	0.92	0.14	0.11	0.12	0.08
P. values	0.001	0.022	0.039	0.018	0.011	NS	NS	NS
Guar meal levels effect								
5% GM	80.19^{b}	90.00^{ab}	98.42^{a}	89.54^{b}	4.80^{b}	3.52^{b}	3.30	3.87^{b}
10% GM	83.94^{a}	92.53^{a}	98.94^{a}	91.81^{a}	5.28^{ab}	3.71^{b}	3.24	4.08^{ab}
15% GM	83.33^{a}	84.86^{b}	94.22^{b}	87.47^{c}	5.49^{a}	4.24^{a}	3.67	4.47^{a}
SE±	2.25	2.59	3.56	1.74	0.25	0.19	0.24	0.15
P. values	0.046	0.001	0.020	0.029	0.037	0.023	NS	0.041
β-mannanase effect								
Without β-m	78.54^{b}	86.67^{b}	96.35^{b}	87.19^{b}	5.55^{a}	3.91	3.57	4.34^{a}
With β-m	86.44^{a}	91.59^{a}	98.04^{a}	92.02^{a}	4.84^{b}	3.73	3.23	3.93^{b}
SE±	1.84	2.11	2.91	1.42	0.21	0.15	0.20	0.12
P. values	0.001	0.011	0.037	0.001	0.036	NS	NS	0.019

[a,b,..] Means within the same column with different superscripts are significantly differ ($P \leq 0.05$)

NS: not significant. GM: guar meal β-m: β-mannanase (250 mg /kg)

Table (4): Effect of treatments, guar meal levels and β-mannanase on egg quality.

Items	**Shape index**	**Albumen weight%**	**Shell weigh%**	**Shell thickness**	**Yolk weight%**	**Yolk index**	**Yolk color**	**Haugh unit**
Treatments effect								
Control	74.86^{c}	59.09^{ab}	10.09^{c}	40.62^{b}	30.82^{b}	43.78^{b}	5.52^{c}	95.60^{b}
5%GM without β-m	78.98^{a}	59.31^{ab}	10.46^{b}	40.95^{b}	30.23^{b}	45.94^{a}	6.19^{b}	98.03^{ab}
5% GM with β-m	76.54^{ab}	60.27^{a}	10.45^{b}	40.00^{b}	29.28^{c}	46.57^{a}	6.00^{b}	98.20^{ab}
10% GM without β-m	77.12^{ab}	58.58^{b}	10.36^{bc}	41.81^{ab}	31.07^{b}	45.87^{a}	6.29^{b}	94.53^{b}
10% GM with β-m	74.81^{c}	59.25^{ab}	10.19^{c}	41.19^{ab}	30.56^{bc}	46.92^{a}	7.10^{a}	97.77^{ab}
15% GM without β-m	76.54^{ab}	57.79^{c}	11.04^{a}	42.86^{a}	31.17^{a}	46.21^{a}	6.38^{b}	102.08^{a}
15% GM with β-m	75.75^{c}	57.03^{c}	10.68^{a}	42.76^{a}	32.30^{a}	45.91^{a}	6.43^{b}	101.62^{a}
SE±	0.36	0.22	0.08	0.31	0.20	0.24	0.06	0.50
P. values	0.025	0.001	0.046	0.012	0.004	0.021	0.001	0.001
Guar meal levels effect								
5% GM	77.76	59.79^{a}	10.46^{b}	40.48^{b}	29.75^{c}	46.26	6.10^{c}	98.11^{b}
10% GM	75.97	58.92^{a}	10.27^{b}	41.50^{ab}	30.81^{b}	46.39	6.69^{a}	96.15^{b}
15% GM	76.15	57.41^{b}	10.86^{a}	42.81^{a}	31.73^{a}	46.06	6.40^{b}	101.85^{a}
SE±	0.65	0.40	0.15	0.57	0.37	0.47	0.10	0.85
P. values	NS	0.001	0.026	0.018	0.001	NS	0.001	0.001
β-mannanase effect								
Without β-m	77.55^{a}	58.56	10.62	41.87	30.82	46.00	6.29	98.21
With β-m	75.70^{b}	58.85	10.44	41.32	30.71	46.47	6.51	99.20
SE±	0.53	0.32	0.13	0.47	0.31	0.38	0.08	0.69
P. values	0.015	NS	NS	NS	NS	NS	NS	NS

[a,b,..] Means within the same column with different superscripts are significantly differ (P ≤ 0.05 NS: not significant. GM: guar meal β-m: β-mannanase (250 mg /kg)

Table (5): Effect of treatments, guar meal levels and β-mannanase on plasma proteins and liver enzymes.

Items	**Plasma proteins**				**Liver enzymes**	
	TP	**Alb**	**Glb**	**A/G**	**AST**	**ALT**
Treatments effect						
Control	4.56	2.32	2.24	1.04	62.50	6.00
5%GM without β-m	5.28	2.64	2.64	1.00	78.00	7.00
5% GM with β-m	4.74	2.39	2.36	1.01	49.50	5.00
10% GM without β-m	4.74	2.47	2.28	1.08	51.50	4.00
10% GM with β-m	4.79	2.71	2.09	1.30	71.50	4.00
15% GM without β-m	4.89	2.62	2.27	1.15	68.00	6.00
15% GM with β-m	5.51	2.25	3.26	0.69	41.50	8.00
SE±	0.15	0.14	0.17	0.13	5.85	0.59
P. values	NS	NS	NS	NS	NS	NS
Guar meal levels effect						
5% GM	5.01	2.51	2.50	1.00	63.75	6.00
10% GM	4.76	2.59	2.18	1.19	61.50	4.00
15% GM	5.20	2.43	2.76	0.88	54.75	7.00
SE±	0.33	0.35	0.36	0.32	10.67	1.08
P. values	NS	NS	NS	NS	NS	NS
β-mannanase effect						
Without β-m	4.97	2.57	2.39	1.08	65.83	5.67
With β-m	5.03	2.45	2.57	0.95	54.17	5.67
SE±	0.27	0.29	0.29	0.26	8.7	0.88
P. values	NS	NS	NS	NS	NS	NS

NS: Not Significant.
TP: Total Proteins Alb: Albumin Glb: Globulins A/G ratio: Alb/ Glb ratioAST: Aspartate transaminase ALT: Alanine transaminase
GM: guar meal β-m: β-mannanase (250 mg /kg

Table (6): Effect of treatments, guar meal levels and β-mannanase on carcass, abdominal fat, immune organs, and other organs weight percent from live body weight.

Items	Carcass weight%	Abdominal fat weight%	Immune organs weight%		Other organs weight%		
			Spleen%	Thymus%	Liver%	Gizzard%	Heart%
Treatments effect							
Control	62.00^{b}	7.28^{a}	0.18	0.07^{c}	2.85	1.15	0.48
5%GM without β-m	69.23^{a}	3.04^{b}	0.13	0.04^{c}	1.93	1.44	0.47
5% GM with β-m	70.84^{a}	3.48^{b}	0.17	0.06^{c}	2.17	1.55	0.57
10% GM without β-m	70.75^{a}	4.06^{b}	0.14	0.18^{a}	1.88	1.51	0.32
10% GM with β-m	68.18^{a}	4.31^{b}	0.15	0.10^{b}	2.59	1.57	0.52
15% GM without β-m	70.36^{a}	3.01^{b}	0.14	0.11^{b}	2.01	1.62	0.46
15% GM with β-m	69.79^{a}	3.95^{b}	0.17	0.09^{b}	1.77	1.66	0.40
SE±	2.92	2.00	0.04	0.05	0.52	0.21	0.12
P. values	0.001	0.041	NS	0.02	NS	NS	NS
Guar meal levels effect							
5% GM	70.04	3.26^{b}	0.15	0.05^{c}	2.05	1.49	0.52
10% GM	69.47	4.19^{a}	0.15	0.14^{b}	2.24	1.54	0.42
15% GM	70.08	3.48^{ab}	0.16	0.10^{a}	1.89	1.64	0.43
SE±	0.69	0.69	0.02	0.01	0.17	0.08	0.05
P. values	NS	0.029	NS	0.001	NS	NS	NS
β-mannanase effect							
Without β-m	70.12	3.37	0.14	0.11^{a}	1.94	1.52	0.42
With β-m	69.60	3.91	0.16	0.08^{b}	2.18	1.59	0.50
SE±	0.56	0.56	0.01	0.01	0.14	0.06	0.04
P. values	NS	NS	NS	0.012	NS	NS	NS

$^{a,b,..}$ Means within the same column with different superscripts are significantly differ ($P \leq 0.05$)

NS: not significant. GM: guar meal β-m: β-mannanase (250 mg /kg)

Table (7): Economic efficiency and relative economic efficiency of experimental diets.

Items	**Control**	**5%GM Without β-mannanase**	**5% GM With β-mannanase**	**10% GM without β-mannanase**	**10% GM with β-mannanase**	**15% GM without β-mannanase**	**15% GM with β-mannanase**
Price/ k feed (L.E.)	5.150	5.074	5.112	5.000	5.038	4.955	4.993
Total feed intake (kg)*	7.94	8.04	8.08	7.81	8.72	7.69	8.05
Total feed cost (L.E.)*	40.90	40.79	41.28	39.04	43.91	38.11	40.18
Egg number*	47.71	48.79	53.08	48.63	54.00	45.17	48.47
Price of one egg	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Price of eggs (L.E.)	57.25	58.55	63.70	58.35	64.80	54.21	58.17
Net revenue (L.E.)	16.35	17.75	22.41	19.31	20.89	16.09	17.99
Economic efficiency (E.Ef.)	0.400	0.435	0.543	0.495	0.476	0.422	0.448
Relative E.Ef.	100.00	108.85	135.80	123.71	119.00	105.63	111.99

* Per hen for overall experimental period

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الملخص العربي

تأثير استخدام مستويات مختلفة من كسب الجوار مع أو بدون انزيم البيتا منانيز على الأداء الإنتاجي لدجاج المنتزة الذهبي البياض.

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اجريت هذه التجربة لتقييم تأثير إضافة مستويات مختلفة من كسب الجوار مع أو بدون إنزيم البيتا منانيز على أداء دجاج المنتزه الذهبي البياض. قسمت 168 دجاجة عمر 22 اسبوع عشوائياً الى 7 مجموعات معاملة كل منها يحتوي على 24 دجاجة مقسمة الى 3 مكرارت يحتوي كل مكرر على 8 دجاجات. غذيت المجموعة الاولى على عليقة اساسية (ذرة + فول صويا) ومثلت معاملة المقارنة. غذيت المجموعات الثانية و الرابعة و السادسة على علائق تحتوي على 5٪ و 10٪ و15٪ كسب جوار على الترتيب بدون إضافة انزيم البيتا منان. بينما غذيت المجموعات الثالثة والخامسة والسابعة على علائق تحتوي على 5٪ و 10٪ و15٪ كسب جوار و مضاف لها انزيم البيتا منانيز (250 ملجم/ كجم علف) على الترتيب لمدة 3 شهور. وقد تم تقدير مقاييس انتاج البيض المختلفة. في نهاية التجربة تم تقدير صفات جودة البيض وتم اجراء تجربة ذبح للتعرف على نمو اعضاء الجسم. وقد تم الحصول على النتائج التالية:-

إضافة 10٪ كسب الجوار لم يوثر بالضرر على النسبة المئوية لإنتاج البيض، كتلة البيض /دجاجة/يوم، الغذاء المستهلك و معامل التحويل الغذائي. و لوحظ تحسن ملموس في القياسات السابقة عند اضافة البيتا منانيز للعلائق التي تحتوي على مستويات مختلفة من كسب الجوار. اضافة كسب الجوار بنسبة اعلى من 10٪ اعاق بوضوح الأداء الإنتاجي للبيض مقارنة بالمستويات الأقل وعليقة المقارنة.

تحسنت معنوياً على مستوى 5٪ في النسبة المئوية لوزن القشرة وسمكها عند اضافة اضافة كسب الجوار بنسبة 15 ٪ مع أو بدون انزيم البيتا منان مقارنة بعليقة المقارنة. بينما لوحظ انخفاض في النسبة المئوية لوزن البياض بزيادة كسب الجوار عن 10٪.

لم تتأثر النسبة المئوية لوزن الكبد ، القانصة ، القلب و الطحال بإضافة كسب الجوار أو انزيم البيتا منانيز بينما سجلت كل علائق الجوار مع أو بدون انزيم البيتا منان انخفاض معنوياً على مستوى 5٪ في النسبة المئوية لوزن الدهن مقارنة بعليقة المقارنة. من ناحية اخرى ادى زيادة مستوى كسب الجوار عن 5٪ لزيادة معنوية في النسبة المئوية لوزن غدة الثيموس.