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Fermented Product by *Monascus purpureus* in Poultry Diet: Effects on Laying Performance and Egg Quality

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Abstract: An experiment was conducted to determine the effect of feeding fermented products by *Monascus purpureus* on performances and egg quality of laying hen. This experiment was arranged in a completely randomized design with four dietary treatments: 0%, 10%, 20% and 30% fermented products by *Monascus purpureus* in the diets and five replications. 200 laying hen *Isa Brown* (22 week of age) were randomly allocated into 4 treatments (5 replications of 10 hens per treatment). Variable measured were feed intake, egg production, feed conversion, egg cholesterol and yolk colour. Results of the experiment indicated that feed intake, egg production, feed conversion, egg cholesterol and yolk colour were affected ($p<0.01$) by increasing fermented products in the diet. Feed intake, egg production and yolk colour in D treatment (used 30% fermented product by *Monascus purpureus*) was the highest than other treatment, but the lowest on egg cholesterol and feed conversion. The conclusion of the experiment that up to 30% fermented products by *Monascus purpureus* improved performance and reduced egg cholesterol 31.49% and increased yolk colour 18.56%.

Key words: Product fermented, *Monascus purpureus*, layer performance, egg quality

INTRODUCTION

Product fermented high carotenoids (β carotene and monacolin) based on by-product could be used as alternative poultry diet, substituted conventional feed stuffs still import. In Indonesia some of corn, soybean meal and fish meal are still imported from abroad. It resulted in a high cost of diets for poultry. The utilization of waste materials from agricultural or industrial wastes (by-products) is often applied to overcome the problem of feed shortage in poultry industry. Feed diversification in the poultry diet is one of many attempts to reduce the cost of feed in the poultry industry.

Another advantage using fermented product high monacolin was reduced egg cholesterol, so eggs safe to eat for anyone including people with *hypercholesterolemia*. Results of the research before, reported that utilization fermented products by *Neurospora crassa* (high β-carotene) substituted corn 50% and decreased cholesterol of hens egg 35% (Nuraini *et al*., 2008). Feeding fermented product high carotenoid monacolin could reduced blood cholesterol of rats. Eisenbrand (2005) reported that used of 2.4 g/day product fermented with *Monascus purpureus* containing 10 mg monacolin (lovastatin) for 12 weeks decreased total cholesterol, LDL cholesterol, triglycerides and increased HDL cholesterol blood serum of rats. According Erdogrul and Azirak (2004), monacolin or lovastatin is secondary metabolites produced by *Monascus purpureus* as hypo-cholesterolemia agent.

Food factor provided to determine the occurrence of poultry accumulation of cholesterol in eggs. Eggs are a source of highly nutritious of animal protein because it complete of amino acids and balanced and not expensive so affordable to be consumed by all levels of society, but some people (people with hypertension) will avoid eating eggs because of cholesterol content. Cholesterol content of hen eggs 425 mg/100 g eggs.

Substrate for fermented product rich carotenoid can used solid substrate based on agro waste/waste agricultural products such as waste of (sago, cassava and tofu) are widely available in the area of West Sumatra (Nuraini *et al*., 2009). Wastes are potentially large to be used as animal feed, because high availability, while still containing nutrient content and not compete with human needs. The success of a solid media fermentation of carotenoid fungi is depend on the given optimum conditions such as: substrate composition, substrate thickness, inoculum dose and duration of incubation. Result of the research before reported that the optimum conditions of *Monascus purpureus* to produce rich monacolin and to increase the nutrient content of fermented products were composition of substrate contain of a mixture of 80% rice bran and 20% tofu waste, the thickness of the substrate 1-2cm, inoculum dose 10% and long incubation 8 days. Nutrient content of fermented product by *Monascus purpureus* increased if compare with before fermentation. Protein content increased from 14.85% to 20.22%, monacolin increased from 0 mg/kg to 400.71 mg/kg. So that this

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experiment want to study the effect of feeding fermented product by *Monascus purpureus* (rich carotenoid monacolin) in the diet on performance and quality of hen egg.

MATERIALS AND METHODS

Experimental design: The study was conducted on 200 hen Isa Brown age 22 weeks. The experimental design used was Completely Randomized Design (CRD) with 4 treatments were: 0, 10, 20 and 30% of fermented product in the ration and 5 replications. The hens were given a diet with 18% crude protein and 2700 ME kcal/kg feed. Own diets were formulated from ingredients such as corn, soybean meal, fish meal, bran, product fermented by *Monascus purpureus*, coconut oil and flour $CaCO_3$. Product fermented contain 60% sago waste with 40% tofu waste then added aquades (water content 70%), stirring evenly, sterilized the material 30 min after boiling water, then allowed to reach room temperature. Inoculated with 10% inoculum *Monascus purpureus* and incubated for 8 days. After the fermentation products are harvested, dried by using sunlight. The diet and water was given *ad libitum*. The environmental temperature was 25°C (neutral thermal zone) and the humidity was 77%. Experimental period was eight weeks. Composition and nutrient content of feed treatment listed in Table 1. The variable observed on each type of hen are feed intake (g/bird/day), daily egg production/hen day (%), egg weight (g/egg), egg mass production (g/bird/day), feed conversion ratio, egg cholesterol (mg/100 g), egg yolk colour. All hens were supplied with feed and water *ad-libitum*. Animal housing and handling procedures during experimentation were in accordance with guidelines of Animal Science Faculty of Andalas University.

Feed consumption was recorded weekly for calculation of average daily feed consumption. Egg production and egg weight were recorded daily. Egg mass (g of egg/hen per day) and feed conversion (g of feed/g of egg) were calculated from egg production, egg weight and feed consumption. Egg cholesterol and yolk colour were measured using 3 randomly selected eggs from each replicate at the middle and end of the experiment. Eggs were weighed and broken. The yolks were separated from the albumen. Each yolk was measured the colour with yolk colour fan by Roche. Cholesterol content analyzed with the extraction samples according to Beyer and Jensen (1989). Each of the extracted samples was then analyzed by using Spectrophotometer UV-BIS (calorimetric method).

Statistical analysis: Data obtained was subjected to analysis of variance. Where significant differences occurred, the means will be separated using Duncan Multiple Range Test (DMRT).

Table 1: Diet composition of laying hen feed fermented product by *Monascus purpureus*

	Ration (%)			
Ingredient	A	B	C	D
Corn meal	57.50	54.00	50.00	42.00
Rice bran	11.00	5.50	4.00	1.00
Soy bean meal	15.50	13.50	11.00	8.00
Fish meal	10.00	10.00	10.00	10.00
Coconut oil	0.50	1.00	2.00	3.00
PF	0.00	10.00	20.00	30.00
Batu meal	5.50	5.50	5.50	5.50
Topmix	0.50	0.50	0.50	0.50
Amount	100.00	100.00	100.00	100.00
Nutrition				
Crude protein (%)	17.47	17.39	17.31	17.11
Fat (%)	2.52	3.47	4.46	5.47
Crude fiber (%)	5.54	6.07	6.96	7.88
Ca (%)	2.59	2.55	2.52	2.49
P (%)	0.64	0.61	0.59	0.57
Lysine (%)	1.14	1.06	0.98	0.90
Methionine (%)	0.42	0.43	0.43	0.44
Monacolin (mg/kg)	0.00	40.07	80.14	120.21
ME (Ccal/kg)	2707.10	2751.10	2750.60	2747.25

PF: Product Fermented by *Monascus purpureus*; ME (Ccal/kg) = Metabolizable energy (Ccal/kg)

RESULTS

Feed consumption, hen day production, egg weight, egg mass and feed conversion: Diets containing product fermented by *Monascus purpureus* influenced on laying hens performance. The effect of feeding fermented product by *Monascus purpureus* on laying hens performance are presented in Table 2. Increasing product fermented by *Monascus purpureus* in the diet of laying hens were significantly ($p<0.05$) affected feed consumption, hen day production, egg weight, egg mass and feed conversion.

Feed consumption data showed that birds fed product fermented by *Monascus purpureus* (PF) 30% (105.42 g/bird/day) not different with birds fed PF 20% (103.22 g/bird/day) but higher than ($p< 0.05$) birds fed PF 10% (100.62 g/bird/day) and PF 0% (96.58 g/bird/day) The effect of feeding fermented product by *Monascus purpureus* on hen day production, the present data demonstrated that the control treatment (PF 0%) and PF 10% (51.71% and 54.63%, respectively) lower than ($p<0.05$) as compared to birds fed PF 20% and PF 30% (58.97% and 61.35%, respectively).

Concerning egg weight results revealed that the treatment fed PF 30% (61.27 g/egg) not significantly change as compared with PF 20% (58.79 g/egg) but had higher mean value of egg weight than the treatment fed PF 10% and PF 0% (54.91 g/egg and 51.96 g/egg, respectively). The data of egg mass production showed that the treatment fed PF 0% (26.84 g/bird/day) had lower mean value ($p<0.05$) of egg mass production than the treatment PF 10%, PF 20% and PF 30% (29.98

Table 2: Laying hens performance feeding fermented product by *Monascus purpureus*

	Ration				
Parameter	0% PF (A)	10% PF (B)	20% PF (C)	30% PF (D)	SE
Feed consumption (g/bird/day)	96.58^{c}	100.62^{b}	103.22^{a}	105.42^{a}	0.78
Hen day production (%)	51.71^{b}	54.63^{b}	58.97^{ab}	61.35^{a}	1.34
Egg weight (g/egg)	51.96^{b}	54.91^{b}	58.79^{a}	61.27^{a}	1.20
Egg mass production (g/bird/day)	26.84^{d}	29.98^{c}	34.57^{b}	37.55^{a}	0.74
Feed conversion	3.60^{a}	3.35^{b}	2.98^{c}	2.81^{c}	0.06

Note: Means in the same row with different superscript differ significantly ($p<0.05$). PF = Product Fermented

Table 3: Egg quality feeding fermented product by *Monascus purpureus*

	Ration				
Parameter	0% PF (A)	10% PF (B)	20% PF (C)	30% PF (D)	SE
Egg cholesterol (mg/100 g)	114.04^{a}	105.42^{b}	93.14^{c}	78.12^{d}	1.13
Egg yolk colour	9.70^{c}	10.40^{b}	11.10^{ab}	11.50^{a}	0.22

Note: Means in the same row with different superscript differ high significantly ($p<0.01$). PF = Product Fermented

g/bird/day, 34.57 g/bird/day and 37.55 g/bird/day, respectively). The birds fed fermented product by *Monascus purpureus* at the treatment PF 30% (2.81) had lower mean value ($p<0.05$) of feed conversion than the birds fed PF 20%, PF 10% and PF 0% (2.98, 3.35 and 3.60).

Egg cholesterol and egg yolk color: The effect of feeding fermented product on egg quality are presented in Table 3. Increasing product fermented by *Monascus purpureus* in the diet were significantly ($p<0.05$) affected egg cholesterol and egg yolk color.

Egg cholesterol of birds fed PF by *Monascus purpureus* 30% (78.12 mg/100 g) lower ($p<0.01$) than egg cholesterol of bird fed PF 20%, 10% and 0% (93.14 mg/100 g, 105.42 mg/100 g and 114.04 mg/100, respectively). The data of egg yolk color showed that the treatment D or fed PF 30% had mean value of egg yolk color higher ($p<0.01$) than treatment fed PF 20%, 10% and 0%.

DISCUSSION

Feed consumption of laying hens highest at the treatment using 30% Product Fermented (PF) by *Monascus purpureus*, it showed that the fermented product by *Monascus purpureus* preferred (palatable) up to 30% in the ration, even though with reduction of corn and soybean meal in each of these treatments. This is caused by fermentation with *Monascus purpureus* produced a distinctive flavor that is preferred hen (palatable). In accordance with the opinion of Murugesan *et al.* (2005), fermentation products have a preferred flavor and has a few vitamins (B1, B2 and B12) that are preferred when compared to original material.

High feed intake of laying hen, it mean high feed nutrient in the diet which use to produce eggs, so it can increase egg production. According Gunawardana *et al.* (2008), egg production is influenced by feed intake, especially protein intake. High egg production indicate that the product fermented by *Monascus purpureus* until level 30% in rations can reduce the use of corn and soybean meal was still preferred (palatable) by livestock. In addition, the high production of eggs in treatment D (30% PF) compared to treatment A (0% PF) due to the product fermented by *Monascus purpureus* produced unsaturated fatty acid were oleic acid (omega 9), linoleic acid (omega 6) and linolenic acid (omega 3) (Lin *et al.*, 2005). According Grobas and Mateos (1999) 1.5 to 2% linoleic acid is needed for birds during the production phase of the first egg laying period. Linoleic acid deficiency in the diet can reduce egg production.

The higher weight of hen eggs in treatment D (30% PF) and C (20%PF) than in treatment A (0% PF) is caused by protein consumption is also higher in these treatments. It mean the amount of protein contained in the ration required for the formation of eggs was also higher. According Gunawardana *et al.* (2008), protein had a significant effect on egg weight. The high egg weight due to consumption of essential amino acids were also high, especially methionine. In accordance with the opinion Murugesan *et al.* (2005) fermented foods with microorganism having the amino acid content is higher than the original material.

Egg mass is strongly influenced by fermented product with *Monascus purpureus* in rations. This is caused by egg weight and egg production are also higher in treatment D, because egg mass are the product of egg production with egg weight.

The low feed conversion ratio at treatment D than in treatment A is caused by feed intake and egg mass also differed significantly ($p<0.05$). According Varkoohi *et al.* (2010), feed conversion ratio is the ratio between feed intake in producing a number of eggs. Feed conversion can be used as a picture of the production coefficient, the smaller value mean more efficient use of feed to produce egg.

Low cholesterol egg in treatment D compared to other treatments, associated with the use of fermented product rich monacolin. Increasing fermented product by *Monascus purpureus* in the diet caused the higher content of carotenoids monocolin. Monacolin is hyphocholesterolemia agent. According to Erdogrul and Azirak (2004) that red yeast rice (fermentation by *Monascus purpureus*) produced monacolin that can inhibit the action of the enzyme-CoA reductase Hydroksimetyl Glutaryl (HMG Co-A reductase) that play a role in the formation of mevalonat in the synthesis of cholesterol so that cholesterol is not formed. The results of this study showed that fermented product by *Monascus purpureus* until level 30% decreased egg cholesterol 31.49%.

The higher egg yolk color (redness) in treatment D compared to treatment A, (increased score yolk colour 18.56%) caused carotenoid monacolin (red colour) was higher in treatment D (120.21 mg/kg) due to increasing fermented product by *Monascus purpureus* in the diet. Gunawardana *et al*. (2008) reported that the color of yolk depends on the carotenoids in dietary.

Conclusion: Increasing fermented product by *Monascus purpureus* in the diet can improved the performance and egg quality of hen. Feeding fermented product by *Monascus purpureus* up to 30% in hen rations obtained 61.35% hen day production, egg weight of 61.27 g, feed conversion ratio 2.81, can reduced egg cholesterol until 31.49% and increase score of yolk colour 18.56%.

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