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Dietary Inclusion of Guar Meal Supplemented by Β-mannanase I) Evaluation Performance of Laying Hens

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Abstract: To study effects of enzyme supplementation of guar meal (GM)-included diets on productive performance of laying hens, a total number of 144 Lohmann LSL-Lite hens were divided in 24 cages (n = 6) and a 3 × 2 factorial arrangement of treatments was employed. Six iso-caloric and iso-nitrogenous diets including three levels of guar meal (0.0, 25.0 and 50.0 g kg^{-1}) with and without enzyme (Hemicell®, 0.0 and 0.4 g kg^{-1}) were assigned to hens in 4 cages (replicates). Dietary GM inclusion significantly affected egg production (EP) on weeks 1, 4 and 6 as well as the overall trail period. Dietary treatments did not affect feed intake (FI) in the present experiment. Egg mass (g egg hen^{-1} day^{-1}) in hens fed GM-included diet decreased during weeks 4-5 of trial. Including GM to diet of laying hens affected feed conversion efficiency (FCR) during weeks 1, 4, 6 as well as the overall trial period (weeks 1-6). Hens fed diet with 5.0 g GM/100g showed increased FCR compared with the birds fed the control and those fed the diet with 2.5 g GM/ 100g diet during the trial. Enzyme supplementation did not affect FCR. Based on the results of this investigation it can be concluded that adding 5% GM to laying hens' diet has adverse effects on their productive performance and it seems that hens can tolerate GM in the diet up to 2.5% with no detrimental effects on EP, EM and feed efficiency.

Key words: Guar Meal · Enzyme · Egg Production · Feed Intake · Feed Conversion Ratio · Laying Hens

INTRODUCTION

Currently, guar meal is sold at about half the price of soybean meal, making it an appealing potential source of protein in animal feeds. On the opposite side, use of guar meal in poultry feed has been limited because of reported adverse effects, which include diarrhea, depressed growth rate and increased mortality, when fed at relatively high levels [1]. Residual guar gum, a highly viscous galactomannan polysaccharide, is probably the primary factor responsible for the reported ill effects [1], although other antinutritional factors such as saponins [2] and polyphenols [3] have been reported to cause liver, kidney and intestinal damage in mice and rats [4, 5]. Improving poultry performance by dietary manipulation has been the goal of nutritionists. Using feed additives like enzymes [6], organic acids [7] or medicinal plants [8, 9] has been reported by other researchers. Addition of feed enzymes to improve dietary nutrient utilization has become popular during the last 10 yr. There are growing interests in the potential of other enzyme products to improve performance of poultry provided with corn-soybean meal based diets. Hemicell is a fermentation product of *Bacillus lentus*. Its active ingredient is β-mannanase, which can hydrolyze β-mannan in feed. β-Mannan in ingredients such as guar, soybean meal and sesame meal, is a powerful antinutritional factor. β-Mannans are linear polysaccharides composed of repeating D-mannose units with β-1,4 bonds and D-galactose units. Some studies have been conducted to evaluate the effect of β-mannanase on nutrient utilization in several monogastric species. It has been reported that β-mannan significantly reduced growth and increased feed:gain ratio in broilers [10, 11]. Also, Daskiran *et al.* [10] demonstrated that β-mannanase improved the feed:gain ratio and reduced the water: feed ratio and dry fecal output of broilers by degrading the β-mannans. Odetallah *et al*. [12] indicated that β-mannanase also improved feed efficiency of swine and turkey, respectively. In addition, corn-soybean meal based diets are the most popular for rearing broilers as well as laying hens in the Iran. Also, soybean meal contains β-mannan and its derivatives such as β-galactomannan and β-glucomannan. Diet inclusion of β-mannanase reduced intestinal viscosity and increased growth and feed efficiency [13].

This experiment was conducted to assess effects of enzyme supplementation of guar meal (GM)-included diets on productive performance of laying hens.

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Table 1: Ingredients and calculated analysis of experimental diets

Guar meal (g /100 g)	0.0		2.5		5.0	
Hemicel (g /100 g)	0.00	0.04	0.00	0.04	0.00	0.04
			g / 100 g diet			
Corn	67.85	67.85	67.29	67.29	66.73	66.73
Soybean meal	19.94	19.94	16.68	16.68	13.40	13.40
Dicalcium phosphate	0.97	0.97	0.98	0.98	0.99	0.99
Lime stone	9.12	9.12	9.12	9.12	9.13	9.13
Common salt	0.27	0.29	0.30	0.30	0.30	0.30
Guar meal	0.00	0.00	2.50	2.50	5.00	5.00
Hemicell	0.00	0.04	0.00	0.04	0.00	0.04
Vit. & Min. Premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
Sand	1.26	1.22	2.60	2.56	3.93	3.89
DL-Methionine	0.06	0.06	0.04	0.04	0.02	0.02
			Calculated analysis			
ME (Kcal/kg)	2720	2720	2720	2720	2720	2720
Crude protein (%)	14.58	14.58	14.58	14.58	14.58	14.58
Ether extract (%)	2.74	2.74	2.83	2.83	2.94	2.94
Crude fiber (%)	2.89	2.89	2.86	2.86	2.63	2.63
Calcium (%)	3.75	3.75	3.75	3.75	3.75	3.75
Available P (%)	0.29	0.29	0.29	0.29	0.29	0.29
Lys (%)	0.71	0.71	0.68	0.68	0.65	0.65
Met (%)	0.31	0.31	0.30	0.30	0.30	0.30
Met & Cys (%)	0.56	0.56	0.59	0.59	0.63	0.63

[1]The vitamin and mineral premix provide the following quantities per kilogram of diet: vitamin A, 10,000 IU (*all-trans*-retinal); cholecalciferol, 2,000 IU; vitamin E, 20 IU (á-tocopheryl); vitamin K3, 3.0 mg; riboflavin, 18.0 mg; niacin, 50 mg; D-calcium pantothenic acid, 24 mg; choline chloride, 450 mg; vitamin B12, 0.02 mg; folic acid, 3.0 mg; manganese, 110 mg; zinc, 100 mg; iron, 60 mg; copper, 10 mg; iodine, 100 mg; selenium, 0.2 mg; and antioxidant, 250 mg

MATERIALS AND METHODS

A total number of 144 Lohmann LSL-Lite hens were randomly divided in 24 cages (n=6). Hens in 4 cages (replicates) were assigned to feed on one the six experimental diets. Based on a 3×2 factorial arrangement of treatments, six iso-caloric and iso-nitrogenous diets (ME =2720 Kcal/Kg and CP=145 g/kg) including guar meal (0.0, 25 and 50.0 g/kg) and enzyme (0.0 and 0.4 g/kg) were formulated (Table 1). Collected data of feed intake (FI), egg production (EP), egg mass (EM) and calculated feed conversion ratio (FCR) during 6-week trial period was analyzed based on completely randomized design using GLM procedure of SAS.

RESULTS AND DISSCUSION

Effects of diet GM inclusion and enzyme supplementation on EP (%) of laying hens are presented in Table 2. Dietary treatment affected EP in the present experiment. Including GM to diet of laying hens affected EP during weeks 1, 4, 5 as well as the overall trial period (weeks 1-6). Hens fed diet with 5 g GM/100 g showed decreased EP compared with the birds fed control and those fed the diet with 2.5 g GM/100g during the trial; however, the difference was statistically significant only on week 4. Hens tolerated GM in their diet up to 5% during this experiment with no significant effect on EP in assessment of whole trial period (weeks 1-6), but EP in hens fed diet with 5% GM was lower than the two other experimental groups (P>0.05). Almost the similar results were reported by other researchers [14]. They concluded that including GM in laying hens' diets more than 3% decreased productive performance. There was no significant interaction between GM and enzyme on EP, except for week 6 (P=0.027). On week 6, the higher EP was seen in laying hens fed the diet included 2.5% GM supplemented with β-mannanase. These results might be attributed to the fact that the GM by-product has higher concentrations of zresidual gum therefore providing more

Table 2: Effects of dietary inclusion of guar meal (0, 25 and 50 g/kg) and enzyme supplementation (0 and 0.4g/kg) on egg production (%) of laying hens

		Egg production (%)						
Weeks of trial		1	2	3	4	5	6	1-6
Treatments								
Enzyme								
0.00		85.71	77.97	82.14	83.53	82.54	82.53	82.40
0.04		84.72	83.92	86.70	82.34	83.33	82.14	83.86
Guar meal								
0.00		86.30[ab]	82.73	83.03	83.92[a]	86.90	80.65	83.92
2.50		88.99[a]	81.54	88.69	88.99[a]	85.12	86.90	86.70
5.00		80.35[b]	78.57	81.54	75.89[b]	76.78	79.46	78.77
Guar meal	Enzyme							
0.00	0.00	90.47	79.16	82.74	86.31	92.26	85.71[a]	86.11[a]
0.00	0.04	82.14	86.31	83.33	81.54	81.54	75.59[b]	81.74[a]
2.50	0.00	89.88	80.36	88.09	92.26	83.33	85.71[a]	86.60[a]
2.50	0.04	88.09	82.73	89.28	85.71	86.90	88.09[a]	86.80[a]
5.00	0.00	76.78	74.40	75.59	72.02	72.02	76.19[b]	74.50[b]
5.00	0.04	83.92	82.73	87.49	79.76	81.54	82.73[ab]	83.03[a]
SEM		3.14	3.77	3.31	3.12	4.18	2.91	2.42
CV		7.37	9.32	7.85	7.53	10.08	7.06	5.83
Source of variation					Probability			
Guar meal		0.037	0.534	0.102	0.002	0.058	0.042	0.013
Enzyme		0.702	0.069	0.108	0.645	0.819	0.869	0.471
Enzyme × Guar meal		0.071	0.709	0.186	0.069	0.069	0.027	0.047

a-b Means within a column (within main effects) with no common superscript differ significantly (P <0.05), SEM= Standard error of means

substrate for the enzyme [15]. Some studies reported that there was no negative impact on productive performance after adding GM without enzyme to diets at concentrations up to 2.5% in broiler chicks [13, 16] or 5% in laying hen diets [17]. Lee *et al.* [15] reported that GM can be used up to 5% with β-mannanase enzyme in broilers; however, in our study enzyme supplementation as the main effect of factorial arrangement did not affect EP. The work of Verma and McNab [1] showed that the negative effects of GM were more pronounced in young birds. It appears the maximum percentage of GM appropriate for poultry diets is dependent on the bird's age. Since an increase in viscosity is more detrimental to younger chicks [18]; further, low levels inclusion of the GM into the layer diets should not lead to depressed production in the later stages of production. The growth inhibition of GM was significantly less in broiler chickens when GM was included in the grower diet *vs* the starter diet [1]. Generally, viscosity increased with each treatment as digesta traveled through the small intestine from duodenum to jejunum to ileum. Ileal viscosities were more sensitive and consistent to changes in diet composition than other segments of the small intestine. Significant increases in intestinal viscosity decrease body weight gain in broiler chickens [18-20]. On the opposite side, viscosity reduction has been suggested as a primary reason for improved performance with certain endolytic enzymes used in association with barley-based highly viscous cereals [21]. Growth and digesta viscosity were related inversely, which also was observed when other highly viscous ingredients were included in broiler diets [19, 21, 22]. Reductions in EP and feed efficiency, resulting from highly viscous ingredients have been attributed to increased intestinal viscosity, whereas enzyme supplementation has overcome these negative effects [19-22].

Effects of diet GM inclusion and enzyme supplementation on FI (g $hen^{-1}day^{-1}$) of laying hens are presented in table 3. Dietary treatments did not affect FI in the present experiment. Effects of diet GM inclusion and enzyme supplementation on FCR (g: g) are presented in table 4. Dietary treatment affected FCR in the present experiment. Including GM to diet of laying hens affected FCR during weeks 1, 4, 6 as well as the overall trial period (weeks 1-6). Hens fed diet with 5.0 g GM/100g showed increased FCR compared with the birds fed the control

Table 3: Effects of dietary inclusion of guar meal (0, 25 and 50 g/kg) and enzyme supplementation (0 and 0.4g/kg) on feed intake (g hen^{-1} day^{-1}) of laying hens

		Feed intake (g hen^{-1} day^{-1})						
Weeks of trial		1	2	3	4	5	6	1-6
Treatments								
Enzyme								
0.00		119.59	119.46	119.17	119.03	121.44	119.05	119.62
0.04		119.62	119.74	118.77	119.40	121.86	118.41	119.63
Guar meal								
0.00		119.58	119.71	118.69	119.01	122.30	118.02	119.55
2.50		119.67	119.27	118.43	119.04	122.06	118.18	119.44
5.00		119.56	119.82	119.79	119.59	120.59	120.00	119.89
Guar meal	Enzyme							
0.00	0.00	119.67	119.94	119.49	119.82	120.80	120.00	119.95
0.00	0.04	119.49	119.49	117.89	118.21	123.81	116.04	119.15
2.50	0.00	119.64	118.81	118.36	118.09	122.85	117.17	119.15
2.50	0.04	119.70	119.73	118.51	120.00	121.28	119.19	119.73
5.00	0.00	119.46	119.64	119.67	119.19	120.68	120.00	119.77
5.00	0.04	119.67	120.00	119.91	120.00	120.50	120.00	120.01
SEM		0.14	0.37	0.93	0.92	1.14	2.01	0.34
CV		0.24	0.63	1.56	1.54	2.32	3.38	0.56
Source of variation					Probability			
Guar meal		0.735	0.327	0.325	0.778	0.440	0.561	0.407
Enzyme		0.798	0.384	0.599	0.631	0.722	0.699	0.978
Enzyme × Guar meal		0.409	0.222	0.547	0.175	0.276	0.340	0.136

SEM= Standard error of means

Table 4: Effects of dietary inclusion of guar meal (0, 25 and 50 g/kg) and enzyme supplementation (0 and 0.4g/kg) on feed conversion ratio (g feed: g egg) of laying hens

		Feed conversion ratio (g feed: g egg)						
Weeks of trial		1	2	3	4	5	6	1-6
Treatment								
Enzyme								
0.00		2.21	2.40	2.24	2.20	2.29	2.20	2.25
0.04		2.27	2.23	2.14	2.27	2.28	2.20	2.25
Guar meal								
0.00		2.14^{a}	2.22	2.20	2.17^{b}	2.15	2.24	2.19^{b}
2.50		2.17^{b}	2.27	2.06	2.05^{b}	2.21	2.10	2.14^{b}
5.00		2.42^{b}	2.46	2.31	2.48^{a}	2.50	2.38	2.42^{a}
Guar meal	Enzyme							
0.00	0.00	2.00	2.34	2.23	2.10	1.96	2.10^{cd}	2.12
0.00	0.04	2.29	2.11	2.17	2.24	2.35	2.38^{ab}	2.26
2.50	0.00	2.14	2.26	2.01	1.89	2.24	2.04^{d}	2.09
2.50	0.04	2.20	2.28	2.11	2.22	2.19	2.16^{bcd}	2.19
5.00	0.00	2.51	2.60	2.47	2.60	2.68	2.46^{a}	2.55
5.00	0.04	2.33	2.31	2.15	2.37	2.31	2.30^{abc}	2.30
SEM		0.09	0.11	0.09	0.12	0.17	0.08	0.08
CV		8.04	9.88	8.50	10.55	15.63	7.35	7.23
Source of variation					Probability			
Guar meal		0.013	0.128	0.053	0.005	0.148	0.009	0.006
Enzyme		0.445	0.101	0.244	0.427	0.955	0.250	0.931
Enzyme × Guar meal		0.057	0.386	0.108	0.084	0.130	0.047	0.051

a-b Means within a column (within main effects) with no common superscript differ significantly ($P < 0.05$), SEM= Standard error of means

Table 5: Effects of dietary inclusion of guar meal (0, 25 and 50 g/kg) and enzyme supplementation (0 and 0.4g/kg) on average egg weight (g) of laying hens

		Egg weight (g)						
Weeks of trial		1	2	3	4	5	6	1-6
Treatment								
Enzyme								
0.00		63.82	64.81	65.60	66.39a	66.27^{a}	66.09^{a}	65.50^{a}
0.04		62.13	64.08	63.90	63.87b	64.27^{b}	63.59^{b}	63.64^{b}
Guar meal								
0.00		64.98^{a}	65.34	65.06	65.50	66.07	65.73	65.45
2.50		61.80^{b}	64.74	64.70	65.73	65.08	65.13	64.53
5.00		62.15^{b}	63.26	64.50	64.16	64.67	63.67	63.73
Guar meal	Enzyme							
0.00	0.00	66.38	65.12	64.88	66.19	67.01	66.62	66.03
0.00	0.04	63.58	65.55	65.25	64.81	65.13	64.84	64.86
2.50	0.00	61.87	66.00	66.66	68.19	66.55	67.42	66.12
2.50	0.04	61.72	63.47	62.73	63.28	63.6	62.84	62.94
5.00	0.00	63.19	63.32	65.26	64.79	65.26	64.25	64.34
5.00	0.04	61.10	63.20	63.74	63.54	64.08	63.09	63.12
SEM		1.00	1.17	1.14	1.38	1.00	1.19	0.93
CV		3.18	3.65	3.53	4.26	3.07	3.67	2.89
Source of variation					Probability			
Guar meal		0.009	0.220	0.882	0.489	0.376	0.234	0.214
Enzyme		0.054	0.452	0.085	0.039	0.025	0.019	0.025
Enzyme × Guar meal		0.409	0.427	0.197	0.346	0.681	0.332	0.488

a-b Means within a column (within main effects) with no common superscript differ significantly (P <0.05), SEM= Standard error of means

Table 6: Effect of dietary inclusion of guar meal (0, 25 and 50 g/kg) and enzyme supplementation (0 and 0.4g/kg) on (g egg hen^{-1} day^{-1})

		Egg mass (g egg hen^{-1}day^{-1})						
Weeks of trial		1	2	3	4	5	6	1-6
Treatment								
Enzyme		54.70	50.46	53.93	55.64	54.75	54.52	54.00
0.00		52.67	53.68	55.42	52.64	53.55	52.21	53.36
0.06								
Guar meal		55.99	53.91	54.07	54.93^{a}	57.47^{a}	53.02	54.90
0.00		55.24	52.78	57.42	58.73^{a}	55.41^{ab}	56.48	56.01
3.50		49.82	49.52	52.54	48.75^{b}	49.56^{b}	50.59	50.13
7.00								
Guar meal	Enzyme							
0.00	0.00	59.76^{a}	51.33	53.78	57.14	61.81	57.08^{a}	56.82^{a}
0.00	0.04	52.23^{bc}	56.48	54.37	52.73	53.12	48.96^{b}	52.98^{ab}
2.50	0.00	56.07^{ab}	53.06	58.78	63.09	55.53	57.56^{a}	57.35^{a}
2.50	0.04	54.40^{abc}	52.50	56.07	54.37	55.29	55.41^{ab}	54.67^{a}
5.00	0.00	48.27^{c}	46.99	49.25	46.69	46.90	48.92^{b}	47.84^{b}
5.00	0.04	51.37^{bc}	52.05	55.83	50.80	52.23	52.26^{ab}	52.42^{ab}
SEM		3.840	4.586	4.354	5.141	5.886	4.163	3.335
CV		1.92	2.29	2.17	2.57	2.94	2.08	1.66
Source of variation					Probability			
Guar meal		0.009	0.167	0.099	0.003	0.039	0.035	0.005
Enzyme		0.211	0.103	0.413	0.169	0.623	0.190	0.643
Enzyme × Guar meal		0.040	0.381	0.125	0.063	0.082	0.042	0.043

a-b Means within a column (within main effects) with no common superscript differ significantly (P <0.05), SEM= Standard error of means and those fed the diet with 2.5 g GM/ 100g diet during the trial; however, the difference was statistically significant only on weeks 1, 4 and the overall trial period (weeks 1-6). Enzyme supplementation did not affect FCR. There was no significant interaction between GM and enzyme on FCR, except for week 6 (P=0.047). The worst FCR was seen in the hens fed diet with 5.0 g GM/ 100g diet without enzyme during week 6 of trail.

Effects of adding GM to diet and enzyme supplementation on egg weight (EW) are presented in table 5. Dietary treatment affected EW in the present experiment. Including GM to the diet of laying hens affected EW just during week 1. In the present experiment dietary enzyme supplementation caused decreased EW during week 4-6 as well as the overall trail period (weeks 1-6). There was no statistically significant interaction between diet GM inclusion and enzyme supplementation on EW.

Egg mass (g egg hen^{-1} day^{-1}) in hens fed GM-included diet decreased during weeks 4-5 of trial as it is showed in table 6. There was no significant effect of dietary enzyme supplementation on egg mass. There were significant interactions between GM and enzyme on egg mass during weeks 1 and 6 as well as the overall experimental period (weeks 1-6).

CONCLUSION

Based on the results of this investigation it can be concluded that adding 5% GM to laying hens' diet has adverse effects on their productive performance and it seems that hens can tolerate GM in the diet up to 2.5% with no detrimental effects on EP, EM and feed efficiency.

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