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TRUE METABOLISABLE ENERGY (TME) AND TRUE DIGESTIBLE PROTEIN (TDP) VALUES OF BAKER'S YEAST FERMENTED CASSAVA PEEL MEAL USING BROILERS AND TURKEYS

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ABSTRACT

This study determined true metabolisable energy (TME), true metabolisable energy corrected for nitrogen (TMEn) and true digestible protein (TDP) of fermented cassava peel meal (CPM) using broiler chickens and turkeys. Thirty two (32), six week old apparently healthy Marshall broiler chickens and indigenous turkeys each were divided into four groups of 8 birds. Each group was replicated four times and each replicate comprised one male and one female, respectively. Each replicate was placed in an adapted metabolic cage and randomly assigned to three differently treated samples of cassava peel meal (CPM) as follows: CPM treated with 0.0% baker's yeast and fermented for 0hours ($T_{0.00\%/0\text{hours}}$) which served as the control; CPM treated with 0.6% baker's yeast and fermented for 72hours ($T_{0.60\%/72\text{hours}}$) which resulted in ; CPM treated with 0.2% baker's yeast, fermented for 72hours ($T_{0.20\%/72\text{hours}}$) in a completely randomized design (CRD) experiment. The fourth groups were used as fasted birds of broiler chickens and turkeys. The birds were acclimatized for two days in the metabolic cages, starved of feed but not water on the third day and on the fourth day by 8.00am the birds were individually force-fed with 30g each of the corresponding CPM sample assigned to their group. Droppings were subsequently collected for the next 24hours, oven dried and analysed for proximate and gross energy composition. TME, TMEn and TDP were calculated using appropriate formulae. Results obtained indicated a significant ($p<0.05$) increase in the crude protein content of CPM from 7.16% in the control ($T_{0.00\%/0\text{hour}}$) to 14.48% in the $T_{0.60\%/72\text{hours}}$. Gross energy value also significantly ($p<0.05$) increased to 3526.69Kcal/kg at $T_{0.20\%/72\text{hours}}$. TME, TMEn and TDP of the control ($T_{0.00\%/0\text{hour}}$), treatment with the highest energy value ($T_{0.20\%/72\text{hours}}$) and treatment with highest crude protein value ($T_{0.60\%/72\text{hours}}$) were within the range 2859.51Kcal/kg to 3154.82Kcal/kg, 2595.15Kcal/kg to 2883.99kcal/kg and 62.61mg/g to 137.370 mg/g, respectively for turkeys. Values for broilers were in the range 2864.47Kcal/kg to 3155.9Kcal.kg of TME, 2637.98 to 2920.07Kcal/kg of TMEn and 62.77mg/g to 140.91mg/g of TDP. The results indicated that fermentation of CPM with baker's yeast particularly, at 0.60% and 0.20% for 72hours respectively, improved the crude protein, gross energy content of CPM as well as TME, TMEn and TDP of cassava peel meal using 6 weeks old broiler chickens and turkeys.

Key words: Cassava peel meals; broiler chickens; turkeys; TME; TMEn; TDP.

Introduction

In monogastric animals feeding, high fiber feed considered inadequate or waste and in some instances, non-starch polysaccharides (NSP), can exert anti-nutritive activity on the animals. Cassava peel is very rich in carbohydrate but has high fibre content that make it poorly digestible by monogastrics when included in their feed. Yeast is reported to have cellulase enzyme activity which can degrade the fibre in cassava peel thereby making available more energy from the peels (Sani *et al.*, 1992; Raji and Okeniyi, 1998; Belewu and Banjo 1999). This could ultimately promote weight gain

and overall improved performance of animals (Atteh, 2000; Abdulrashid *et al.*, 2007). Measurement of digestibility is therefore, essential in order to define the efficiency of utilization of nutrients within feed and feedstuff and to classify the nutritional quality of feed items and formulate diets for captive birds (Nguyem, 2005). The processes involved in digestion include; maceration, grinding of the feed in the gizzard and added to this is the digestion within the alimentary canal caused by endogenous enzymes of the feed (Chang'a *et al.*, 2003; McNab *et al.*, 1996). Digestibility may be expressed as apparent or true digestibility. Apparent digestibility is a relationship

between the amount of nutrient consumed in the diets and the amount that appears from gastrointestinal tract: It is expressed mathematically as (Nutrient intake – nutrient in faeces/nutrient intake). Apparent digestibility indicate nutrient absorbed but then excreted back into the digestive tract, as well as by endogenous nutrient losses, such as those from the shedding of the intestinal epithelia and mucosa secretions (Bath *et al.*, 2001). The bioassay for True metabolisable energy (TME) therefore, is based on two assumptions, (1) in a previously fasted bird, there is a linear relationship between energy voided as excreta (FE + UE) and the energy input as feed (IE); (2) the intercept of the regression line is a valid estimate of metabolic fecal energy FME + UeE loss (Sibbald, 1982). Thus to measure the relationship between fecal energy of feed origin (FiE) + urinary energy of feed origin (UiE) and IE for several test materials one only needs to measure the FE + UE of birds given no feed or birds given a single level of each test material (Sibbald, 1976). Birds for typical bioassay is deprived of feed for 10 hours to empty feed residues from alimentary canals (Kim *et al.*, 2011). A bird is selected, force fed a known quantity of test material (usually 30-40g) and placed in a wire cage over an excreta collection tray; the time is recorded. The procedure is repeated with one bird in each replication remaining unfed to serve as an estimator of FME + UeE. Approximately 24 hours and exactly 48 hours after housing, the excreta are collected quantitatively, frozen, freeze-dried, equilibrated with atmospheric moisture, weighed, ground and assayed for energy using an adiabatic oxygen bomb calorimeter.

Sibbald (1987) in his extensive review of bioavailable protein the estimation in different feedstuff for poultry and pigs indicated that protein concentration vary widely among feeding stuffs due to many different factors such as species, including genotype, plant fraction, stages of maturity, location of growth, soil fertility, season and year of growth. Availability is a function of two processes; digestion and metabolism.

The fermentation of cassava peel meal (CPM) with baker's yeast improved the crude protein content and gross energy respectively at 0.6% and 0.2% levels of baker's yeast at 72 hours duration of fermentation. Similarly, fermentation increased bulk density and reduced the water holding capacity with increasing levels of baker's yeast and fermentation duration (Obasi *et al.*, 2018).

The objective of this study therefore, was to determine the true metabolisable energy and true digestible protein of cassava peel meal fermented with baker's yeast using broiler chicken and turkeys.

Materials and Methods

The experiment was carried out in the Poultry Unit, School of Agriculture and Agricultural Technology (SAAT) Teaching and Research Farm, Federal

University of Technology Owerri, Imo State. Owerri is located at latitude 5°10' N and 6°35' N and longitude 6°35' E and 7°28' E, Owerri lies within the rainforest zone of Southeast Nigeria, which has a bimodal rainfall pattern and total annual rainfall range of 1700-2100mm. The maximum ambient temperatures are 27°C to 36°C during dry season of the year (November-March) and minimum ambient temperature range is 20°C to 26°C during the cold rainy season (April-October). The relative humidity ranges from 57-91% and is in the warm humid tropics (NRCRI, 2004).

Experimental materials, design and procedure: Fresh cassava peels were wet milled and divided into 3 parts of 1kg each, the first part, which served as the control treatment had no baker's yeast and was not fermented ($T_{0.00\%/0hr}$). The second part was mixed with 0.6% baker's yeast slurry and fermented for 72hours ($T_{0.60\%/72hours}$) representing highest crude protein (HCP) content material. The third 1kg of wet milled fresh cassava peel was mixed with 0.2% baker's yeast, fermented for 72hours ($T_{0.20\%/72hours}$). The processing method ($T_{0.60\%/72hours}$ and $T_{0.20\%/72hours}$) employed in this study were results from earlier studies Obasi *et al.* (2018) which produced the highest gross energy and crude protein values, respectively. Other equipment and materials used were metabolic cages improvised from battery cage units for laying birds fitted with individual cage feeder, drinker and tray placed under each cage (above the ground) for the collection of droppings. A funnel fused glass tube was also used for force-feeding the birds.

Thirty two (32), six-week old apparently healthy Marshall Broiler chickens (1.0 – 1.2kg live weight) and thirty two (32), six-week old apparently healthy indigenous turkeys (900g -1.1kg live weight) each were divided into four groups of 8 birds (4 males and 4 females each). Each group was replicated four times with each replicate comprising one male and one female broiler chicken and 1 male and 1 female turkey, respectively. Each replicate was placed in one cage with an empty cage separating it from another to prevent mix up of droppings. The three CPM treatments ($T_{0.00\%/0hrs}$, $T_{0.60\%/72hours}$ and $T_{0.20\%/72hours}$) were then randomly assigned to the groups in a completely randomized design (CRD) experiment. The fourth group was used as fasted birds.

The modified and simplified assay Sibbald (1976) was adopted for this study. The birds were held in the cages for 2 days prior to the commencement of the experiment to get them used to the cage and feeding arrangement having been previously raised on deep litter. During the two days, the broiler chickens were offered commercial finisher broiler chicken diets while turkeys were fed turkey starter mash at 8.00am each day. The birds were thereafter, starved of feed but not water on the third day for 24hours. At the end

of the starvation period (8.00am on the fourth day) the birds were individually force fed with 30g each of the corresponding CPM treatment sample assigned to their treatment group through a funnel fused glass tube inserted directly into the crop. Droppings were subsequently collected for the next 24hours on replicate basis, dried in a force drought oven at 60°C the weight of each dried sample was recorded on replicate basis.

Proximate and gross energy determination: Proximate composition of the CPM samples and droppings were determined according to the methods of AOAC (2010), while gross energy values of the samples were determined using the bomb calorimeter method as outlined by AOAC (1995).

Determination of True metabolisable energy (TME): The true metabolisable energy of the droppings was determined on replicate basis based on the equation below as outlined by (11):

$$\text{TME (Kcal/g air dried)} = \frac{(\text{GEF} \times \text{X}) - (\text{Yef} - \text{Yec})}{\text{X}}$$

GEF = gross energy of the feedstuff (Kcal/g)
Yef = energy voided as excreta by fed birds
Yec = energy voided as excreta of fasted birds
X = weight of feeding stuff fed (g)

Determination of True metabolisable energy corrected for nitrogen balance (TMEn): The TMEn for each replicate was calculated by the method of Parsons *et al* (1982) as follows:

$$\text{TMEn} = \frac{\text{FEF} - (\text{EEF} + 8.22\text{NF}) + (\text{EEU} + 8.22\text{Nu})}{\text{FC}}$$

FEF = gross energy of the total feed consumed (Kcal)
EEF = energy in excreta collected from fed birds (Kcal)
EEU = energy in excreta collected from fasted birds (Kcal)
NF = Nitrogen retained by fed birds (g)
NU = Nitrogen retained by fasted birds (g)
FC = Dry feed consumed (g)

Determination of True digestible protein (TDP): The TDP was calculated per replicate using the equation of Sibbald (1976) as follows:

$$\text{TDP (g)} = \frac{(\text{G.P.F} \times \text{X}) - (\text{Ypf} - \text{Ypu})}{\text{X}}$$

G.P.F = gross protein of feedstuff (mg/g)
Ypf = protein voided as excreta by fed birds
Ypu = protein voided as excreta by fasted birds
X = weight of feedstuff fed (g)

Statistical Analysis: The means of data collected were subjected to analysis of variance (ANOVA) and means separated where significant treatment existed using R – Core Team (2012) application.

Results and Discussion

True Metabolisable Energy, True Metabolisable Energy Corrected for Nitrogen and True Digestible Protein of Fermented Cassava Peel Meal Using Broiler Chickens

True metabolisable energy (TME): The TME value of the fermented cassava peel meal in the control ($T_{0.00/0\text{hrs}}$), highest gross energy sample ($T_{0.20\%/72\text{hrs}}$) and highest crude protein sample ($T_{0.60\%/72\text{hrs}}$) ranged from 2864.47 to 3155.91Kcal/kg for broiler chickens with treatment $T_{0.0\%/0\text{hrs}}$ and $T_{0.20\%/72\text{hrs}}$ recording significantly ($p < 0.05$) lower and higher TME, respectively compared to the other group (Table 1 and Fig.1). The TME value corresponded with the gross energy value for the groups. The TME value for the control ($T_{0.0\%/0\text{hrs}}$) was lower than the (3481kcal/kg) TME value reported by Akanno (1998) for untreated cassava peels. Ukachukwu (2005) however, reported a much lower range (1.80 to 2.74 Kcal/g) for composite cassava products using adult broiler chickens. This disparity could be attributed to differences in the composition of the cassava products and the variety of the cassava peels (Ukachukwu, 2005).

True metabolisable energy corrected for nitrogen (TMEn): TMEn value using broiler chickens in this study were expectedly lower than the TME and ranged from 2637.89Kcal/kg for the control ($T_{0.0\%/0\text{hr}}$) to 2920.07Kcal/kg for the treatment with the highest gross energy ($T_{0.20/72\text{hrs}}$) (Table 1 and Fig.1). Treatment $T_{0.20/72\text{hrs}}$ and $T_{0.60\%/72\text{hrs}}$ recorded significantly ($p < 0.05$) higher TMEn value than the control ($T_{0.00\%/0\text{hrs}}$) and corresponded with the gross energy value. Akanno (1998) reported a TMEn value for cassava peels using broiler chickens that was within the range of the values obtained in this study. Ogbonna (1998) also reported values similar to those obtained in this study for unfermented cassava peels.

Table 1: Metabolisable energy and digestible protein of cassava peel meal fermented with Baker's yeast using broiler chickens

Parameters	Control	Highest Energy (HGE)	Gross Highest Protein (HCP)	SEM
	T _{0.00%} /0hours	T _{0.20%} /72hours	T _{0.60%} /72hours	
Gross Energy	3208.44	3526.69	3464.52	
True metabolisable energy (Kcal/kg)	2864.47 ^c	3155.91 ^a	3119.26 ^b	50.14
True Metabolisable Energy corrected for nitrogen (Kcal/kg)	2637.98 ^b	2920.07 ^a	2831.11 ^a	44.86
Crude protein (CP)(mg/g)	716.00	917.00	1448.00	
True digestible protein (mg/g)	62.77 ^c	90.75 ^b	140.91 ^a	11.44

^{abc} Means within a row with difference superscript are significantly different (p<0.05)

True digestible protein (TDP): The TDP values obtained of cassava peel meal among broiler chickens in this study ranged from 62.77mg/g in treatment T_{0.00%}/0hr to 140.91mg/g in T_{0.60%}/72hrs. These TDP values corresponded with the crude protein values for the groups, (Table 1). Expectedly the group (T_{0.60%}/72hrs) with the highest (1448mg/g) crude protein value recorded the highest TDP (140.91mg/g) value which also, indicated

significantly (p<0.05) higher percentage digestibility of protein than the control (Table 1 and Fig. 1) This TDP value nevertheless, was lower than the 160.40mg/g reported by Akanno (1998) for fermented cassava peels meal using broilers. The baker's yeast and fermentation process did not appear to have significantly improved the TDP as suggested by Oyediji *et al* (2008) though marginal increases were observed.

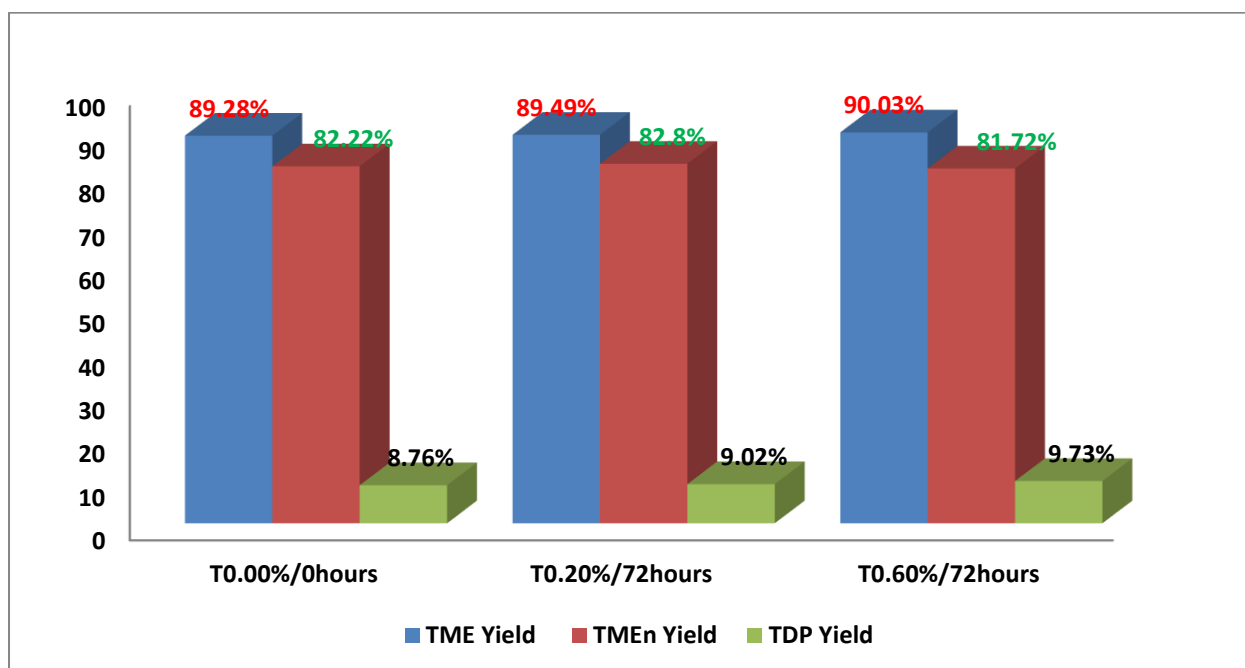


Fig.1: Percentage TME, TMEn and TPD Yield of baker's yeast treated cassava peel meal using broiler chickens

True Metabolisable Energy, True Metabolisable Energy Corrected for Nitrogen and True Digestible Protein of Fermented Cassava Peel Meal Using Turkey

True metabolisable energy (TME): TME value of baker's yeast fermented CPM using turkeys in this study ranged from 2859.51Kcal/kg for the control (T_{0.00%/0hour}) to 3154.82Kcal/kg for T_{0.20%/72hrs}, (Table 2 and Fig. 2). The values, as in the broiler study corresponded to the gross energy values. The TME values obtained in this study with turkeys were slightly higher than that recorded for the broilers. Significantly (p<0.05) higher TME values were recorded for T_{0.20%/72hrs} followed by T_{0.60%/72hrs} than T_{0.00%/0hrs}. Achinewhu *et al* (1998) reported that long

fermentation durations could degrade fibre and increase the utilization of agro by products.

True metabolisable energy corrected for nitrogen (TMEn): The TMEn values recorded for turkeys followed the same pattern as TME. Treatment T_{0.00%/0hours} recorded a significantly (p<0.05) lower value than T_{0.20%/72hours} and T_{0.60%/72hours}, (Table 2 and Fig. 2). The values were 80.88%, 81.77% and 81.83% TMEn yields, respectively and were much higher than that reported by Ukachukwu (2005) for composite cassava products. It is possible from these results that the level of baker's yield and duration of fermentation had a slightly beneficial effect on the TME yield of cassava peel meals (Achinewhu *et al.*, 1998).

Table 2: Metabolisable energy and true digestible protein of cassava peel meal fermented with baker's yeast using turkey.

Parameters	Control	Highest energy	gross	Highest protein	crude	SEM
	T _{0.00%/0hours}	T _{0.20%/72hours}		T _{0.60%/72hours}		
Gross Energy	3208.44	3526.69		3464.52		
True metabolisable energy (Kcal/kg)	2859.51 ^c	3154.82 ^a		3087.87 ^b		49.95
True metabolisable energy corrected for nitrogen (Kcal/kg)	2595.16 ^b	2883.99 ^a		2837.41 ^a		48.87
Crude Protein (CP) (mg/g)	716.00	917.00		1448.00		
True digestible protein (mg/g)	62.16 ^c	89.29 ^b		137.37 ^a		11.08

^{abc} Means within a row with different superscripts are significantly different.

True digestible protein (TDP): The TDP values of fermented cassava peel meal for turkeys in this study ranged from 62.16mg/g for T_{0.00%/0hour} to 137.37mg/g for T_{0.60%/72hours}. Expectedly, T_{0.00%/0hour} recorded significantly (p<0.05) lower value than T_{0.20%/72hours} and T_{0.60%/72hours}. These values were very close to that recorded for broilers (Table 2). The TDP yield range

in this study was 8.68 to 9.49% (Fig. 2) which was much higher than the 1.5% and 1.98% reported for true protein and crude protein of cassava peels, respectively (Oyenuga, 1968). The highest TDP value obtained in this study was however; lower than the 160.40mg/g reported by Akanno (1998) for broiler chickens.

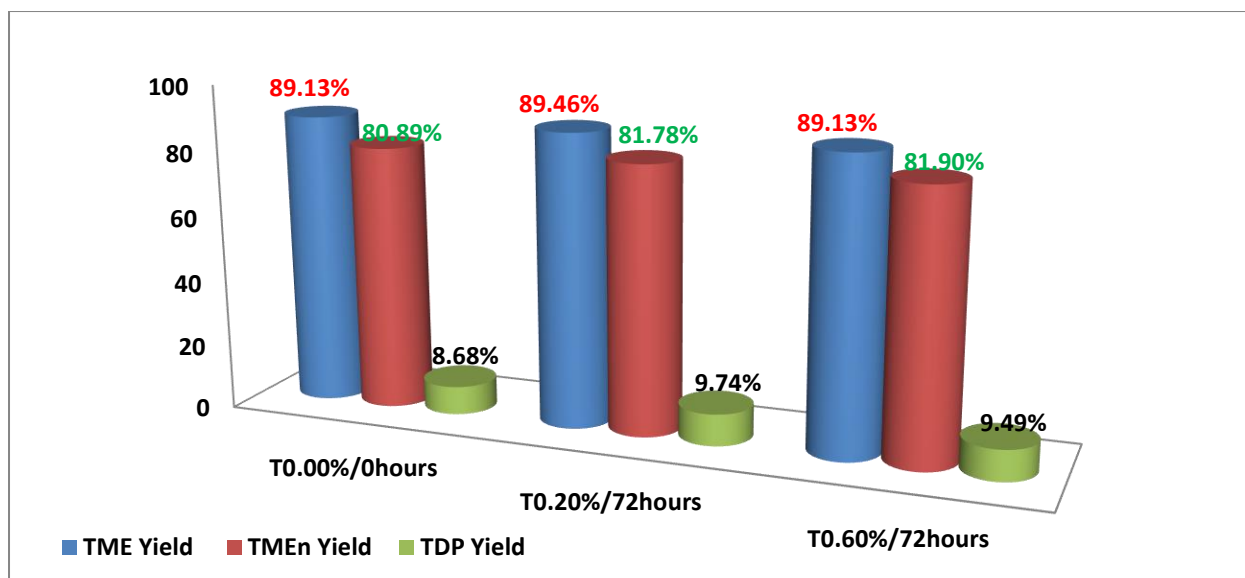


Fig.2: Percentage TME, TMEn and TPD yield of baker's yeast treated cassava peel meal Using turkeys

True Metabolisable Energy, True Metabolisable Energy Corrected for Nitrogen and True Digestible Protein of Fermented Cassava Peel Meal: Broilers versus Turkeys

True metabolisable energy (TME): TME value for 6 weeks old broiler chickens and turkeys, respectively are presented in Table 3 and Fig.3. TME values obtained in this study were similar ($p>0.05$) for cassava peel meal (CPM) treated with the same baker's yeast level and fermentation duration using both broiler chickens and turkeys. The three baker's yeast levels and fermentation duration produced significantly ($p<0.05$) different TME values from each other with both broiler chickens and turkeys. Results from TME yield however, indicated similar

($p<0.05$) values within the treatment groups ranging from 89.27 to 90.03% (Fig. 3), with broilers showing slightly higher yields than turkeys.

True metabolisable energy corrected for nitrogen (TMEn): TMEn values obtained in this study ranged from 2595.15kcal/kg to 2920.07kcal/kg, (Table 3). However, the results showed that broiler chickens and turkeys at $T_{0.20\%/72hrs}$ (2920.07kcal/kg versus 2883.99kcal/kg) produced significantly ($p>0.05$) higher TMEn than the other groups (Table 3 and Fig. 3). Broiler chickens and turkeys fed CPM without baker's yeast treatment ($T_{0.00\%/0.0hr}$) (Control) recorded similar ($p>0.05$) TMEn values and this trend were observed in other groups. TMEn yield equally showed the same pattern with TME (Fig. 3).

Table 3: TME, TMEn and TDP values of cassava peel meal fermented with baker's yeast By broiler chickens versus turkeys

Parameters		Levels of yeast/duration of fermentation						SEM
		T0.00/0.00hr		T0.20/72hrs		T0.60/72hrs		
		Broiler	Turkey	Broiler	Turkey	Broiler	Turkey	
Gross	Energy	3208.44	3208.44	3526.69	3526.69	3464.42	3464.52	
(kcal/kg)								
True	metabolisable	2864.47 ^c	2859.51 ^c	3155.91 ^a	3154.82 ^a	3119.26 ^b	3087.87 ^b	34.35
energy (kcal/kg)								
True	metabolisable	2637.98 ^b	2595.15 ^b	2920.07 ^a	2883.99 ^a	2831.11 ^a	2837.40 ^a	32.31
energy corrected for								
nitrogen(kcal/kg)								
True	digestible	62.77 ^c	62.61 ^c	90.75 ^b	89.29 ^b	140.91 ^a	137.37 ^a	7.73
protein (mg/g)								

^{abc} Means within a row with different superscript are significantly different ($p<0.05$)

True digestible protein (TDP): Significant differences ($p>0.05$) were observed in TDP values for the treatments $T_{0.00\%/0hr}$ (62.77mg/g and 62.61mg/g) versus $T_{0.20\%/72hrs}$ (90.75mg/g and 89.29mg/g) and $T_{0.60\%/72hrs}$ (140.91mg/g and 137.37mg/g) for broiler chickens and turkeys, respectively (Table 3 and Fig. 3). Broiler chickens and turkeys in each treatment group however, produced similar ($p>0.05$) TDP value (Table 3 and

Fig. 3). TDP yields in all the groups ranged from 8.76% for turkeys in $T_{0.00\%/0hr}$ to 9.74% for broiler chickens in $T_{0.20\%/72hrs}$. Significantly ($p<0.05$) higher yields were observed among , turkeys and broiler chickens on $T_{0.20\%/72hrs}$ and $T_{0.60\%/72hrs}$. The variation in yields between broiler chickens and turkeys agrees with (NRC, 1994) that Nitrogen retention varies with species and age of broiler chickens.

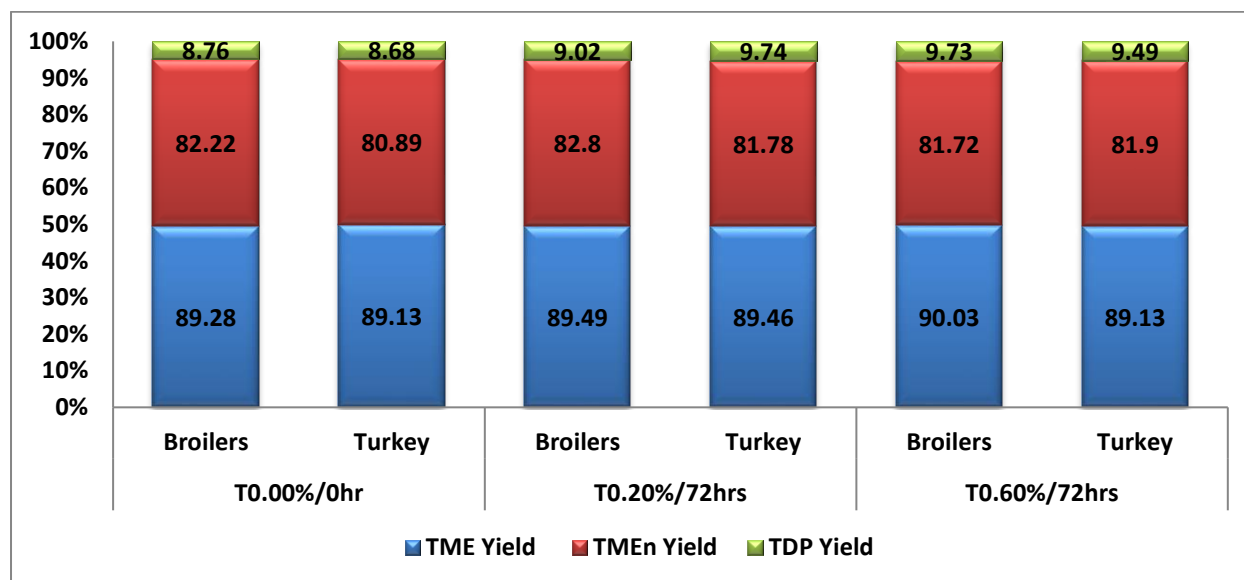


Fig. 3: Comparative TME, TMEn and TDP Yields of cassava peel meal fermented with Baker's yeast by broiler chickens versus turkeys

Conclusion

Conclusively, there was improvement in the true metabolisable energy (TME), True metabolisable energy corrected for nitrogen (TMEn) and True digestible protein (TDP) of cassava peel meal fermented with baker's yeast using broilers and turkeys.

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