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# Research Article
# Growth Performance and Carcass Analysis of Broilers Fed with Enhanced Quality Palm Kernel Meal

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## Abstract
**Background:** Palm Kernel Meal (PKM) is one of the most promising and cheap agro-industrial by products which can be incorporated in animal rations to reduce the cost of feed. **Objective:** The present study investigated growth performance and carcass analysis of broiler chickens fed different levels of enhanced quality PKM. **Methodology:** A total of 540 one-day-old male Cobb500 chicks underwent a 35 days feeding trial in the Climatic Control House of the Energy and Protein Centre of the Malaysian Palm Oil Board (MPOB) in Keratong, Pahang, Malaysia. The birds were divided into four treatment groups: corn-soy ration [control, T1: 0% MPOB-quality (Q)-PKM] and corn-soy rations formulated with 10% (T2), 20% (T3) and 30% (T4) MPOB-Q-PKM. Each treatment group was subdivided into nine replicates comprised of 15 birds per replication. The rations were formulated to be isocaloric and isonitrogenous. **Results:** The T1 and T2 had a significantly higher ($p<0.05$) average body weight gain and total feed consumption during the starter period (days 1-20) than T3 and T4. However, the feed conversion ratio for T1, T2 and T3 were not significantly different ($p>0.05$). During the finisher period (days 21-35), the average body weight and total feed consumption for T1 and T2 were significantly higher than that of T3 and T4. The T2 had the best feed conversion ratio, which was significantly lower ($p<0.05$) than all other treatments except T1. Carcass analysis showed no significant differences ($p>0.05$) in thigh, drumstick, wing, or abdominal fat percentage among the four treatments. However, T2 showed the highest breast meat yield (23.59% of live weight), with the lowest from T4 (18.74% of live weight). **Conclusion:** Present results indicate that incorporation of 10% MPOB-Q-PKM in broiler feed produces better growth performance and comparable carcass quality with the control diet.

Key words: Broiler, palm kernel meal, Malaysian Palm Oil Board-Quality-Palm Kernel Meal (MPOB-Q-PKM), growth performance, carcass quality

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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

Cultivation of poultry has contributed greatly to the agricultural industry in developing countries, especially with respect to protein production. Protein production not only contributes to the economy, but also to the well-being and health of the population. Nowadays, the price of poultry products has become expensive due to the gradual increase in imported ingredients for poultry feed production. Feed costs are considered to be the most important element in determining profitability in the poultry industry[1]. In Malaysia, this problem is more evident due to the dependence on imported feedstuffs, such as corn, soybean meal, rice bran and wheat pollard. The utilization of local agricultural wastes as a source of energy and protein may offer a partial solution to reduce feed costs. These homegrown energy and protein feeds were intended to reduce the need for feed import, especially corn and soybean meal. According to Perez *et al*.[2], Palm Kernel Meal (PKM) is one of the most promising and inexpensive agro-industrial byproducts that can be incorporated in animal feed rations to reduce feed costs[3-6]. The PKM is a coproduct of the palm kernel oil extraction (solvent-based or mechanical) process[7].

Enhanced quality PKM is referred to as Malaysian Palm Oil Board-Quality Palm Kernel Meal (MPOB-Q-PKM). It is an innovative and improved product from traditional methods in producing Palm Kernel Cake (PKC) or Palm Kernel Expeller (PKE), especially since production of PKM powder is free from dirt and palm kernel shells[8]. Utilization of PKM in poultry rations is very limited because it is highly fibrous, gritty[9,10], unpalatable and availability of essential amino acids in PKM is relatively low[7]. The crude fiber content of PKM ranges from 16-18%, which is acceptable for most ruminant animals but considered high for nonruminants, the shell contains as much as 10% fiber[11]. Previous studies have been contradictory regarding the effect of PKM on the growth performance of broiler chickens. A study conducted by Yeong[12] indicated that up to 20% PKC can be incorporated in the poultry diet without any adverse effects on broiler or layer chicken performance. A higher level of PKC in poultry rations likely results in energy deficiency due to its high fiber content[13]. Thus, the recommended level of PKC for broiler chickens is between 15 and 20%.

Improvement in the nutritional value of MPOB-Q-PKM with a reduction in crude fiber and an increase in crude protein has been shown to enhance its utilization in the total mixed ration of poultry[8]. Reducing the crude fiber content of MPOB-Q-PKM is also expected to increase the utilization of PKC as an ingredient in livestock rations. Moreover, the true metabolizable energy value of MPOB-Q-PKM indicates it has a higher digestibility compared to PKE[14] and is comparable to corn[8]. Partial replacement of soybean meal and corn with MPOB-Q-PKM in formulated feed would not only greatly reduce the production cost of animal protein in Malaysia, but would also make Malaysian livestock industries more competitive in the country and help reduce import costs and dependencies. The purpose of the current study was to examine the influence of feeding different levels of MPOB-Q-PKM on the growth performance and carcass quality of broiler chickens and explore its potential for commercialization.

## MATERIALS AND METHODS

The present study was conducted at the Energy and Protein Centre of the MPOB Keratong Research Station in Pahang, Malaysia, in September 2016.

**Materials:** The PKM used herein was collected from the MPOB Keratong Research Station. Palm kernels were separated from their shells, ground and the oil extracted from the kernels by solvent extraction to produce the final MPOB-Q-PKM product.

**Feed formulation:** Broiler rations were formulated to be isocaloric and isonitrogenous using FORMAT software and met National Research Council recommendations (NRC)[15]. Birds were divided into four different groups: Corn-soy rations with 0% (control, T1), 10% (T2), 20% (T3), or 30% (T4) MPOB-Q-PKM. The compositions of experimental diets during the starter (days 1-20) and finisher (days 21-35) period are shown in Table 1 and 2, respectively. Each treatment group was subdivided into nine replicates comprised of 15 birds per replication.

**Birds, housing and feeding:** Five hundred and forty 1 day old Cobb500 broiler chicks purchased from Sinmah Livestocks Sdn. Bhd. (Alor Gajah, Melaka, Malaysia) were raised for 35 days in the Climatic Control House at the Energy and Protein Centre of the MPOB Keratong Research Station. Water was provided *ad libitum* throughout the experimental period.

**Chemical analysis:** Samples of each experimental ration type were analyzed for proximate composition following the recommended Association of Official Analytical Chemists procedure (AOAC)[16]. The moisture content in samples from each total mixed ration was analyzed using a Moisture Analyzer (AND, Japan). The crude fat content of the feed samples was determined using an ether extraction

Table 1: Composition of experimental broiler chicken diets (starter period, days 1-20)

| | | Amount (%) | | | |
|---|---|---|---|---|---|
| Ingredients | Requirements | T1 | T2 | T3 | T4 |
| Corn | | 49.92 | 46.77 | 34.00 | 24.78 |
| Soybean meal | | 30.85 | 25.06 | 23.17 | 19.75 |
| MPOB-Q-PKM | | - | 10.00 | 20.00 | 30.00 |
| Fishmeal | | 3.00 | 6.00 | 6.00 | 7.40 |
| MPOB-HIE | | 4.00 | 5.30 | 9.99 | 13.80 |
| Wheat pollard | | 7.00 | 4.00 | 4.00 | 2.00 |
| Feed additives* | | 5.23 | 2.87 | 2.84 | 2.27 |
| **Calculated nutrient composition** | | | | | |
| **Components** | | | | | |
| Crude protein | 22.00 | 22.33 | 22.51 | 22.53 | 22.66 |
| ME (MJ $kg^{-1}$) | 12.65 | 12.98 | 13.43 | 14.01 | 14.59 |
| Calcium | 1.00 | 1.10 | 1.09 | 1.09 | 0.98 |
| Available phosphorus | 0.45 | 0.95 | 0.41 | 0.42 | 0.44 |
| Lysine | 1.10 | 1.46 | 1.27 | 1.25 | 1.24 |
| Methionine | 0.50 | 0.58 | 0.58 | 0.57 | 0.58 |
| Methionine + cysteine | 0.90 | 1.41 | 1.43 | 1.42 | 1.43 |
| Threonine | 0.72 | 0.83 | 0.85 | 0.84 | 0.84 |
| Tryptophan | 0.20 | 0.29 | 0.30 | 0.33 | 0.35 |
| Arginine | 1.25 | 1.39 | 1.60 | 1.82 | 2.06 |

Data presented as the mean of 9 replicates (N = 15 birds each), *Includes limestone, dicalcium phosphate, salt, lysine, methionine, choline chloride, salinomycin and broiler vitamin and mineral premix, T1: Control, 0% Malaysian Palm Oil Board-Quality-Palm Kernel Meal (MPOB-Q-PKM), T2: 10% MPOB-Q-PKM, T3: 20% MPOB-Q-PKM, T4: 30% MPOB-Q-PKM. MPOB-HIE: Malaysian Palm Oil Board-High Energy

Table 2: Composition of experimental broiler chicken diets (finisher period, days 21-35)

| | | Amount (%) | | | |
|---|---|---|---|---|---|
| Ingredients | Requirements | T1 | T2 | T3 | T4 |
| Corn | | 56.80 | 57.58 | 48.37 | 36.06 |
| Soybean meal | | 21.58 | 15.31 | 9.24 | 7.95 |
| MPOB-Q-PKM | | - | 10.00 | 20.00 | 30.00 |
| Fishmeal | | 5.00 | 7.73 | 10.69 | 10.22 |
| MPOB-HIE | | 6.00 | 6.00 | 9.00 | 13.00 |
| Wheat pollard | | 7.00 | 2.00 | 2.00 | 2.00 |
| Feed additives* | | 3.62 | 1.38 | 0.70 | 0.77 |
| **Calculated nutrient composition** | | | | | |
| **Components** | | | | | |
| Crude protein | 20.00 | 19.25 | 19.51 | 19.55 | 19.56 |
| ME (MJ $kg^{-1}$) | 13.38 | 13.84 | 14.19 | 14.72 | 15.19 |
| Calcium | 0.80 | 1.44 | 0.76 | 0.74 | 0.74 |
| Available phosphorus | 0.30 | 0.41 | 0.42 | 0.41 | 0.41 |
| Lysine | 0.85 | 1.06 | 1.07 | 1.07 | 1.05 |
| Methionine | 0.32 | 0.36 | 0.39 | 0.42 | 0.42 |
| Methionine+cysteine | 0.60 | 1.09 | 1.14 | 1.18 | 1.17 |
| Threonine | 0.72 | 0.74 | 0.75 | 0.76 | 0.75 |
| Tryptophan | 0.16 | 0.23 | 0.24 | 0.25 | 0.28 |
| Arginine | 1.00 | 1.16 | 1.33 | 1.49 | 1.68 |

Data presented as the mean of 9 replicates (N = 15 birds each), *Includes limestone, dicalcium phosphate, salt, lysine, methionine, choline chloride, salinomycin and broiler vitamin and mineral premix, T1: Control, 0% Malaysian Palm Oil Board-Quality-Palm Kernel Meal (MPOB-Q-PKM), T2: 10% MPOB-Q-PKM, T3: 20% MPOB-Q-PKM, T4: 30% MPOB-Q-PKM. MPOB-HIE: Malaysian Palm Oil Board-High Energy

method on a SOXTHERM® machine (Gerdhart, Germany), while the metabolizable energy was analyzed using a bomb calorimeter (IKA®-WERKE, Germany). Crude protein was determined according to the Kjeldahl method using a Kjeltec™ machine (FOSS, Sweden). The samples were ashed for 2 h at 600°C. Crude fiber was determined using a Fibertec™ 2010 system (FOSS, Sweden).

**Growth performance:** Feed intake and total weight gain of broilers were recorded daily to assess weight gain and Feed Conversion Ratio (FCR). The Average Broiler body Weight (ABW), feed intake and FCR (kg feed consumed/kg weight gained) were calculated for each ration. Mortality was also observed and recorded daily. Growth performance was evaluated during the starter and finisher periods.

**Carcass quality:** On 36th day, three birds from each replication were randomly selected and sacrificed for carcass analysis. Carcass parameters, such as dressing yield (skin), breast meat yield, abdominal fat and weight of visceral organs (heart, gizzard and liver) were recorded. The yield for each part was then expressed as a percentage of the live weight of the birds.

**Statistical analysis:** All collected data were subjected to statistical analysis using one way analysis of variance and mean differences among treatments were evaluated by Duncan's Multiple Range Test using SAS 9.1™ (SAS Inst., Inc., Cary, NC, USA). Significance was set at $p<0.05$.

## RESULTS AND DISCUSSION

**Growth performance (starter period):** Data on the total feed consumption (TFC), ABW and FCR of male Cobb500 broilers are presented in Table 3. During the starter period, the highest TFC and ABW were with the T2 ration. While T2 results were not significantly different ($p>0.05$) from the T1 ration, they were significantly higher compared to T3 and T4 rations. These results indicate that the highest acceptable level of MPOB-Q-PKM in starter broiler diets is only 10%. The best FCR was produced by the T1 ration, followed by T2 and T3, with the poorest FCR from T4. Generally, rations with higher levels of MPOB-Q-PKM in the starter period (T3 and T4) resulted in the lowest conversion of feed to body weight and therefore, a poor FCR. These results were in line with findings of Mardhati *et al.*[17] who have reported that inclusion of 20% PKC resulted in poor ABW and FCR values compared to corn-soy-based rations fed during the starter period. The use of PKM in the monogastric diet is limited due to its high fiber content and broken shell particles which can reduce digestive enzyme action on PKC/PKE and could harm the stomach[18], especially of young birds.

**Growth performance (finisher period):** The T1 rations showed the highest TFC (3.23 kg per bird) compared to other treatments during the finisher period (Table 3) but was not significantly different ($p>0.05$) from that of the T2 ration. The lowest TFC was seen with the T4 ration (2.36 kg per bird). The ABW for the T2 ration was the highest, followed by T1, T3 and T4 rations. The best FCR stemmed from the T2 ration, which was significantly lower ($p>0.05$) than T3 and T4 rations but not T1. Panigrahi and Powell[19] conducted a study using higher levels of PKM (30, 40 and 50%) in broiler diets and concluded that FCR decreases as the level of dietary PKM increases. This might be due to the inefficiency of digesting high fiber feeds by broiler chicks, as well as the light and fibrous texture of PKM which limits its utilization in broiler diets. According to Ezieshi and Olomu[20] and McDonald *et al.*[21], the higher crude fiber content of PKC may have negatively affected digestion and was implicated in reducing the digestibility of the feed.

Soltan[22] reported that up to 10% PKC inclusion in broiler feed had no adverse effect on growth performance of broilers, which is in line with results from the current study. However, inclusion of up to 20% PKC with enzyme supplementation resulted in a comparable weight gain and feed efficiency compared to the control group. Indeed, supplementation with enzymes does improve the productivity of fibrous feed ingredients. These findings have suggested a way to overcome the fibrous components in PKC (e.g., β-mannan and non-starch polysaccharides) that are not easily digested by poultry.

**Carcass quality:** The live and carcass weights of broilers were both significantly higher ($p<0.05$) with the T1 ration versus all other rations except T2 (Table 4). The same result was also observed for carcass yield analysis, broilers fed the T1 ration showed the highest overall carcass yield, which was significantly higher ($p<0.05$) than T3 and T4 but not T2, rations. Individual carcass parameter analysis revealed

Table 3: Total feed consumption, average body weight and feed conversion ratio of male Cobb500 broiler chicken in the starter (days 1-20) and finisher (days 21-35) periods

| | Treatments | | | |
|---|---|---|---|---|
| Parameters | T1 | T2 | T3 | T4 |
| **Starter period** | | | | |
| Weight at day 1 (kg) | 0.048 | 0.048 | 0.049 | 0.049 |
| TFC (kg) | $1.12\pm0.03^{a}$ | $1.15\pm0.01^{a}$ | $1.00\pm0.03^{b}$ | $0.90\pm0.13^{b}$ |
| ABW (kg) | $0.84\pm0.01^{a}$ | $0.86\pm0.01^{a}$ | $0.65\pm0.07^{b}$ | $0.50\pm0.03^{c}$ |
| FCR | $1.33\pm0.05^{b}$ | $1.34\pm0.02^{b}$ | $1.48\pm0.10^{b}$ | $1.81\pm0.21^{a}$ |
| **Finisher period** | | | | |
| TFC (kg) | $3.23\pm0.07^{a}$ | $3.12\pm0.03^{a}$ | $2.67\pm0.15^{b}$ | $2.36\pm0.23^{c}$ |
| ABW (kg) | $1.98\pm0.04^{a}$ | $2.01\pm0.02^{a}$ | $1.39\pm0.10^{b}$ | $0.96\pm0.11^{c}$ |
| FCR | $1.63\pm0.06^{cd}$ | $1.55\pm0.02^{d}$ | $1.92\pm0.09^{bc}$ | $2.54\pm0.36^{a}$ |

Data presented as the Means±standard deviation of 9 replicates (N = 15 birds each), $^{a-d}$Values in the same row with different superscripted letters are significantly different ($p<0.05$), T1: Control, 0 Malaysian Palm Oil Board-Quality-Palm Kernel Meal (MPOB-Q-PKM), T2: 10% MPOB-Q-PKM, T3: 20% MPOB-Q-PKM, T4: 30% MPOB-Q-PKM, TFC: Total feed consumption, ABW: Average body weight, FCR: Feed conversion ratio

Table 4: Carcass quality analysis of broiler chickens fed different levels of Malaysian Palm Oil Board-Quality-Palm Kernel Meal (MPOB-Q-PKM)

| Parameters | Treatments T1 | T2 | T3 | T4 |
|---|---|---|---|---|
| Live weight (kg) | 2.50[a] | 2.15[ab] | 1.88[b] | 1.24[c] |
| Carcass weight (kg) | 2.05[a] | 1.75[ab] | 1.49[b] | 0.94[c] |
| Carcass yield (%) | 81.92[a] | 81.56[a] | 79.17[b] | 76.03[c] |
| **Carcass parts (% LW)** | | | | |
| Thigh and drumstick | 29.69[a] | 31.26[a] | 30.28[a] | 32.68[a] |
| Breast | 22.95[a] | 23.59[a] | 21.61[ab] | 18.74[b] |
| Wing | 7.65[a] | 7.42[a] | 8.05[a] | 8.57[a] |
| Abdominal fat | 1.99[a] | 2.54[a] | 2.30[a] | 2.03[a] |

Data presented as the means of 9 replicates (N = 15 birds each), [a-d]Values in the same row with different superscripted letters are significantly different ($p<0.05$), T1: Control, 0% MPOB-Q-PKM, T2: 10% MPOB-Q-PKM, T3: 20% MPOB-Q-PKM, T4: 30% MPOB-Q-PKM

there was no significant difference ($p>0.05$) in thigh, drumstick, wing and abdominal fat yields among any of the treatments. However, the T2 ration showed the highest live weight percentage of breast meat (23.59%), the lowest was obtained with the T4 ration (18.74% of live weight). The carcass quality parameters assessed in the present study were lower than those reported by Mardhati *et al.*[17] on birds fed a 20% PKC/PKE diet. On the other hand, Soltan[22] and Abdollahi *et al.*[23] reported a lower dressing percentage than the present study with or without enzyme supplementation of 10-20% PKC diets. At a higher level (30%) of PKC, results of the present study showed higher dressing percentage compared to the results of Okeudo *et al.*[24] (76.03% versus 72.05%).

## CONCLUSION

The present study showed that inclusion of 10% MPOB-Q-PKM in broiler starter and finisher feeds did not elicit a noticeable negative effect on growth performance and was comparable to the corn-soy-based diet (control, 0% MPOB-Q-PKM) with better FCR at week 5. However, addition of more than 10% MPOB-Q-PKM produced poor performance in terms of ABW and FCR.

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