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Research Article
Effects of the Addition of *Moringa oleifera* Leaf Meal to a Ration Containing Rice Hull Supplemented with Starpig on the Production Performance and Nutritional Content of Eggs of Bali Duck

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Abstract

Objectives: This study aimed to determine the effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig on the production performance and nutritional content of egg of Bali duck. **Materials and Methods:** This study used a completely randomized design (CRD). The four treatments included control ration A = ration without rice hull, *Moringa oleifera* leaf meal and starpig, B = ration containing 10% rice hull, C = ration containing 10% rice hull and 1% *Moringa oleifera* leaf meal and D = ration containing 10% rice hull, 1% *Moringa oleifera* leaf meal and 1% starpig. Each treatment consisted of four replicates and each replicate contained three female Bali ducks with homogeneous body weight. The variables observed included the production performance and nutritional content of egg of Bali duck, which were based on feed consumption, feed antioxidant consumption, final body weight, water content, protein content, fat content and total cholesterol. **Results:** Treatment B increased ration consumption and treatments C and D did not affect ration consumption compared with that after treatment A. Antioxidant consumption was the highest for treatment D. Treatment D also increased the egg protein content, reduced the fat content and total cholesterol of eggs and had no effect on the water content compared with those after treatment A. **Conclusion:** *Moringa oleifera* leaf meal in a ration containing rice hull supplemented with starpig improves production performance and nutritional content of egg of Bali duck.

Key words: Bali duck, production performance, nutritional content of egg, *Moringa oleifera* leaf meal, rice hull

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Increasing livestock productivity requires sufficient feed because feed represents 85% of the costs of a farm business[1], so rations containing alternative feed ingredients, including rice hull, are needed. Milling grain into rice produces 50 - 63% rice, 8-12% rice bran and 20-30% rice hull[2]. The nutritional content of rice hull includes 12.5% water, 3.1% crude protein, 29.2% nitrogen free extract, 35% crude fiber, 2.7% fat and 17.5% ash with low digestibility[3]. To improve digestibility, probiotics such as Starbio are needed. Starbio contains cellulase, lipase and proteolytic enzymes to help the digestive process[4]. Supplementation of rice hull ammoniated urea and Starbio does not affect the slaughtering or carcass weight; however, this supplementation increases the carcass and meat percentages and decreases carcass fat[5]. Yadnya and Trisnadewi[6] reported that rations containing cassava (*Manihot utilissima*) leaf supplemented with starpig (starbio and pignox) had no effect on the feed conversion ratio ($p>0.05$) but reduced the cholesterol content of Bali duck. Furthermore, feed with rice hulls containing noni leaf (*Morinda citrifolia*) increased antioxidant capacity, egg nutritional content and egg lipid profiles[7]. Fermented rice hull with *Piper betle* leaf improved production and egg nutritional content[8].

Improving livestock productivity requires feed additives, such as *Moringa oleifera* leaf, which contains vitamin A, thiamin, riboflavin, niacin, pantothenic acid, pyridoxine, vitamin B12, vitamin D, calcium, magnesium, selenium, tryptophan, flavonoids, methionine and histidine; these factors are needed for metabolic processes[9]. Darrashcytha *et al*.[10] reported that *Moringa oleifera* leaf had no effect on triglycerides and reduced high-density lipoprotein (HDL) in white rats (*Rattus norvegicus*). Sulasmi *et al*.[11] found that the addition of 5% *Moringa oleifera* leaf meal had the best effect on body weight gain and the feed conversion ratio in broiler chicken compared with the effects of the addition of 5% *Leucaena leucocephala* and 5% *Gliricidia sepium* leaf meal. The addition of *Moringa oleifera* leaf to rations does not affect egg production and improves the egg quality of quail[12]. The addition of 2% *Moringa oleifera* leaf to rations could improve egg production in laying hens[13].

This research was performed to study the effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig on production performance and egg nutritional content of Bali duck.

MATERIALS AND METHODS

Experimental design: The experiment used a completely randomized design (CRD) with four treatments, including a control ration [(ration without rice hull, starpig and *Moringa oleifera* = A); ration containing 10% rice hull (B); ration containing 10% rice hull and 1% *Moringa oleifera* leaf meal (C) and ration containing 10% rice hull, 1% *Moringa oleifera* leaf meal and 1% starpig (D)]. Each treatment consisted of four replicates and each replicate consisted of three ducks with homogenous weight. Thus, the study used 48 Bali ducks at twenty-two weeks of age.

Cage and equipment: This experiment used two-floor battery colony systems with 16 partitions. Each cage partition was 70 cm long, 65 cm wide and 70 cm high. Each part was equipped with food trays and drinking water. The trays were made from bamboo and were located at the external parts of the cages.

Ration composition: The ration consisted of yellow corn, soybean, copra meal, rice bran, fishmeal, coconut oil, NaCl, B12 mineral and coconut oil. Rice hull, *Moringa oleifera* leaf meal and starpig were also added according to the treatment. The ingredient composition of each treatment is shown in Table 1 and the chemical composition is shown in Table 2.

Table 1: Composition of the ration for Bali duck (22-32 weeks)

	Treatments			
Ingredients (%)	A	B	C	D
Yellow corn	55.36	49.98	49.98	49.98
Soybean	9.37	12.45	12.45	12.45
Copra meal	11.31	9.82	9.82	9.82
Fish meal	10.13	8.10	8.10	8.10
Rice bran	13.18	7.00	6.00	5.00
B12 mineral	0.50	0.50	0.50	0.50
NaCl	0.15	0.15	0.15	0.15
Rice hull	-	10.00	10.00	10.00
Starpig	-	-	-	1.00
Moringa oleifera leaf meal	-	-	1.00	1.00
Coconut oil	-	2.00	2.00	2.00
Total	100.00	100.00	100.00	100.00

Table 2: Chemical composition of the ration for Bali duck (22-32 weeks)

	Treatments				
Chemical components	A	B	C	D	Standard: Scott *et al.*[16]
Metabolizable energy (kca kg^{-1})	2,886.82	2,895.27	2,877.81	2,865.37	2,800-2,900
Crude protein (%)	17.53	17.64	16.98	17.54	15-17
Ether extract (%)	5.73	6.11	6.41	6.91	3-6
Crude fiber (%)	4.56	7.6	7.91	6.28	6-9
Calcium (%)	0.98	0.97	0.96	0.98	0.80
Available phosphorus (%)	0.80	0.65	0.55	0.58	0.5

A: Control ration (without rice hull and *Moringa oleifera* leaf meal and starpig), B: Ration contains 10% rice hull, C: Ration contains 10% rice hull and 1% *Moringa oleifera* leaf meal, D: Ration contains 10% rice hull, 1% *Moringa oleifera* leaf meal and 1% starpig

Observed variables: The variables observed included the production performance (feed consumption, feed antioxidant consumption and final body weight) and egg nutritional content (water content, protein content, fat content and total cholesterol) of Bali duck.

Data analysis: Data were analyzed using analysis of variance. If significant differences were noted among the treatments, data were further analyzed using Duncan's Multiple Range Test ($p<0.05$)[14].

RESULTS AND DISCUSSION

Effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig on the production performance of Bali duck: The effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull and supplemented with starpig on bali duck production performance are presented in Table 3.

Feed consumption for treatment A was 10.916 kg head^{-1} (Table 3) and treatment B increased feed consumption by 6.17% ($p<0.05$). Treatments C and D increased feed consumption but these treatments were not significantly different ($p>0.05$) compared with feed consumption after treatment A. Satria[13] found that the addition of *Moringa oleifera* leaf meal to rations increased the consumption of rations by 126.80 g head^{-1} day^{-1}. *Moringa oleifera* leaf contains vitamin A, vitamin B1, vitamin C, vitamin D, magnesium and selenium[9] and increases the palatability of rations. Thus, livestock consume more feed. Lekyo[12] reported that the addition of *Moringa oleifera* leaf meal to rations did not affect ration consumption in quails.

The lowest antioxidant consumption was noted for treatment A and this treatment showed significant differences ($P<0.05$) compared with treatments B, C and D. The amount of antioxidant consumption depends on feed consumption and the amount of antioxidant in the ration[15]. The amount of antioxidant consumption highly depends on the amount of ration consumed multiplied by the antioxidant content in the ration. Furthermore, the use of *Piper beetle* leaf as a source of antioxidants influences the consumption of antioxidant rations[8].

The final body weight in treatment A was 1274.83 g (Table 3). Treatment B reduced the final body weight. Treatment C increased the final body weight by 6.51%; however, this value was not significantly different ($p>0.05$) compared with that after treatment A. Treatment D increased the final body weight by 7.51% ($p<0.05$) compared with that after treatment A. This finding is consistent with that reported by Yadnya and Trisnadewi[6] indicating that the addition of rice hull supplemented with starpig increased the final body weight compared with that after treatment A. Satria[13] found that the addition of Moringa leaf significantly increased the final body weight.

Effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig on egg nutritional content of Bali duck: The effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull and supplemented with starpig on egg nutritional content of Bali duck is shown in Table 4.

The water content in treatment A was 68.24 (Table 4). Treatment B, C and D increased the water content but the values were not significantly different ($p>0.05$) compared with that after treatment A. This finding may be because the nutritional ration provided is similar to the standard[16]. In addition, there is a balance in water metabolism given the similarity in the amounts of water entering and exiting[16]. Yadnya *et al.*[8] reported that a diet containing rice hull and supplemented with *Piper betle* leaf had no significant effect on the egg water content compared with all treatments ($p>0.05$).

The fat and protein contents of ducks egg in treatment A were 14.52 and 11.95%, respectively (Table 4). Treatment B reduced the fat content but the effect was not significant ($p>0.05$). Treatments C and D reduced the fat content by 6.61

Table 3: Effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig on bali duck production performance over 10 weeks

	Treatments[1]				
Variables	A	B	C	D	SEM[3]
Feed consumption (kg head^{-1})	10.916^{b} [2]	11.590^{a}	11.058^{b}	11.289^{ab}	2.408
Feed antioxidant consumption (g head^{-1})	93.44^{d}	169.98^{c}	191.96^{b}	261.96^{a}	2.097
Final body weight (g head^{-1})	1,274.83^{b}	1,261.83^{b}	1,357.91^{ab}	1,370.66^{a}	4.248

[1]Control ration (without rice hull and *Moringa oleifera* leaf meal and starpig), B: Ration contains 10% rice hull, C: Ration contains 10% rice hull and 1% *Moringa oleifera* leaf meal, D: Ration contains 10% rice hull, 1% *Moringa oleifera* leaf meal and 1% starpig, [2]Values with different letters in the same row are significantly different ($p<0.05$), [3]Standard error of the treatment means

Table 4: Effects of the addition of *Moringa oleifera* leaf meal to a ration containing rice hull and supplemented with starpig on egg nutritional content of Bali duck over 10 weeks

	Treatments[1]				
Variables	A	B	C	D	SEM[3]
Water content (%)	68.24	70.19	70.00	69.32	0.9980
Protein content (%)	11.95^{c} [2]	16.25^{b}	17.31^{ab}	17.91^{a}	0.3830
Fat content (%)	14.52^{a}	14.49^{a}	13.6^{b}	13.36^{b}	0.2230
Cholesterol total (mg/100 g)	207.92^{c}	168.8^{b}	139.24^{c}	115.62^{c}	0.7376

[1]Control ration (without rice hull and *Moringa oleifera* leaf meal and starpig), B: Ration contains 10% rice hull, C: Ration contains 10% rice hull and 1% *Moringa oleifera* leaf meal, D: Ration contains 10% rice hull, 1% *Moringa oleifera* leaf meal and 1% starpig, [2]Values with different letters in the same row are significantly different ($p<0.05$), [3]Standard error of the treatment means

and 7.98% ($p<0.05$), respectively, compared with that after treatment A. Treatments B, C and D increase the egg protein content by 35.14, 44.85 and 49.87% ($p<0.05$), respectively, compared with that after treatment A. *Moringa oleifera* leaf contains Zn minerals similar to those found in Pignox. Zn facilitates hydroxy peptidase enzyme activity in protein metabolism, so the protein levels increase[17]. Consistently, Yadnya *et al.*[8] reported that the addition of *Piper beetle* leaf to a ration containing rice hull fermented by *Lactobacillus complex* bacteria reduced the fat content and increased the protein content in duck eggs.

The total cholesterol level in duck eggs after treatment A was 207.92 mg/100 g (Table 4). Treatments B, C and D reduced total cholesterol by 19.01, 33.03 and 44.39% ($p<0.05$), respectively, compared with that after treatment A. Reductions in total cholesterol in eggs due to the presence of antioxidant compounds in *Moringa oleifera* leaf could be attributed to the inhibition of the formation of mevalonic acid from acetyl-coenzyme A due to inhibition of the activity of 3-methyl, 3-hydroxy-glutaryl-CoA reductase enzymes in the conversion of acetyl-CoA to mevalonic acid, thereby reducing the cholesterol levels[18]. The study by Yadnya *et al.*[8] reported that rice hull fermented with *Lactobacillus complex* bacteria supplemented with *Piper betle* leaf reduced the total cholesterol level compared with that after feeding control rations.

Bali duck fed the control ration (treatment A) exhibited 207.92 mg/100 g total cholesterol (Table 4). Treatment B, C and D significantly reduced total cholesterol ($p<0.05$) compared with that after treatment A because *Moringa oleifera* leaf meal contains antioxidant compounds, such as the flavonoid mevalonic acid that is formed from acetyl-CoA. These compounds inhibit the activity of 3-methyl, 3-hydroxy-glutaryl-CoA reductase enzyme, which converts acetyl-CoA to mevalonic acid and reduces cholesterol formation[18]. The results of this experiment are consistent with research conducted by Partama *et al.*[19] demonstrating that the addition of fermented rice hull to diets supplemented with *Piper beetle* significantly reduced the total cholesterol levels ($p<0.05$) compared with that after other treatments. Satria[13] reported that a diet containing *Moringa oleifera* leaf meal improved egg quality and significantly reduced total cholesterol ($p<0.05$) compared with those after other treatments.

CONCLUSION

It can be concluded that the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig could improve the production performance and egg nutritional content of Bali duck.

SIGNIFICANCE STATEMENT

This study found that the addition of *Moringa oleifera* leaf meal to a ration containing rice hull supplemented with starpig improves the production performance and nutritional content of eggs of Bali duck. This research reveals the role of *Moringa oleifera* leaf meal and starpig, which contains vitamins, minerals and enzymes, in duck. These topics have not been previously explored.

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