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EFFECT OF FEEDING DIFFERENT LEVEL OF PKC AND PHYSICAL FORM OF DIET ON THE PRODUCTIVITY OF BROILER CHICKENS UNDER HOT AND HUMID TROPICAL CONDITION

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The experiment consisted of two sub-trials, conducted to assess the productivity of broiler chickens fed on the different level of PKC (palm Kernel cake) diet, and growth responses of broilers fed the diets based on pellet and mash form. In main trial, a total of 175 day old male chicks (Cobb500) was randomly distributed into 7 dietary treatments [$D_{1,}$ $D_{2,}$ D_3(10%), D_4(15%), D_5(20%), D_6(25%), D_7(30%)], with five replicates and five birds per replicate in a CRD. Birds were fed commercial starter diet up to 21 days and then finisher or test diet supplemented with PKC was provided the birds *ad libitum* from 22 to 35d. Results of main trial showed that feed intake (FI), live weight (LW), feed conversion ratio (FCR) and mortality (%) of broilers were unaffected (P>0.05) by feeding commercial diet until 21d. The FI, LW, body weight gain and mortality of broilers fed on test diets were also unaffected (P>0.05) between treatment except for FCR from 22 to 35 d. Birds fed on control (D_1& D_2) diets had a better (P<0.05) FCR than the birds fed on other diets from 22 to 35d. Results of second sub-trial showed that broilers preferred the pellet (P) diet to the mash (M) diet at 42d, as the FI of broilers was higher (P<0.01) on P than the M diet, with no influence on the LW, FCR and mortality. It can be deduced that PKC can be used successfully up to 30 % in the broiler diet as a cheap source of protein supplement to replace other costly protein sources for poultry production.

Keywords: Growth, PKC, feed form, broiler chickens

The energy and protein content of the diet represents as the major nutrient contents for diet formulation of poultry. The requirement of poultry is met mostly by the various sources of cereal grains, oil seeds including their by-products. The major portion of the ingredients is imported from the aboard, and a little part of those is recovered from home-grown to meet the huge demand of men and animal along with intensive poultry production. Besides, the low production and high demand of these ingredients for both men and animals have been creating a constant force to explore other potential feed sources (Raihan *et al.,* 2008). Therefore, there is a need to explore cheaper sources of protein and energy feedstuffs to replace the expensive stuffs for livestock production and to ease the food-feed competition in the future.

However, the considerable increase in the cost of poultry diets round the world has been driven a force to search for cheaper sources of dietary energy and protein to be used to partially substitute the grains and oilseed traditionally used in broiler diets. Palm kernel cake (PKC) might be as an alternative protein source to replace the costly oilseeds (soybean, canola), and to minimize the feed cost for poultry production. *PKC is considered a medium grade protein feed, containing 14.6 to18.0% crude protein, useful for livestock production either as a single feed, with only minerals and vitamins supplementation, or mixed with other feedstuffs.* Palm kernel cake is the major by-product in palm oil extraction. The PKC is obtained by solvent or expeller processes.

Malaysia has an abundant amount of palm kernel cake (PKC), which is considered to be an agro-industrial waste derived from the extraction process of oil from palm fruits (Alshelmani *et al.*, 2016). Expeller PKC contained 90% DM, 4.1% ash, 15.6% fibre, 8% fat, 12.9% protein and ME 1672 Kcal/kg. PKC is cheaper in cost and its production and cultivation in the tropical countries are predominant. Many countries such as Malaysia, Indonesia, Thailand and Nigeria are the most important PKC producing countries. Lately in Nigeria, PKC is being used for the large scale animal feeding (Umunna *et al*., 1980; Onwudike, 1986). The introduction of this agro-industrial by-product in poultry feeding was necessitated by the scarcity and rapid increase in the cost of the more conventional protein supplements, groundnut cake, mustard oil cake, til oil cake and so on.

The inclusion of PKC in poultry diet may lead to increased fibre content as it contains higher level of crude fibre (15.6 %) and anti-nutritive factor *i.e* β-Mannan (30%). This properties of PKC can cause depression in feed conversion ratio and reduce weight gains by 20-25% in poultry. Further, the surface, width and height of intestinal villi of broiler chickens could be decreased due to inclusion of increased levels of fibre in poultry diets (Moharrery and Mohammadpour, 2005 and Kalmendal *et al.*, 2011). Thus, the effective nutrient utilization of poultry fed on PKC diet may be affected negatively. However, different formulation strategies such as processing (pelleting, grinding), different inclusion level, selection of suitable feedstuff, dietary manipulation, supplementation, crop breeding etc., could be followed to improve the quality and nutritive value of PKC diet for poultry.

In this regard, there is need to develop PKC based diet for poultry in order to replace conventional protein ingredients and to reduce the feed cost. Costs of feeding broilers and its protein requirement could be easily reduced and met with the use of less costly feed ingredients such as PKC. Diets formulated with different level of PKC along with proper processing such as pelleting, could have a considerable potential to enhance the productivity of broiler chickens. The focus of this study therefore is to assess and highlight the potentials of PKC as a popular feed ingredient in monogastric animal feeding towards sustainable livestock development.

Lately different types of feed forms are being introduced by the commercial feed mills to nourish the broiler chicken. These are crumble, mash, pellet etc., fed the birds for the different age group. Various feed forms can directly affect the cost of complete feed and production performance of broiler chicken (Jahan *et al*., 2006). Generally, pellet and crumble cost slightly more than the same feed in mash form. Broilers are typically practised on single feeding system in confinement, although their ancestors are grown up on a self-selecting feeding condition in the wild or range state (Hossain *et al.*, 2013). If the modern meat chickens are allowed to different form of feed selection, birds could show their inherent preference to sort out, balance their own feed and thrive better under this rearing condition as their ancestral birds do. The objective of the current study was to assess the productivity of broiler fed on different level of PKC diet and the preference of bird to the physical form of feed *i.e* mash or pellet.

MATERIALS AND METHODS

Animal husbandry and bird management:

Two trials were conducted subsequently with a total of 199 day-old mail broiler chicks (Cobb 500, 47.0 ± 0.23g) from hatch to 42 days. In the main trial, 175 chicks were assigned into seven dietary treatments *i.e,* D_1, D_2, D_3, D_4, D_5, D_6 and D_7 and each treatment replicated five times with five birds per replicate in a completely randomized design (CRD) from d1 to 35 days. Birds were reared in an open-sided housing condition under cage rearing system. Chicks were fed commercial starter diet *ad libitum* from d1 to 21 days. Commencing from day 22, the chicks were equally assigned to7 treatment groups, these are (i) basal or positive Control diet(D1, 0% PKC), ii) Control diet as negative (D2,

Table 1. Ingredient and nutrient composition of finisher or test diets (22-35 days)

Ingredients (%)	Diets						
	D_1	**D_2**	**D_3**	**D_4**	**D_5**	**D_6**	**D_7**
Corn	61.5	49.55	48.22	47.99	47.46	45.70	40.26
PKC	0.00	0.00	10.00	15.0	20.0	25.00	30.00
Soybean meal	29.40	21.64	11.40	8.30	5.80	1.60	1.16
Corn gluten	0.00	0.80	6.60	8.30	9.70	11.90	11.60
Fish meal	**0.00**	**4.50**	**4.50**	**4.50**	**4.50**	**4.50**	**4.50**
Wheat pollard	**1.84**	**11.69**	**7.71**	**4.60**	**1.30**	**0.00**	**0.00**
Palm oil	**4.10**	**7.10**	**6.90**	**6.80**	**6.80**	**7.10**	**8.70**
Sand	**0.00**	**2.30**	**1.60**	**1.20**	**1.0**	**0.43**	**0.00**
DCP	1.40	0.95	0.100	1.00	1.00	1.00	1.00
Limestone	0.90	0.75	0.70	0.70	0.65	0.65	0.60
K-carbonate	0.00	0.00	0.12	0.25	0.32	0.50	0.53
Sodium sulphate	0.00	0.00	0.40	0.40	0.50	0.50	0.50
Salt/Nacl	0.45	0.35	0.10	0.10	0.00	0.00	0.00
Choline Cl-70%	0.05	0.06	0.10	0.12	0.13	0.15	0.15
Vita premix	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Min premix	0.10	0.10	0.10	0.10	0.10	0.10	0.10
L-lysine	0.07	0.06	0.34	0.43	0.51	0.60	0.63
DL-methionine	0.14	0.10	0.06	0.05	0.04	0.03	0.03
L-Threonine	0.00	0.00	0.06	0.06	0.08	0.09	0.10
L-Tryptophan	0.00	0.0	0.04	0.05	0.06	0.08	0.09
	100	100	100	100	100	100	100
[1]Nutrient composition(%)							
ME (Kcal/kg)	3099	3102	3101	3100	3099	3100	3100
CP	19.00	18.99	19.0	18.99	19.02	18.99	18.99
DEB	243.00	231.00	223.00	216.00	215.00	214.00	217.00
EE	7.01	10.46	10.86	11.07	11.36	11.96	13.80
CF	3.31	5.95	5.92	5.85	5.99	5.85	6.11
Ca	0.77	0.76	0.76	0.77	0.76	0.77	0.76
Av.P	0.39	0.41	0.40	0.39	0.39	0.38	0.38
D Lys	1.05	1.06	1.06	1.09	1.06	1.05	1.05
D Met	0.43	0.43	0.43	0.43	0.43	0.44	0.44
D Thr	0.22	0.21	0.18	0.20	0.19	0.19	0.20
Tryp	**0.72**	**0.72**	**0.73**	**0.72**	**0.73**	**0.72**	**0.72**

[D_1 and D_2 refer to control diets without any PKC, whereas D_3, D_4, D_5, D_6 and D_7 diets were supplemented with 10%, 15, 20, 25 and 30 % PKC, respectively, [1]Nutrient composition was measured on calculated basis]

0% PKC) iii) basal diet with 10% PKC (D3), iv) basal diet with 15 % PKC (D4), v) basal diet with 20% PKC (D5), Vi) basal diet 25 % PKC (D6), and vii) basal diet with 30 % PKC (D7). Starter diet was procured from the commercial sources and fed the birds up to 21 days; and later finisher or test diets were formulated by supplementation with the different levels of PKC to feed the birds from d22 to 35 days. All the test diets were iso-caloric and iso-nitrogenous in nature, and supplied the birds *ad libitum* in a mash form from d22 to 35 days (Table 1).Chicks were brooded with a with a temperature of 33 ^{o}C for the first two days of rearing period. The temperature was then gradually reduced by 1 or 2 ^{o}C every 1 or 2 days until the chicks were 19 days old at which point the temperature was maintained at 24^{o} C for the rest of the trial. Continuous lighting program was maintained entire the trial period.

Data collection

Mortality was recorded as it occurred, while body weight and feed intake were measured weekly for the calculation of body weight gain, and FCR was corrected for mortality.

Feed selection test

A sub-sample of 24 male broiler chickens (35 days old) of similar strain and body weight was sub-divided into 8 cages (replicates), with four chicks per cage. Diet (D3) as stated in the above (Table 1) was considered herein as test diet and later pelleted to conduct this sub-trial. All the birds had a free access to two forms of diet *i.e*, pellet (P) and mash (M) *ad libitum* from d35 to 42 days. Feed intake was calculated daily, body weight, FCR and mortality were measured at the end of trial period.

Statistical analyses

All collected data were statistically analyzed using Minitab software (Minitab Version 16, 2000). The data were analyzed using one-way ANOVA with diet as factor. The significance of differences between means was determined by Fisher's least significant difference $P \leq .05$.

RESULTS

Growth responses of broiler chickens fed on different level of PKC diet

The growth responses of broiler chicken in terms of feed intake (FI), live weight (LW), body weight gain (BWG), feed conversion ratio (FCR) and mortality of broiler chickens are shown in Tables (2 & 3). The results of FI, LW, FCR and mortality of broilers fed commercial diet were not (P>0.05) influenced by dietary treatment from d1-21, as shown in Table 2. The data on FI, LW and weight gain of broilers fed test diets were unaffected (P>0.05) between treatment except for FCR on day22 to 35d (Table 3).The result also showed that comparatively better FCR (P<0.01) was found in the birds fed control diets (D_1, D_2) than those fed on other diets in this study (Table 3). The BWG tended to be significant (P<0.053) between treatment. The initial body weight on day 22 and the mortality (%) of broiler from day 22 to 35d were also unaffected (P>0.05) between treatment (data not shown).

Table 2. Feed intake (FI), live weight (LW), feed conversion ratio (FCR) and mortality of broilers fed commercial diet only from d1-21 days

Growth responses of broiler chickens fed on the different forms of compound feed:

Except for FI, the result of BW, BWG and FCR of broiler chickens fed on the pelleted **(P)** or mash **(M)** diet was not influenced (P>0.05) by treatment from day 35 to 42d (Table 4). The results showed that birds ate more (P<0.05) of the pelleted **(P)** diet than the mash **(M)** diet from 35 to 42daysunder the two different forms of feeding condition, as shown in Table 4. The choice of broilers was 58.53% in favour of Pdiet whereas the preference for M diet was 41.67%. Birds consumed 16.86% more P diet than the M diet in this experiment. The selection was 58.53% for P, and 41.67% for M diet, respectively.

DISCUSSION

Growth responses of broiler chickens fed on different level of PKC supplemented diet:

In some parts of the world, the concern for continued availability of conventional feedstuffs along with an increase in the production of palm kernel meal (PKM) has driven to research and establish the maximum inclusion level of palm kernel meal in broiler diets. PKC (also called Palm kernel meal) has a good potential to be used as carbohydrate and protein sources, and it is palatable and free from aflatoxin (Sundu*et al*., 2006). The crude protein content of PKC might vary from 12 to 23 % depending upon the efficiency of the process used to extract the oil (PNI, 1990). The focus of this study therefore is to assess and highlight the potentials of PKC as a major feed ingredient in monogastric animal feeding towards sustainable livestock development.

Table 2. Feed intake (FI), live weight (LW), feed conversion ratio (FCR) and mortality of broilers fed commercial diet only from d1-21 days

Parameters	Days	Dietary Treatments								
		D_1	**D_2**	**D_3**	**D_4**	**D_5**	**D6**	**D7**	**Pooled SEM**	**P-values**
FI (g/b)	1-21	1274.8	1269.0	1240	1303.3	1260.0	1368.0	1318.0	12.536	0.081
LW (g/b)	1-21	994.20	959.0	937.14	963.6	957.14	998.33	948.60	7.646	0.163
FCR	1-21	1.34	1.36	1.32	1.35	1.32	1.37	1.39	0.0164	0.776
Mortality (%)	1-21	3.33	3.23	0.00	3.33	0.00	0.00	2.85	0.918	0.698

[Data represent mean values of five replicates consisting of 5 birds each replicate from d1-21days]

Table 3. Feed intake (FI), live weight (LW),initial body weight (IBW), body weight gain (BWG) and FCR of broilers fed on different level of PKC diets from 22-35 days

Parameters	**Days**	**Dietary Treatments**								
		D_1	D_2	D_3	D_4	D5	D6	D7	Pooled SEM	P-values
IBW(g/b)	**22**	996.0	984.0	994.0	994.0	974.0	1002.0	970.0	6.169	0.767
FI(g/b)	22-35	1756.0	1808.0	1820.0	1784.0	1678.0	1736.0	1852.0	17.630	0.195
BWG (g/b)	**22-35**	956.0	958.0	896.0	874.0	850.0	826.0	860.0	12.508	0.053
FCR	**22-35**	1.84^{cd}	1.88^{c}	2.05^{ab}	2.06^{ab}	1.98^{ab}	2.10^{a}	2.15^{a}	0.0213	0.01

[Data represent mean values of five replicates consisting of 5 birds each replicate from d22 to 35 days; Means bearing uncommon superscripts in a row are significantly different at P<0.05; D_1 and D_2 refer to diets without any PKC, whereas D_3, D_4, D_5, D_6 and D_7 diets were supplemented with 10%, 15, 20, 25 and 30 % PKC, respectively; SEM, standard error of means]

However, the growth responses and feed consumption results of the broilers revealed no significant difference between the treatments in the current study. The results imply that birds on the different level of PKC supplemented diet gained similar or identical body weight or grew evenly entire the trial period fed on similar amount of PKC supplemented diet. Further it could suggest that broiler chickens might consume equal amount of PKC supplemented diet to meet its body requirement or breed or genetic standards. In addition, the identical growth of birds fed on PKC supplemented diet could occur due to provision of an ideal nutrient composition or well-balanced diet (Hossain *et al.*, 2014).

Although the FCR of broiler fed on supplemented diets was poorer than the birds fed on control diet, birds grew uniformly having no significant influence on the feed intake, growth responses and mortality. The reason for poor FCR of broilers fed on PKC diet is not obvious, but it may occur due to presence of anti-nutritional factors and high crude fibres contained in the PKC. PKC has been reported to contain β-mannan which has anti-nutritional properties and it might retard the full utilization of nutrients in PKC by monogastric animal (Oluwafemi, 2008). The digestion, absorption and utilization of

Table 4. Feed intake (FI), initial body weight(IBW), body weight(BW), body weight gain(BWG) and FCR of broilers fed on pellet (P) vs mash (M) type of diets from 35 to 42 days

Traits	Age (days)	Treatment			
		P	M	SEM	P-values
FI(g/b)	35-42	1043.6[a]	762.5[b]	41.73	0.05
IBW(g/b)	35	1958.3	1921.0	47.77	0.707
BW(g/b)	42	2679.2	2437.4	75.12	0.159
BWG(g/b)	35-42	720.8	516.5	68.55	0.187
FCR	35-42	1.53	1.60	0.168	0.837

[Data represent mean values of four replicates consisting of three birds each replicate; Means having uncommon superscripts in a row are significantly different at P<0.05; P-pellet and M-mash diet].

nutrient are reduced by the presence of high level of crude fibre and anti-nutritional factors in the diets (Wahrenham *et al.,* 1994; Akande *et al.,* 2010). The PKC is considered as a medium grade plant protein, and it is reported that this protein might have potentiality to bind the epithelial cells lining of the small intestine that leads to interfere with nutrient absorption and digestibility (Liener, 1989; Siddhuraju *et al.,* 2002).

The feed intake of bird on supplemented diet (D7) is somewhat numerically increased compared to control or basal diet (D1 or D2), although there is a possibility of decreasing feed digestibility as PKM supplemented diet (D7) contains high fibre. The increased trend of feed consumption could make total digestible nutrient intake relatively high. Moreover, higher fibre digestion could induce the birds to consume more feed to meet their nutrient requirement (Hossain *et al.,* 2016). β-mannan is the non-starch polysaccharide (NSP)found as a main component in PKM, which may act as a prebiotic (Sundu *et al.,* 2006). The feed intake of broiler chicks might be increased by probiotic reported by Yeo and Kim (1997).

Growth performances of broiler chickens fed on the different forms of complete diets:

It is obvious from the result that body weight gain and FCR were not influenced by feeding on the different forms of complete diets except for feed consumption. Feed intake of broiler chickens was differed significantly by the physical form of feed in this study. Broiler showed greater preference to consume pelleted (P) feeds than those on mash (M) diet.Broiler chickens ingested 16.86% more P diet than the M diet in this experiment. Similar results were found by the previous investigators (Hamm and Stephenson, 1959; Bolton and Blair, 1977; Moran, 1990, Bertechini *et al*., 1992; Nir *et al*., 1995). It is clear that birds preferred 'P' diet when they were allowed to two forms of similar diet. Our findings are agreed with the report of previous researchers (Jahan *et al.,* 2006; Rose *et al.,* 1986; Yo *et al.,* 1997), who showed that physical forms of diets could influence the feed selection. Apart from physical form(size, type, structure, texture) of the complete diet, sensorial characteristics of food materials such as colour, smell, flavour, taste or palatability could also play a significant role in feed consumption of broiler chickens (Cruze *et al.,* 2005).

However, in this study it is noted that birds grew evenly fed on either form of diets, although bird on P group consumed greater amount of diet than the mash (M) diet. The reason for identical growth and development of broiler chicken from feeding both form of complete diet, probably could be due to similar amount of nutrition retrieved from the either form of complete diet. It is apt to mention herein that both diet (P or M) had a similar feed and nutrient composition except for physical form only in this study. After all, it can be said that the supply of identical ration with similar nutrient composition to broiler chickens might help them to grow uniformly.

CONCLUSIONS

It would appear from the result that PKC could be used as a potential substitute of the protein and carbohydrate sources up to 30 % in poultry diet without affecting their growth performance. Further, broiler preferred pellet to mash diet which implies that the physical form of the complete diet could also influence the feed consumption of the broiler chicken with no effect on the growth responses of the bird in the current study.

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