



Effects of Feeding Palm Kernel Cake with Crude Enzyme Supplementation on Growth Performance and Meat Quality of Broiler Chicken

Hassan Usman Zamani^{1,2,*}, Teck Chwen Loh¹, Hooi Ling Foo^{4,5}, Samsudin A. A.^{1,3}, Alshelmani M. I.^{1,6}

¹Department of Animal Science, Faculty of Agriculture Universiti Putra Malaysia, Serdang, Malaysia

²Department of Agricultural Education, School of Vocational Education, Umar Suleiman College of Education Gashua, Gashua, Nigeria

³Institute of Tropical Agriculture, Universiti Putra Malaysia, Serdang, Malaysia

⁴Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Serdang, Malaysia

⁵Institute of Bioscience, Universiti Putra Malaysia, Serdang, Malaysia

⁶Department of Animal Production, Faculty of Agriculture, University of Sebha, Sebha, Libya

Email address:

talk2zamani@gmail.com (H. U. Zamani)

*Corresponding author

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Abstract: Ingredients used in monogastric diet contain certain quantity of anti-nutritional factors, such as high fiber content in PKC, and complex carbohydrate in corn and soybean meal which cannot be degraded easily by poultry. Exogenous enzyme can be used to supplement enzymes available in the digestive tract of the birds to a certain level that is effective, or to provide hydrolytic capacity that is totally absent. The objective of this study was to study the effects of feeding Palm kernel cake with crude enzymes on growth performance and meat quality of broiler chicken. Four days solid state fermentation was conducted using *Paenibacillus curdlanolyticus* DSMZ 10248 as cellulolytic bacteria and palm kernel cake PKC as substrate, at different moisture ratio to produce enzymes. The enzymes produce were administered at different inclusion level into a broiler diet. A total of 252 male broilers were raised in a battery cage from day old to 42 days; 6 birds/cage. The birds were divided into 7 groups all the diet contains 15% PKC+corn and soybean meal. The dietary treatment consisted of: (i) Diet without enzyme (ii) Diet+0.1% commercial enzyme (iii) Diet+0.2% crude enzyme (iv) Diet+0.4% crude enzyme (v) Diet+0.6% crude enzyme (vi) Diet+0.8% crude enzyme (vii) Diet+1% crude enzyme. The result showed that higher body weight and feed intake were observed in group fed diet+1% crude enzyme, while lower body weight and feed intake were recorded in the control group. The findings of this research had showed that crude enzyme utilization on broiler diet improved growth performance of broiler chicken with little effects on meat quality, specifically pH, texture and color.

Keywords: Cellulolytic Bacteria, Crude Enzyme, Poultry Growth Performance, Palm Kernel Cake (PKC), Solid State Fermentation (SSF)

1. Introduction

Incorporation of PKC in livestock and poultry diet is limited due to high fiber level, gritty nature, unpalatability, relatively low availability of amino acids and copper content. However, some reports indicated that the performance of birds fed 10-15% PKC without enzymes was significantly

reduced [1]. Similarly, it was reported that birds fed 10% PKC showed lower body weights compared to those fed 10–15% fermented PKC [2]. Several studies have been conducted on enzymes production by solid state fermentation using agro-industrial waste using microbes such as bacteria

and fungi. It has been reported that important enzymes have traditionally been obtained from submerged fermentation because of the ease of handling and greater control of environmental factors like pH, and temperature [22]. SSF can improve the yield and reduces cost of enzyme production. Production of enzymes from microorganisms is much higher and cost effective. It was reported by Rashid *et al.*, [23] that enzymes with mannanase activity could break down the non-starch polysaccharides (mannans) of PKC, thereby improving its nutritive quality. It was also reported that variety microorganisms were studied to produce cellulase and xylanase [24]. However, SSF has been found to be more closely studied for enzyme production. [25]

Many feed ingredients used in monogastric diets contain significant quantities of anti-nutritional factors (ANF) which limit both their feed value and usage [3]. The role of enzymes as feed additive in poultry diets is well established [4]. This research work was aimed at feeding PKC supplemented with locally crude enzyme produced by SSF to broiler diet at different inclusion levels. Even though there are limited literatures on the use of crude enzyme to monogastric diet. Hence, the objectives of this study was to investigate the effects of different inclusion rates of crude enzyme in palm kernel cake dietary on growth performance and meat quality of broiler chicken.

2. Materials and Methods

2.1. Birds and Experimental Diets

A total of 252 male broiler one-day old chicks (Cobb 500) were raised in battery cage system in Department of Animal Science, Universiti Putra Malaysia (UPM). The birds were randomly distributed into seven groups with six replicates per each group and 6 chicks per cage (replicate) for the period of 42 days. Feeds and water were supplied *ad-libitum*. Feed intake and body weight were recorded weekly. Upon arrival, the birds were vaccinated with (IB-ND) against infectious bronchitis IB and new castle disease ND.

2.2. Production and Extraction of Crude Enzyme

Enzymes were produced as described by Alshelmani *et al.* [1, 4]. Enzymes were produced via SSF, and PKC was used as substrate and *Paenibacillus curdlanolyticus* DSMZ 10248 was used as bacteria. Enzymes were extracted by adding distilled water and Whatman filter paper No. 1 was used to filtrate. The aliquot was consider as crude enzyme

2.3. Data and Sample Collection

The individual body weight (BW) and feed intake (FI) were recorded weekly. Total weight gain (TWG) and feed conversion ratio (FCR) were calculated at 6 weeks. 12 birds from each treatment were slaughtered using halal method and 60g breast meat was collected for sampling and meat quality analysis.

Measurement of Meat Quality

pH determination: The pH was determined using the

indirect method. The pH was determined at 7 day post mortem using a pH meter (Mettler Toledo, AG 8603, and Switzerland). The pH meter was first calibrated at pH 4.0 and then 7.0 prior to use. Approximately 0.5 g of each crushed muscle sample was homogenized (Wiggen Hauser® D-500, Germany) for 20 seconds in 10 ml; ice cold deionized water in the presence of 5Mm sodium iodoacetate (Merck Schuchardt OHG, Germany) to prevent further glycolysis. The pH of the resultant homogenates was measured using the electrode attached to the pH meter.

Colour determination: Breast meat colour were determined using Colour Flex spectrophotometer (Hunter Lab Reston, VA, USA) using International Commission on Illumination (CIE) Lab-values (also known as L*, a*, b*) with D56 illuminant and 10° standard observer, tristimulus values (X, Y, Z) and reflectance at specific wavelength (400-700) nm to express the meat colour data. The three fundamental CIE Lab outputs: L* describes lightness on a scale running from 0 indicating black (all light absorbed) to 100 indicating white (all light reflected), a* describes redness on a scale that starts from +60 (red) to -60 (green) and b* describes yellowness, which ranges from +60 (yellow) to -60 (blue). The device was calibrated against black and white reference tiles before use. Meat samples were transferred from -80°C freezers into a 4°C chiller overnight, the samples were then unpacked, and sliced into meat cubes of approximately 10mm of thickness and bloomed for 30 minutes. The samples were placed in the colour flex cup with the bloomed surface facing down. For each sample, the values of L*, a* and b* were recorded in triplicate (the cup rotates 90° in the second and third readings).

Drip loss were calculated as describe by [20]. The fresh meat samples were from breast at day 0 was individually weighed (approximately 20g) and recorded as initial weight (W1). The samples were then put into sealed polyethylene plastic bags, placed within a container and stored in a chiller at 4°C. After the 7 days storage, the samples were removed from the bags, gently blotted dry, weighed, and recorded as W2. The percentage of drip loss was calculated and expressed as the percentage of differences of sample initial weight and sample weight after 7 days storage divided by sample initial weight

$$\text{Drip loss, \%} = [(W1 - W2) \div W1] \times 100$$

Where, W1=initial sample weight and W2=sample weight after 7 days storage.

Cooking loss: The samples used for colour determination were collected and used for determining cooking loss. After colour determination, the samples were individually weighed and recorded as initial weight (W1), placed in water-impermeable and vacuum packed. The samples were then cooked in a pre-heated water bath set at 80°C. When the internal temperature of the samples reaches 78°C as monitored using a stabbing temperature probe inserted into the geometric centre of the sample, the cooking went on for another 10 minutes. The cooked samples were then removed from the water bath, equilibrated to room

temperature, removed from the bag, blotted dry without squeezing, and reweighed (W2). The cooking loss percentages were calculated using the following equation [20]

$$\text{Cooking loss, \%} = [(W1 - W2) \div W1] \times 100$$

Where, W1=initial sample weight before cooking and W2=cooked sample weight

Shear force: It was calculated as described by [21]. The samples used for cooking loss determination were collected and used for determining tenderness of the meat. Meat tenderness was measured using the Volodkovitch shear force test. The analysis is based on the mechanical force (kg) required to shear the muscle fibres of a cooked meat sample. The textural assessment of cooked poultry meat tenderness were conducted using the TA. HD plus[®] texture analyser (Stable Micro System, Surrey, UK) equipped with a Volodkovitch blade set. The equipment was calibrated at 5 kg for weight, 10 mm return distance for height and the blade speed was set at 10 mm/sec. Three replicate blocks (1×1×2cm) were cut as parallel to the direction of the muscle fibers as possible. Each block was sheared with the Volodkevitch jaw (stainless steel probe shaped like an incisor) on texture analyzer (Stable Micro System, Surrey, UK)

2.4. Experimental Design and Data Analysis

The experimental design was based on completely randomized design (CRD), and data were analyzed by using General Linear Model statistical analysis system SAS[®] 9.3 (SAS Institute 2003) by one-way ANOVA. Duncan's Multiple Range Test were used to compare the significant difference between the treatments at $P < 0.05$.

3. Results

3.1. Growth Performance

The effects of feeding different inclusion level of crude enzyme on body weight, total weight gain, feed intake and feed conversion ratio were shown in figures 1, 2, 3, and 4. Inclusion of locally produced enzymes in broiler diet significantly increased ($P < 0.05$) the body weight and total weight gain, in the groups fed 15% PKC+locally produced enzymes, whereas the body weight, total weight gain, feed intake were significantly lower ($P > 0.05$) in the groups fed 15% PKC without enzyme. In addition, the groups of chicken fed 15% PKC without enzyme showed higher feed conversion ratio than other groups. The result showed that higher body weight and feed intake were observed in T7, while lower body weight and feed intake were recorded in T1. (Figure 1)

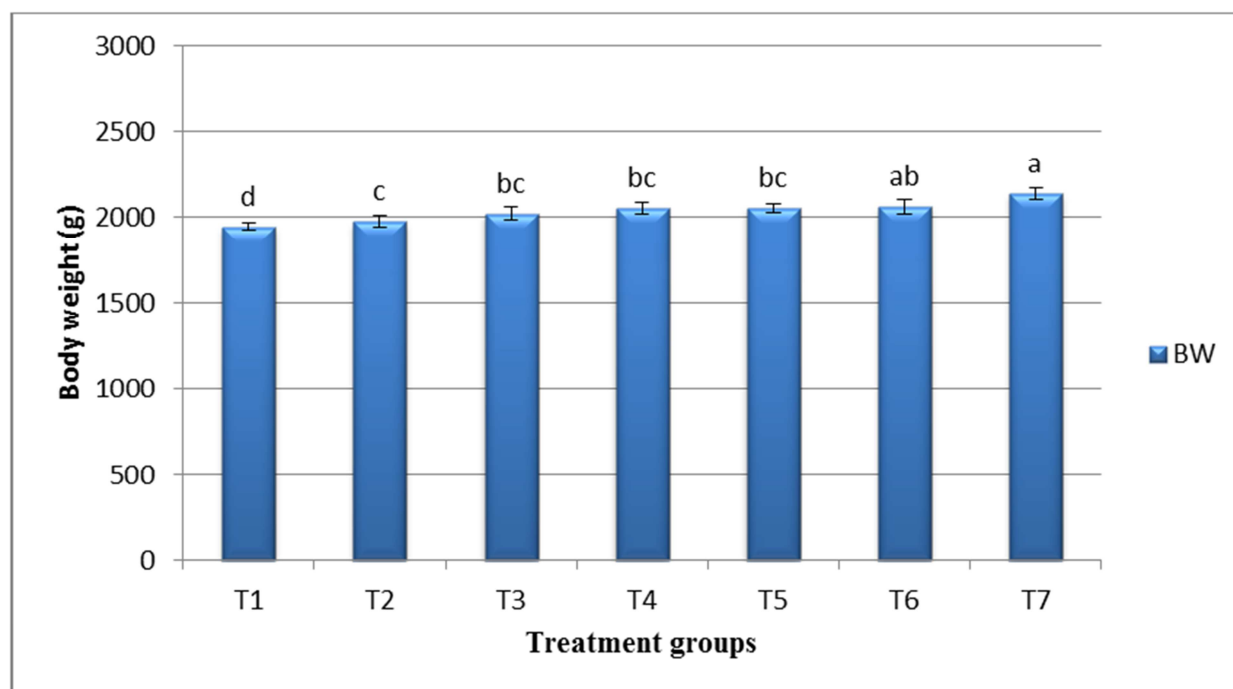


Figure 1. Effects of locally produced enzymes on body weight of broiler chicken.

^{a-d} Means with different superscript are significantly different at ($P < 0.05$)

T1: (15% PKC) T2: (15% PKC+0.1 commercial enzyme) T3: (15% PKC+0.2% crude enzyme) T4: (15% PKC+0.4% crude enzyme) T5 (15% PKC+0.6% crude enzyme) T6: (15% PKC+0.8% crude enzyme) T7: (15% PKC+1% crude enzyme)

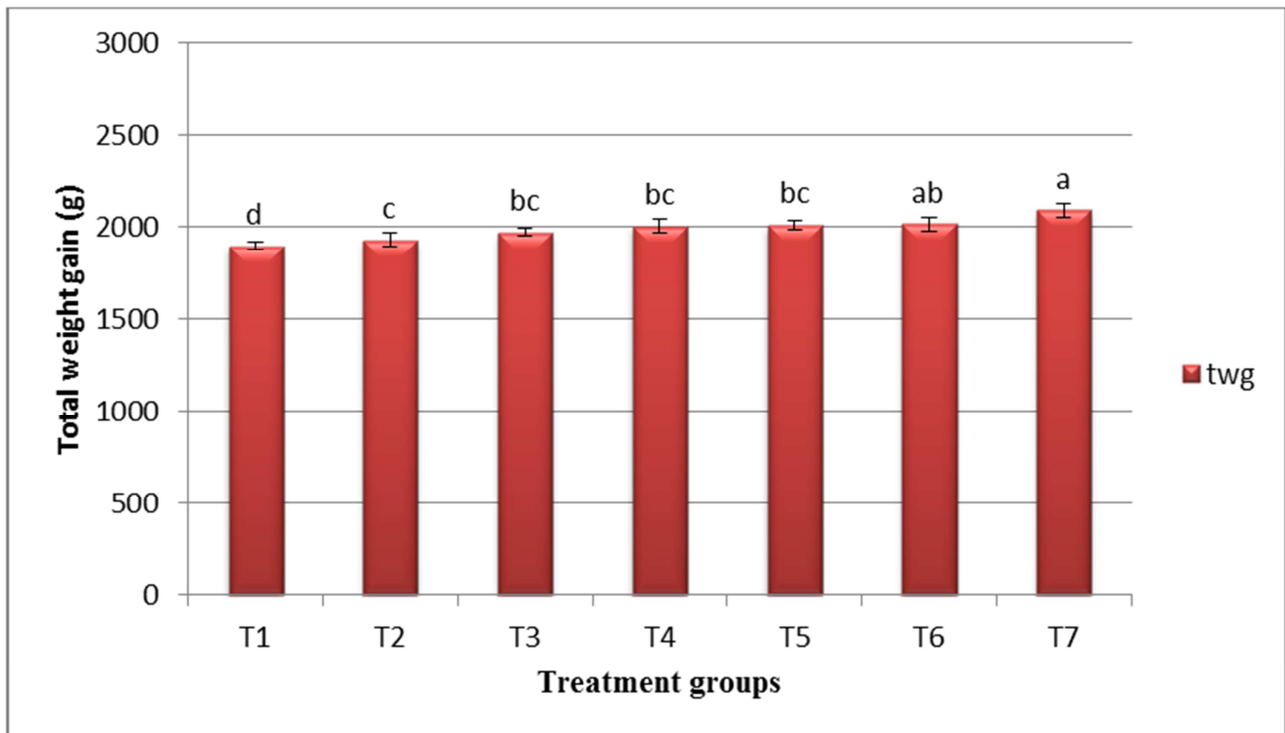


Figure 2. Effects of locally produced enzymes on total weight gain of broiler chicken.

^{a-d} Means with different superscript are significantly different at ($P < 0.05$)

T1: (15% PKC) T2: (15% PKC+0.1 commercial enzyme) T3: (15% PKC+0.2% crude enzyme) T4: (15% PKC+0.4% crude enzyme) T5 (15% PKC+0.6% crude enzyme) T6: (15% PKC+0.8% crude enzyme) T7: (15% PKC+1% crude enzyme)

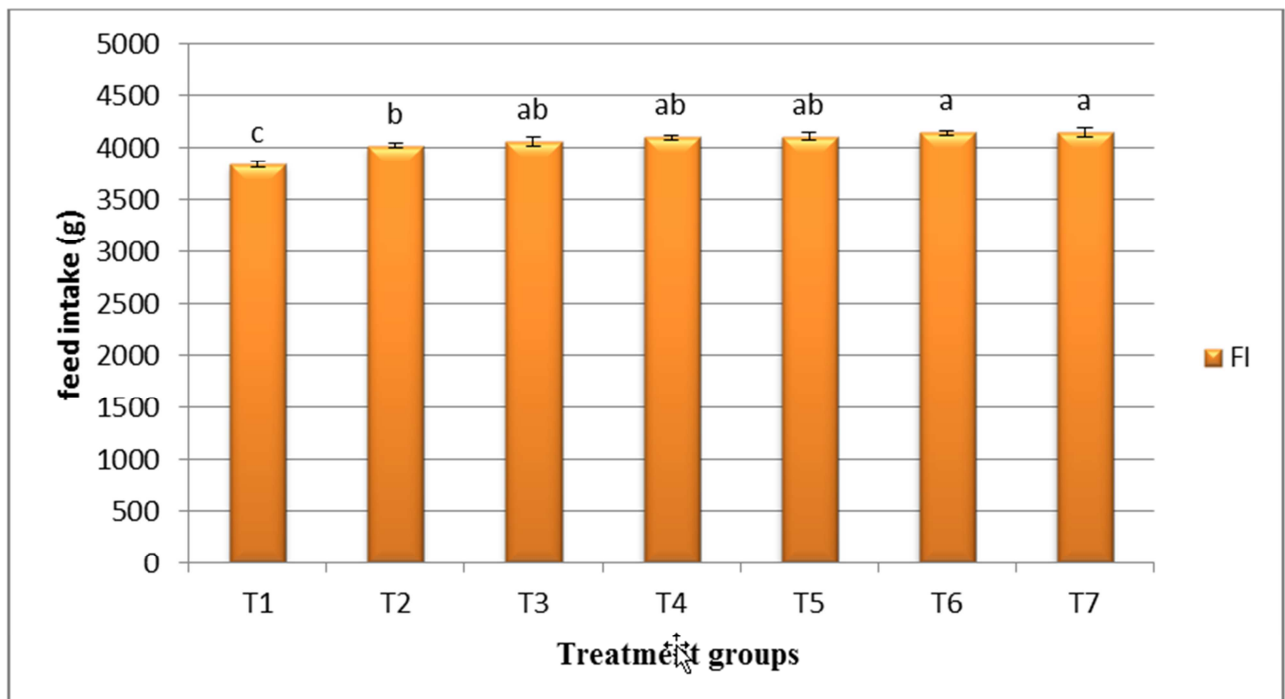


Figure 3. Effects of locally produced enzymes on feed intake of broiler chicken.

^{a-c} Means with different superscript are significantly different at ($P < 0.05$)

T1: (15% PKC) T2: (15% PKC+0.1 commercial enzyme) T3: (15% PKC+0.2% crude enzyme) T4: (15% PKC+0.4% crude enzyme) T5 (15% PKC+0.6% crude enzyme) T6: (15% PKC+0.8% crude enzyme) T7: (15% PKC+1% crude enzyme)

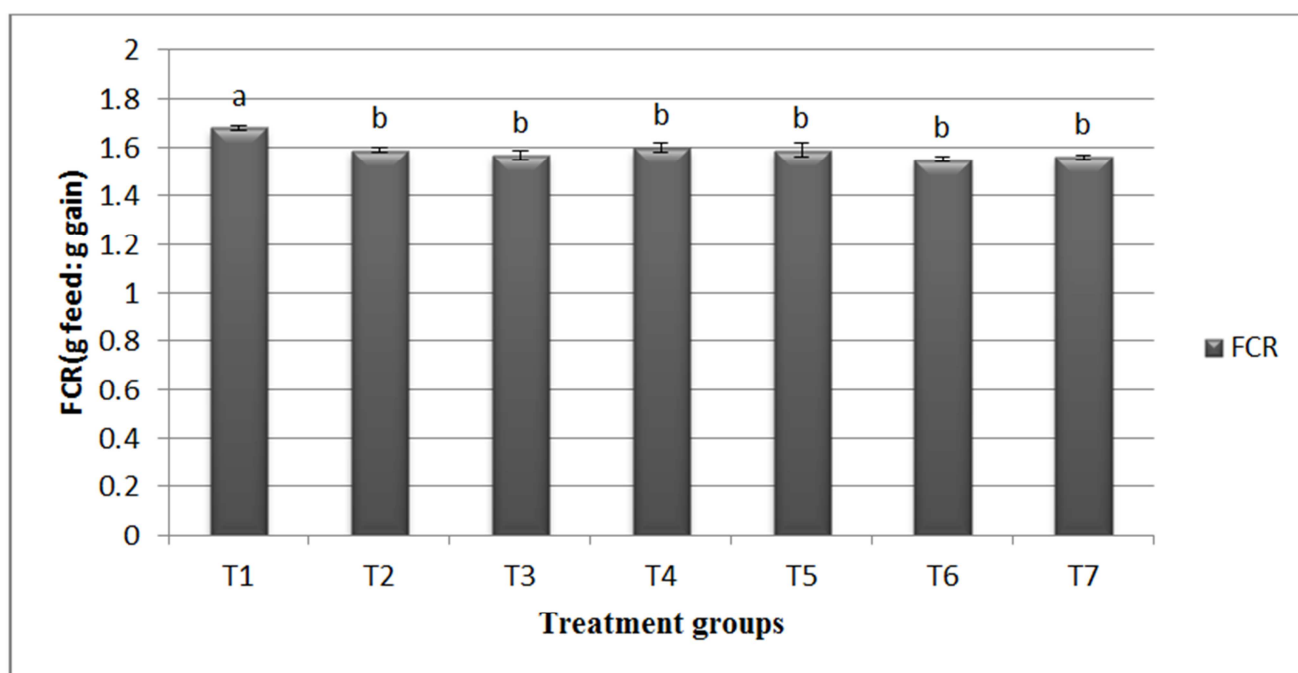


Figure 4. Effects of locally produced enzymes on feed conversion ratio of broiler chicken.

^{a-b} Means with different superscript are significantly different at ($P < 0.05$)

T1: (15% PKC) T2: (15% PKC+0.1 commercial enzyme) T3: (15% PKC+0.2% crude enzyme) T4: (15% PKC+0.4% crude enzyme) T5 (15% PKC+0.6% crude enzyme) T6: (15% PKC+0.8% crude enzyme) T7: (15% PKC+1% crude enzyme).

3.2. Meat Quality

The effects of feeding locally produced enzymes on breast meat color, drip loss, cooking loss, pH, and texture are presented in Table 1. There were no significant differences ($P > 0.05$) among the treatment groups for pH, and drip loss, while the result for texture analysis indicated that higher texture was observed in the control group (T1), T2, T3, compare to the other treatments. Similarly, the result for cooking loss indicated that it was significantly increased ($P < 0.05$) in T7, T5, T3, T6, and T1 compare to other

treatment group.

The breast meat color was in normal range for all treatment groups. The result for redness (a^*) showed that is significantly lower ($P < 0.05$) in the control group compare to the other treatments. While the result for lightness (L^*), showed that is significantly lower ($P < 0.05$) in T1 and T2 compare to other treatments. Similarly, the result for yellowness (b^*) showed that is significantly lower ($P < 0.05$) in T7 compare to other treatment group (Table 1).

Table 1. Effects of locally produced enzymes on meat quality of broiler chicken.

Dietary treatments							
Parameters	T1 15% PKC	T2 15% PKC	T3 15% PKC	T4 15% PKC	T5 15% PKC	T6 15% PKC	T7 15% PKC
L^*	49.20±1.01 ^c	50.12±0.43 ^{bc}	50.98±1.10 ^{abc}	51.49±1.82 ^{abc}	54.02±0.95 ^a	53.28±1.01 ^{ab}	51.20±0.42 ^{abc}
a^*	5.76±0.42 ^c	9.32±1.24 ^b	13.01±0.62 ^a	12.29±0.45 ^a	12.52±0.35 ^a	11.40±0.97 ^a	11.89±0.47 ^a
b^*	12.19±0.64 ^b	12.42±0.52 ^b	15.35±1.19 ^a	12.79±0.61 ^{ab}	13.35±0.61 ^{ab}	13.34±0.78 ^{ab}	11.93±0.81 ^b
Breast pH	5.80±0.01 ^a	5.79±0.02 ^a	5.77±0.03 ^a	5.75±0.009 ^a	5.77±0.02 ^a	5.76±0.02 ^a	5.75±0.02 ^a
Cooking loss (%)	22.33±1.8 ^{ab}	19.59±1.2 ^b	23.83±1.7 ^{ab}	22.92±0.4 ^{ab}	23.66±1.7 ^{ab}	20.37±1.0 ^{ab}	24.40±0.5 ^a
Drip loss (%)	0.93±0.07 ^a	0.95±0.04 ^a	0.97±0.08 ^a	0.97±0.10 ^a	0.87±0.11 ^a	0.91±0.07 ^a	0.92±0.06 ^a
Shear force (kg/cm ²)	1.14±0.12 ^a	1.06±0.11 ^{ab}	1.15±0.82 ^a	0.79±0.06 ^b	0.98±0.07 ^{ab}	0.82±0.09 ^b	0.93±0.05 ^b

The result were presented as Mean values±SE

^{a-c} Means with different superscript within the same row are significantly different at ($P < 0.05$)

T1: (15% PKC) T2: (15% PKC+0.1 commercial enzyme) T3: (15% PKC+0.2% crude enzyme) T4: (15% PKC+0.4% crude enzyme) T5 (15% PKC+0.6% crude enzyme) T6: (15% PKC+0.8% crude enzyme) T7: (15% PKC+1% crude enzyme)

L^* , lightness; a^* , redness; b^* , yellowness

4. Discussion

4.1. Growth Performance

The reduction of body weight, total weight gain, feed intake, and higher FCR in the broiler chicken fed 15% PKC without enzymes might be attributed to the reduction of CF, ADF, and NSP in the PKC as mention by Alshelmani *et al.* [4]. Moreover, the decrease in body weight, digestibility and feed intake might also be attributed to the amount of complex carbohydrate content in corn and soybean meal. The finding were in agreement with Soltan [1], who reported that inclusion of 10-15% PKC in broiler diet can lead to decrease in body weight. He also stated that feed conversion ratio were higher in the groups treated with 10–15% PKC. The result were also consistent with Aya *et al.* [5], who reported that lower body weight were observed in birds fed diet with the inclusion level of 10% PKC.

The increase in body weight, total weight gain and feed intake in the groups of birds fed 15% PKC supplemented with locally produced enzyme could be attributed to the reduction of non-starch polysaccharide and complex carbohydrate due to supplementation of enzymes.

The findings are in agreement with Nadeem *et al.* [6], who reported that the performance of birds fed diet with enzyme supplementation was higher compare to the control groups. It was also reported that body weight, weight gain, average daily gain of chickens at 42 days of age in the control is the lowest among the birds in the dietary treatments [7]. The result obtained for this study were consistent with Rahman *et al.* [8], who reported that multi enzyme supplementation in broiler diet showed significant positive effects on weight gain, and feed intake among the treatment groups compared to the control. In addition, the findings of this study are in agreement with Makhdum *et al.* [9], who reported that high weight gain values and low FCR were recorded in the groups treated with crude enzyme compared to the control. Moreover, it was reported that enzyme supplementation improved body weight and body weight gain in broilers [5]. Enzyme supplementation might improve broiler performance by at least two mechanisms: increasing feed intake and improving nutrient digestibility [10]. Many authors reported an improvement on performance of broiler chicken fed diet with enzymes supplementation [13, 14, 11,] However, few studies claimed that there were no significant difference between treatment groups fed diet with enzyme and the control groups. Possibly this could be attributed to the differences in diet formulation and other management practices [15]

4.2. Effects of Enzymes Utilisation on Broiler Meat Quality

Meat color is an important quality attributes both for the consumer's selection of fresh meat at the retail level and for the consumer's final evaluation and acceptance of a meat product at time of consumption. Because of its importance to final product quality, factors affecting poultry meat color have been extensively examined. Factors shown to affect

poultry meat color includes bird sex, age, strain, method of processing, exposure to chemicals, cooking method, irradiation, and freezing [16].

The result for meat analysis is shown in Table 1 there were no significant different ($P>0.05$) for pH between the dietary treatments. The finding was in agreement with Meng *et al.* [17], who reported that pH, drip loss and water holding capacity did not differ among all dietary treatments in pigs.

The result obtained for these studies showed that addition of enzymes to broilers diet has little effects on meat quality. The result were consistent with Borba *et al.* [18], who reported that dietary enzyme had no effects on the different meat quality like pH, cooking loss drip loss, color, and texture. It was reported by Okeudo *et al.* [12], who claimed that there was no significant difference in meat quality among the dietary treatments.

In addition, it was reported that significant difference were observed in pH and color in broiler meat among the treatment groups [16]. In another research as well, there was observable improvement in meat quality [17] reported that there was improvement in broiler meat quality in terms of juiciness; shear force value, tenderness, and cooking loss as demonstrated by [19].

5. Conclusion and Recommendation

The findings of this research had clearly indicated that crude enzyme utilization on broiler diet improved growth performance of broiler chicken. However, it has little effects on meat quality. No significant difference was observed in pH, and drip loss. Higher body weight and feed intake were recorded in in the groups fed diet with 1% crude enzyme, whereas lower body weight, feed intake and higher FCR were observed in the control group. Studies on the use of locally produced enzymes on broiler diet at a larger scale should be conducted.

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Biography



Hassan Usman Zamani Hassan zamani is a bonafide indigene of Potiskum local government Yobe state. He works at Umar Suleiman College of Education Gashua. He has published article in academic journal in Scientific Journal of Agriculture and many conference papers.