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Combined Effect of Soybean Hulls and Enzyme (β-Mannanase) on the Production Performance and Economics in Golden Brown Laying Hens (RIR×Fayoumi) During the Mid-Peak Production Period

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ABSTRACT

This study aimed to determine the influence of fiber degrading enzymes (β-Mannanase) and soybean hulls (SH) on the production performance, and economics in the laying hens during the mid (33 to 36 weeks) peak production period in the laying hens. Two hundred golden brown (RIR×Fayoumi) laying hens were purchased and divided into five groups CON, T1, T2, T3, and T4. Each group had 4 replicates with 10 birds per replicate. The CON group was fed a corn-soybean basal diet while the T1 group diet contained 3% SH+20mg/kg enzyme; T2, 3% SH+30mg/kg enzyme; T3, 9% SH+20mg/kg enzyme, and T4; 9% SH+30mg/kg enzyme in the feed. The result indicated ($P<0.05$) higher overall feed intake and weight gain in the T2 group and better feed conversion ratio in T2 and T3 groups, and water intake in the T1 and T2 diet groups than in the remaining groups while egg production, hen day egg production, and mortality were not effaced ($P>0.05$). Total revenue calculated was ($P<0.05$) higher in the T2 diet group as compared to the remaining groups, while the profit and cost-benefit ratio in the CON and T1 diet groups than in the remaining groups. It is concluded that the combination of an enzyme (β-Mannanase, 20mg/kg) and the replacement of soybean meal in the diet by 3%SH had a positive effect on the overall performance and economics of golden-brown laying hens (RIR×Fayoumi) during the mid-peak production period.

INTRODUCTION

Exogenous enzyme research has gained popularity due to its distinct characteristics. Exogenous enzymes can be added to animal feed to achieve a variety of objectives, including the removal or hydrolysis of anti-nutritional components, the breakdown of non-structure protein (NSP), improve nutrient digestibility, and the supplementation of endogenous enzymes (Abu, 2019). Exogenous enzymes can thus increase the use of inexpensive materials in animal feed in addition to improving feed efficiency consumption because the viscosity of the digesta decreases with use, potentiating the activity of endogenous enzymes on particular substrates (Ribeiro *et al*., 2011). In many species of poultry, the introduction of fibrous feed materials to the diet at a rate of 3 to 5% will not have an impact on nutrient digestibility or growth performance (Jimenez-Moreno *et al*., 2009). Enzymes have been used in chicken diets for the past 50 years to increase the nutritional value of the feed ingredients while

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lowering feed costs without sacrificing weight gain and feed efficiency (Walters, 2019). Soybean hulls (SH) are a byproduct of the extraction of oil from soybean seeds. According to Rojas *et al*. (2014), the effectiveness of the de-hulling process might affect the chemical composition of SH. As a result, the SH may contain various amounts of celluloses (29-51%), hemicelluloses (10-25%), proteins (11-15%), lignin (1-4%), and pectin (4-8%) (Mielenz *et al*., 2009; Shuaib *et al*., 2022). As a result, poultry cannot synthesize the enzymes necessary to break down the non-starch polysaccharides (NSPs) present in the cell wall of the grains and instead keep them un-hydrolyzed, which results in reduced feed efficacy (Dami, 2018). Recent studies have suggested that dietary adjustments, including the addition of suitable synthetic enzymes (cellulase and hemicellulase) supplied in the diet of birds, can be used to counteract the unfavorable effects of NSPs (Abu, 2019). These enzymes degrade NSPs, lessen intestinal adhesion, and ultimately increase nutrient absorption by enhancing the function and health of the gut (Creswell, 1994; Abu, 2019). It was therefore supposed that the addition of enzyme (β-mannanase-Hemicell^{TD}) in a SH-based diet may compensate for the undesirable effect of the SH-based diet. Thus, this study was carried out to assess the effect of dietary inclusion of SH supplemented with enzyme (β-mannanase) on golden brown laying hens (RIR×Fayoumi) production performance and economics during the mid-peak production period.

MATERIALS AND METHODS

Housing and experimental environment

The study was performed at the University of Agriculture Peshawar poultry farm (semi control). Two hundred (200) golden brown (RIR×Fayoumi) layer birds of age 33 weeks were used for the experimental purpose and were reared for 4 weeks (33 to 36 weeks). Birds were assigned randomly into five groups of 40 birds each. Every group had four experimental replicates with 10 birds each. The experimental diets were formulated in the Sadiq Brother (SB) Feed Mill (Rawalpindi). The CON group had a basal diet (Corn-soybean meal) while the T1 group contained 3%SH+20mg/kg enzyme; T2, 3%SH+30mg/kg enzyme, T3; 9%SH+20mg/kg enzyme, and the T4 group 9%SH+30mg/kg enzyme (β-Mannanase (Hemicell™), USA) in the feed. All of the birds in the poultry shed received uniform environmental and managemental conditions. The room temperature was kept at 75°F, and there was enough light (17 h per day). A regular immunization program was given to the flock. The composition of experimental diets is shown in Table I.

Table I. Experimental diets.

Nutrient (%)	CON	Diet			
		T1	T2	T3	T4
Corn	53.10	52.10	52.10	50.50	50.50
Canola meal (34%)	4.15	3.85	3.670	2.16	2.14
Soybean meal (44%)	24.30	23.60	23.60	22.20	22.20
Guar meal	0.00	1.00	1.00	1.00	1.00
Soybean hull	0.00	3.00	3.00	9.00	9.00
β-Mannanase (Hemicell)	0.00	0.002	0.003	0.002	0.003
PBM Hi fat	2.00	1.02	1.00	1.02	0.85
Poultry oil	2.79	2.78	2.71	2.66	2.67
Salt	0.32	0.32	0.41	0.26	0.41
Sodium bicarbonate	0.10	0.10	0.10	0.10	0.10
Limestone/Chips	11.10	10.10	10.3	8.98	9.15
Celite	1.00	1.00	1.00	1.00	1.00
DCP	0.77	0.77	0.75	0.77	0.62
DLM	0.08	0.08	0.08	0.07	0.08
Choline chloride (70 %)	0.10	0.10	0.10	0.10	0.10
Vitamin premix broiler*	0.07	0.07	0.07	0.07	0.07
Mineral premix*	0.06	0.06	0.06	0.06	0.06
Phytase	0.01	0.01	0.01	0.01	0.01
Enramycin	0.02	0.02	0.02	0.02	0.02
Ethoxyquin/Antioxidant	0.01	0.01	0.01	0.01	0.01
NSPs	0.02	0.00	0.00	0.00	0.00
Total	100	100	100	100	100

*To provide one kg of diet: Retinyl acetate, 4400 IU; DL-α-tocopheryl acetate 12 IU; Cholecalciferol 118µg; Thiamine 2.5mg; Menadione sodium bisulphite 2.40 mg; Niacin 30mg; Vit.B_2 4.8 mg; D-pantothenic acid 10 mg; Vit. B_6 5mg; Vit. B_7 130 µg; Cyanocobalamine 19 µg; Vit.B_9 2.5 mg; Mn 85 mg; Zinc 75 mg; Fe 80 mg; Iodine 1 mg; Selenium 130 µg; Copper 6 mg. PBM, Poultry by product meal; DCP, Dicalcium phosphate; DLM, DL-Methionine, NSPs, Non-starch polysaccharides. CON, Control; T1=3%SH+20mg/kg enzyme β-Mannanase; T2=3%SH+30mg/kg enzyme β-Mannanase; T3=9%SH+20mg/kg enzyme β-Mannanase; T4=9%SH+30mg/kg enzyme β-Mannanase (Hemicell).

Production performance parameters

Feed intake (FI) was calculated by the formula

FI= Total feed offered- total feed used

while egg production was noted daily. Hen day egg production (HDEP) was calculated by the formula

HDEP= Total number of eggs in a given period ÷ Number of days× number of alive hens on each of these days.

The body weight gain (BWG) was recorded on weekly basis by the formula

BWG= Final body weight - initial body weight

Mortality was recorded on daily basis along with its possible cause of death after postmortem examination. Daily water intake was recorded by subtracting the total water used from the total water offered.

Table II. Effect of dietary inclusion of soybean hull and enzyme on the production performance and economics in laying hens.

Parameters	Weeks	CON	Treatments				P. value
			T1	T2	T3	T4	
Feed intake (g)	33	733±0.70^{d}	745±0.77^{c}	772±0.82^{a}	732±0.97^{d}	764±1.31^{b}	0.001
	34	727±0.70^{d}	738±0.77^{c}	767±0.82^{a}	727±0.97^{d}	760±1.31^{b}	0.001
	35	737±0.70^{e}	758±0.77^{c}	776±0.82^{a}	744±0.97^{d}	769±1.31^{b}	0.013
	36	752±0.85^{c}	765±0.77^{b}	792±0.77^{a}	750±0.90^{c}	762±1.33^{b}	0.033
	Overall	2949±12.8^{d}	3006±13.8^{c}	3107±14.7^{a}	2953±15.7^{d}	3055±15.8^{b}	0.003
Egg production	33	5.00±0.68	5.19±0.58	5.36±0.41	5.08±0.58	5.16±0.92	0.201
	34	4.95±0.58	5.17±0.68	5.34±0.68	5.07±0.35	5.12±0.68	0.396
	35	4.95±0.35	5.14±0.92	5.32±0.89	5.09±0.58	5.14±0.58	0.605
	36	4.90±0.89	5.09±0.58	5.30±0.68	5.04±1.70	5.07±0.89	0.873
	Overall	19.8±0.68	20.5±0.58	21.3±0.41	20.2±0.58	20.4±0.92	0.201
FCR	33	1.75±0.03^{b}	1.72±0.01^{c}	1.72±0.01^{c}	1.72±0.02^{c}	1.77±0.04^{a}	0.020
	34	1.76±0.01^{b}	1.71±0.01^{c}	1.72±0.02^{c}	1.72±0.01^{c}	1.78±0.03^{a}	0.027
	35	1.78±0.01^{a}	1.76±0.01^{b}	1.75±0.02^{c}	1.75±0.01^{c}	1.79±0.02^{a}	0.030
	36	1.84±0.01^{a}	1.80±0.02^{b}	1.79±0.02^{c}	1.78±0.05^{c}	1.80±0.03^{b}	0.036
	Overall	1.78±0.03^{a}	1.75±0.01^{b}	1.74±0.01^{c}	1.74±0.02^{c}	1.78±0.02^{a}	0.049
HDEP (%)	33	72.8±0.24	75.1±0.20	76.2±0.18	73.4±0.16	74.2±0.21	0.063
	34	72.6±0.14	74.2±0.16	74.8±0.12	73.4±0.10	74.1±0.11	0.161
	35	72.0±0.19	73.4±0.17	75.0±0.15	73.0±0.20	73.4±0.16	0.241
	36	73.0±0.22	74.0±0.24	75.3±0.19	73.0±0.27	73.4±0.25	0.126
	Overall	74.0±0.28	75.5±0.26	76.1±0.21	74.4±0.25	75.1±0.23	0.221
Weight gain (g)	33	7.00±1.04^{c}	9.25±1.60^{b}	11.0±2.21^{a}	7.25±1.25^{c}	9.00±1.65^{b}	0.048
	34	6.00±0.64^{c}	9.00±0.95^{b}	12.0±2.67^{a}	8.25±1.49^{b}	10.0±1.68^{b}	0.029
	35	8.00±1.08^{c}	10.0±1.08^{b}	14.2±2.28^{a}	10.2±1.31^{b}	11.7±0.85^{b}	0.041
	36	11.5±1.19	13.0±0.91	13.2±1.65	12.0±1.58	12.7±1.54	0.893
	Overall	32±4.19^{d}	41.0±3.19^{bc}	50.2±8.46^{a}	38.0±4.87^{c}	43.0±5.40^{b}	0.019
Water intake (Litter)	33	1.18±0.48^{b}	1.21±0.29^{a}	1.22±0.29^{a}	1.19±0.49^{ab}	1.20±0.32^{a}	0.002
	34	1.19±0.21^{c}	1.23±0.59^{a}	1.23±0.07^{a}	1.21±0.45^{b}	1.21±0.53^{b}	0.001
	35	1.20±0.29^{b}	1.24±0.49^{a}	1.24±0.07^{a}	1.23±0.45^{a}	1.23±0.81^{a}	0.021
	36	1.22±0.29^{d}	1.25±0.07^{ab}	1.26±0.07^{a}	1.23±0.29^{cd}	1.24±0.07^{bc}	0.003
	Overall	4.87±0.26^{c}	4.95±0.46^{a}	4.96±0.39^{a}	4.87±0.42^{c}	4.89±0.37^{b}	0.671
Mortality (%)	33	0.00	0.00	0.00	0.00	0.00	---
	34	0.00	0.00	0.00	0.00	0.00	---
	35	0.00	0.00	0.00	0.00	0.00	---
	36	0.00	0.00	0.00	0.00	0.00	---
	Overall	0.00	0.00	0.00	0.00	0.00	---
TR (Pak Rs)		327±1.24^{d}	342±2.18^{b}	354±1.84^{a}	339±1.96^{c}	340±1.72^{bc}	0.041
Profit (Pak Rs)		139±2.20^{a}	137±1.77^{a}	132±0.79^{b}	130±3.03^{b}	126±3.59^{c}	0.019
CBR		1.69±0.01^{a}	1.67±0.01^{a}	1.62±0.03^{b}	1.63±0.01^{b}	1.59±0.02^{c}	0.003

Means in the same row with different superscripts are significantly different (P<0.05). FCR, feed conversion ratio; HDEP, Hen day egg production; TR, Total revenue; CBR, Cost benefit ratio.

Feed conversion ratio (FCR) was determined by the formula

FCR= Feed intake (kg) ÷ number of eggs ×12

Total revenue (TR) was calculated by the formula

TR = Total number of eggs × price per egg.

The profit was determined by the formula

Profit = Total revenue - total cost

while cost-benefit ratio (CBR) was calculated by the formula e.g.

CBR = TR ÷ total cost

Statistical analysis

The data on performance and economics parameters were subjected to the analysis of variance (ANOVA) technique using a completely randomized design (CRD). The general linear model (GLM) procedure (Steel *et al*., 1997) of SPSS 21.0 was used to analyze the data statistically. Tukey's test was applied to compare the mean significant differences at a 5 percent level.

RESULTS

Table II shows the results regarding the production performance and economic parameters. Overall and weekly feed intake was recorded as higher ($P<0.05$) in the T2 diet group while egg production, HDEP, and mortality were not effected ($P<0.05$). FCR during weeks 33 and 34 was calculated ($P<0.05$) better in the T1, T2, and T3 diet groups than in the control and T4 groups while weeks 35, 36, and overall showed a ($P<0.05$) better FCR in the T2 and T3 diet groups than in the all-other groups. The weight gain during weeks 33, 34, 36, and overall was recorded ($P<0.05$) higher in the T2 diet group as compared to the remaining diet groups. During all weeks, water intake was lower in the control group than in the remaining groups but overall showed a ($P<0.05$) lower value in the control and T3 diet groups as compared to all other groups. The total revenue had a ($P<0.05$) higher value in the T2 diet group while the profit and CBR showed a ($P<0.05$) higher value in the CON and T1 diet groups than in the remaining groups.

DISCUSSION

In this study, the inclusion of SH and β-Mannanase at different levels resulted in significantly higher overall feed intake and weight gain in the T2 group, better FCR in T2 and T3 groups, and water intake in the T1 and T2 diet groups than in the remaining groups. Our results are in agreement with the findings of Esonu *et al*. (2006) who recorded significantly higher feed intake and non-significant mortality in broilers when fed 20% soya bean hulls meal and 1% enzyme (Safzyme) in the feed. Abreu *et al*. (2018) also investigated a higher feed intake in the hens receiving 100g/ton enzyme complex than the ration without enzyme (control). The present study result is also in line with the finding of Danang and Tintin (2016) who reported higher feed intake for the laying hens with enzymes between 0.1-0.5% in the feed. Similarly, Javer *et al*. (2015) demonstrated that the combination of the distiller's dried grains with solubles (DDGS) levels and enzymes had a significant impact on feed efficiency (FCR). Our results are also in agreement with the finding of Esonu *et al*. (2005) in the laying hens and presented higher weight gain for 10, 20, and 30% SH and 2% cellulitic enzyme in the diet as compared to a diet having only 10, 20 and 30% SH without the enzyme addition. The result is also in line with the findings of Abreu *et al*. (2018) who presented the beneficial effect of 100 g/t of the enzyme complex (xylanase, ß-glucanase, and phytase-based) for feed formulations to enhance the performance and improved eggs production in the laying hens. Mathlouthi *et al*. (2003) also described that enzyme supplementation did not effect egg production. Similarly, Silversides *et al*. (2006) reported no change in egg production with supplementation of xylanase and phytase individually or in combination with wheat-based laying hen diets with low levels of phosphorus. Jalal and Scheideler (2001) also recorded no significant difference in egg production on enzyme (phytase) supplementation to corn-soya-based layer diets. In agreement with the results of the present study, the more efficient FCR (from 2.15 to 2.03) was recorded by Danang and Tintin (2016) when the enzyme between 0.1-0.5% was provided in the feed to the treatment groups. Javer *et al*. (2015) also investigated improved FCR from 2.11 to 1.99 on administering the enzyme Quatrazyme (20 mg/kg) in the feed. The better feed intake in the SH and enzyme diet groups is due to the beneficial effect of the enzyme on the gastrointestinal tract and its ability to break down the cell wall of the SH into easily digestible components (already analyzed digestibility in this study) and similarly, Almirall *et al*. (1993) had concluded that an increase in the feed intake occurred only after the enzyme supplementation decreased viscosity by degrading NSP components of the diet. The higher body weight gain in the soybean hulls and enzyme diet group is due to the improved feed intake. The better FCR in the T2 diet group than in the remaining groups is due to the relatively higher egg production in this group. Whether the water intake increases or decreases depends on the nature of the dietary fiber, however, factors such as environmental temperature, feed composition, and the physicochemical properties of the different ingredients and components of the diet might affect this relationship (Carre *et al*., 2013). Water intake is highly correlated with feed intake (Jiménez-Moreno *et al*., 2016) which is similar to the present study results and the increased feed intake in the enzyme and SH groups has resulted in increased water intake. The TR had a (P<0.05) higher value in the T2 diet group as compared to all other groups, while the profit and CBR showed a (P<0.05) higher value in the CON and T1 diet groups than in the remaining groups and similarly, Esonu *et al*. (2006) also shown negative feed cost savings and higher feed costs when using 10 and 20% SH meal and cellulitic enzyme (Safzyme) 0.1% in the broiler finisher diet. Sousa *et al*. (2019) also recorded higher feed cost per egg carton when using different fiber sources (SH and coffee husks) and enzyme (xylanase) 0.075 g/kg in the laying hens feed. The inclusion and improvement achieved by the enzymes in the diet are influenced by a range of factors, including the nature and quantity of cereal in the diet, the amount of anti-nutritive ingredient in a particular cereal, the amount of the enzymes used, the type and age of the animal, the bird's physiology and the kind of gut microflora (Bedford, 1996). The higher total revenue in the T2 group than in the remaining groups is due to the higher egg production. The control group had comparatively higher profit as compared to all other groups which is due to the lower feed intake in the CON group than in all other treatment groups. The use of dietary SH and enzymes in layer feed depends especially on the market prices of feed, birds, eggs, and enzymes.

CONCLUSION

The findings of the present study showed overall better production performance and economics in a diet containing 3% soybean hull along with β-Mannanase at 20mg/kg. Therefore, the replacement of soybean meal by 3% SH along with β-Mannanase at 20mg/kg in feed is recommended for golden brown laying hens (RIR×Fayoumi) at the mid-peak production period.

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IRB approval

The study was approved by the Advanced Studies and Research Board (ASRB), The University of Agriculture Peshawar (No.1145/ASRB/UAP) dated 22/07/2020.

Ethical statement

This study was approved by the Animal Welfare and Care Committee of the Faculty of Animal Husbandry and Veterinary Sciences, The University of Agriculture, Peshawar, Pakistan, and all the measures and tools were considered to minimize the pain and discomfort to birds during the conduction of this experiment.

Statement of conflict of interest

The authors have declared no conflict of interest regarding the publication of this article.

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