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Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(SI): 16-23. **OPEN ACCESS**

Effects of replacing soybean meal with rubber seed meal on growth, carcass yield, and proximate composition of *Hybrid Ayam Kampung (Gallus gallus domesticus)*

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Reviewed by: Dr. Zarinah Zakaria, Dr. Ahmad Syazni Kamarudin

Different levels of rubber seed meal (RSM) supplemented as a replacement of soybean were evaluated on growth rate, carcass yield, the relative weight of organs, breast, and the liver of the chemical composition of *Hybrid Ayam Kampung* chicken. The birds were randomly separated into 12 groups with 3 replicates made available for each of the 3 treatments (T1, T2, and T3) and control groups. The control groups were fed with a basal diet without RSM, and other groups were fed with the diets that consisted of 3 RSM levels of 10% RSM (T1), 20% RSM (T2), and 30% RSM (T3). The lowest final weight and weight gain were found in T3 groups (p>0.05), with no significant differences among RSM-treated, and control groups. Significantly lower Feed Conversion Ratio (FCR) were observed in T1 and T2 than that of the control. Carcass and organ variables were better compared among the control, T1 and T2 RSM groups. There were no significant differences (p<0.05) in all carcass, and relative organ weigh except for the heart. Overall, 10 – 20% RSM could replace soybean as protein source without detrimental effects on growth rate and carcass deposition.

Keywords: Rubber seed meal, growth, carcass quality

INTRODUCTION

The present research is a struggles that geared toward the study of feed properties and potential utilization of protein sources from locally available cash crops, especially from underutilized high-protein tree crop (Khattab et al. 2009) was as a result of incessant increase in price and the unavailability conventional plant-based proteins. Moreover, the European community prohibit protein supplements for animals. (European Commission Decisions No. 98/272/CE and 2000/374/CE) this scenario has force animal nutritionists to use soybean (*Glycine max*), which is known for its high content of protein and was widely adopted for the formulation of animal feed. Nevertheless, it has become paramount that under the conditions of confined poultry production, balance nutrition plays a serious role in optimal development and healthy bird's condition. In general, the cost of feed engulfed the greatest operational cost in poultry production and interprets for about 70 – 80% of total operating costs (Sharma et al.

2014). Animal feeds are expected to be environmentally and economically sustainable. Source of protein is one of the costliest constituents in the feeds for poultry, and in poultry production soybean meal (SBM) is the major protein ingredient. Nevertheless, the conventional protein source is becoming rare and viable due to industrial use and human consumption as a staple diet and its cost is mostly beyond the income of poultry farmer and, feed producers (Gadzirayi et al. 2012). Therefore, the need for a low-cost source of protein as a total or partial replacement of SBM is a global issue that needs to be study. Therefore, rubber seed can be described as a favourable by-product of natural rubber plantation (*Hevea brasiliensis*) from natural rubber production (Oluodo et al. 2018). Accordingly, the Association of Natural Rubber Producing Countries (ANRPC), Malaysia is projected to have covered rubber plantation of 1.05 million hectares of in 2013. Based on an average of 1000 kg estimated seeds per ha/yr (Eka et al. 2010), the anticipated production of rubber seed annually in Malaysia would be about 1.05 million metric tons (Oluodo et al. 2018). Fewer than 25% of rubber seeds are used for replanting, while the majority of the seeds are underutilized around the environs (Oluodo et al. 2018; Suprayudi et al. 2015). Rubber seed meal contains reasonably high protein and lipid but has in it some anti-nutritional factor such as cyanogens compound (Sharma et al. 2014), which on hydrolysis yields toxic hydrogen cyanide and other presumed carbonyl compounds that cause physiological failure of the birds (Francis et al. 2001). However, the toxicity of the seeds can be eradicated by storage and the use of heat. Thus, rubber seed meal (RSM) is a favourable substitute seed meal rich in protein for animal consumption (Udo et al. 2018). However, fewer studies have been conducted on the nutritional composition of RSM in poultry feed (Khatun et al. 2015 & Paschal et al. 2017). The objectives of the research was to evaluate the effects of replacing SBM with RSM on growth indices, carcass yield, and offal organs of *Hybrid Ayam kampung (Gallus gallus domesticus).*

MATERIALS AND METHODS

Ethical Approval

Procedures in this study were approved by Universiti Sultan Zainal Abidin Animal and Plant Research Ethics Committee (UAPREC) under number UAPREC/04/009. The study was conducted at Universiti Sultan Zainal Abidin (UniSZA) Tembila Campus at the Universiti livestock farm located in Besut Campus, Kuala Terengganu.

Source and Processing of Rubber Seed

The experimental rubber seeds were procured from RISDA, Terengganu, Malaysia. All raw seeds were collected fresh and boiled for 15 minutes at 100^{o}C, then seeds were dehusked, and ageing was done with 90% rice husk ash (RHA) for 24 hours. The seeds were washed thoroughly then boiled again for 30 mins at 100^{o}C. After boiling the seeds, the seeds were placed in the oven at 40^{o}C for 24 hours.

Experimental Design

In total, 96 one-day-old unsexed of *Hybrid Ayam Kampung* were procured from a commercial hatchery and brooding was done for two weeks. After the brooding period, the birds were randomly assigned in four treatments groups in the controlled, isolated facility for 35 days period. Birds with an average initial body weight of (190.84 ± 0.70g) after the brooding period were randomly assigned into 12 groups (8 birds for each group) with 3 replicates for each of control and 3 treatments. The 3 treatment groups were fed with different level of RSM % T1 (10 % RSM), T2 (20 % RSM), T3 (30 % RSM) and basal diet without RSM. A continuous lighting system from incandescent lamps was provided through the trial.

Birds were provided with freshwater and feed were provided *ad libitum* on a daily basis throughout the experimental period. Routine vaccination was carried on Newcastle disease, and Infectious Bronchitis at an appropriate time. Growth indices and mortality were recorded on a daily and weekly basis. Experimental diets were formulated with appropriate crude protein and metabolizable energy adopting the guideline (National Research Council, 1994).

Sampling and Analytical Methods

At 35 d, all birds were weighted to determine the final body. The daily weight gain (DWG) and feed conversion ratio (FCR) were subjected to these formulas respectively (final weight − initial weight)/35 ($g \cdot d^{-1}$) and total feed intake/(total final weight − total initial weight + total mortality weight).

Carcass and Organ evaluation

After 35 d, 12 birds were randomly selected from each treatment group. The birds fasted for 8 h without a feed, but the water was made available, and the Malaysian Protocol for the Halal Meat and Poultry Production MS 1500: 2009 was adopted for the slaughtering process. Before slaughtering live weight was taken and the carcass weight was taken immediately after slaughter. De-feathering followed after scalding in hot water at 63^{o}C for 3 minutes. The carcass was eviscerated and the edible viscera (liver, gizzard and heart) were separated, and their weights were taken. The percentage yield of dressed carcass without head and feet were estimated using this formula (Eviscerated weight (without head and feet)/pre-slaughter live weight x 100).

Proximate Analysis

After standard cutting, breasts and livers were obtained from the 4 treatment groups (T1, T2, T3, and control). According to AOAC (2006), proximate composition of the samples analyzed in accordance with the official standard methods of analysis. The Kjeldahl method was adopted for the determination of crude protein while the other hand Soxhlet method was adopted for the determination of crude fat. The samples were subjected to 550°C overnight for determination of ash while samples were placed at 105°C in an oven until a constant weight is achieved for moisture content.

Statistical Analysis

Data compiled were subjected to a one- way analysis of variance using the GLM procedure of SPSS 22.0 for Windows (SPSS Inc., Chicago, IL), and the differences among means were separated by Duncan's multiple range test. A (p<0.05) was described to be statistically significant.

Table 1. Ingredients composition and nutritive value of the starter ration (0-14 days)

Ingredients (kg/100kg)	**Control**	**T1 10%**	**T2 20%**	**T3 30%**
Maize	48.00	48.00	48.00	48.00
Wheat Pollard	4.50	4.50	4.50	4.50
Palm oil	1.50	1.50	1.50	1.50
Fish meal	4.50	4.50	4.50	4.50
Rubber seed meal	-	3.75	7.50	11.25
Soybean meal	37.50	33.75	30.00	26.25
DCP	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25
Mineral Premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Estimated Chemical Composition				
Metabolizable energy (MJ/kg)	12.60	13.07	13.63	14.00
CP (g/100g)	23.69	23.18	22.17	21.18

Control: Without RSM; T1: diet with 10 % RSM; T2: diet with 20 % RSM, T3: diet with 30 % RSM, 1Vitamin mineral premix provided (per kg of diet): Vitamin A, 5000 I.U., Vitamin D3 1000,000 I.U., Vitamin E 15,000 mg; Vitamin K3, 100 mg; Vitamin B1, 1,200 mg; Vitamin B2, 2,400 mg Biotin, 32 mg; Vitamin B12, 10 mg; Folic acid, 400 mg; Choline chloride, 120,000 mg; Manganese, 40,000 mg; Iron, 20,000 mg; Zinc 18,000 mg; Copper, 800 mg; Iodine, 620 mg; Cobalt, 100 mg; Selenium 40 mg.

Table 2 Ingredients composition and nutritive value of the finisher ration (15 - 35 days)

Ingredients (kg/100kg)	Control	T1 10%	T2 20%	T3 30%
Maize	53.00	53.00	53.00	53.00
Wheat Pollard	3.00	3.00	3.00	3.00
Palm oil	1.50	1.50	1.50	1.50
Fish meal	1.00	1.00	1.00	1.00
Rubber seed meal	-	3.75	7.50	11.25
Soybean meal	37.50	33.75	30.00	26.25
DCP	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25
Mineral Premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Estimated Chemical Composition				
Metabolizable energy (Mj/kg)	12.70	13.17	13.63	14.10
CP (g/100g)	21.82	21.39	20.39	19.39

Control: Basal without RSM; T1: basal diet with 10 % RSM; T2: basal diet with 20 % RSM, T3: basal diet with 30 % RSM, [1]Vitamin mineral premix provided (per kg of diet): Vitamin A, 5000 I.U., Vitamin D_3 1000,000 I.U., Vitamin E 15,000 mg; Vitamin K_3, 100 mg; Vitamin B_1, 1,200 mg; Vitamin B_2, 2,400 mg Biotin, 32 mg; Vitamin B_{12}, 10 mg; Folic acid, 400 mg; Choline chloride, 120,000 mg; Manganese, 40,000 mg; Iron, 20,000 mg; Zinc 18,000 mg; Copper, 800 mg; Iodine, 620 mg; Cobalt, 100 mg; Selenium 40 mg.

RESULTS

Table 3; Supplemental effects of RSM replacement on growth performance of *Hybrid Ayam Kampung*

Items	Con	T1	T2	T3	SEM
Initial weight (g)	190.8	190.8	191.4	190.2	0.70
Final weight (g)	1114.5	1099.5	1101.7	1037.9	30.00
DFI (g)	54.6	52.2	50.7	46.6	4.70
BWG (g)	206.4	204.4	197.9	188.9	14.40
FCR	1.84	1.70	1.63	1.79	0.10
ADWG (g)	29.5	29.2	28.3	27.0	2.10

Mean values with their pooled standard errors of the means. Growth parameters of Hybrid Ayam Kampung chickens, basal diet (Control group), basal diet with 10 % RSM (T1 group), basal diet with 20% RSM (T2 group), and basal diet 30% RSM (T3 group). RSM: Rubber Seed Meal; FCR: Feed Conversion ratio; ADWG: Average daily weight gain; DFI: Daily feed intake

Table 4; Supplemental effects of RSM replacement on carcass yield of Hybrid *Ayam Kampung*

Carcass Yield	Con	T1 10%	T2 20%	T3 30%	SEM
Live Weight (g)	1200.0	1148.8	1181.3	1143.8	77.2
Dressing weight (g)	1104.8	1058.2	1069.1	1052.8	71.2
Dressing (%)	83.2	79.74	82.93	79.4	0.8
Eviscerated weight (g)	963.4	923.5	903.0	878.8	72.6
Breast (g)	215.6	213.8	211.5	197.8	14.4
Drumstick g)	141.9	132.8	130.9	129.7	11.2
Thigh (g)	128.4	123.4	126.6	121.5	9.7
Wing (g)	131.3	116.6	104.8	106.8	8.6
Back (g)	156.1	160.5	141.2	140.3	13.0
Neck (g)	35.7	32.4	31.1	33.0	2.5
Head (g)	57.6	56.3	50.6	54.4	4.7
Shank (g)	63.2	57.9	61.8	61.7	5.8

Mean values with their pooled standard errors of the means. Carcass yield of *Hybrid Ayam Kampung* chickens, basal diet (Con group), basal diet with 10 % RSM (T1 group), basal diet with 20% RSM (T2 group), and basal diet 30% RSM (T3 group). RSM: Rubber Seed Meal

Table 5. Supplemental effects of RSM replacement on offal organs of *Hybrid Ayam Kampung*

Offal organs	Con	T1 10%	T2 20%	T3 30%	SEM
Full gizzard	59.4	45.12	53.67	49.35	5.85
Empty gizzard	36.7	31.10	34.30	33.30	3.25
Heart	7.57^{b}	4.82^{a}	5.88^{a}	5.80^{a}	0.53
Liver	21.36	22.48	22.09	23.57	1.43
Kidney	0.86	0.91	0.96	1.03	0.88
Spleen	2.73	2.38	2.33	2.27	0.59
Proventiculus	7.44	5.87	6.45	5.57	0.48
Small intestine	20.90	21.14	24.96	24.31	2.49
Large intestine	20.35	19.36	20.24	16.90	1.86

Mean values with their pooled standard errors of the means. Offal organs of *Hybrid Ayam Kampung* chickens, basal diet (Con group), basal diet with 10 % RSM (T1 group), basal diet with 20% RSM (T2 group), and basal diet 30% RSM (T3 group). RSM: Rubber Seed Meal. The mean values with different superscript lowercase letters across the row in the table were significantly different (P<0.05).

DISCUSSION

Growth Performance

As indicated in Table 3, no dissimilarity in RSM dietary inclusion rate on body weight gain, feed intake and feed conversion ratio of *Hybrid Ayam Kampung*. It has been widely reported that inclusion rate at 10 - 20% did not have detrimental effects on the physiological system in terms of feed intake, body weight gain, and feed conversion ratio (Aguihe et al. 2017; Khatun et al. 2015). Due to previous findings, decrease in feed intake and feed palatability may be attributed to the inclusion rate, but in this study inclusion rate of RSM in diets seem to appropriate, which resulted in positive overall growth performance. It could be concluded that the appropriate inclusion of RSM in poultry production would not decrease feed palatability.

Additionally, no discrepancies in the present results when compared with the control and treated groups in terms of body weight gain. Furthermore, birds with an inclusion rate of 20% RSM showed comparable growth indices with the control diet in the study but also obtained the lowest FCR. This finding is in agreement with the previous study of Khatun et al. (2015), the inclusion rate on 20% RSM on Broiler strain (Cobb 500) obtained similar results. A similar approach of replacement of SBM with RSM, the inclusion rate was up to 50%, which did not affect the growth response and feed utilization in terms conversion into carcass disposition (Khatun et al. 2015; Ijaiya et al. 2011). However, contrary to the earlier findings which stated that inclusion rate RSM did not have adverse effects on growth performance and nutrient utilization, which might occur due to residual effect of cyanogen compound present in RSM (Alegbeleye et al. 2004; Sharma et al. 2014).

High cyanogen compound in diets is known to have positive effect on growth depression of animal through the interference with sulfur amino acid metabolism in particular, as well disruption thyroid function and iodine uptake in the body (Tewe et al.1984; Lukuyu et al. 2014). Low growth rate and feed efficiency were observed on livestock fed on diets with residual hydrogen cyanide due to poor processing method (Sharma et al. 2014; Aguihe et al. 2017). Overall in this study, T1 (10% RSM) and T2 (20% RSM) may have minimal quantity of HCN due to the percentage of replacement, which perhaps justifies the substantial improvement in growth indices and feed utilization that is comparable to the control diet group. Balance ration in terms of amino acids in diets tends to improve protein absorption rate, enhance palatability, increase feed intake but this can only be achieved when deactivation of residual anti-nutritional factors especially HCN (Tuleun and Igba, 2008).

Carcass Quality

Carcass performance is a vital key to appraise the livestock performance and production of poultry. Most studies reported native breeds had lower carcass traits compared to conventional broiler (Tang et al. 2009 and Wang et al. 2006, 2009). As observed in standard commercial broilers, its high breast meat is a major contributory factor to high percentage carcass yield. Generally, the dressing percentage of poultry product greater than 80% it is regarded as meat. Accordingly to Wang et al. (2006) eviscerated yield above 60% is considered has acceptable meat performance. In Table 4, the dressing percentage recorded was greater than 70%, which is considered as excellent meat performance. However, T3 (30% RSM) has a much lower dressing weight and dressing percentage. The lesser carcass developmental outcome detected in birds fed with 30% RSM diet could be accredited to the hindering action of the residual cyanogen compound on the use of nutrients which were unable to be detoxified (Tuleun et al. 2007; Emenalom et al. 2004). The per cent mass of drumstick, breast and thigh were similar (P>0.05) in the midst of the control, T1 (10% RSM), T1 (20% RSM) group and this is an indication that 10 – 20% of the rubber seeds have a progressive impact on the carcass yield of the *Hybrid Ayam Kampung* as reflected by the greater dressed percentage, showing better palatable ration of live body weight (Oluyemi and Roberts, 2000). Besides, the decrease in cyanogen compound concentration by T1 (10% RSM) and T2 (20% RSM) as resulted to better efficacy of protein utilization in birds, directly influence growth development and increase tissue disposition in the birds (Sharma et al. 2014). Finding from Bamgbose and Niba, (1998) stated that quality and consumption of the ration have influence on improved carcass yield, it was observed that birds on 10% RSM and 20% RSM diets resourcefully consumed their feed as shown by their increased (P>0.05) dressed mass, breast, thigh and drum stick cuts weight compared to the control group. However, the lesser carcass yield shown by 30% RSM group could be as a result of deficiency in the utilization of nutrients ascribed to residual cyanogen activity (Ologun et al. 1998).

Offal Organs

In response to deficient protein and amino acids and other factors related to residual ANFs, they tend to increase in the size of the liver. These could primarily disrupt the production of protein by the liver, liver function and also bringing about the hypertrophic effect which results to unexpected rise of liver weight (Tuleun and Igba, 2008; Akinmutumi et al. 2008). T3 group (Table 4) obtained the higher mean value of the kidney weight (*p*>0.05) than other nutritive treatments. The increment in the weight of the kidney is in agreement with the findings of Ologhobo et al. (2011), which stated that the major enzyme in cyanide decontamination (Rhodenase) is found mostly in the kidney, and hence, escalation in the activities of the enzymes could be responsible for the rise in the recorded mass of the kidney. Major detoxification organs are acknowledged to be the liver and kidney and rise in the rate of activities in these organs due to detoxification of residual anti-nutrient, hence will give rise to an expansion in size of these organs (Aguihe et al. 2017). Thus, there were no substantial differences among treated groups and control group on the liver and kidney mass of the birds, but T3 exhibits higher weight than among other treatments signifying the level of HCN present in this level of replacement.

CONCLUSION

In conclusion, our result suggests that supplementation of the daily ration with 10 – 20% (RSM) is the potential replacement of conventional protein source for *Hybrid Ayam Kampung*. The RSM supplementation could improve growth indices, FCR, carcass disposition without detrimental effects on the end product. In further studies, the effects of supplementation RSM on an extended growing period with a large number of birds *Hybrid Ayam Kampung* (*Gallus gallus domesticus*) and determination of HCN level of processed rubber seed meal.

CONFLICT OF INTEREST

Authors declared no conflict of interest.

ACKNOWLEDGEMENT

This study was partially funded by Akuajaya Enterprise, Sabah, Malaysia. Thanks are due to all involved workers and organizations (FBIM, UniSZA, Terengganu; Ong Chuan Hin Rice Milling Sdn. Bhd, Kedah; LIGS, Sabah, RISDA Semaian Negeri, Terengganu).

AUTHOR CONTRIBUTIONS

Rosli NA and Mohd-Rosly NFI were responsible for the design and conduct of the experiment including laboratory analysis. Rosli NA and Oluodo LA wrote the manuscript. Ting JN and Mohd-Rosly NFI responsible for the statistical analysis of data. Komilus CF and Oluodo LA took the responsibility of proofreading and correction of manuscripts. All authors read and approved the final version.

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