

EFFECT OF MASH DIETARY FIBER ON PERFORMANCE AND CANNIBALISM IN LAYING HENS

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ABSTRACT

An experiment was conducted to observe the effect of dietary fiber given in mash form on performance and cannibalism mortality in laying hens. Three different diets: a wheat-based diet, a guar gum diet (a wheat-based diet + 20 g/kg guar gum) and a lucerne meal diet (a wheat-based diet + 40 g/kg lucerne meal) in mash form were offered for 12 weeks. The results showed that birds fed guar gum diet had the lowest intake ($p < 0.01$), egg weight ($p < 0.05$), body weight ($p < 0.05$) and the lowest egg production ($p < 0.01$) compared to those fed other diets. Diets did not have a significant effect ($p > 0.05$) on feed to egg ratio and cannibalism mortality, but numerically the birds fed the guar gum diet had the highest mortality (11.3%) and the lucerne diet had the lowest (6.9%). The lack of profound differences was probably due to the diets were given in mash form. In conclusion, diets containing high soluble NSP reduced the performance and increased the mortality due to cannibalism in laying hens. The use of mash form may have a potential in reducing the negative effect of soluble NSP on cannibalism.

Keywords: cannibalism mortality, dietary fiber, laying hens, mash form, NSP

INTRODUCTION

Cannibalism, the behaviour where birds peck and eat flesh of other birds, is a major problem for the Indonesian and world layer industry. According to Cumming *et al.* (1998), in some strains, mortality from cannibalism is not less than 10%, depending on the production system and management strategies and appears highest in current commercial strains such as ISA Brown. In Indonesian egg industry, especially in Java, has a flock size of approximately 100 thousands layers and 10% mortality during lay means a loss of approximately 400 million rupiah annually. In addition to the direct cost through loss of birds in lay and during rearing, there is also a considerable cost associated with lost productivity, disposal of birds, and flock morbidity.

The common method used by poultry industry to minimize the negative effect of feather pecking leading to cannibalism is beak trimming (Blokhuys and van der Haar, 1989). However, despite the benefit of beak trimming in reducing

mortality due to cannibalism, some believe that the pain caused by beak trimming is not acceptable on welfare grounds. Therefore, an alternative method in controlling cannibalism needs to be sought.

Hartini *et al.* (2002) and Hartini and Choct (2010b) found that diets high in insoluble non-starch polysaccharides (NSP) were effective in reducing mortality due to cannibalism. Millrun diets (Hartini *et al.*, 2002) and rice hull diets (Hartini and Choct, 2010b) given to laying hens resulted in approximately 13% less mortality than wheat diets. The high cannibalism mortality in wheat diet was caused by the higher soluble NSP contained in it. Soluble NSP increased digesta viscosity (Hartini and Choct, 2010a), thereby decreasing rate of feed passage. Decrease rate of feed passage may reduce the time birds spend on feeding, thereby increasing the incidence of cannibalism.

Beside levels of NSP, the form in which the diet fed has also been reported to affect cannibalism. Mash form is believed to reduce the

occurrence of feather pecking leading to cannibalism (Bessei *et al.*, 1999; Aerni *et al.*, 2000). It is suggested that fine feed encouraged the hens to feed longer than coarse feed, consequently decreasing their rate of feather pecking leading to cannibalism. Indeed, a video observation of hens fed several mash and pelleted diets showed that mash-fed hens ate for longer periods than pellet-fed hens during the first 11 h (proportion of time spent eating: 32.5 to 41.3% for mash and 20 to 25% for all the pelleted diets) (Vilarino *et al.*, 1996).

Based on the above explanation, it is hypothesized that the mash form may affect the degree of dietary fiber response on cannibalism. The current experiment, therefore, was designed to investigate the effect of dietary fiber given in mash form on performance and cannibalism mortality in laying hens.

MATERIALS AND METHODS

Experimental diets

Diets used in this experiment were based on wheat and sorghum (420 g/kg wheat/250 g/kg sorghum), which were formulated according to commercial specifications. Three different diets: a wheat-based diet, a guar gum diet (a wheat-based diet + 20 g/kg guar gum) and a lucerne meal diet (a wheat-based diet + 40 g/kg lucerne meal) in mash form were offered for 12 weeks. Wheat- and guar diets represented soluble NSP diets, whereas lucerne diet represented insoluble NSP diet. Levels of NSP in the diets were determined by the methods described by Theander and Westerlunds (1993). The composition of experimental diets can be seen in Table 1. During the experiment, feed was given *ad libitum* and water was available continuously.

Bird Management

Non-beaked-trimmed ISA brown laying hens ($n = 825$; at 37 weeks) were allocated randomly into cages with five birds per cage. The birds were divided into 3 groups of 275 birds each, or 55 cages per treatment and were offered the experimental diets for 12 weeks. Birds were held under a natural light condition supplemented with artificial light (>80 lux) to a total of 16 h/d.

Variables Measurements

Variables measured were feed intake (g/d), hen-day egg production (HDEP, %), egg weight (g), body weight (g), feed to egg ratio, and

cannibalism mortality (%). Feed intake, egg production, egg weight (samples of eggs) and body weight were recorded weekly, whereas mortality was recorded daily. For welfare reason, birds, which were wounded or blood seen were removed from the cage and recorded as "dead".

Statistical Analysis

The data obtained were analysed statistically using one-way analysis of variance (Manugistics, Inc., Rockville, MD). After a significant F test ($P < 0.05$), Duncan's multiple-range test was used to inspect differences among group means.

RESULTS AND DISCUSSION

Bird Performance and Mortality

Feed intake, egg weight, body weight, and egg production were affected by diets (Table 2). Birds fed guar gum diet had the lowest intake ($p < 0.01$), egg weight ($p < 0.05$), body weight ($p < 0.05$) and the lowest egg production ($p < 0.01$) compared to those fed other diets. Mortality was only numerically different ($p > 0.05$, Table 2) with birds fed the guar gum diet having the highest mortality (11.3%) and the lucerne diet the lowest (6.9%). Feed:egg ratio did not differ amongst birds given different diets ($p > 0.05$, Table 2).

Based on the hypothesis that insoluble fibres have the potential to reduce cannibalism mortality, it had been expected that lucerne meal addition would produce a strong positive impact in reducing cannibalism and the reverse for guar gum addition. But, the effect of those diets on cannibalism mortality was only numerically different. The lack of profound differences was probably due to the diets were given in mash form. Mash form has been reported to reduce the aggressive behaviour of birds (Aerni *et al.*, 2000). The mechanism proposed is that mash form encourages birds to spend longer time eating and keep feed in the crop and gizzard longer, thus reducing the incidence of pecking leading to cannibalism. Eating time in birds fed mash diets was longer than those fed pelleted diets (Vilarino *et al.*, 1996). Indeed, mash form appears to reduce the negative effect of soluble NSP diet on cannibalism.

However, at the same insoluble NSP level (68.9% for wheat-, 67.5% for guar- and 66.4% for lucerne diets), it was still clearly shown that lucerne meal addition was more effective in reducing cannibalism mortality than the other diets. Chemical and physical structure of lucerne

Table 1. Ingredients of the Experimental Diets (g/kg)

Ingredients	Wheat	Guar ^A	Lucerne ^B
Wheat	426.0	426.0	426.0
Sorghum	250.0	250.0	250.0
Meat meal	87.5	87.5	87.5
Sunflower meal	50.0	50.0	50.0
Soybean meal	33.0	33.0	33.0
Rice pollard	50.0	50.0	50.0
Soy flour	5.0	5.0	5.0
Limestone	85.0	85.0	85.0
Rockphos ^C	5.0	5.0	5.0
Kynofos ^D	0.5	0.5	0.5
Sodium bicarbonate	1.5	1.5	1.5
Choline chloride	0.3	0.3	0.3
DL-methionine	1.2	1.2	1.2
L-Lysine	1.5	1.5	1.5
Layer premix	2.0	2.0	2.0
Pigment	1.5	1.5	1.5
Chemical composition			
ME, MJ/kg	11.30	11.30	11.30
Crude Protein, %	17.00	17.00	17.00
Fat, %	3.61	3.61	3.61
Crude Fibre, %	3.46	3.46	3.46
Methionine, %	0.35	0.35	0.35
Lysine, %	0.78	0.78	0.78
Calcium, %	4.19	4.19	4.19
Non-phytate Phosphorus, %	0.50	0.50	0.50
Sodium, %	0.15	0.15	0.15
Soluble NSP, g/kg	6.00	22.90	9.30
Insoluble NSP, g/kg	86.90	67.50	66.40

^AA guar gum diet had 20 g/kg guar gum added to the wheat diet

^BA lucerne meal diet had 40 g/kg lucerne meal added to the wheat diet

^CRockphos: 35% Ca, 16% P

^DKynofos: Dicalcium Phosphate dihydrate, feed grade, and is produced by reacting defluorinated phosphoric acid (H₃PO₄) with slake lime (Ca(OH)₂) to produce a dicalcium phosphate dihydrate (CaHPO₄·2H₂O). Total Phosphorus (P) 18%, Calcium 23% and Magnesium 1.5%

meal has been suggested to be a factor contributing to the reduction of mortality in this case. This is in agreement with the previous

research by Hartini and Choct (2010b). Inclusion of rice hulls has also been observed to produce a better result in reducing cannibalism mortality

Table 2. Feed Intake, Egg Weight, Body Weight, Feed Egg Ratio, Hen-day Egg Production (HDEP) and Mortality due to Cannibalism of Laying Hens Fed Different Diets in a Mash Form

Diet	Wheat	Guar	Lucerne	Pooled SEM	Significance
Feed intake (g/d)	153 ^a	111 ^c	147 ^b	2.0	**
Egg wt (g)	64 ^a	62 ^b	65 ^a	0.8	*
Body weight (g)	2064 ^a	1827 ^b	2190 ^a	21.8	*
Feed:egg ratio	2.3	2.5	2.4	0.1	NS
HDEP (%)	83 ^a	71 ^b	86 ^a	2.4	**
Cannibalism mortality (%)	8.4	11.3	6.9	2.1	NS

^{a-c}Mean values within a row with different superscripts indicate differ significantly ($p < 0.05$); * $p < 0.05$; ** $p < 0.01$; NS: Not Significant

than the other diets (Hartini and Choct, 2010b).

The potential of lucerne meal addition in reducing cannibalism may also lie on its effect on the gizzard development and resultant beneficial effect on digesta transit time. The ability of insoluble fiber to stimulate gizzard function had been mentioned in previous studies by Hartini and Choct (2010b). The finding in the present study accentuated the previous suggestion that a longer retention of insoluble fiber in the gizzard, resulted in birds feeling more ‘settled’ or less frustrated between feeding bouts, but feeling hungry more frequently. Feeding high-NSP diets increased eating time (van Krimpen *et al.*, 2009). Prolonged eating time may be useful in reducing feather pecking behaviour

It has been mentioned previously that insoluble fibre accumulated longer in the gizzard, but it was also found that the crop and the gizzard in quails fed on a diluted (40% cellulose) diet emptied faster compared to those fed with undiluted food (Savory, 1985). This indicated that high fibre diets tend to accumulate longer in the gizzard, but once it is emptied from the gizzard, it passes through the gut quickly. Thus, in the present study, it is likely that lucerne meal addition was able to increase the rate of digesta transit time, resulting in birds feeling hungry more frequently and eventually decreasing the initiation of pecking or cannibalising. Lower transit time was found in birds fed high-insoluble NSP diet than those fed high-soluble NSP diets (Hartini, 2003).

Addition of guar gum to a wheat-based diet produced the numerically highest mortality. This supports the hypothesis that high-soluble NSP

content increases the incidence of cannibalism. The anti-nutritive effect of soluble NSP is likely to be performed through increased gut viscosity (Shakouri *et al.*, 2009). The gel-like environment caused by increased viscosity is likely to affect the movement of digesta along the gut, which, in turn, could depress food intake and subsequently bird performance. The fact that birds fed guar gum diet had the lowest feed intake and the poorest performance compared with the other diets supports the suggestion. In addition, feeding guar gum diets has been reported to slow down the rate of digesta passage and feeding behaviour (Furuse and Mabayo, 1996). Decreased feeding behaviour may give more time for bird to engage in other activities such as pecking each other.

CONCLUSION

In conclusion, diets containing high soluble NSP reduced the performance and increased the mortality due to cannibalism in laying hens. The use of mash form may have a potential in reducing the negative effect of soluble NSP on cannibalism, but further study is needed to confirm that 1) there is a comparative effect of NSP diet offered in different feed form on cannibalism, and 2) there is a positive effect of high-insoluble NSP offered in mash form on cannibalism.

REFERENCES

Aerni, V., H. El-Lethey, and B. Wechsler. 2000. Effect of foraging material and food form on feather pecking in laying hens. *Br. Poult. Sci.*

41:16-21.

- Bessei, W., K. Reiter, T. Bley, and F. Zeep. 1999. Measuring pecking of a bunch of feathers in individually housed hens: first results of genetic studies and feeding related reactions. *Lohmann Information* 22:27-31.
- Blokhuis, H. J. and J.W. van der Haar. 1989. Effects of floor type during rearing and of beak trimming on ground pecking and feather pecking in laying hens. *Appl. Anim. Behav. Sci.* 22:359-369.
- Cumming, R. B., W. Ball and J. V. Nolan. 1998. Mortality patterns in Australia and imported laying hens. *Proceeding of the 10th Australian Poultry Science Symposium*. Sydney, Australia. 1998. Page 168.
- Esmail, H. M. 1997. Fiber nutrition. *Poult. Int.* (July): 31-34.
- Furuse, M. and R. T. Mabayo. 1996. Effects of partially hydrolysed guar gum on feeding behaviour and crop emptying rate in chicks. *Br. Poult. Sci.* 37:223-227.
- Hartini, S. 2003. *Dietary Amelioration of Cannibalism in Laying Hens*. PhD Thesis. University of New England, Armidale, New South Wales, Australia.
- Hartini, S., and M. Choct. 2010a. Effect of non-starch polysaccharides derived from different grains on performance and digestive activity in laying hens. *J. Indonesian Trop. Anim. Agric.* 35(2):95-100.
- Hartini, S., and M. Choct. 2010b. The effect of diets containing different level of non-starch polysaccharides on performance and cannibalism in laying hens. *J. Indonesian Trop. Anim. Agric.* 35(3):145-150.
- Hartini, S., M. Choct, G. Hinch, A. Kocher and J. V. Nolan. 2002. Effects of light intensity during rearing, beak trimming and dietary fibre sources on mortality, egg production and performance of ISA brown laying hens. *J. Appl. Poult. Res.* 11:104-110.
- Savory, C. J. 1985. An investigation into the role of the crop in control of feeding in Japanese quail and domestic fowls. *Physiol. Behav.* 35: 917-928.
- Shakouri M.D, P.A. Iji, L.L. Mikkelsen and A.J. Cowieson. 2009. Intestinal function and gut microflora of broiler chickens as influenced by cereal grains and microbial enzyme supplementation. *J. Anim. Physiol. Anim. Nutr.* 93(5):647-658.
- Theander, O. and E. Westerlund. 1993. Determination of individual components of dietary fiber. In: *Dietary Fiber and Human Nutrition* (G.A. Spiller, ed). CRC Press, Inc. Boca Raton, Florida. Page 77-98.
- van Krimpen, M.M., R. P. Kwakkel, C. M. C. van der Peet-Schwering, L. A. den Hartog, and M. W. A. Verstegen. 2009. Effects of nutrient dilution and on starch polysaccharide concentration in rearing and laying diets on eating behavior and feather damage of rearing and laying hens. *Poult. Sci.* 88:759-773
- Vilarino, M., M.L. Picard, J.P. Melcion and J.M. Faure. 1996. Behavioural adaptation of laying hens to dilution of diets under mash and pellet form. *Br. Poult. Sci.* 37: 895-907.