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Meat quality and biochemical composition of *Hybrid Ayam Kampung (Gallus gallus domesticus)* fed with rubber seed meal

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Abstract

Soybean meal (SBM) is an imported protein source used as feed for poultry. The increasing import value of soybean meal put pressures to poultry feed producers to look for other natural sources as potential substitutes for this source. Rubber seed meal (RSM) is a potential product from rubber trees grown in most Southeast Asian countries, including Malaysia. This study investigates effect of different levels of rubber seed meal supplemented as replacement of soybean on meat quality, breast, and liver chemical composition of *Hybrid Ayam Kampung*. Birds were randomly assigned into 12 groups with 3 replicates were available for each of the 3 treatments (T1, T2, and T3) and control groups. The control groups were fed a basal diet without RSM, and other groups were fed the diets that consisted of 3 RSM levels at initial values of 10% RSM (T1), 20% RSM (T2), and 30% RSM (T3). There were significant differences ($p<0.05$) in contents of breast meat chemical composition including crude protein (CP) at 19.90 - 23.08%, and ash (0.88 – 1.08%) among all groups with the exception of crude fat and moisture. Also, there were significant differences ($p<0.05$) in all contents of liver chemical composition. Meat quality parameter assays showed that pH, and colour (45 mins & 24 h), cooking loss, water holding capacity (WHC), and shear force were used as indicators. Results showed no significant difference ($p>0.05$) with the exception of the pH_{24h}, and $(b^*)_{45mins}$. Higher pH_{24h} was observed ($p<0.05$) in T2 compared with T1, and control. However, As for RSM treated group, there was a significant difference ($p< 0.05$) in $(b^*)_{45mins}$ compare with that of the T2 (6.95±0.57), with the lowest $(b^*)_{45mins}$ found in control (4.97±0.57). Conclusively, RSM could be used as a replacement up to 10 – 20% without detrimental effects on meat quality and nutritional composition.

Keywords: Rubber seed meal, growth, meat quality

INTRODUCTION

In most developing nations, intensified competition for conventional concentrates such as soybean, maize and groundnut has resulted in unavailability and rising prices of feed ingredients for poultry production (Thirumalaisamy et al. 2016). The prevailing scenario has compelled the need to search for substitute feed resource for poultry production. The replacement of imported and high-cost conventional protein feed with a readily available, cheap and non-consumable is an appropriate strategy to minimize the cost of poultry production. In addition, the cost of feed is known to have engulfed a large portion of operating cost in poultry production, which accounts for about 70 - 80% of total operating expenses (Sharma et al. 2014). The environmental and economic viability of animal feed is a necessity. Soybean meal (SBM) is the main protein ingredient in poultry production; it is characterized by high monetary value and demand for industrial and staple food consumption (Udo et al. 2016; Taiwo, 2005). In recent times, livestock production is aimed at increasing profit margin, and minimizing the cost of production without detrimental impact on the end product during the cost of production to its end users or consumers (Ahaotu, 2011; Aderemi et al. 2006).

One of such promising non-conventional feed resources is rubber seed meal, which is gotten from the rubber tree (*Hevea bransiliensis*) and widely found in Southeast Asia, and West Africa (Oluodo et al. 2018; Udo et al. 2016). Report from the Association of Natural Rubber Producing Countries (ANRPC), projected that Malaysia had estimated land coverage of 1.05 million hectares of rubber plantation in 2013. Based on forecasted land coverage, the average of 1000 kg seeds per ha/yr (Eka et al. 2010), can be achieved as the annual production of rubber seed in projected to 1.05 million metric tons in Malaysia. Less than a quarter of the estimated production of rubber seed is utilized for cultivation, while 75% of seeds are underutilized around the environs (Oluodo et al. 2018; Suprayudi et al. 2015). Rubber seed meal contains sizable amount of protein and high lipid but also encompasses some anti-nutritional factor such as cyanogens compound (Sharma et al. 2014), hydrolysis of the rubber seed trigger the yields of toxic hydrogen cyanide and other presumed carbonyl compounds that attribute to the physiological dysfunction of the birds (Francis et al. 2011). However, storage and heat treatment technique have proven to be effective in eliminating toxic factors. Thus, rubber seed meal (RSM) is a cheap and promising protein source in animal feeds (Udo et al. 2016). However, no systematic attempt has been made to evaluate rubber seed meal on *Hybrid Ayam Kampung*. Therefore, the study was conducted to evaluate the comparative effect of different level of RSM on meat quality and nutritional composition of breast and liver.

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.

Experimental birds

Experimental unsexed of *Hybrid Ayam Kampung* live birds were obtained after a 35 days feeding experiment using 3 treatments with different level of RSM % T1 (10 % RSM), T2 (20 % RSM), and T3 (30 % RSM) basal diet without RSM was carried out.

Meat Quality

At 35 d, 12 birds were randomly picked from control and treatment groups. The birds were fasting 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. Scalding in hot water at 63°C for 3 minutes then de-feathering followed immediately. The breast muscles and liver were collected for each treatment for meat quality and biochemical analysis.

pH

After 35 d, the breast meat were collected for pH evaluation at 45 mins and 24 h using a digital portable pH meter (HI 99163). After determination, the pH_{45min} of breast muscle then samples were put in vacuum-packed and preserved for 24 h in a refrigerator at 4°C for the determination of pH value at 24 h (Genchev et al. 2008).

Colour

According to Cheng et al. (2018), breast meat colour was taken at 3 different proximity across the breast meat using a handheld chromameter (Konica Minolta CR-400 Chromameter), and the colour was reported in the CLE-LAB trichromatic system as L* (lightness), a* (redness) and b* (yellowness) values.

Water Holding Capacity (WHC)

WHC was determined through pressing technique, and measurement was taken in triplicate following the method described by Carvalho et al. (2017) with slight modifications. After 24 h *post-mortem*, the breast meat was trimmed into cube weighing 5 g, then placed between Whatman No.1 two filter papers and two glass plate. Pressure was applied to raw breast meat for the determination of WHC of breast muscle, which results in water loss. 5 kg mass was subjected to the top glass plate for 10 min. The difference in weight of breast meat initially and after subjecting pressure represents water loss.

$$\text{WHC \%} = 100 - \frac{Wi - Wf}{Wi} \times 100$$

Where, Wi = initial weight of the sample (g)
Wf = final weight of the sample (g)

Cooking loss

According to Cheng et al. (2018) with slight modification, the cooking loss was accessed at 24h *post- mortem.* About 10 g of breast meat was cooked in a water bath in vacuum-packs for 20 mins with an internal temperature of 75°C, and then afterwards allowed to it attains room temperature. Estimation of cooking loss was calculated by differences in mass based initial muscle weight (%).

$$\text{Cooking loss} = \frac{W2 - W1}{W1} \times 100$$

Where, W1= weight of sample before cooked
W2= weight of sample after cooked

Shear Force

The shear force is a determinant factor of meat tenderness in livestock. According to Omar et al. (2018) shear force determined with slight modifications. Two adjacent muscle strips 1.0 cm (width) x 3.0 cm (length) in the direction of muscle fibre in triplicates were subjected to cut from cooked breast and then it was sheared once. The trimmed breast strips were placed on the surface of texture analyzer in a direction which is perpendicular to the Warner-Bratzler blade with a 30.0 kg mass transducer and down stroke distance of 30.0 mm which outcome determine the tenderness or shear force.

Proximate Analysis

After standard cutting, breasts and livers were obtained from the 4 treatment groups (T1, T2, T3, and control). Accordingly 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

All data 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 discrepancies among means were separated by Duncan's multiple range test. The (p<0.05) was described to be statistically significant

RESULTS AND DISCUSSION

Table 1. Biochemical Analysis Breast and Liver of Hybrid Ayam Kampung

Items (%)	Con	T1	T2	T3	SEM
Breast					
CP	23.10^{c}	21.40^{b}	21.30^{b}	19.90^{a}	0.29
Moisture	75.90	74.60	77.70	75.10	1.99
Crude fat	0.40	0.60	0.80	1.00	0.03
Ash	0.90^{a}	0.90^{a}	1.00^{b}	0.90^{a}	0.31
Liver					
CP	18.40^{a}	19.70^{b}	19.30^{b}	18.80^{ab}	0.20
Moisture	75.50^{c}	76.30^{d}	73.40^{a}	74.30^{b}	0.54
Crude fat	0.20^{a}	0.40^{b}	0.70^{c}	0.70^{c}	0.18
Ash	1.20^{a}	1.30^{b}	1.40^{b}	1.20^{a}	0.08

Mean values with their pooled standard errors of the means. Biochemical analysis of breast and liver of Hybrid Ayam Kampung, basal diet (Con group), a basal diet with 10 % RSM (T1 group), a 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).

Table 2. Meat quality of Breasts of Hybrid Ayam Kampung

Items	Con	T1	T2	T3	SEM
Breast meat					
pH_{45mins}	5.91	5.85	5.83	5.94	0.04
pH_{24h}	5.06^{a}	5.03^{a}	5.14^{c}	5.12^{bc}	0.02
Colour Parameters					
Lightness $(L^*)_{45min}$	23.33	18.89	20.00	22.02	1.33
Redness $(a^*)_{45min}$	2.49	2.71	2.30	2.45	0.14
Yellowness $(b^*)_{45min}$	4.97^{a}	6.72^{b}	6.95^{b}	5.34^{ab}	0.57
Lightness $(L^*)_{24h}$	31.70	31.28	34.50	36.02	1.61
Redness $(a^*)_{24h}$	2.58	1.94	1.85	2.61	0.25
Yellowness $(b^*)_{24h}$	6.18	7.21	5.61	5.67	0.56
WHC (%)	81.96	82.69	83.26	83.70	0.71
Cooking loss (%)	18.04	17.31	16.74	16.23	1.22
Shear force (Kg/cm^2)	6.25	9.10	8.51	10.21	1.69

Mean values with their pooled standard errors of the means. Carcass yield of Hybrid Ayam Kampung chickens, basal diet (Con group), a basal diet with 10 % RSM (T1 group), a basal diet with 20% RSM (T2 group), and basal diet 30% RSM (T3 group). RSM : Rubber Seed Meal; pH45 = Post-mortem at 45 mins; pH24 = Post-mortem at 24 h; WHC = Water holding capacity. The mean values with different superscript lowercase letters across the row in the table were significantly different (P<0.05)

Meat Quality

Several factors affect the meat quality of chickens, which are pre-postmortem treatment, slaughtering technique, diet composition, heat stress, and genetics. From the previous study, one of the important parameter in evaluating meat quality is the pH, it has a positive correlation with tenderness, water holding capacity and redness Le Bihan et al. (2008) but Zhang et al. (2012) reported it as negative correlation with lightness and cooking loss of the meat.

Moreover, when subjected to oxidative stress, the muscle's glycogen content, which is converted into lactic acid, in turn leads to a decline in the pH of muscles (Wang et al. 2009). In agreement with the earlier statement on the contributory effect of pH on the colour and texture of the meat (Akşit et al., 2006; Chan et al. 2011). In this study, the pH_{45mins} of breast muscles of T1 (10% RSM), T2 (20% RSM), and T3 (30% RSM) were all in the same trend with the control diet. However, there was a significant decline in the pH_{24h} value among the RSM based groups and control. T3 and T2 show a better outcome at pH_{24h} as compared to other groups. pH obtained in this study is in agreement with the previous finding of Hertanto, (2009) which states that pH ranging from 5.0 – 6.0 of breast muscle is classified as fine fibre, not mushy and yellowish-white colour while pH above 6.0 refers as hard and darker colour. Some attributes are known to influence meat quality parameters which are known as pre-slaughter stressors which entails heat stress, feed withdrawal, transport, and water deprivation could be the attributing factors that may influence meat quality in this study. The factors above can trigger the development of rigor mortis, directly induce a faster declination of the pH and L* value in chicken meat (Mota-Rojas et al. 2006). Other meat quality parameters have their dependency on the value of pH of meat.

Colour is one physical property of meat; almost 85% of consumers base their preference on colour as a deciding factor for buying meat. Generally, no significant difference was observed in the colour properties except for b^*_{45mins} of the breast muscles, but lower values were recorded in the redness and lightness, which may be influenced by high environmental factors. Zhang and Barbut, (2005) and Zhang et al. (2012) findings on ideal L* on broiler strain were between 46 and 53. Furthermore, L* value less than 46 is classified to be dark, firm, dry, which is translated to be a dark colour, low shelf life due to high water holding capacity. Accordingly, to previous literature, a* value breast meat of broiler strain ranges between 0.96 and 4.50, and b* values were in the range of 6.7 to 13.5 (Le Bihan-Duval et al. 2001, 2008; Berri et al. 2001). Furthermore, Khan et al. (2017) published a report stating that myoglobin contents of meat influence the colour parameters and myoglobin decline mostly immediately after oxidation under heat stress.

It is very important to take into account the water-holding properties and cooking loss of meat. Weight of chicken products have a correlation with retention and gain or losses of moisture and thus influence the economic value. As reported by Chen et al. (2012), ability of chicken meat to hold water and loss of meat which occurs during cooking are very crucial parameters in meat quality assessment, exudation from the meat might result to loss of nutrients which might reduce the nutritional composition of the meat. In addition, water distribution within muscles has an influence on juiciness, tenderness as well as overall visual appearance.

According to Rodbotten et al. (2000) shear force is commonly expressed as tenderness capacity of meat, and it is one vital sensory qualities that influence the choice of the consumer. The shear force value for the breast meat samples across the dietary treatment (6.25 – 10.21 kg/cm^2), which the highest shear force was obtained from the T3 (30%) while the least value was the control group. The heavy commercial line of broilers has dissimilarity with our finding, which the average shear force of 1.48 kg/cm^2, which is substantially lower than our finding (Duval et al. 2008). Moreover, Khan et al. (2017) findings on shear force value on broiler chicken meat as 19.00 – 20.12 kg/cm^2, which higher than our findings. Basically, our findings on shear force show closer trend toward the outcome of Yousefi et al. (2012) that obtain shear force value of 12 kg/cm^2 on sheep meat. Literally, in this study, the tenderness of *Hybrid Ayam Kampung* was classified to higher than that of the broiler meat, but seems to be closer to red meat.

Biochemical Analysis of Breast and Liver

The variation on the crude protein percentage of the breast meat may be due to the protein content, and quality of rubber seed meal (17.71%) is lower than soybean meal (44%) whereas the energy value is higher in rubber seed meal (5580 kcal kg^{-1} DM) and lower in soybean meal (2240 kcal kg^{-1} DM). The liver crude protein range from 18.37 to 19.71% which T1 (10% RSM) obtained the high value while the least is the control group with

(18.37 %), but all values were above the previous study which recorded 17.70% crude protein (Seong et al. 2015). In general, Pereira and Vicente (2013) reported the level of raw pork chop (17.3%) and significantly higher than that in duck meat (12.3%) but protein content of liver of *Hybrid Ayam Kampung* show similar trend with pork meat. However, the liver of *Hybrid Ayam Kampung* has lower values in comparison with those in common muscle tissues such as beef and chicken.

CONCLUSION

Overall, the results in this work showed that RSM replacement certain percentage displayed a comparable meat quality, and the nutritional composition of the breast meat and liver. Based on these results, the use of 10 – 20% RSM in *Hybrid Ayam Kampung* diet was recommended to meat quality. The partial replacement of rubber seed meal to the diets of Hybrid *Ayam Kampung* do not have detrimental effects on meat quality and biochemical composition.

CONFLICT OF INTEREST

Authors declared no conflict of interest.

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AUTHOR CONTRIBUTIONS

Mokhtar NF and Rosli M were responsible for the design and conduct of the experiment, including laboratory analysis. Noret N and Oluodo LA wrote the manuscript. Mokhtar NF and Rosli M were 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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