CARCASS TRAITS, ANTIOXIDANT STATUS AND MEAT COLOUR OF WEST AFRICAN DWARF GOAT FED COMBINATIONS OF COCOA POD, CASSAVA PULP AND *ACACIA* LEAF

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ABSTRACT

A study on carcass characteristics and meat quality of WAD goat was carried out. Twenty (20) WAD goats with age range of 12 – 13 months and average body weight of 14.60 ± 0.05 kg **were divided** ***randomly into five treatment groups, consisted of 4 goats and subjected them to thirty-two weeks feeding trial. Combinations of cocoa pod, cassava pulp and Acacia leaf diets were formulated containing four levels of fermented cocoa pod at 0, 5, 10, 15 and 20 and cassava pulp at 40, 45, 50, 55, 60 percent levels respectively while 40 % of Acacia leaf cut across the groups. The results showed that the dressing percentage ranged from 39.11 % (T1) to 44.08 % (T5). The values were significantly difference (p<0.05) among the treatments. Goats on combinations of (20: 40: 40) (T5) had the highest values for carcass length (57.50 ± 0.47 cm). Primal cuts yield of goats on combinations of T5(20 : 40 : 40) had the highest values for neck (506.50 ± 22.92g), lungs (133.50 ± 4.57 g), heart (78.00 ± 2.22 g), rib (6.39 ± 0.38 g), liver (251.50 ± 13.63 g) and pancreas (36.50 ± 2.08 g). The dressing percentage (44.08 ± 0.80 %) and meat quality; Superoxide dismutase (2.88 ± 0.15 U/min/mg protein) of WAD goat fed 20 % diet cocoa pod silage was significantly (p<0.05) high compared to other groups. This study concludes that cocoa pod could be included in WAD goats diets up to 20 % based on their*** **carcass** ***characteristics and meat quality.***

Keywords: *Acacia* leaf, Cassava pulp, Cocoa pod, Carcass traits, Meat quality, WAD goat

INTRODUCTION

Goat production under intensive system management requires standardization of different goat husbandry practices. Goats can be raised in many semi-arid areas because of their adaptability to low rainfall regions and unavailability or scarcity of forages which resulted in low reproductive performance. In order to maintain feedlot system, there is need for feed planning so as to reduce cost of rearing or production (Andrade-Montemayor *et al.,* 2011). The most indigenous breed in West Africa is West African Dwarf goat and it can adapt to any harsh environmental conditions and has the potentials for increasing productivity. They are prolific meat producer than other breeds (Babale *et al*., 2019). One of the most important factors in small ruminant production is feed intake, if the feed intake by the animals is too low, it will affect the production which will result in poor efficiency of feed conversion. Meat is an essential product with high consumption rate globally. Meat is one of the important products in human consumption, very nutritious; desired food for the masses which in building up their body requirement and one of the constituents of balanced diet (Ahmad

et al., 2018). So, the quality of meat or carcass sometimes may be determined by the voluntary feed intake by the animals Likewise, changes in fat, carcass and conformation may affect the meat quality (Panea *et al.*, 2008). The assessment indices of meat can be determined through the carcass trait values (Eniolorunda *et al.*, 2011). The carcass traits are an important factor in commercial assessment because carcass with good conformation (lean meat) command higher price than the carcass poor conformation (Kempster *et al.*, 1982). The edible and saleable proportions of goats vary from one country to another because of the differences in eating habits, by-products values and dressing percentage of goat breed compared with sheep and cattle. The aggregate consumptions of goats vary from one region to another because of differences in eating habits and the value of the by-product. For example, the goats' dressing percentage ranges from 30 to 60 % which increases based on maturity. Bucks may also have higher dressing percentage than goat and well-fed goats have higher dressing percentage than those fed inadequate diets or feeds (Ocheja *et al.*, 2016). The quality of lean meat could depend on the palatability of the lean and the degree of marbling. So, it is easy to admit that their economic values depend on the composition of their carcass (Shija *et al.*, 2013).

In the tropical countries, non-carcass parts such as heart, head, kidney, blood, spleen, lungs and trachea are important because they are edible, saleable and serve as animal protein source. Carcass to bone ratio with the dressing percentage can be used to measure the differences in the meat quality and body condition of the animal (Shija *et al.,* 2013). Local goat meat (chevon) production systems also affect weight at slaughter and carcass weight which results in many different products (Zervas and Tsiplakou, 2011). Based on carcass quality in small ruminants, it is important to compile some basic information about the animals such as age and weight that led to an official classification according to the different categories' existent depending on state legislation. Lipid oxidation affects the quality of the meat products during processing and preservation. It also leads to the growth of metabolites which reduces the meat nutritional quality and change the flavour of the meat which causes health hazards economics losses due to inferior quality (Maqsood and Benjakul, 2011). Antioxidants had been reported to minimize rancidity, hinder lipid oxidation without damaging the nutritional properties which resulted in maintaining meat quality and shelf life (Damodaran *et al.,* 2007). Most natural antioxidants possess higher application in meat processing due to consumers acceptability of them over the synthetic antioxidants (Kumar *et al.*, 2015).

The carcass of goats usually has lean meat, high percentage of meat to small bone ratio with low subcutaneous fat and moderate carotenoids levels (Tshabalala *et al.,* 2003). Carotenoids are phytochemicals which are normally synthesized by higher plants. Carotenoid metabolism majorly takes place at the animal organ such as liver. The body changes the beta-carotene into vitamin A which is used mainly for vision, cell growth, healthy organ maintenance like liver, lungs, kidney and heart. Meat-producing animals reared on high forage rations pass a portion of the ingested carotenoids into the milk, meat and body fat (Daley *et al.*, 2010).

The utilization of some agro-industrial by-products such as cocoa pod and cassava pulp as alternative feedstuff for livestock feeding had been reported by many researchers. One of the by-products being utilized by many livestock farmers is the cocoa pod (Oddoye *et al.*, 2013). Toxicity of cocoa pod caused by theobromine had resulted in reduced feed intakes in livestock. So, the reduction or low cocoa pod inclusion in animal diets could improve the palatability, which could influence high feed intake by the animals (Laconi and Jayanegara, 2015). Cocoa pod contained anti-nutritional factors such as theobromine and caffeine which could cause excessive stimulation of kidneys, fast heartbeat, allergic skin reactions, constipations, intestinal discomfort and dysfunction of sensory organs (Martínez-Pinilla *et al.*, 2015). They are detrimental to animals' health which sometimes caused cardiac and nervous system malfunctions which might

lead to death (Olugosi *et al*., 2019). The raw cocoa pod meal contained crude fibre (61.80 %), ether extract (8.83 %), ash (9.30 %), NFE (10.70 %), ADF (68.64 %) and NDF (75.08 %), crude protein was about 7.0 %. It contained potassium, magnesium, phosphorus and calcium (Vriesmann *et al.,* 2012). Fermentation process of cocoa bean decreased ash (3.48 – 2.92 %), protein (21.63 – 17.62 %), fat (55.21 – 50.40 %) contents and increase carbohydrate content from 15.47 – 24.93 % (Afoakwa *et al*., 2013).

Likewise, cassava pulp contained two cyanogenic glycosides; linamarin (80 %) and lotaustralin (20 %) which combine to produce a compound known as hydrogen cyanide (HCH). HCN is detrimental to animal health. Cassava pulp is high in fermentable carbohydrates, moisture content and low in fibre and nitrogenous compounds (Ubalua, 2007). The pulp is high in fermentable carbohydrates and moisture content and low in fibre and nitrogenous compounds (Ubalua, 2007). Gross energy varied between 16.2 to 16.84 MJ/Kg^{-1}, fat (0.4 – 0.9 %); crude protein (2.0 – 4.0 %) and starch (37.0 – 75.0 %) (Chauynarong *et al.,* 2015). Some methods had been used in the treatment of agro by-products such as biological, chemical and physical treatments (Adamafio *et al*., 2011).

Acacia Martius, 1829 (Fabaceae: Fabales) leaves are quite rich in protein (about 13 – 24 %) counting on maturity and on the quantity of ligneous material included within the brow. Its leaf, flowers and young pods are browsed to a substantial extent by goats and sheep. During both dry and rainy seasons, *Acacia* was found to rank high for protein content, and to possess lower NDF and lower total condensed tannins than others browse species (Alam *et al*., 2007). Screening of most browse plants for anti-nutritional factors such as phenolic and tannin contents is limited by the inconsistent techniques used for quantification of tannins for example (Schofield *et al.,* 2001).

Thus, it was proposed that combinations of cocoa pod, cassava pulp and *Acacia* leaf would enhance the carcass quality and antioxidant status and prevent oxidative spoilage of chevon. The objective of this study was to determine the effect of dietary combinations of cocoa pod, cassava pulp and *Acacia* leaf on carcass traits, antioxidants status and carotene levels of West African dwarf goats.

MATERIAL AND METHODS

Processing of Fed Materials: Cocoa pods were collected from a reputable cocoa farm at Ijan Ekiti, Ekiti State, Nigeria. The pods were sundried to a moisture content of 37 % and pounded (using mortar and pestle) to an average size of 0.6 cm^2 and ensiled at 37^{0}C. Cassava pulp and ground cocoa pod with the inclusion of *Acacia* leaf at different ratio were ensiled in a polythene bag and packed inside 20 litres plastic as described by Patil *et al.* (2019). All fed materials were analysed for their proximate compositions using AOAC (2005). The wilted chopped *Acacia* leaf, cocoa pod and cassava pulp were mixed with over ripe banana slurry at rate of 5 % of the weight of diets and packed in the bag. Uniform compaction was ensured until the bags were filled and tightly tied. Each plastic was compacted with a 20 kg weight to remove air and create an anaerobic condition for proper fermentation. The bags were closed with the load placed on it until expiration of fermentation (7 weeks). The cocoa pod, cassava pulp and *Acacia* leaf were combined in ratio as presented in Table 1. The prepared diets were analysed for their proximate composition (AOAC, 2005).

Toxicity and Antinutritive Factors of Fed Ingredients: The toxicity and antinutritive factors in cassava pulp was adopted from Montagnac *et al*. (2009), while that of *Acacia* leaf was from the study of McSweeney *et al*. (2008) and that of cocoa pod came from Ozung *et al.* (2016).

Experimental Site and WAD Goats Management: The study was carried out at the Teaching and Research farm of the Department of Animal Science, Landmark University, Omu-Aran, Kwara State, Nigeria. Twenty sexually mature WAD goats (20 goats) aged 13 months with average body weight of 14 ± 0.05 kg were sourced from livestock market at Otun Ekiti, Nigeria. After 14 days of

acclimatization, the animals were allotted to five dietary treatments in a completely randomized design with four animals per treatment in an intensive system of management

Feeding Trials: The goats were kept in well ventilated pens (3 x 1.5 m^2) using strong iron poles and expanded metal wire mesh. The floors were bedded with grass straw and were equipped with wooden slated platform that covered three-quarters of the pen area. All the goats were weighed and randomly allotted to different dietary groups (Table 1). The animals were dewormed by using a broad spectrum anthelmintic (Super Ivermectin), according to their body weight and sprayed with acaricide (Parannex) against external parasites. 5 ml Ox-tetracycline (OTC) was administered to all the goats to control Contagious Caprine Pleural Pneumonia (CPPP) before onset of the experiment. The animals were managed intensively throughout the experimental period (90 days) and adequate nutrition and health care were ensured throughout the feeding trials. The experimental feeds were given to the animals in one meal ration per day. The silage was supplied 10 % above expected daily intake of the animal and fresh water and mineral salt lick were given *ad libitum*.

Slaughtering, Tissue Sampling and Post-Mortem Storage: At the end of the feeding trial, the animals were maintained under fasting conditions (with availability of drinking water) for up to 18 hours. Fasting before slaughtering was necessary so as to reduce the volume of gut contents and bacteria; therefore, reduced the risk of contamination of the carcass during dressing. It is a practice for the animals to receive their last feeds on the day before slaughter which would assure complete bleeding and ease of evisceration (internal organs). The following measurements were taken.

Pre-slaughter weight: Animals were weighed immediately before slaughtered using hanging scale (Salter); after slaughtering, the skin was removed carefully and body components such as head, neck, thigh, shoulder, ribs, heart, liver, kidney, trachea, pancreas, full and empty stomach were carefully removed and weighed in grammes to the nearest 0.01 g using sensitive weighing balance (Mx Rady 300, Wintech Nigeria Limited).

Dressing percentage: After evisceration and carcass dressing, the carcasses and offal were subjected to post-mortem aerobic refrigerated storage at 4^oC. On day 0, about 10 g of each sample was excised, snap frozen in liquid nitrogen and store at -80^oC until further analysis, while the remaining portions were left intact for further analysis.

Antioxidant Enzymes Determination: The antioxidants statuses of the goat meats were estimated using chevon homogenate prepared by digesting 5 g of frozen (4^0C) grounded chevon in 0.05 M phosphate buffer. The resulting digest was centrifuged for 20 minutes at 5000 rpm. The supernatant was used for assay of the antioxidants as follows:

Glutathione enzymes assay: Glutathione peroxidase (GPx) was estimated using the method of Rotruck *et al.* (1973), by adding 0.2 mL of chevon homogenate, 0.5 mL 0.4 M buffer (pH 7.0), 0.2 mL 2 mM GSH, and 0.1 mL 0.2 mM H_2O_2, and incubated at room temperature for 10 minutes along with a control tube containing all reagents except enzyme source. The reaction was arrested by adding 0.5 mL of 10 % TCA and centrifuged at 4000 rpm for 5 minutes.

The method of Beutler *et al.* (1963) was followed in estimating the level of reduced glutathione (GSH). Exactly 0.2 ml of chevon homogenate was added to 1.8 ml of distilled water followed by the addition of 3 ml of the precipitating solution and then shaken thoroughly. The mixture was allowed to stand for 5 minutes and then filtered. 1 ml of filtrate was added to 4 ml of 0.1 M phosphate buffer (pH 7.4). At the end of the reaction, 0.5 ml of the Ellman reagent was added. A blank was prepared with 4 ml of the 0.1 M phosphate buffer, 1 ml of diluted precipitating solution (3 parts to 2 parts of distilled water) and 0.5 ml of the Ellman reagent. The absorbance was read at 412 nm against the reagent blank.

Superoxide dismutase assay: Superoxide dismutase (SOD) activity was estimated by the method of Soon and Tan (2002) by adding 2.1 mL of 50 mM buffer, 0.02 mL of enzyme source, and 0.86 mL of distilled water. The reaction was initiated with 0.02 mL of 10 mM pyrogallol and change in absorbance monitored at 420 nm. One unit of SOD is the amount of enzyme required to inhibit the auto-oxidation of pyrogallol by 50 % in a standard assay system of 3 mL. The specific activity was expressed as units/min/mg protein.

Catalase assay: CAT activity was measured by measuring the exposure of H_2O_2 characterized by a drop in absorbance at 240 nm according to a modified method described by Aebi (1984). A 5 g sample was mixed with 25 mL of 50 mM phosphate buffer (pH 7.0 at 25 °C) using a homogenizer (Ultra-Turrax T25 Introductory, Ika Werke GmbH and Company, Staufen, Germany) for 15 seconds at 1000 rpm. The admixture was centrifuged at 1000 rpm at 2 °C for 15 minutes. The supernatant of the admixture was taken and filtered through a Whatman filter paper number 1. Furthermore, 100 µL of filtered supernatant was mixed with2.9 mL of 30 mM H_2O_2. The drop in absorbance at 240 nm was recorded every 30 s for 3 min. The CAT activity was expressed as units/ g sample.

Carotenoid Assay: The carotenoid contents in muscle samples were extracted and determined followed the method described by Okonkwo (2009).

Data Analysis: The data obtained were subjected to analysis of variance (ANOVA) using SPSS Version 20.0. The level of significance was set at $p<0.05$.

RESULTS

Toxicity, antinutritive factors and proximate composition of fed ingredients: The proximate composition of the experimental diets in Table 1 showed that the highest dry matter was obtained from treatment 5 (73.19 %) followed by treatment 4 (65.27 %). Treatment 5 also had higher crude fibre (15.68 %) and ash (6.17 %) contents. The least NFE (35.08 %) values were also obtained from Treatment 1. Theobromine concentration of the diets was highest (0.57 %) in diet 5 (20 % inclusion of ensiled cocoa pod in the diet) and least (0.19 %) in diet 2 (5 % inclusion of cocoa pod in the diet).

Carcass Traits of West African Dwarf Goats Fed Combinations of Cocoa Pod, Cassava Pulp and *Acacia* Leaf: The carcass traits of growing West African dwarf goats fed ensiled combinations of cocoa pod, cassava pulp and *Acacia* leaf was presented in Table 2. The dressing percentage ranged from 39.11 % in T1 to 44.08 % in T5. The values were statistically not significant ($p>0.05$) and did not follow any definite trend. The slaughter weight, dressed weight and carcass length were significantly different ($p<0.05$). Goats on combinations of 20 % cocoa pod, 40 % cassava pulp and 40 % *Acacia* leaf (T5) had the highest values for carcass length (57.50 ± 0.47 cm).

The weight for the head of goats was not significantly different ($p>0.05$). However, the weights for neck, thigh, shoulder, ribs, heart, liver, kidney and trachea were significantly different ($p<0.05$) (Table 3). Goats on combination T5 (20:40:20) had the highest neck (506.50 ± 22.39 g), lungs (133.50 ± 4.51 g), heart (87.00 ± 2.11 g), thigh 427.50 ± 3.92 g), rib (6.39 ± 0.30 g), kidney (23.00 ± 0.85 g), liver (251.50 ± 13.63 g) and pancreas (36.50 ± 2.04 g) weights. However, T2 (5: 55: 40) (102.00 ± 4.41g) was statistically similar ($p>0.05$) with T3 (10:50:40) (102.50 ± 4.51 g) for lungs, while T1 (0:60:40) (71.00 ± 2.10g) was statistically similar ($p>0.05$) with T2 (5:55:40) (71.50 ± 2.11 g) for heart. It appeared that goats fed T5 (20: 40: 40) had best utilization the diets for muscle build up and hence meat production. Since they had the highest weights in the high muscle cuts i.e., neck, shoulder and thigh.

Antioxidants Enzymes: The antioxidants status of chevon was shown in Table 4. The diets significantly affect ($p<0.05$) the superoxide dismutase, catalase, glutathione peroxidase and carotenoids activities in the biceps femoris muscle of the goats.

Table 1: Dietary percentage compositions of combinations of cocoa pod, cassava pulp and *Acacia* leaf fed West African dwarf goats

Feed Ingredients	T1 (Control)	T2	T3	T4	T5
Cocoa pod	0.00	05.00	10.00	15.00	20.00
Cassava pulp	60.00	55.00	50.00	45.00	40.00
***Acacia* leaf**	40.00	40.00	40.00	40.00	40.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME (Kcal/Kg)	5.01	4.50	4.60	4.77	4.88
Crude protein (%)	12.53 ± 0.03	11.25 ± 0.02	11.58 ± 0.03	11.94 ± 0.04	12.20 ± 0.14
Crude fibre (%)	5.19 ± 0.01	6.39 ± 0.01	7.88 ± 0.04	10.62 ± 0.03	15.68 ± 0.03
Ether extract (%)	12.13 ± 0.04	13.56 ± 0.03	14.34 ± 0.04	15.58 ± 0.03	18.56 ± 0.04
Calcium (%)	161.70 ± 0.28	166.45 ± 0.21	172.35 ± 0.21	202.55 ± 0.07	210.45 ± 0.07
Phosphorus (%)	126.37 ± 0.01	126.52 ± 0.01	127.04 ± 0.12	128.20 ± 0.02	131.65 ± 0.01
Theobromine content	0.00	0.19	0.38	0.47	0.57

T1: 0% cocoa pod, 60% cassava pulp and 40% Acacia leaf; T2: 5% cocoa pod, 55% cassava pulp and 40% Acacia leaf, T3: 10% cocoa pod, 50% cassava pulp and 40% Acacia leaf; T4: 15% cocoa pod, 45% cassava pulp and 40% Acacia leaf, T5: 20% cocoa pod, 40% cassava pulp and 40% acacia leaf

Table 2: Effects of combinations of cocoa pod, cassava pulp and *Acacia* leaf on carcass traits of West African dwarf goats

Parameters	T1	T2	T3	T4	T5
Live weight (kg)	11.25 ± 0.25^{c}	10.40 ± 0.10^{a}	10.55 ± 0.25^{b}	11.25 ± 0.25^{c}	12.25 ± 0.25^{d}
Slaughter weight (kg)	10.40 ± 0.10^{c}	9.25 ± 0.25^{a}	9.50 ± 0.20^{b}	10.25 ± 0.25^{c}	11.62 ± 0.21^{d}
Hot carcass weight (kg)	4.40 ± 0.10^{b}	4.30 ± 0.10^{a}	4.42 ± 0.20^{b}	4.88 ± 0.04^{c}	5.40 ± 0.10^{d}
Carcass length (cm)	54.00 ± 1.00^{a}	55.25 ± 0.75^{b}	55.50 ± 0.50^{b}	56.75 ± 0.75^{c}	57.50 ± 0.50^{d}
Dressing percentage (%)	39.11 ± 0.02^{a}	41.30 ± 0.60^{b}	41.90 ± 0.92^{b}	43.38 ± 0.98^{c}	44.08 ± 0.80^{d}

^{abcd} Mean ± SEM on the same row with different letter superscript are significantly different ($p<0.05$); T1: 0% cocoa pod, 60% cassava pulp and 40% Acacia leaf; T2: 5% cocoa pod, 55% cassava pulp and 40% Acacia leaf, T3: 10% cocoa pod, 50% cassava pulp and 40% Acacia leaf; T4: 15% cocoa pod, 45% cassava pulp and 40% Acacia leaf, T5: 20% cocoa pod, 40% cassava pulp and 40% Acacia leaf

Table 3: Effects of combinations of cocoa pod, cassava pulp and *Acacia* leaf on wholesale cut of West African dwarf goats

Parameters	T1	T2	T3	T4	T5
Head (g)	897.00 ± 19.52^{e}	748.50 ± 18.53^{a}	767.50 ± 18.43^{b}	784.50 ± 18.53^{c}	868.00 ± 19.55^{d}
Neck(g)	383.00 ± 22.39^{c}	310.00 ± 20.01^{a}	379.50 ± 22.26^{b}	450.50 ± 22.79^{d}	506.50 ± 22.92^{e}
Skin weight (g)	630.00 ± 25.09^{a}	645.00 ± 25.11^{b}	670.00 ± 25.15^{c}	693.50 ± 25.23^{d}	839.00 ± 25.55^{e}
Fat(g)	24.00 ± 5.49^{a}	51.50 ± 7.48^{b}	61.50 ± 8.56^{c}	67.00 ± 8.76^{d}	69.00 ± 8.82^{e}
Lungs (g)	101.50 ± 4.51^{a}	102.00 ± 4.51^{b}	102.50 ± 4.52^{b}	124.50 ± 4.54^{c}	133.50 ± 4.57^{d}
Heart(g)	71.00 ± 2.11^{a}	71.50 ± 2.13^{a}	73.00 ± 2.15^{b}	76.00 ± 2.16^{c}	78.00 ± 2.22^{d}
Liver(g)	250.00 ± 13.63^{d}	174.50 ± 13.42^{a}	189.50 ± 13.45^{b}	214.50 ± 13.56^{c}	251.50 ± 13.63^{d}
Kidney (g)	22.50 ± 0.85^{c}	19.00 ± 0.83^{a}	20.50 ± 0.85^{b}	22.00 ± 0.87^{c}	23.00 ± 0.89^{d}
Full stomach(g)	2031.50 ± 97.91^{e}	1294.00 ± 97.65^{a}	1446.00 ± 97.68^{b}	1799.00 ± 97.73^{c}	2000.50 ± 97.91^{d}
Empty stomach (g)	404.50 ± 15.26^{c}	346.50 ± 15.28^{a}	363.00 ± 15.34^{b}	414.00 ± 15.46^{c}	477.50 ± 15.55^{d}
Full intestine (g)	1076.50 ± 46.97^{c}	878.50 ± 46.92^{a}	972.50 ± 46.94^{b}	1095.00 ± 46.95^{c}	1299.00 ± 46.98^{d}
Tail (g)	22.50 ± 1.06^{c}	20.00 ± 1.03^{a}	21.10 ± 1.05^{b}	21.75 ± 1.05^{b}	22.90 ± 1.06^{c}
Thigh (g)	410.00 ± 3.92^{a}	412.50 ± 3.92^{b}	419.00 ± 3.93^{c}	423.00 ± 3.95^{d}	427.50 ± 3.97^{e}
Shoulder (g)	413.00 ± 10.27^{a}	461.00 ± 10.33^{b}	463.50 ± 10.34^{c}	484.00 ± 10.43^{d}	505.00 ± 10.45^{e}
Limbs(g)	70.50 ± 2.40^{a}	83.00 ± 2.45^{b}	86.85 ± 2.47^{c}	88.00 ± 2.47^{d}	90.00 ± 2.49^{e}
Ribs (g)	4.00 ± 0.30^{a}	6.00 ± 0.35^{b}	6.26 ± 0.35^{b}	6.27 ± 0.36^{b}	6.39 ± 0.38^{b}
Pancreas (g)	23.50 ± 2.04^{b}	18.50 ± 2.02^{a}	24.00 ± 2.04^{b}	26.50 ± 2.05^{c}	36.50 ± 2.08^{d}
Trachea (g)	22.50 ± 1.08^{c}	17.50 ± 1.06^{a}	18.50 ± 1.07^{b}	19.00 ± 1.07^{b}	23.00 ± 1.08^{c}

^{abcde} *Mean ± SEM on the same row with different letter superscript are significantly different (p<0.05); T1: 0% cocoa pod, 60% cassava pulp and 40% Acacia leaf; T2: 5% cocoa pod, 55% cassava pulp and 40% Acacia leaf, T3: 10% cocoa pod, 50% cassava pulp and 40% Acacia leaf; T4: 15% cocoa pod, 45% cassava pulp and 40% Acacia leaf, T5: 20% cocoa pod, 40% cassava pulp and 40% Acacia leaf*

Table 4: Effects of combinations of cocoa pod, cassava pulp and *Acacia* leaf on meat quality of biceps femoris muscle of West African dwarf goats

Parameters	Treatments	Storage Days			
		0	1	4	7
Superoxide dismutase (U/min/mg protein)	T1	8.47 ± 0.49^{a}	8.06 ± 1.00^{a}	6.92 ± 0.45^{b}	6.44 ± 1.16^{c}
	T2	5.26 ± 0.02^{a}	4.89 ± 0.24^{b}	4.45 ± 0.13^{b}	3.68 ± 0.12^{c}
	T3	4.31 ± 1.47^{a}	4.22 ± 0.43^{b}	3.94 ± 0.70^{c}	3.22 ± 0.23^{d}
	T4	4.25 ± 0.40^{a}	4.14 ± 0.13^{a}	3.86 ± 0.35^{b}	3.27 ± 0.70^{c}
	T5	3.77 ± 0.44^{a}	3.28 ± 0.63^{b}	3.04 ± 0.30^{c}	2.88 ± 0.15^{d}
Catalase activity (µmol/min/mg-protein)	T1	4.36 ± 0.18^{a}	3.97 ± 0.08^{b}	3.10 ± 0.05^{c}	3.14 ± 0.05^{c}
	T2	3.16 ± 0.10^{a}	3.02 ± 0.23^{ab}	2.65 ± 0.42^{c}	2.50 ± 0.15^{c}
	T3	3.09 ± 0.11^{a}	2.84 ± 0.07^{b}	2.47 ± 0.09^{c}	2.17 ± 0.60^{d}
	T4	2.97 ± 0.15^{a}	2.90 ± 0.11^{a}	2.55 ± 0.12^{b}	2.21 ± 0.18^{c}
	T5	2.66 ± 0.14^{a}	2.50 ± 0.12^{b}	2.35 ± 0.36^{c}	2.12 ± 0.20^{d}
Glutathione (GSH) Conc. (mmol/min/mg-protein)	T1	6.81 ± 1.10^{a}	6.46 ± 1.16^{a}	6.04 ± 0.87^{b}	5.54 ± 0.73^{c}
	T2	3.89 ± 0.03^{a}	3.65 ± 0.02^{a}	2.94 ± 0.03^{b}	2.25 ± 0.05^{c}
	T3	2.82 ± 0.17^{a}	2.63 ± 0.02^{a}	2.13 ± 0.01^{b}	1.95 ± 0.04^{c}
	T4	2.79 ± 0.03^{a}	2.75 ± 0.05^{a}	2.34 ± 0.06^{b}	2.01 ± 0.02^{c}
	T5	1.99 ± 0.04^{a}	1.85 ± 0.01^{a}	1.52 ± 0.02^{b}	1.15 ± 0.02^{c}
Glutathione peroxidase GPx Conc. (g of GSH consumed /min/mg of protein	T1	10.43 ± 1.13^{a}	10.07 ± 1.18^{a}	9.26 ± 1.20^{b}	8.74 ± 0.87^{c}
	T2	8.81^{a} ± 0.50^{a}	7.92 ± 0.81^{b}	7.23 ± 0.56^{b}	6.75 ± 0.68^{c}
	T3	7.33^{a} ± 0.32^{a}	7.29 ± 0.24^{a}	6.83 ± 0.20^{b}	6.08 ± 0.20^{c}
	T4	7.01^{a} ± 0.10^{a}	6.91 ± 0.12^{b}	6.62 ± 0.08^{b}	6.33 ± 0.12^{c}
	T5	5.71^{a} ± 0.18^{a}	5.61 ± 0.22^{b}	5.32 ± 0.12^{c}	4.93 ± 0.15^{c}
Carotenoid (µg/g tissue)	T1	3.11 ± 0.13^{a}	2.02 ± 0.22^{b}	1.62 ± 0.12^{c}	1.33 ± 0.15^{d}
	T2	2.52 ± 0.10^{a}	1.34 ± 0.09^{b}	1.12 ± 0.08^{b}	1.06 ± 0.06^{c}
	T3	2.01 ± 0.14^{a}	1.23 ± 0.20^{b}	1.04 ± 0.05^{b}	0.81 ± 0.01^{c}
	T4	1.75 ± 0.10^{a}	1.11 ± 0.10^{b}	0.93 ± 0.07^{c}	0.73 ± 0.08^{c}
	T5	1.40 ± 0.18^{d}	0.96 ± 0.16^{c}	0.62 ± 0.01^{b}	0.53 ± 0.04^{a}

^{abcde} Mean ± SEM on the same row with different letter superscript are significantly different ($p<0.05$); T1: 0% cocoa pod, 60% cassava pulp and 40% Acacia leaf; T2: 5% cocoa pod, 55% cassava pulp and 40% Acacia leaf, T3: 10% cocoa pod, 50% cassava pulp and 40% Acacia leaf; T4: 15% cocoa pod, 45% cassava pulp and 40% Acacia leaf, T5: 20% cocoa pod, 40% cassava pulp and 40% Acacia leaf

Regardless of the diet, the antioxidant enzymes observed on day 0 were greater ($p<0.05$) than those observed on other storage days. The concentration of the enzymes decreased over the storage. The decrease in superoxide dismutase, catalase and glutathione peroxidase activities ($p<0.05$) as postmortem storage progressed indicate the breakdown of antioxidant system in the tissues.

Carotenoid Level: The activity of carotenoids significantly decreased ($p<0.05$) as postmortem storage progressed and the least values were obtained in goats fed 20 % cocoa pod, 40 % cassava pulp and 40 % *Acacia* leaf.

DISCUSSION

The uses of cassava products as feed ingredients in livestock feeds is limited due to the concentration of toxic hydrogen cyanide (HCN) in its cultivars, high fibre and ash content (Tewe*,* 1992). In ruminants, high concentration of hydrogen cyanide (HCN) can alter growth and production system (Salkowski and Penney, 1994). Likewise, high concentration of theobromine in cocoa pod inclusion in ruminant diets may lead to excessive stimulation of kidneys, heart attack, skin irritations, nervous system malfunctions and death (Olugosi *et al.*, 2019). In this study, after fermentation, the theobromine concentration of the pod drastically reduced. The concentration of theobromine increased with increased levels of cocoa pod in the diets. The reduction in theobromine concentration during fermentation with low cocoa pod concentration in this study might be traced to decanting after fermentation and thus would make the feed more palatable to the animals. This reduction coefficient in theobromine agreed with the findings of Adamafio *et al.* (2011), Bentil *et al.* (2015) and Oduro-Mensah *et al.* (2018) who reported significant decrease in theobromine concentration after fermentation.

The dressing percentage in this study corroborates the reports of Ukanwoko *et al*. (2009) who reported decrease in dressing percentage when fed dietary cassava peel and cassava leaf meal-based to West Africa dwarf goats. The lower dressing percentage in this study may be due to the exclusion of the head, legs and internal organs such as heart, kidney, lungs and liver in the dressed carcass. Gökdal (2013) indicated that dressing percentage is the combination of yield and financial values which can be influenced by factors such as weight, age, nutritional level, fatness and dressing processes. Mahgoub *et al.* (2011) reported that the dressing percentage of goats ranged between 35 to 53 % while Tshabalala *et al.* (2003) reported a range of 42 to 45 % which corroborates the findings of this study. Subcutaneous fat is not well developed in goat and fat accretion occurs at a later stage in the growth process compared to other livestock species (Webb *et al.*, 2005).

The results of the antioxidant enzymes in biceps femoris muscle of the goat's chevon revealed that the superoxide dismutase, catalase and glutathione peroxidase were significantly high with goats fed T1 diet and low in goats fed T5 diet. The increase in this value implied that the effect of the diets was more on combinations of T1(0:60:40) compared to combinations of T5(20 : 40 : 40). In the recent study, irrespective of tissue, the superoxide dismutase, catalase, and glutathione peroxidase activities decreased ($p<0.05$) over storage period across the group. This was in contrast to the findings of Adeyemi *et al.* (2016) who indicated that there was stability in catalase, superoxide dismutase and glutathione peroxidase activities during an 8day ageing of semimembranosus muscle in goats. This may be due to dietary influence or methods of storage. The dietary and tissue balance of antioxidant nutrients is important in protecting tissues against free radical accumulation and damage. This study gives reference values for carcass traits and meat quality in West African dwarf goats, as well as the level of antioxidants enzymes. It is essential that while focusing on the nutritional components for improving production/reproduction, the antioxidant status of the ruminants must be maintained at the proper times to optimize the ruminant production (Nayyar and Jindal, 2010). Moreover, the decrease ($p<0.05$) in superoxide dismutase, catalase and glutathione peroxidase activity as

post-mortem storage progressed reflect the breakdown of antioxidant defence system in the tissues, these results corroborate the reports of Adeyemi *et al*. (2016) who reported decreased in carotenoid contents over an 8-day chill storage of semimembranosus muscle in goats.

Conclusion: The study showed that the combinations of cocoa pod, cassava pulp and *Acacia* leaf have significant effects on the carcass traits of West African dwarf Goat. Goats on combinations of T5 (20: 40: 40) had the highest values for carcass length. Goats on combinations of T5 (20: 40: 40) had the highest values for neck, lungs, heart, thigh, rib, kidney, liver and pancreas. It appeared that goats on combinations of T5 (20: 40: 40) best utilized the diets for muscle build up and hence meat production. Since they had the highest weights in the high muscle cuts i.e., neck, shoulder and thigh. Fruits, browse plants, agro industrial by products (natural antioxidants) could serve as good alternative antioxidants properties which can influence consumer acceptability and consumption of that meat products.

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