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Effect of Palm Kernel Cake and Coconut-based Formulated Diet on Malaysia Village Chicken Growth Performances and Meat Quality

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ABSTRACT

The potential of the usage of palm kernel cake (PKC)-coconut based feeds has been considered as an alternative to commercial feed due to their low cost and abundance in availability and accessibility in Malaysia. However, previous studies have shown that the use of high fiber feed such as PKC resulted in poor performance of poultry due to low digestibility and palatability. In this study, a total of 400 village chickens from purebred and crossbred strains were reared to evaluate the effects of PKC and coconut-based feeding on their production performance. Body weight (BW), carcass evaluation, abdominal fat, meat conversion percentage, proximate analysis, and amino acid profile analyses were recorded in the study. The results showed that the Type A feed that contained higher fiber level resulted in poorer BW and carcass weight for both strains. It could be suggested that inconsistent size of fiber particles could influence the chicken's digestibility. However, it was also shown that the quality of the meat of the village chicken and Type A feed were better in terms of having lower abdominal fat and crude fat contents. It also resulted in higher CP in crossbred strain meat which is correlated significantly with meat conversion percentage. Type B-fed

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chicken meat recorded low meat conversion percentage indicating higher formation in bone mass and feather, which is supported by the data of the ash in crossbred strain, indicating higher formation of mineral build-up such as bone mass. Furthermore, there were 11 amino acids that were recorded to be significantly higher in Type A-fed chicken meat compared with Type-B fed chicken meat, indicating a higher meat quality. In conclusion, the usage of Type-A feed as daily feed for village chicken was beneficial and exhibited prominent values in terms of quality and cost-effectiveness. However, more studies should be done to improve the digestibility and palatability of Type A feed to improve in their overall performances so that it can be used widely in poultry, particularly in village chicken farming.

Keywords: PKC-coconut-based, proximate analysis, purebred, crossbred, village chicken

INTRODUCTION

The usage of PKC-based feed that contains higher fiber content for chicken farming is considered less efficient in terms of digestibility and palatability, especially in the chicken industry. It was studied that by increasing the fiber content in the diet, it could help in the development of production of enzyme, improve digestibility, and organs development in poultry (Mateos, Jiménez-Moreno, Serrano, & Lázaro, 2012; Rodriquez & Preston, 1997). As for broiler production, the usage of high fiber content diet has been limited. However, in the village chicken industry, it is seen to be an option for the farmers in order to decrease the feed cost. This is also due to the fact that village chicken grows slower (Azahan, Azlina Azma, & Noraziah, 2011), thus taking longer time before it can be marketed, as well as requiring higher maintenance and feed costs.

In Malaysia, palm kernel cake is highly available due to the importance of oil palm industry to the country. The palm kernel cake is usually used for ruminant animals, such as goat and cattle, as supplementary diet. However, in poultry, it was stated by Alimon (2004) that the usage of high PKC content might result in toxicity to the chicken due the high fiber contents in the diets. Furthermore, author also suggested that an inclusion of a maximum of 20% of PKC in poultry feed is adequate (Alimon, 2004). Meanwhile, coconut-based feed is also considered as a feed ingredient that exhibits good palatability for chicken. A previous study has shown that feeding chicken with extracted coconut meat did not gave any adverse effects to the chicken egg production as well as results in an increment of feed consumption (Moorthy & Viswanathan, 2010).

It is known that purebred village chicken grows slower compared to commercial broiler, thus resulting in slower expected weight for market. Crossbred village chicken is the product of crossbreeding the purebred village chicken with broilers to improve their growth rate and production of eggs.

The slow growth of village chicken is due to many factors, such as genetics, environment, nutrition, parasites, young mortality, and diseases (Cumming, 1991). Furthermore, the growth of chicken is governed by the ability to digest feed that contains crude protein. It was suggested that 90% of amino acid content inside poultry meat to be an indicator for actual crude protein content in the meat (Hunton, 1995). Furthermore, the quality of protein within any meat is largely influence by the amino acid concentration and it is also responsible for human wellness and health (Schaafsma, 2000).

The objectives of this research were to investigate the effects of local feed ingredients that were based on palm kernel cake and coconut-based feed towards the growth performance of village chicken as well as to identify the quality of the meat by observing proximate and amino acid data of the meat of chicken fed using the 2 types of diets and using 2 types of village chicken, which were purebred and crossbred village chicken in Malaysia.

MATERIALS AND METHODS

A total of 400 of 1-day old village chickens with cumulative weight 38 grams, from purebred (n = 200) and crossbred (n = 200) strains, were reared in Livestock Science Centre, Institute of Biological Sciences, University of Malaya from April 2016 to February 2017. The study was approved by University of Malaya Institutional Animal Care and Use Committee (UMIACUC) with ethics number I/02022017/03112016-01/R.

Table 1

The composition and dry matter percentage of formulated feed ingredients (Type B) (Mazlishah, Zazali, Wan Khadijiah, Wan Syahidah, & Abdullah, in press)

Ingredients	Amount (Kg)	Dry matter (DM, %)
Corn	29.8	87.0
Rice Bran	11.9	91.0
Palm Kernel Cake	7.4	90.6
Coconut Meat	14.1	43.0
Soybean Meal	26.0	91.0
Vitamin Premix	4.5	-
Mono-Dicalcium Phosphate (MDCP)	4.5	-
Salt	0.9	-
Limestone	0.9	-
TOTAL	100	-

**The composition of vitamin premix for the study was included Vitamin A, D3, E and C. The specific amounts were disclosed due to the company privacy.*

Table 2

Comparison of proximate analysis between Type-A diet and Type-B diet (Mazlishah et al., in press)

Nutrients composition	Type A	Type B
Dry matter (%, DM)	81.16	89.05
Crude protein (%, DM)	14.95	13.40
Crude fat (%, DM)	3.78	3.02
Crude fiber (%, DM)	12.22	3.12
Ash (%, DM)	5.18	4.43
Gross energy (MJ/kg DM)	17.13	16.30
Metabolizable energy (MJ/kg DM)	9.84	9.36

There were 2 types of diets used in this study. Commercial diet was labelled as Type-B and the formulated diet was labelled as Type-A feed. The diets were given to the chicken after Week 3 of rearing. There were 4 groups with 100 chicks in each group (purebred: type A, purebred: type B, crossbred: type A, and crossbred: type B). Each group consisting 100 chicks were divided into 5 pens where each pen consisting 20 chicks. At one time, 2 groups from same strains were reared due to limited space. Table 1 shows the composition of the formulated diet used in the study based on (Mazlishah et al., 2018). There were 2 local ingredients used in the study which were palm kernel cake (PKC) and coconut meat (milk extracted coconut meat). The chemical composition is shown in Table 1 and the proximate analysis of the feed is shown in Table 2. The body weight (BW) at Weeks 8 and 12 were recorded for crossbred strains, while BW at Week 12 and Week 16 were recorded for purebred strain. The age of slaughtering for purebred and crossbred strains were different due to each strain reaching the required weight for market (1.5 kg) at different times. Carcass performances (carcass weight, abdominal fat, and meat conversion percentage), feed conversion ratio (FCR), and proximate analysis on chicken meat were also recorded. Carcass evaluation and live weight were carried out to identify the maximum weight gain for the village chicken given the two types of diet. Eviscerated chicken carcasses were separated from the bone for meat quantity percentage and weight. Then, fresh meats were dried inside an oven at 98°C for 48 hours. The carcass quality and meat conversion of the chicken were compared among the diets and strains.

Proximate and amino acid profile analyses were carried out using the dried meat at the Veterinary Public Health Laboratory, Bandar Baru Salak Tinggi, Sepang, Selangor. The parameters measured for proximate analysis were dry matter (DM), crude protein (CP), crude fat (CF), crude fiber (CFb), and total ash. The amino acid profile analyses were conducted using Ultra Performance Liquid Chromatography with Photodiode Array (UPLC - PDA) Triplicates for each sample were tested using the dried meat in crossbred village chicken to identify the meat's amino acid content for the village chickens that were fed with Type-B and Type-A. The meat to bone percentage was calculated based on the following formula:

$$Meat - Bone\ percentage\ (\%) = \frac{Deboning\ meat\ weight}{Carcass\ weight} \times 100$$

Statistical analysis: The data were analyzed using Statistical Package for the Social Science (SPSS) software T-test for each slaughtered age (Crossbred: W8 and W12) and (Purebred: W12 and W16) with diets as treatments for live body weight, carcass performances, proximate analysis, and amino acid profile comparison between Type-A and Type-B. ANOVA was used to calculate the mean differences in meat conversion percentage. ANOVA could not be used to differentiate the significance of means between strains due to difference in age of slaughtering.

RESULTS AND DISCUSSION

The body weight for village chicken for purebred was significantly heavier for Type B at Week 12, while no significant differences were seen in Week 16 for both Type-B and Type-A. Meanwhile, carcass weight for purebred showed similar trends with the body weight. The abdominal fat content for purebred was significantly higher for Type-B chickens at Week 16 of age. The meat to bone percentage showed that Type-A chickens produced more meat than Type-B chickens at Week 12 and 16 of ages. However, the FCR for Type-A fed purebred village chickens were obviously higher compared to Type-B for the same strain as shown in Table 3.

The usage of high fiber feed ingredients such as PKC in poultry diets is one of the alternative feed ingredients to minimize the cost of the feed. However, the limitation of the PKC amount that could be utilized by poultry is only up to 20-30% in the diet. Higher levels of PKC, more than 30%, could cause a reduction in energy due to the high level of fiber content in the feed (Zahari & Alimon, 2005). Type-A feed that was used in this study had higher crude fiber (12.22%) compared with Type-B (3.12%). This high percentage of crude fiber inside Type-A feed might have been contributed by the PKC amount in the diet despite the amount used was well below the maximum recommended PKC level (Alimon, 2004), which was 7.4% from the total formulated diet. The relatively high crude fiber content in Type-A diet might be due to the uneven manual mixing and surface area of the PKC particles grounded using the machines, which were non-similar and structurally inconsistent inside the mixture of the feed. Furthermore, it was also stated in a previous study that PKC had abundance of insoluble fiber as well as non-starch polysaccharides (NSPs) (Alimon, 2004; Fransech & Brufau, 2004; Sundu & Dingle, 2003). Besides, the level of PKC in Type-A diet that was high compared with Type-B might also affect the physiology of the intestinal villi, which could lead to the decrease in width, height, and surface area of the intestinal villi. This could result in poor utilization and digestibility of the feed that would also affect the body weight for Type-A fed chicken for both strains (Kalmendal, Elwinger, Holm, & Tauson,

Table 3

Body weight, carcass weight, abdominal fat, meat to bone percentage and feed conversion ratio for Purebred village chicken at Week 12 and Week 16

	Purebred				
	Week 12			Week 16	
	Type B	Type A		Type B	Type A
Body Weight, (g)	2359.0±92.3**	1846.0±100.9*	Body Weight, (g)	2295.0±196.2*	2303.0±121.0*
Carcass Weight, (g)	1761.0±67.2**	1332.0±73.6*	Carcass Weight, (g)	1837.0±165.9*	1754.0±105.9*
Abdominal fat, (g)	4.5±1.7*	5.4±1.6*	Abdominal fat, (g)	24.1±6.6**	7.5±1.7*
Meat-bone percentage, (%)	39.2	47.4	Meat-bone percentage, (%)	52.4	60.0
Feed conversion ratio (FCR) (Weeks 3–12)				2.9±0.6*	5.2±1.6*

* indicates no significant difference in same row using T-test (p>0.05)

** indicates no significant difference in same row using T-test (p<0.05)

Table 4

Body weight, carcass weight, abdominal fat, meat to bone percentage and feed conversion ratio for crossbred village chicken at Week 8 and Week 12

	Crossbred				
	Week 8			Week 12	
	Type B	Type A		Type B	Type A
Body Weight, (g)	1718.0±47.4**	1408.0±28.0*	Body Weight, (g)	2791.0±149.9**	1951.0±116.8*
Carcass Weight, (g)	1321.0±85.6**	1020.0±25.9*	Carcass Weight, (g)	2146.0±109.6**	1818.0±83.0*
Abdominal fat, (g)	15.6±4.5**	3.9±1.8*	Abdominal fat, (g)	31.0±7.0**	9.9±9.5*
Meat-bone percentage, (%)	48.6	50.1	Meat-bone percentage, (%)	45.0	48.0
Feed conversion ratio (FCR) (Weeks 3–12)				2.4±0.4*	2.6±0.4*

* indicates no significant difference in same row using T-test (p>0.05)

** indicates no significant difference in same row using T-test (p<0.05)

2011; Moharrery & Mohammadpour, 2005). The physical nature of the high fiber ingredients such as PKC is coarse and ground which is harder to grind and digest, thus could result in accumulation of fiber particles inside the poultry gizzard (Hetland, Svihus, & Choct, 2005).

Meanwhile, the CP recorded for Type-A was slightly higher compared to Type-B diet as shown Table 2. This might be due the higher dietary fiber content for Type-A diet, which is correlated with accumulation of fiber in gizzard. This would result in the increase of antiperistaltic movements inside the gastrointestinal tract (GIT) that could help in the secretion of pancreatic enzymes due to the increase of cholecystokinin release. This will further increase the GIT activity as well as increase the CP and other dietary components' digestibility as shown in Table 2 (González-Alvarado, Jiménez-Moreno, Lázaro, & Mateos, 2007; Hetland et al., 2005; Jiménez-Moreno, González-Alvarado, Lázaro, & Mateos, 2009; Svihus, Juvik, Hetland, & Krogdahl, 2004). Type-B fed crossbred village chicken recorded significantly higher body weight, carcass weight, and abdominal fat compared to Type A. Meanwhile, Type-A recorded higher percentage of meat to bone ratio compared to Type-B. However, the FCR for Type-A fed crossbred village chicken was slightly higher compared to Type-B fed chicken as shown in Table 4. The meat conversion percentage of CVC fed with Type A feed was significantly higher for both male and female chicken compared with Type B fed CVC as shown in Table 5.

Table 5

Percentage of meat conversion for purebred village chicken (PVC) and crossbred village chicken (CVC) fed on Type-A and Type-B diets based on genders

Strains	Type B (Mean ± SEM)		Type A (Mean ± SEM)	
	Male	Female	Male	Female
PVC (Week 12), (%)	27.8±0.6[a]	37.8±0.3[b]	32.1±0.7[ab]	34.2±0.9[b]
CVC (Week 8), (%)	31.8±0.4[a]	31.8±0.3[a]	31.0±0.9[a]	32.0±0.6[a]
PVC (Week 16), (%)	37.9±0.5[a]	41.5±0.7[b]	39.0±0.5[a]	36.7±0.9[a]
CVC (Week 12), (%)	33.6±0.5[b]	27.9±0.6[a]	43.6±0.8[c]	36.1±0.03[b]

[a,b,c] Means with the same superscript letter in same row shows no significant difference using ANOVA (P>0.05).

The high crude fiber in the feed affected the growth performances recorded in the experiment, where the live weight recorded for the village chicken in both strains were significantly heavier in chickens that were fed on Type-B compared with Type-A at their first slaughtering ages, respectively. However, there was an improvement in body weight for purebred village chicken as it recorded no significant differences between chicken fed with Type-B (2295.0±196.2 g) compared with Type-A fed chicken (2303.0±121.0 g). Despite that, in crossbred village chicken, the body weight for Type-B (2791.0±149.9 g) fed chickens were still significantly heavier than Type-A fed chickens (1951.0±116.8 g). This might be due to the fact that crossbred village chickens grow faster, thus exhibiting the capability of crossbred village chickens to utilize feed better compared with purebred village chickens. Similar trend was also observed for carcass weight for both strains (Table 3).

One of the main advantages in the village chicken from the consumers' perspective is the preference for low fat content in the meat and carcass of village chicken or indigenous chicken (Ahn, Park, Kwon, & Sung, 1997; Musa, Chen, Cheng, & Mekki, 2006). Purebred and crossbred village chickens showed highly significant differences in abdominal fat content fed on Type B (24.1±6.6 g, 31.0±7.0 g) compared to Type-A (7.5±1.7 g, 9.9±9.5 g) at Week 16 for purebred and Week 12 of age for crossbred village chicken, respectively. The differences in abdominal fat content in chickens fed on Type-B and Type A might be due to the differences in the difference of CP content between Type-B (13.40%) and Type-A (14.95%), which was mentioned in a previous research done by Summers and Leeson (1979). They stated that the similarity in energy content in the diet and differences in crude protein content in the diet could influence the deposition of fat in poultry. Moreover, the data for proximate analysis on village chicken meat for crude fat also showed high-fat deposition in Type-B fed chicken meat (5.5±0.1%) compared to Type-A (3.3±0.8%) for crossbred village chicken. However, the data was contradicted by a previous research that recorded high-fat depots in chickens that were on feed based on palm oil source diet compared with Type-A fed chicken meat in terms of crude fat content (Velasco et al., 2010).

Meanwhile, the FCR recorded was different between the purebred and crossbred village chickens, where the FCR for purebred fed on Type-B and Type-A were 2.9 and 5.2respectively. Meanwhile, crossbred village chicken recorded FCR 2.4 and 2.6 for Type B and Type A fed chickens respectively. FCR for crossbred strains were lower with no significant differences between Type-B and Type-A fed chickens. This might be due to genetics reason where crossbred village chickens could grow faster and bigger as they have higher utilization ability for the feed compared to purebred village chickens. Furthermore, the genetics factor of purebred village chickens could also influence the nutritional factor, where the usage of high fiber contents feed such as PKC could also result in reduction of body weight, as well as lowering the FCR value due to the low utilization capability of the feed (Pushpakumara, Priyankarage, Nayananjalie, Ranathunge, & Dissanayake, 2017; Sharmila, Alimon, Azhar, Noor, & Samsudin, 2014). In addition, the fat content recorded in crossbred village chickens were higher compared with purebred village chickens. This might be due to the low protein catabolism in the crossbred strain that was used to fulfill the requirement for growth and muscle mass, which was higher compared to slow growing chickens (Dransfield & Sosnicki, 1999).

Table 6

Proximate analysis of crossbred village chicken meat using 2 types of diets

Composition	Type A	Type B	T-test significance
Dry matter, DM (%)	97.9±0.3	97.5±0.04	ns
Crude Protein, CP (%)	84.5±1.1	78.4±2.5	**
Crude Fat, CF (%)	5.3±0.6	4.9±0.9	ns
Crude Fiber, CFb (%)	3.3±3.3	1.8±1.3	ns
Ash, (%)	5.3±0.4	9.4±1.6	**

* indicates no significant difference in same row using T-test (p>0.05)
** indicates no significant difference in same row using T-test (p<0.05)

Table 7

Proximate analysis of purebred village chicken meat using 2 types of diets

Composition	Type A	Type B	T-test significance
Dry matter, DM (%)	97.6±0.2	97.2±0.4	ns
Crude Protein, CP (%)	89.3±2.2	87.7±0.3	ns
Crude Fat, CF (%)	3.3±0.8	5.5±0.1	**
Crude Fiber, CFb (%)	5.2±3.1	2.4±1.8	**
Ash, (%)	4.9±0.3	6.8±0.3	ns

* indicates no significant difference in same row using T-test (p>0.05)
** indicates no significant difference in same row using T-test (p<0.05)

The meat conversion percentage showed significant differences in male and female Type-A fed chickens (43.6±0.8% vs. 36.1±0.03%), especially in crossbred village chickens compared with Type-B fed chickens (33.6±0.5% vs. 27.9±0.6%). This indicates higher potential of useful development aspect in chicken such as meat as has been shown in chicken fed with Type-A compared with Type-B fed feed. This could mean that Type-B feed could result in the formation of more bone and feather than meat (Table 5). This could be supported by the data from proximate analysis, where CP in meat for Type-A (84.5±1.1%) fed chicken meat were significantly higher compared CP in Type-B (78.4±2.5%) fed chicken meat for crossbred village chicken as shown in Tables 6 and 7. Purebred village chicken showed no significant differences in CP content in the meat despite apparent high CP recorded for Type-A (89.3±2.2%) compared with Type-B (87.7±0.3%) fed purebred meat. In addition, the low percentage of meat conversion in Type-B reflects high ash content in Type-B (9.4±1.6%), where it was significantly higher than in Type-A (5.3±0.4%) chicken meat, especially in crossbred village chicken. This indicates that the formation of bone mass in Type-B fed chickens were higher than Type-A fed chickens. Significant data on crude fiber in purebred village chicken meat fed on Type-A was recorded (5.2±3.1%) compared in Type-B fed chicken meat (2.4±1.8%), while no significant differences recorded in crossbred village chicken. The high crude fiber in purebred strain meat was higher than recorded by Ogunmole, Taiwo and Ayankoso (2013) that used exotic chickens. Furthermore, higher crude fiber in purebred strain might be related to the tenderization of the meat, where high proteolytic activity could increase tenderization of meat due to the weakening of muscle fiber inside the meat (Dransfield & Sosnicki, 1999).

The amino acid profile analysis in crossbred village chicken meat fed on Type B and Type-A diets showed that the 11 amino acids were significantly higher in Type-A fed chicken meat compared with Type-B chicken meat as shown in Table 8. The 11 amino acids were serine, arginine, proline, lysine, threonine, aspartate, alanine, methionine, leucine, tyrosine, and phenylalanine. Some of the amino acids are responsible for the village chickens' unique characteristics preferred by consumers, such as glutamate that is responsible for village chicken flavor. The study of both Type-B and Type-A fed chicken meats recorded high glutamate content compared with the commercial broiler as reported by previous researchers (Choe et al., 2010; Shahidi, 2012; Wattanachant, 2008). The optimum level of essential amino acids in the meat is important to provide the required nutritive value to the meat. It was previously stated that 90% of amino acid comprised the amount of crude protein present in the meat (Hunton, 1995).

Table 8

Amino acid profile in crossbred village chicken meat fed on Type-A and Type-B diets

Amino Acid	Amount (Mean±SEM)		T-test significance
	Type A (n=10) (%)	Type B (n=10) (%)	
Histidine	6.89±2.13	5.15±2.10	Ns
Serine	9.35±4.10	4.91±3.00	**
Glycine	6.89±2.13	5.17±0.66	Ns
Arginine	8.61±0.80	5.62±0.31	**
Proline	5.41±0.41	3.66±0.47	**
Cysteine	14.31±1.39	11.19±1.34	ns
Lysine	2.41±0.62	0.16±0.03	**
Valine	2.52±0.33	1.87±0.25	ns
Aspartate	13.52±0.92	8.33±0.83	**
Glutamate	15.92±1.92	13.52±1.55	ns
Threonine	6.04±0.57	4.14±0.50	**
Alanine	8.24±0.62	4.77±0.36	**
Methionine	4.79±0.32	3.52±0.51	**
Tyrosine	10.59±0.79	5.09±0.58	**
Isoleucine	8.99±0.60	7.88±0.52	ns
Leucine	10.50±1.39	3.89±0.27	**
Phenyalanine	6.19±0.60	3.09±0.18	**

* indicates no significant difference in same row using T-test ($p>0.05$)

** indicates no significant difference in same row using T-test ($p<0.05$)

CONCLUSION

From the findings of the present study, it could be summarized that the inclusion of PKC and milk extracted coconut meat into the feed formulation in the diet could directly affect the growth performance and the carcass quality of the village chicken. Type-A feed resulted in lower body weight and carcass quality in village chickens in both strains due to digestibility and palatability of the feed, which could affect the ability of the village chicken to utilize the feed to its full potential. This might be due to higher fiber content compared to Type-B diet. However, the high fiber content inside the Type-A diet might have also caused other dietary components to improve. Despite the low growth rate and low carcass quality, the village chickens are continually in high demand due to its unique preferences by the consumers who believe that village chicken meat has medicinal properties, preferred taste, and healthier to consume. In the present research, proximate analysis showed that Type-A feed gave low abdominal fat, crude fat, and is higher in terms of crude protein in the meat and meat conversion percentage. Furthermore, the unique characteristics of village chickens such as flavor and tenderization could be observed more in Type-A meat by observing the amino acid contents and crude fiber in both strains, especially in crossbred village chicken meat compared with Type-B meat. Thus, it could be said based on the data that Type-A could increase the quality of the meat produced by the village chicken by observing the amino acid content where most of Type-A fed chicken produced highly significant data compared to Type-B fed chicken's meat. However, more studies should be conducted to improve the digestibility and palatability of Type-A feed, to ensure the growth and sustainability of village farming in the country.

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