Buletin Peternakan 43 (3): 179-183, August 2019

ISSTAP
Indonesian Society for Sustainable Tropical Animal Production

Bulletin of Animal Science

ISSN-0126-4400/E-ISSN-2407-876X Accredited: 36a/E/KPT/2016
http://buletinpeternakan.fapet.ugm.ac.id/

Doi: 10.21059/buletinpeternak.v43i3.44618

Influence of Hemicell® Addition on Diets Containing Different Levels of Crude Fiber on Performance of Laying Hens

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Article history
Submitted: 30 March 2019
Accepted: 8 August 2019

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ABSTRACT

This study was conducted to examine the effect of Hemicell® addition on diets containing different levels of crude fiber on performance and egg quality of laying hens. A total of 72 laying hens aged 21 weeks were randomly divided into 18 experimental units. A completely randomized design with factorial design 2×3 and 3 replications was employed in this study. Factor A was crude fiber level (5% and 8%) and factor B was the level of Hemicell® (0, 100x10^3 and 200x10^3 IU/kg ration). Results showed that crude fiber significantly (P<0.01) increased feed consumption and decreased the performance of laying hens. The addition of Hemicell® in diets significantly (P<0.01) decreased feed consumption and increased the performance of laying hens. Hemicell® addition (100 IU) to a diet containing 8% crude fiber significantly (P<0.05) affected egg mass, feed conversion ratio, egg yolk score and egg weight. It can be concluded that diet with 8% crude fiber added with Hemicell® (100 IU) could increase egg mass, feed conversion ratio, egg weight and yolk color score.

Keywords: Crude fiber, Egg quality, Hemicell®, Laying hens, Performance

Introduction

Inclusion of relatively cheaper and affordable ingredient such as palm kernel meal (PKM) has been proposed to reduce feed cost. Palm kernel meal is the residue obtained after extraction of oil from the palm kernel, and it is produced in large amounts in Indonesia. The feed ingredient contains around 14-16% crude protein (CP) and 1600-1700 kcal/kg metabolizable energy (ME), and it also contains 35%-40% mannan, which is poorly digestible for poultry (Sundu *et al.*, 2006; Verduzco *et al.* 2009; Barros *et al.,* 2015). To overcome the problem of mannan, the addition of its respective enzyme i.e. mannanase has been recommended (Hofacre *et al.,* 2003; Wu *et al.*, 2005; Sundu *et al.*, 2006; Baurhoo *et al.*, 2007). Hemicell® is a fermented product from *Bacillus lentus* and its active ingredient is *β*-mannanase that hydrolyzes *β*-mannan. Presently little information is available regarding the relationship between different levels of PKM inclusion and Hemicell® addition on egg production and egg quality in laying hens. Hemicell® supplementation must be able to break the bonds of mannan in complex carbohydrates to make it easier for palm kernel waste or PKM that has complex reserves to be used by the hen gastrointestinal. The ability of Hemmicel® will cause nutrients from available ingredients and be easily digested so that it is expected to improve the performance of laying hens and egg quality. Therefore, this study was conducted to investigate the effect of Hemicell® addition at different levels of PKM inclusion on performance, egg production and eggshell quality in laying hens.

Materials and Methods

A total of 72 Isa brown laying hens aged 21 weeks with average of body weight 1,400±102.59 g were randomly allocated to 6 treatments with 3 replications per treatment and 4 hens per replication. The 6 treatments were arranged in a 2×3 factorial design with two levels of dietary crude fiber (5 and 8%) and three levels of Hemicell® (Received from Behn Meyer Indonesia) (0, 100x10^3 and 200x10^3 IU/kg ration). All birds were allocated to cages with 2 hens per each cage room (35 cm W × 35 cm D × 40 cm H) for eight weeks. During that period, both feed and water were offered *ad libitum*. Experimental diets were formulated to be iso-nitrogenous (19% CP) and iso-caloric (2,900 kcal ME/kg diet). Corn, palm kernel meal, and soybean meal were the major ingredients. The formula and nutrient composition of experimental diets are shown in Table 1.

Parameter measured were: egg production was recorded daily as well as egg weight and mortality. Hen day egg production (HDEP), average daily feed consumption, feed conversion ratio (FCR), and mortality were calculated weekly at the end of feeding trial. Physical quality of egg was observed at the fifth, sixth, seventh, eight weeks by taking randomly two eggs from each replicate. Statistical analysis of variance (ANOVA) and the statistical analysis was continued with Duncan's multiple range test (Steel and Torrie, 1995) when the treatment indicated significant effect (P<0.05).

Result and Discussion

Effects of treatments on egg production

The crude fiber in the diet decreased hen day egg production (P<0.01; Table 2). Supplementation Hemicell® in diet improved HDEP (P<0.01). Higher crude fiber in diet accelerates rate of nutrient passage in digestive tract and therefore decreases nutrient absorption (Connell, 1981). Such poor nutrient utilization of PKM diets could be attributed to nonstarch polysaccharides (NSP) which are poorly utilized in poultry digestive system (Meng *et al*., 2005) and even act as anti-nutritive factors (Marquardt, 1997). Apparently supplementation of Hemicell® in diet can break down *β*-mannan to mannooligosaccharides and simple sugar, and thus supply more nutrients for laying hens (Ferket *et al*., 2002; Hooge, 2004; Lee *et al*., 2013). Further, such supplementation increased feed intake and egg production in hens aged over 73 weeks.

Diet with 8% dietary crude fiber increased feed intake (P<0.01). In agreement to our finding, Chong *et al*. (2008) reported an increase of feed intake of laying hens by PKM inclusion in diets. High fiber diets are known to increase the rate of feed passage through the gastrointestinal tract and thus may result in a lower actual ME values of the diets. Also, high dietary fiber may

Table 1. Composition of the experimental diets and their nutrient contents

Composition	Treatment					
	A1B1	A1B2	A1B3	A2B1	A2B2	A2B3
Feed ingredients	....................................%...					
Yellow corn	43	43	43	23	23	23
Rice bran	5.50	5.50	5.50	7.00	7.00	7.00
Palm kernel meal	12	12	12	28	28	28
Soybean meal (44%)	11.5	11.5	11.5	8.87	8.87	8.87
CGM	6	6	6	6.4	6.4	6.4
Fish meal	8	8	8	8	8	8
Palm oil	4.07	4.07	4.07	8.8	8.8	8.8
DCP	0.5	0.5	0.5	0.7	0.7	0.7
CaCO3	8.7	8.7	8.7	8.5	8.5	8.5
NaCl	0.2	0.2	0.2	0.2	0.2	0.2
Premix	0.5	0.5	0.5	0.5	0.5	0.5
DL-Methionine	0.03	0.03	0.03	0.03	0.03	0.03
Hemicell, IU/kg	0	100	200	0	100	200
Total	100	100	100	100	100	100
Nutrient contents						
ME (kkal/kg)	2,905	2,905	2,905	2,901	2,901	2,901
Crude protein (%)	19.2	19.2	19.2	19.2	19.2	19.2
Crude fibre (%)	5.03	5.03	5.03	8.07	8.07	8.07
Crude fat (%)	6.91	6.91	6.91	12.1	12.1	12.1
Calcium (%)	4.01	4.01	4.01	4.02	4.02	4.02
Total P (%)	0.6	0.6	0.6	0.64	0.64	0.64
Lysine (%)	0.97	0.97	0.97	0.85	0.85	0.85
Methionine (%)	0.44	0.44	0.44	0.39	0.39	0.39

A1B1, crude fiber 5% +0 IU Hemicell; A1B2, crude fiber 5% + 100 IU Hemicell; A1B3, crude fiber 5% + 200 IU Hemicell; A2B1, crude fiber 8% + 0 IU Hemicell; A2B2, crude fiber 8% + 100 IU Hemicell; A2B3, crude fiber 8% + 200 IU Hemicell.
Means in the same column/row with different uppercase superscripts are significantly different at P<0.01.
Means in the same column/row with different lowercase superscripts are significantly different at P<0.05.

Table 2. Effect of treatments on feed consumption, egg production, egg mass and feed conversion ratio of laying hens

Variable	Crude fiber	Hemicell (B)			Average
	(A)	B1	B2	B3	
Feed	A1	104.5±0.22	104.2±0.25	104.0±0.35	104.2±0.31^{A}
consumption	A2	106.1±0.04	105.6±0.19	105.1±0.40	105.6±0.46^{B}
(g/bird/day)	Average	105.3±0.87^{A}	104.9±0.83^{B}	104.6±0.64^{B}	
Egg	A1	79.3±2.73	81.7±2.79	83.6±2.46	81.6±2.97^{A}
production	A2	66.9±5.48	77.9±5.41	79.6±1.85	74.8±7.15^{B}
(%)	Average	73.1±7.82^{B}	79.8±4.38^{A}	81.6±2.96^{A}	
Egg mass	A1	2,420±123^{b}	2,548±83.5^{b}	2,576±108^{a}	2,485±116
(g/bird/day)	A2	1,873±147^{d}	2,334±139^{c}	2,421±95.8^{b}	2,209±279
	Average	2,147±323	2,396±123	2,499±125	
Feed	A1	2.42±0.12^{C}	2.38±0.08^{BC}	2.26±0.09^{C}	2.35±0.08
conversion	A2	3.18±0.24^{A}	2.54±0.15^{B}	2.44±0.10^{B}	2.72±0.40
ratio	Average	2.80±0.54	2.46±0.12	2.35±0.12	

A1B1, crude fiber 5% + 0 IU Hemicell; A1B2, crude fiber 5% + 100 IU Hemicell; A1B3, crude fiber 5% + 200 IU Hemicell; A2B1, crude fiber 8% + 0 IU Hemicell; A2B2, crude fiber 8% + 100 IU Hemicell; A2B3, crude fiber 8% + 200 IU Hemicell.
Means in the same column/row with different uppercase superscripts are significantly different at P<0.01.
Means in the same column/row with different lowercase superscript sare significantly different at P<0.05.

Increased is integration of intestinal epithelial cells, causing an increase in secretion of the mucosa into small intestine and leads to losses of endogenous amino acids. Low water holding capacity and higher bulkiness of PKM were sugested as an accelerator of digesta passage and therefore, increased the feed consumption (Sundu *et al*., 2006; Tafsin *et al.,* 2017). Hemicell® supplementation in diet significantly decreased (P<0.01) feed consumption. Supplementation Hemicell® in diet containing PKM can degrading mannan may be due to the improvement in digestibility and nutrient utilization of diet.

Hemicell® supplementation to diet with 5% dietary crude fiber significantly (P<0.05) improved feed conversion ratio and increased egg mass. Diet with 8% dietary crude fiber was poorer feed conversion and decreased egg mass. This was probably due to the ability of 200×10^3 IU Hemicell® kg-1 which was able to work optimally with 5% crude fiber content, but not so with 8% crude fiber content. Hemicell® can break down complex Mannan polysaccharides into simpler carbohydrates. Tafsin *et al*. (2007) reported, the use of mannan polysaccharides as much as 4000 ppm showed the effect antinutritive indicated by the conversion ratio was poorer. Hemicell® supplementation to the diet improved feed conversion and increased egg mass. Wu *et al*. (2005) reported that the addition of *β*-mannanase improved feed conversion in hens fed a low-energy diet. Lee *et al.* (2005) reported that Hemicell® reduced the feed:gain ratio of guar germ diets of broiler chicken.

Effects of treatments on physical quality of eggs

Egg quality data are presented in Table 3. Hemicell® supplementation to diet with 8% dietary crude fiber highly significantly (P<0.01) increased egg weight. Egg weight is certainly depended upon sufficient and balanced feed intake (Gnanasigan *et al.* 2014). Diets high in NSP require enzyme supplementation to reduce the antinutritive (viscosity) properties of NSP or to enhance nutrient availability (Hsiao *et al.,* 2006; Adrizal *et al*., 2011; Tafsin *et al.,* 2017). Hemicell® supplementation to diet have influenced the availability of nutrient, because of mannanase enzyme work.

Hemicell® supplementation to diet with 8% dietary crude fiber significantly (P<0.05) affected yolk color score. Various researchers who have studied the availability of nutrients in PKM have reported a lower nutrient digestibility for PKM compared with other protein ingredients, such as soybean meal (Sundu *et al*., 2006; Tafsin *et al.,* 2017). Effect of supplementation enzyme and PKM could indicate that mannan molecule was being degraded by mannanase and that released nutrients. In the other study (Chong *et al*., 2008), diet with inclusion palm kernel meal decreased the yolk color score with higher level (25%) of supplementation, but no influence with lower level (12.5%) of supplementation. Even though the PKM diets had greater palm oil (4.07% to 8.07%) supplementation, it did not improve the yolk color score. Crude palm oil, which is red and could contain up to 700 ppm of carotenoids, is different from commercial palm cooking oil, which has been refined, is colorless, and contains a minimal amount of carotenoids (May, 1994; Benites *et al.,* 2008).

There were no differences in eggshell thickness due to either dietary mannanase or PKM inclusion (Table 3). The average of eggshell thickness was 0.177-0.200 mm Nonsignificant effect of dietary PKM levels or enzyme supplementation on the eggshell thickness further suggested that the availability of nutrients in the corn- and soybean meal-based diet was comparable with those of the PKM diets, for which the ME and amino acids requirements were formulated to be similar. Chong *et al*. (2008) reported dietary inclusion of PKC or enzyme supplementation did not influence eggshell quality. The negligible effect of enzyme supplementation on eggshell quality has also been reported in quails (Hume *et al.,* 2003; Sariçiçek *et al*., 2005). Hemicell® supplementation in diet with 8% dietary crude fiber did not affect the Haugh Unit. The average of Haugh unit was 84.55-91.20. The analysis showed that dietary crude fiber and Hemicell® supplementation levels did not affect the quality of the eggs freshness.

Table 3. Effect of treatments on egg quality of laying hens

Variables	Crude fiber (A)	Hemicell (B) B1	B2	B3	Average
Egg weight (g)	A1	54.5±1.56[A]	53.7±0.01[A]	55.0±0.79[A]	54.4±0.64
	A2	50.0±1.35[B]	53.6±0.94[A]	54.3±0.92[A]	52.6±2.30
	Average	52.2±3.17	53.6±0.12	54.7±0.48	
Eggshell thickness (mm)	A1	0.178±0.02	0.182±0.01	0.182±0.01	0.180±0.01
	A2	0.177±0.01	0.200±0.03	0.200±0.02	0.193±0.02
	Average	0.177±0.01	0.191±0.02	0.191±0.04	
Egg yolk score	A1	8.78±0.10[a]	8.61±0.25[a]	8.67±0.01[a]	8.69±0.15
	A2	7.72±0.19[c]	8.22±0.09[b]	8.11±0.35[bc]	8.02±0.31
	Average	8.25±0.59	8.42±0.27	8.39±0.38	
Haugh unit	A1	90.7±1.81	90.6±0.53	91.2±1.53	90.8±1.24
	A2	84.6±1.79	90.1±3.07	91.2±3.91	88.6±4.06
	Average	87.6±3.74	90.3±1.99	91.2±2.66	

A1B1, crude fiber 5% + 0 IU Hemicell; A1B2, crude fiber 5% + 100 IU Hemicell; A1B3, crude fiber 5% + 200 IU Hemicell; A2B1, crude fiber 8% + 0 IU Hemicell; A2B2, crude fiber 8% + 100 IU Hemicell; A2B3, crude fiber 8% + 200 IU Hemicell.
Means in the same column/row with different uppercase superscripts are significantly different at P<0.01.
Means in the same column/row with different lowercase superscripts are significantly different at P<0.05.

Conclusions

Increasing crude fiber content in rations decreases egg production, and increases ration consumption. The addition of 200×10^3 IU Hemicell® kg-1 into rations containing 5% crude fiber increases egg mass production, egg yolk score and decreases feed conversion.

Acknowledgments

Thanks for Behn Meyer Indonesia for funding this experiment.

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