ISSN 1682-8356
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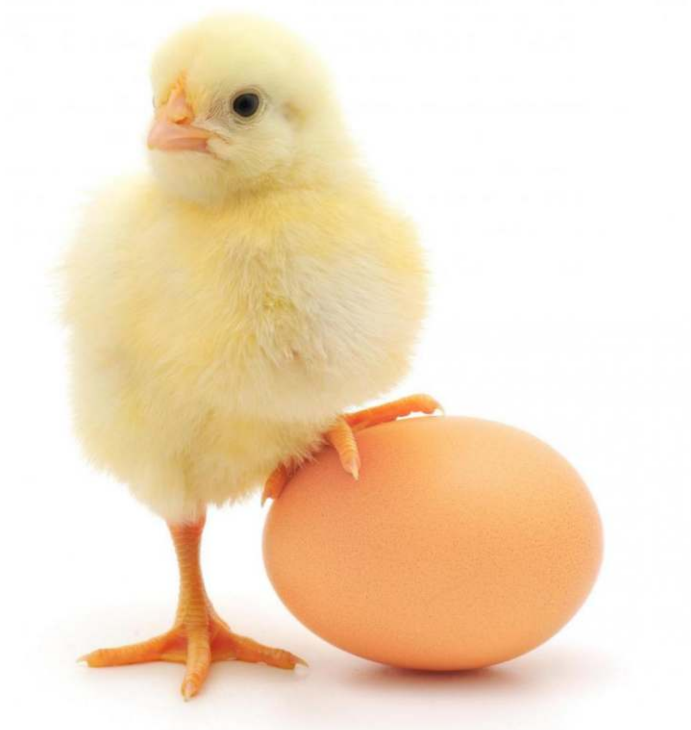

INTERNATIONAL JOURNAL OF
POULTRY SCIENCE

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International Journal of Poultry Science 15 (8): 325-329, 2016
ISSN 1682-8356

Effects of Substituting Soybean Meal with Fermented Rubber Leaves and Seeds (*Hevea brasilliensis*) on Egg Production and Egg Quality in Native Laying Hens

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Abstract: This study aims to determine the levels of fermented rubber leaves and seeds that can be used to substitute 100% of the soybean meal in native laying hen rations without adverse effects on laying hen production. Two hundred and forty laying hens aged 20 weeks were used in this experiment. The completely randomized design assigned six treatments to replace 0, 20, 40, 60, 80 or 100% of soybean meal with fermented rubber leaves and seeds in four replicate experiments. The variables measured were feed intake, feed conversion and income over feed cost (gross profit) as well as variables related to egg production (hen day production and egg weight) and egg quality (the thickness of eggshells and the yolk color index). Data were analyzed statistically using ANOVAs and if the results showed significance, Duncan's Test (DMRT) was used. The results showed that the performance of laying hens was not affected significantly by substituting soybean meal with fermented rubber leaves and seeds. Feed intake, feed conversion and egg production were not influenced either. In summary, fermented rubber leaves and seeds can substitute for 100% of the soybean meal in the rations of laying hens.

Key words: Fermented leaves and rubber seeds (*Hevea brasilliensis*), substitution, hen day production, native laying hen

INTRODUCTION

Soybean meal is one of the feed material sources of vegetable protein in poultry rations, containing high protein and more complete amino acids than other vegetable feed ingredients. Unfortunately, its availability is sometimes limited. The amount of soybean meal required is constantly increasing along with the development of poultry farming. The need for more soybean meal is met almost 100% from imports, which were approximately 1.86204 million tons in 2012 (Central Bureau of Statistics, 2013). To reduce dependency on imported feed ingredients such as soybean meal, it is necessary to find an alternative raw material feed. A potential source that has not been widely used is the leaves and seeds of rubber tree (*Hevea brasilliensis*), which are agricultural waste products. This plant has high adaptability and can grow to a height of 0 to 1500 meters. The rubber plant is a plantation crop. According to the Central Bureau of Statistics (2012), extensive rubber plantations in Indonesia (5,487,305 ha) make it the largest rubber-producing country in the world. One hectare on a rubber plantation grows 400-500 trees.

The low nutrient content and the presence of anti-nutritional substances in the plant resulted in minimal use. The leaves and seeds of the rubber tree contain 15.70-18.62% crude protein, 10.89% fat, metabolizable energy of 1762.95 to 2301.64, nitrogen retention of 53.42 to 71.19 and crude fiber at 15.73 to 18.62 (Poultry Laboratory, 2013). According Oluyemi *et al*. (1976), the metabolizable energy of rubber tree leaves and seeds are approximately 4,835 kcal/kg; rubber tree leaves and seeds also contain various amino acids, such as aspartic acid 10.25, glutamic acid 14.73, lysine 2.55, arginine 7.23, methionine 0.92 and threonine 2.65 (Orok and Bowland, 1974). The main obstacle in the use of rubber tree leaves and seeds as animal feed is the high levels of cyanide (HCN). According Lauw *et al*. (1967), the HCN content of the leaves and seeds of fresh rubber is 330 mg/100 g. According to Syahruddin and Herawaty (2009), the HCN content of the leaves and seeds of the rubber tree can be reduced or eliminated by the processes of storage, extraction, drying, soaking in water or boiling. It is said that soaking the leaves and seeds of the rubber plant for 24 h can reduce the levels of HCN, while according Toh and Chia (1977), boiling the leaves and seeds at 160°C can eliminate toxic HCN. Syahruddin and Herawaty (2010) showed that the leaves and seeds of fresh rubber plants used in the diet of broiler chickens in excess of 9% of the diet could reduce weight gain and feed intake. Processing needs to be conducted so that the quality of the rubber tree leaves and seeds can be increased. One way that they can be used is by fermenting the leaves and seeds of the rubber tree with the microbe (Trichoderma harzianum), which is able to increase the percentage of crude protein to 23.98%,

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according to Syahruddin and Herawaty (2012). This study was aimed to determine effectiveness of the use of rubber leaves and seeds fermented with Trichoderma harzianum in biological tests. Fermented rubber leaves and seeds will be used to substitute as much as 0, 20, 40, 60, 80 and 100% of the protein soybean meal in the rations of native layers.

MATERIALS AND METHODS

Biological experiments were conducted to determine the effects of a 100% replacement of soybean meal protein with fermented rubber tree leaves and seed in the rations of native layers. The study was conducted at the Faculty of Animal Science andalas University, Padang.

Research materials: The experiment used 240 native layers, aged 20 weeks, for 8 weeks in a cage-shaped battery. The rations were prepared by adding fermented rubber leaves and seeds (DBKF). The rations were composed to contain equivalent levels of protein and energy.
The treatments were as follows:

R0: DBKF of 0% (control diet without replacement of soybean meal)
RI: Replacement of 20% soybean meal protein with DBKF
R2: Replacement of 40% soybean meal protein with DBKF
R3: Replacement of 60% soybean meal protein with DBKF
R4: Replacement of 80% soybean meal protein with DBKF
R5: Replacement of 100% soybean meal protein with DBKF

The diet composition for each animal is shown in Table 1 and the content of nutrients and metabolic energy are shown in Table 2.

Processing and data analysis: All data were analyzed using analysis of Variance (ANOVA) of a completely randomized design according to Steel and Torrie (2012). Differences between treatments were tested with Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effect of treatments on consumption, hen-day egg production, egg weight and feed conversion on native layers: The average feed consumption, hen-day egg production, egg weight and feed conversion per head per week during the study is presented in Table 3.
The results of the analysis of variance show that the substitution of soybean meal protein with protein from fermented rubber leaves and seeds up to 100% in the diet of native laying hens did not have significant ($p>0.05$) effects on feed consumption, hen-day egg production, egg weight or feed conversion.
The results in Table 3 show that the feed intake levels obtained during the study with fermented rubber leaves and seeds (DBKF) ranged from 559.33 to 572.68 g/head/week, or from 79.04 to 80.86 g/head/day. Average feed intake in this study was lower than that reported by Nurtini (1988), which was 90-100 g/head/day and by Cresswell and Gunawan (1982) at 88 g/head/day. According to Mansjoer (1985), the feed consumption of laying hen aged 25-70 weeks is 115 g/head/day. The non-significant differences of feed consumption may be due to the fermentation process appropriately improving their quality of the rubber leaves and seeds and giving them a palatability similar to soybean meal; consequently, the use of fermented rubber leaves and seeds up to 29.35% of the ration for laying hens, equal to 100% soybean meal substitution, had no effect on feed intake. Moreover, non-significant effects on feed consumption were also due to the nutrient content of metabolizable energy, protein and other nutrients being similar in each treatment.
The effects of treatment on hen-day egg production during the study are presented in Table 3, which shows a non-significant effect among the treatments ($p>0.05$). The lack of differences is due to the feed conversion, the protein and energy content of the rations (17% and 2800 kcal/kg) as well as other food substances being relatively common and in accordance with the needs of the laying hens; thus, the treatments result in the same egg production as well as the same maintenance and management of the environment. Nurtini (1988) states that the factors affecting egg production are genetic factors, management and feed rations. In addition to the good quality of the rations, factors that affect egg production are age, maintenance, environment, management, diseases and the amount of food (NRC, 1994). In general, hen-day egg production generated in this study ranged from 35.41 to 37.12%, or an average of 36.53% lower when compared with the results of Kingston (1979), which showed that the hen-day egg production in native layers in Indonesia was 41.3%. Low hen-day production is due to the genetic traits of the chicken; that is, some chickens do not produce eggs every day. This situation, according to Kingston (1979), is that egg production is influenced by genetic factors, management and feeding. In addition to genetic factors, egg production was also influenced by the contents of the substances consumed, especially protein, energy, methionine, lysine, calcium and phosphorus in the rations. Utilization of fermented rubber leaves and seeds (DBKF) in native layer rations up to 29.35%, or a 100% substitution of soybean meal protein, can be done, with a hen-day egg production of approximately 36.53%. Production at R5 was only 35.41%, but with a relatively low cost of the ration compared with other treatments, this can produce a considerable profit. This is due to the

Table 1: Composition of Rations for Native Layers (CP 17% and ME 2800 kcal/kg)

	Percentage					
Ingredient	RO	RI	R2	R3	R4	R5
Corn	50	49.13	48.26	47.39	46.52	45.65
Soybean meal	20	16	12	8	4	0
DBKF	0.0	5.87	11.74	17.61	23.48	29.35
Fine rice bran	15.5	14.5	13.5	12.5	11.5	10.5
Fish meal	6.0	6	6	6	6	6
Bone meal	1.5	1.5	1.5	1.5	1.5	1.5
Flour shells	4.0	4.0	4.0	4.0	4.0	4.0
Coconut oil	2.5	2.5	2.5	2.5	2.5	2.5
Top mix	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100

Table 2: Nutrient contents of rations

Components	RO	RI	R2	R3	R4	R5
Crude protein (%)	17.68	17.59	17.49	17.40	17.31	17.21
Fat (%)	3.91	3.90	3.89	3.88	3.87	3.86
Crude fiber (%)	4.78	5.17	5.56	5.95	6.34	6.73
Ca (%)	3.03	3.01	2.99	2.92	2.90	2.88
P total (%)	0.68	0.69	0.70	0.71	0.72	0.73
ME (kcal/kg)	2842.80	2840.30	2837.80	2835.30	2832.80	2830.30
Methionine	0.296	0.295	0.293	0.291	0.290	0.289
Lysine (%)	1.11	1.053	0.99	0.93	0.87	0.82

Description: The result of the calculation

Table 3: Average feed consumption, hen-day egg production, egg weight and feed conversion of laying hen per week

Treatments	Feed consumption (g/head/week)	Hen-day egg production (%)	Egg weight (g/head/week)	Feed conversion ratio
RO	559.33	36.79	101.79	5.44
R1	565.39	37.12	104.33	5.37
R2	569.68	36.09	105.26	5.36
R3	572.08	36.77	102.87	5.51
R4	568.08	36.13	99.63	5.64
R5	565.92	35.41	99.51	5.63
Average	566.746	36.535	102.23	5.49

Table 4: Effects of treatments on eggshell thickness, yolk color score and income over feed cost

Treatments	Eggshell thickness (mm)	Yolk color score	Income over feed cost (Rp)
RO	0.33	8.49	3822.75
RI	0.32	8.55	4152.03
R2	0.33	9.00	4353.15
R3	0.33	9.05	4537.23
R4	0.32	9.17	4722.75
R5	0.31	9.06	4819.07
Average	0.32	8.89	4400.66

fermentation process improving the quality of the rubber leaves and seeds, thus affecting the quality of the rations and allowing for maintained egg production. According to Rasyaf (2004), fermented rubber leaves and seeds cannot be fed to native layers as more than 20% of the diet; however, in the current study, the fermented leaves and rubber seeds (DBKF) can be supplied in the diet as much as 29.35%, or as a 100% replacement of soybean meal protein, without affecting production and providing greater profits. The average weights of chicken eggs are shown in Table 3 and ranged from 99.51 to 105.26 g/head/week or 37.70 to 38.94 g/egg. This result is slightly lower than in a report by Iskandar (1991), which indicated that the weight of chicken eggs intensively reared at 41 g/egg, but not much different from that reported by Mansjoer (1985) of 39.96 g/egg. The weights of the eggs produced in this study were not influenced much by the level of soybean meal protein substitution with fermented rubber leaves and seeds (DBKF). The weights of the eggs produced were very similar because the consumption of feed, energy and protein content of the rations as well as other food substances, were relatively the same for each treatment due to the processing of the rubber leaves and seeds. According to Romanoff and Romanoff (1963), the levels of protein in the diet have a major influence on egg weight. A decline in energy and protein consumption can lead to a decrease in egg weight (Balnave, 1981). The weight and size of eggs are also influenced by the content of methionine, lysine, calcium and phosphorus in the rations. The ration contents had 0.037 grams methionine and a lysine content of 0.66 g/head/day, which is capable of producing normal eggs in terms of weight and size. The need for calcium to produce large eggs normally is 3.7% for 40-week-old layer hens and the need for phosphorus is 0.353% (Wahju, 1992). Methionine consumption in this study amounted to 0.23 g/head/day and lysine consumption ranged from 0.68 to 0.88 g/head/day. The average feed conversions during the study are shown in Table 3 and ranged between 5.63 and 5.64. The results from the analysis of variance showed that among the treatments there were no significant effects ($p>0.05$) on feed conversion. This result is due to the feed consumption and the weight of eggs produced being the same because the feed conversion ratio is the amount of feed consumed divided by the weight of eggs produced. These data indicate that increasing the rate of substitution of soybean meal to 100% with rubber leaves and seeds, fermented with the mold Trichoderma harzianum for 8 days at a temperature of 30°C, can increase the quality of the rations and, in turn, will result in the conversion rate relatively the same as the control diet.

Effects of the treatments on eggshell thickness, yolk color score and income over feed cost: The average thickness of the eggshells, the yolk color score and income over feed cost are shown in Table 4.

The mean thickness of eggshells and the yolk color score ranged from 0.31 to 0.33 and from 8.49 to 9.17 mm, respectively. The results of the analysis of variance on eggshell thickness showed that the treatments had no significant effects ($p>0.05$). This result is caused by the content of calcium and phosphorus in all ration types being similar, with calcium ranging between 2.88 to 3.03% and phosphorus ranging between 0.66 to 0.73%. These values are consistent with the recommendations of the NRC (1994). Eggshell thickness in this study is the same as that recommended by Stadelman and Cotterrill (1977); furthermore, the thickness and color of the eggshell is caused by pigment ovophirin deposited on the surface of the egg, with a thickness less than 0.33 mm. According to Mansjoer (1985), eggshells less than 0.31 mm are too thin to be marketed, while the eggs that are good have a thickness of approximately 0.32 mm. The yellow color of the eggs produced in this study varies from yellow to orange, with yellow egg scores ranging from 8.49 to 9.17. According to Cresswell and Gunawan (1982), consumers generally like golden colored egg yolks, which give an attractive appearance that stimulates appetite or interest. The intensity of the egg yolk color is determined by the concentrations of carotenoid pigments (Romanoff and Romanoff, 1983). Anggorodi (1985) stated that lutein, zeaxanthin and kryptoxanthin are responsible for the pigmentation of egg yolk color and the addition of xanthophylls in poultry feed can increase the egg yolk color score. The average incomes in this study are presented in Table 4. The advantage gained during the study ranged from Rp. 3822.75 to Rp. 4819.07 or Rp. 180.33 to Rp 235.28, per egg. It can be observed that the profits increased with increasing use of fermented rubber leaves and seeds (DBKF) in the rations. This result is due to the fermented leaves and seeds costing less than soybean meal.

Conclusions: The use of fermented rubber leaves and seeds (DBKF) in rations had non-significant effects on the production performance of native laying hens based on feed intake, feed conversion and egg production. Substitution of soybean meal protein with fermented rubber leaves and seeds in the ration can be up to 100% in the diet of native laying hens.

ACKNOWLEDGEMENTS

Thanks profusely conveyed to Mr. Rector of Andalas University which has provided funding for the implementation of this study,financed by funds BOPTN Andalas University in accordance with the Letter of Agreement Implementation Research Cluster Research Grant Professor of No. 88/UN.16/HKRGB/LPPM/2016. May 9th, 2016.

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