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PERFORMANCE NUTRIENT DIGESTIBILITY OF YANKASA SHEEP FED DIETRY LEVELS OF CASSAVA AND MAIZE COMPOSITES

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Abstract

The production of Yankasa sheep serves significant socio-economic purposes and it is one of the most common, abundant, and widely distributed sheep in Nigeria. This sheep breed is unable to reach its full potential due to high feed costs and poor nutrient intake. Therefore, the effect of 82 days of feeding with dietary levels of cassava and maize composites on performance and apparent nutrient digestibility were investigated. To do this, forty, 8–10-months old Yankasa sheep were divided into five groups of eight sheep. Each group was assigned to one of the experimental diets in a completely randomized design labelled, Treatment 1 (100% maize composite), Treatment 2 (75% maize composite and 25% cassava composite), Treatment 3 (50% maize composite and 50% cassava composite), Treatment 4 (25% maize composite and 75% cassava composite) and Treatment 5 (100% cassava composite). The dry matter intake (DMI) g/d, supplement DMI, total DMI, daily weight gain, feed conversion ratio and dry matter digestibility were significantly improved ($p< 0.05$) in 50%MC/50%CC than those fed the other treatments. Dressing percentage and leg weights were higher in 75%MC/25%CC and 50%MC/50%CC treatments. DMI (g/kgW$^{0.75}$), final body weight, total weight gain, empty weight and crude protein digestibility were better in 75%MC/25%CC, 50%MC/50%CC and 25%MC/75% CC. Combination of varying levels of maize and cassava composites in sheep diets provided nourishable diets. However, Treatment 3 (50%MC/50%CC) gave the most enhanced performance and dry matter digestibility, and is hence recommended for enhanced Yankasa sheep production.

Keywords: Body weigh changes, Carcass characteristics, Growth performance, Nutrient intake, Nutrient digestibility.

Introduction

The vast majority of Nigerians rely on the livestock sector for employment and supply of vital nutrients. Nigeria had a population of 88.2 million goats, 49.1 million sheep, 20.9 million cattle, 9.2 million pigs, and 258.5 million birds (NBS, 2024) which is most likely to be higher today. In Nigeria, the main goal and focus of livestock

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production is to supply the population with good quality animal protein. According to Ben-Salem and Smith (2008), the bulk of the rural population in Nigeria is dependent on livestock and their by-products, and the country's economy is still centred on the production of sheep, goats, and cattle. In addition to producing meat, small ruminants help the leather industry by producing skin, which the FAO estimates to be 7,500 tonnes annually (Mubi *et al*., 2012). Small ruminants are widely distributed throughout rural, urban, and peri-urban areas and make up approximately 63.7% of all domestic livestock in Nigeria. The northern part of the country is home to 70% of these

Small ruminants. According to importance, the native sheep breeds are Balami (10%), Uda (10%), West African dwarf (20%), and Yankasa (60%) (Ramalan *et al*., 2022). The short generation interval and high multiple birth rate allowed for the rapid population increase in sheep today (Markos, 2006). The majority of sheep in the Guinea and Sudan Savannah belt of West Africa are Yankasa sheep (Iheukwumere *et al*., 2008). Yankasa are tall hairy white coloured sheep with black colourations around the muzzles and the eye regions and reaching a height of 50 to 70 cm at the withers, weigh 30 to 50 kg, and have exceptional sexual agility. It is estimated that more than 60% of the 39 million sheep in the nation are of the Yankasa breed, making sheep the second most important livestock species in the nation (FAOSTAT, 2013). The Yankasa sheep breed is the most common and abundant in Nigeria, found throughout the semi-arid and subhumid regions.

The scarcity and high cost of feeds significantly restrict ruminant production vis-a-vis sheep production in many developing countries. According to Jiwuba *et al*. (2022), the lack of feed is especially pronounced during the dry season when natural pastures become poor in crude protein and highly fibrous. Nigeria is producing livestock using non-traditional energy and protein components derived from agriculture and agro-industrial waste (Okonkwo *et al.,* 2008). Cassava (*Manihot esculenta*) is a tropical tuberous food plant that belongs to the *Euphorbiaceae* family. It is grown all throughout the tropical regions for its tuberous roots, are used to make breads, tapioca, cassava flour, laundry starch, alcoholic beverages etc. Ukachukwu (2008) identified cassava as the best option for addressing the persistently high feed costs in livestock industry. Nigeria is currently the world's biggest producer of cassava (Ezenwaka *et al*., 2018). It has roughly 3.65 Kcal/g ME of energy and about 17- 21% crude protein. The leaves and tender stems make up the foliage, which is a good source of protein, vitamins and dietary ash (Akinfala, 2000). Additionally, the stems contain reasonable dietary fibre. The nutritional value of cassava composite meal, which is a blend of entire leftover stems, and leaves, was documented (Ukachukwu, 2005), who concluded that it might be used as a feed ingredient for livestock and poultry.

Maize (*Zea mays* L.) is the most widely cultivated cereal worldwide. One of the most important grain crops in Africa today is maize, which was brought to the continent from central Mexico before 1500 BC. It quickly expanded to every part of the continent after being introduced. Maize is used to make a variety of industrial products, including biofuels, animal feed, and human consumables. In Africa, maize is an essential component of animal feeding regimens. There is a dearth of information on the utilisation of different combination of cassava and maize composites. This study therefore presents information on nutrient intake, body weight gain, carcass indices and apparent nutrient digestibility of Yankasa sheep fed dietary levels of cassava and maize composites. If is assumed that different combinations of cassava and maize composites will have a beneficial effect on the nutrient intake, body weight changes, carcass characteristics and apparent nutrient digestibility in Yankasa sheep, due to better nutrient balance. Therefore, the objective of this study was to evaluate the effect of dietary levels of cassava and maize composites on the nutrient intake, body weight gain, carcass characteristics and apparent nutrient digestibility of Yankasa sheep.

Materials and Methods

Experimental location

This experiment was conducted at the small ruminant unit of the teaching and research farm, Michael Okpara University of Agriculture, Umudike, Nigeria. The study area lies between latitude 05^{o} 28^{1} N and longitude 07^{o} 31^{1} E.

Sourcing of the cassava and maize composites

The cassava (TME 419) and maize (ba super) were sourced from the National Root Crop Research Institute, Umudike. Freshly harvested and discarded vegetative parts of the cassava and maize were harvested, chopped to a length of 1-3cm prior to feeding.

Experiment diets

The cassava and maize composites were further prepared into five treatments. Treatment 1: 100% maize composite (MC) and 0% cassava composite (CC), Treatment 2: 75% maize composite and 25% cassava composite, Treatment 3: 50% maize composite and 50% cassava composite, Treatment 4: 25% maize composite and 75% cassava composite and Treatment 5: 0% maize composite and 100% cassava composite. The composites were thoroughly mixed in accordance with the treatment combinations, before being fed fresh to the experimental sheep. The supplemental diet was formulated from palm kernel meal, maize offal, groundnut meal, wheat offal, bone meal, limestone, salt and vitamin premix as shown in Table 1.

Table 1. Composition of the supplemental diet

Palm kernel meal	20.00
Maize offal	40.00
Groundnut meal	8.00
Wheat offal	27.50
Bone meal	2.00
Limestone	1.00
Salt	1.00
Vitamin premix	0.50
Total	100.00

Animal management

In this study, forty Yankasa rams weighing about 10.26 kg and aged 8 to 10 months were sourced from Leggal market, Shongom Local Government Area, Gombe State. The experimental animals were acclimated for 21 days prior to the commencement of the study in accordance with the approval and directives of the Animal Ethics Committee of Michael Okpara University of Agriculture, Abia State, Nigeria. Before the trial, the sheep were administered Ivermectin (1 ml/10 kg body weight (injected subcutaneously) and Albendazole (0.1 mg/kg BW given orally) to treat external and internal parasites. The sheep were vaccinated against *Peste' Petit de' Ruminante'* (PPR) with PPR vaccine at a dosage of 1 ml subentaneously. For a preliminary period of 21 days, the animals were gradually fed wilted *Panicum maximum* in the morning (8.00 hr) and the supplemental diet in the evening (16.00 hr).

Experimental design, housing and feeding

The sheep were randomly divided into 5 groups each with 8 sheep constituting a replicate. The five experimental diets (100%MC, 75%MC/25%CC, 50% MC/50%CC, 25%MC/75%CC and 100%CC) were allotted to the groups in a completely randomized design. The animals were kept in separate pens with well-ventilated cemented floors having feeders and drinkers. For 82 days, each animal was fed a specific treatment diet in the morning (08:00 hour). Feeding was based on 3.5% body weight per day and to ensure about 10% left over, in addition to 0.5 kg supplemental diet that was fed at 16:00 h. Fresh drinkable water was made available regularly.

Estimation of different parameters

Each animal's voluntary feed intake was calculated daily by subtracting the previous day's feed refusals from the current day's feed supply. The sheeps' initial live weights were taken using spring balance at the start of the feeding trial and weekly afterwards in the morning before feeding. At the conclusion of the trial, the sheep were weighed to determine their final live weight. Other parameters were computed using the following equations-

Feed intake (kg) = $feed\ given - feed\ left\ over$ *…………(1)*

Average daily feed intake (g/d) = $\frac{total\ feed\ intake}{number\ of\ experimental\ days}$ *……..(2)*

Total weight gain (kg) = $final\ body\ weight - initial\ body\ weight$ *….(3)*

Average daily weight gain (g/d) = $\frac{total\ weight\ gain}{number\ of\ experimental\ days}$ *………..(4)*

Feed Conversion Ratio = $\frac{daily\ feed\ intake}{daily\ weight\ gain}$ *……………..(5)*

Dry matter intake (DMI) (g/day) = $\frac{feed\ intake\ x\ dry\ matter\ analysed}{100}$ *………(6)*

Dry matter intake as percentage of body weight (%) =

$$\frac{dry\ matter\ intake}{body\ weight\ of\ the\ animal}\ x\ 100$$ *…..(7)*

Other growth performance indexes were computed accordingly.

Digestibility studies

Each treatment group comprising eight Yankasa sheep was transferred to and housed in separate metabolism cages with facilities for collecting faeces and fed the designated diets for 2 days. Thereafter, the other treatment groups were subjected to the same exercise. During each 2 – day feeding period (8 days for the 4 phases), drinking water was provided *ad libitum*. Sample of each diet was collected and used for dry matter (DM) determination and proximate composition analysis.

Faecal samples (not contaminated with urine) were collected and bulked for each animal. A sub sample from each animal was dried in forced draft oven at 100-105^{0}C for 48 hours and used for DM determination. Another sample was dried at 60^{0}C for 48-72 hours for determination of proximate composition. Apparent coefficient digestibilities for nutrients were determined as given below:

$$\frac{\text{Nutrient in feed- nutrient in faeces}}{\text{Nutrient in feed}} \times \frac{100}{1}$$

Proximate analyses

AOAC (2005) procedures were used to analyse all the feed, and faecal samples for proximate components. Triplicate samples of the composite combinations were analysed for dry matter (DM), crude protein (CP), crude fibre (CF), ash, ether extract (EE), nitrogen-free extract (NFE) and organic matter (OM) according to the methods of AOAC (2005). The neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) fractions were determined using Van Soest *et al.*'s (1991) methods.

The gross energy was calculated using the formula according to Nehring and Haelien (1973); T = 5.72Z1 + 9.50Z2 + 4.79Z3 + 4.03Z4 + 0.9%

where;

T = gross energy;

Z1 = crude protein;

Z2 = crude fat;

Z3 = crude fibre;

Z4 = nitrogen-free extract.

Statistical analyses

The experimental design was a completely randomised design (CRD). Data obtained were analysed using analysis of variance (ANOVA) as described by SAS (2008). Significant means were separated using the Duncan Multiple New Range Test (Duncan 1955) at $P < 0.05$.

Results and Discussion

Proximate compositions

Table 2 shows the proximate compositions of the dietary levels of cassava and maize composites. Crude protein (CP), crude fibre, gross energy and neutral detergent fibre (NDF) showed significant ($p<0.05$) differences while dry matter (DM), ether extract (EE), ash, nitrogen free extract (NFE) acid detergent fibre (ADF) and acid detergent lignin (ADL) were not significantly ($p>0.05$) influenced across the groups. Crude protein value of 100% cassava composite (100%CC) was significantly ($p<0.05$) higher than the other treatments. The CP content was the highest (17.48%) for 100%CC with a corresponding lowest value of 7.73% recorded for 100%MC. Crude fibre was significantly ($p<0.05$) higher in 100%MC in comparison to 25% MC 75%CC and 100%CC. Neutral detergent fibre showed significant ($p<0.05$) difference and followed a similar pattern with the CF, with 100%MC and 75% MC/25%CC been higher than 25%MC/75%CC and 100%CC. Gross energy also showed significant difference ($p>0.05$), with 100%MC, 50% MC/50%CC and 25%MC/75%CC showing higher energy values ($p<0.05$) than 75%MC/ 25%CC and 100%CC.

Table 2. Chemical compositions of the varying levels of cassava and maize composites

Parameter	Dietary levels				100%CC	SEM
	100%MC	75%MC/ 25% CC	50% MC/ 50%CC	25%MC/75 % CC		
Dry matter	92.76	93.91	92.76	91.56	90.42	12.64
Crude protein	7.73[c]	10.09[bc]	12.26[b]	13.97[b]	17.48[a]	3.72
Crude fibre	19.28[a]	17.63[a]	14.52[ab]	12.37[b]	10.39[b]	6.35
Ether extract	2.96	2.84	2.46	2.31	3.75	3.38
Ash	4.24	5.53	5.38	5.18	6.33	2.92
Nitrogen free extract	59.51	57.82	58.14	57.73	52.47	8.41
Gross Energy (Kcal/g)	402.42[a]	389.71[b]	402.29[a]	399.09[a]	371.71[b]	29.03
Neutral detergent fibre	54.95[a]	51.78[a]	48.93[ab]	43.81[b]	40.46[b]	6.84
Acid detergent fibre	32.86	38.17	27.47	23.26	23.09	4.71
Acid detergent lignin	12.97	12.83	10.94	10.06	11.87	2.39

[a-d] means within the same row with different superscripts are significantly different ($p<0.05$); MC= Maize composite; CC= cassava composite

Generally, the CP contents of the diets were above 7 and 8% by ARC (1980) and Norton *et al*. (1994) respectively, which are the minimum dietary recommendations for rumen motility and function. The high CF values reported in this study is an indication of the suitability of the composite combinations to supply needed fibre for the animals. Jiwuba (2018) in an earlier study postulated that adequate supply of dietary fibre stimulates rumen motility, equilibrium in rumen ecosystem and chyme chewing. The high NDF values observed in all the diets were in agreement with the findings of Lalman (2012), which stipulated that, ruminant diets should contain at least 20% NDF on a dry matter basis to ensure optimal roughage digestion. The NDF fraction is composed of hemicellulose, cellulose and lignin, which aggregate to stimulate and aid rumen motility (Jiwuba *et al*., 2023). The energy values reported in this study is in agreement with earlier reports of ARC (1980) and NRC (1981) on the energy requirements of small ruminants.

Nutrient intake studies

The nutrient intake of Yankasa sheep fed dietary levels of cassava and maize composites are presented in Table 3. All the parameters examined showed significant (P <0.05) differences except TDMI%BW (g/kgW$^{0.75}$) and Crude fibre intake (g/kgW$^{0.75}$). Daily feed intake was enhanced in 50% MC/50%CC compared to 100% MC and 100% CC. DM intake for the composites was significantly (p<0.05) higher 50% MC/50%CC. The increased DM intake for 50% MC/50%CC may be attributed to the greater palatability of the diets due to better nutrient balance. DM intake for the supplement was higher (p<0.05) for 25% MC/75%CC in comparison to the other treatments. However, total DM intake represented as g/d and g/kgW$^{0.75}$ increased significantly (P<0.05) for the Yankasa sheep fed 50% MC/50% CC. Total DM intakes (g/d) obtained herein were in conformity with the findings of Adeleke *et al.* (2022) for Yankasa rams fed roughage and concentrate supplement at different sequences and intervals. Dry matter intake as per metabolic weight (DMI) (g/kgW$^{0.75}$) obtained in this study (76.66 - 91.85 g/kgW$^{0.75}$) were well above the voluntary DMI of 58 g/kgW$^{0.75}$ recommended by Akinsoyinu (1985) and 68 g/kgW$^{0.75}$ recommended by Kearl (1982) as maintenance requirement for small ruminants in Nigeria and small ruminant breeds found in developing countries respectively. The improved intake obtained in this study can be described by the better supply of both nitrogen and readily available carbohydrates to the rumen microbes which possibly enhanced the rate of degradation of the diets, microbial growth and the fractional outflow of liquid matter from the rumen. In earlier study, Mpairwe *et al*. (2003) observed that providing supplements with adequate CP to ruminants could enhance DMI, rumen degradation and nutrient flow to the small intestine and culminated in higher animal performance. The dry matter intake as percentage body weight (DMI% BW) differed significantly (P<0.05) among the treatment groups, with 25%MC/75%CC and 100%CC showing significantly (p<0.05) higher values. However, the values for all the treatments (3.50-4.43%) compared well with the values of 3%, and 2.8-4.0% recommended daily DM intake (as % BW) requirements for meat type sheep in the tropics by Devendra and McLeroy (1982), and Nuru (1985) respectively. The results generally indicate that animals on the various treatment diets showed positive DM status as evidenced by a general positive performance of the sheep. The CP intakes (g/d and g/kg W$^{0.75}$) of the sheep fed the 100%MC and 75% MC/25%CC had lower (p<0.05) values and 50% MC/50%CC, 25%MC/75%CC and 100%CC had higher (p<0.05) values. Protein intake is a major determinant of small ruminant performance due to increased availability of fermentable nitrogen and other nutrients required by rumen microbes as well as the greater opportunities for some of the protein to escape rumen fermentation (Jiwuba, 2023). The high CP intake of sheep in the 50%MC/50%CC, 25%MC/75%CC and 100%CC could be due to the higher proportion of CP in the treatments.

Body weight changes

Table 4 shows the body weight gain of Yankasa sheep fed dietary levels of cassava and maize composites. Final body weight, total weight gain and daily body weight showed significant (p<0.05) differences across the groups. Daily weight gains of the sheep showed significant (p<0.05) difference with 50% MC/50%CC showing higher (p<0.05) value in comparison with other treatments. Total feed intake and daily feed intake were significantly (p<0.05) influenced by the composite combinations. The combinations were better (p<0.05) consumed than the sole maize and cassava composites. Feed conversion ratio was significantly (p<0.05) higher in 100%MC and 100%CC in comparison with 50% MC/50%CC. The animals on 50% MC/50%CC gave the highest (p<0.05) daily weight gain (g/day) of 139.63 g/d while those on 100% CC and 100%MC diets yielded significantly lower daily weight gain of 84.02 g/d and 86.71 g/d respectively. The differences in daily weight gain of Yankasa sheep could be attributed to the influence of the combinations in providing protein and energy needed both for effective rumen function and body metabolism by the sheep. Sheep fed 50% MC/50%CC diet yielded the most superior daily weight gain and feed conversion ratio. The improved performance could be attributed to the better nutrient balance of the diet.

Carcass evaluation

The carcass characteristics of Yankasa sheep fed dietary levels of cassava and maize composites is presented in Table 5. Live weight at slaughter and empty weight were significantly (p<0.05) higher in 75% MC/25%CC, 50% MC/50%CC and 25% MC/75% CC in comparison to the 100%MC and 100%CC**.** Dressed weight was lowest in 100% CC and highest in 75%MC/25%CC and 50% MC/50%CC combinations. Dressing percentage (DP) was higher (p<0.05) in 75% MC/25% CC and 50%MC/50%CC. Leg weights were significantly (p<0.05) influenced with 75% MC/25%CC and 50% MC/50%CC composites showing higher (p<0.05) weights than the other treatment. The DP results were mostly in line with the values reported for tropical breeds by Steele (1996) and Devendra, and Mc Leroy (1982). The findings of the current study also supported the idea that dressing percentage increased with increasing slaughter weight. According to Devendra and Mc Leroy (1982), most tropical sheep and goats dress out between 40 and 50% on balanced diets. However, Anjaneyulu and Joshi (1995), reported 38 to 56 % as baseline for tropical sheep and goats. The higher DP recorded for the sheep on the 75% MC/25%CC and 50% MC/50%CC combinations may be attributed to higher slaughter weights. However, less consideration is given to DP in the tropics than in temperate zones because nearly all the offal is eaten as food, with some parts and organs selling for more money than carcass meat. The significant difference reported for leg indicated that the diets supported the growth and development of the cut parts. The higher leg weights observe in 75% MC/25% CC and 50%MC/50%CC may indicate that the two composite combinations were able to promote the growth and development of the legs.

Table 3. Nutrient intake of Yankasa sheep fed varying levels of cassava and maize composites

Parameters (g/d)	100% MC	75%MC/ 25% CC	50% MC/ 50%CC	25%MC/ 75% CC	100CC	SEM
Daily feed intake (g/d)	470.24[b]	520.98[ab]	555.98[a]	511.59[ab]	398.29[c]	9.63
Dry matter intake (DMI)	436.19[c]	489.25[b]	515.73[a]	468.41b[c]	360.13[d]	1.40
DMI ($g/kgW^{0.75}$)	95.45[c]	104.03[ab]	108.22[a]	100.69[b]	82.67[d]	2.22
Supplement dry matter intake (SDMI)	65.33[c]	75.38[b]	78.18[b]	81.79[a]	61.39[c]	3.62
Total DMI	501.52[c]	564.63[b]	593.91[a]	495.61[c]	421.52[d]	1.17
Total DMI ($g/kgW^{0.75}$)	105.98[b]	115.83[a]	120.31[a]	105.04[b]	93.03[c]	1.11
Total dry matter intake as percentage of body weight (TDMI%BW) (%)	3.50[b]	3.82[b]	3.74[b]	4.40[a]	4.43[a]	4.95
TDMI%BW ($g/kgW^{0.75}$)	2.26	2.73	2.69	3.03	3.05	0.46
Crude protein intake (CPI)	36.34[c]	52.57[b]	68.16[a]	71.47[a]	69.62[a]	3.48
CPI ($g/kgW^{0.75}$)	14.80[c]	19.52[b]	23.72 [a]	24.59 [a]	24.10 [a]	2.67
Crude fibre intake	90.66[a]	91.85[a]	80.73[b]	63.28[c]	41.36[d]	5.14
CFI ($g/kgW^{0.75}$)	29.38	29.67	26.93	22.44	16.31	2.62

[a-d] means within the same row with different superscripts are significantly different ($P<0.05$)

Table 4. Body weight gain of Yankasa sheep fed varying levels of cassava and maize composites

Parameters	100% MC	75%MC/ 25% CC	50% MC/ 50%CC	25%MC/75% CC	100%CC	SEM
Initial body weight (kg)	10.45	11.21	10.76	12.54	11.78	2.23
Final body weight (kg)	17.56[b]	21.55[a]	22.21[a]	21.82[a]	18.67[b]	3.40
Total weight gain (kg)	7.11[b]	10.34[a]	11.45[a]	9.28[ab]	6.89[b]	2.22
Total feed intake (kg)	38.56[b]	42.72[a]	45.59[ab]	41.95[a]	32.66[c]	4.47
Daily weight gain (g/d)	86.71[c]	126.10[b]	139.63[a]	113.17[b]	84.02[c]	9.62
Daily feed intake (g/d)	470.24[b]	520.98[ab]	555.98[a]	511.59[ab]	398.29[c]	9.63
Feed conversion ratio	5.42[a]	4.13[ab]	3.98[b]	4.52[ab]	4.74[a]	0.69

a-d means within the same row with different superscripts are significantly different (P<0.

Table 5. Carcass characteristics of Yankasa sheep fed varying levels of cassava and maize composites

Parameters	100% MC	75%MC/ 25% CC	50% MC/ 50%CC	25%MC/ 75% CC	100%C C	SEM
Live weight at slaughter (kg)	16.77[b]	20.03[a]	20.79[a]	19.73[a]	16.83[b]	2.61
Empty weight (kg)	14.43[b]	17.44[a]	18.23[a]	17.57[a]	14.54[b]	1.40
Dressed Weight (kg)	8.61[b]	11.42[a]	11.49[a]	9.44[ab]	7.35[c]	2.22
Dressing Percentage (%)	51.34[b]	57.01[a]	55.27[a]	47.85[c]	43.67[d]	3.62
Meat cuts expressed as percentage (%) of dressed weight						
Loin	16.65	18.94	19.44	12.41	11.47	1.17
Set	5.86	5.98	5.98	5.54	5.87	1.11
Shoulder	10.58	9.61	7.58	8.00	11.16	2.47
Leg	30.56[b]	36.84[a]	34.76[a]	27.87[c]	23.95[d]	5.82
End	5.15	4.78	4.42	4.51	5.62	1.78

a-d means within the same row with different superscripts are significantly different (p<0.05)

Table 6. Apparent digestibility of Yankasa sheep fed varying levels of cassava and maize composites

Parameter	Dietary levels				100%CC	*SEM*
	100% MC	75%MC/ 25% CC	50% MC/ 50%CC	25%MC/ 75% CC		
Dry matter digestibility	60.67[b]	70.65[b]	75.76[a]	62.54[b]	61.78[b]	5.98
Crude protein digestibility	67.56[b]	71.55[a]	72.21[a]	70.82[a]	68.67[b]	4.78
NDF digestibility	56.71	56.10	59.63	53.17	54.02	2.85
ADF digestibility	40.24	40.98	35.98	41.59	38.29	4.56
ADL digestibility	34.85	32.76	34.76	31.63	34.96	1.41

a-d means within the same row with different superscripts are significantly different (P<0.05)

Digestibility studies

The apparent nutrient digestibility of Yankasa sheep fed dietary levels of cassava and maize composites is presented in Table 6. The DM digestibility and CP digestibility and showed significant (P<0.05) difference across the treatments. NDF digestibility, ADF digestibility and ADL digestibility were not significantly (p>0.05) affected by the composite combinations. 50 MC/50%CC produced significantly (p<0.05) high DM digestibility in respect to the other groups. The higher DM digestibility is in disagreement with the report of Bakshi and Wadhwa (2004) who reported that high neutral detergent fibre and acid detergent lignin depress dry matter digestibility. The higher dry matter digestibility recorded for sheep fed 50% MC/50%CC may be attributed the nutritional synergy, optimal carbohydrate-fibre balance and enhanced microbial fermentation; a view corroborated. The study showed that the sheep had a positive crude protein digestibility which ranged from 67.56 -72.21%. The differences observed in crude protein digestibility could be connected to the source of the protein, CP content in the diet (percentage combination) and solubility in the rumen. The high CP digestibility recorded for the sheep fed 75%MC/25%CC, 50%MC/50%CC and 25%MC/75%CC is an indication that the composite combinations are highly soluble and degradable better than the sole diets.

Conclusion

It could be concluded that 50% MC/50%CC showed significant improvement in dry matter intake, supplement dry matter intake, total dry mater intake, daily weight gain, feed conversion ratio and dry matter digestibility. Dressing percentage and leg weights were better in 75%MC/25%CC and 50%MC/50%CC combination. Dry matter intake (g/kgW$^{0.75}$), final body weight, total weight gain, live weight at slaughter, empty weight and crude protein digestibility were however better in 75%MC/25%CC, 50%MC/50%CC and 25%MC/75%CC in comparison to 100%MC and 100%CC. Combination of varying levels of maize and cassava composites in sheep diets provided nourishable diets for the sheep. However, treatment 3 (50%MC/50%CC) gave the most enhanced total dry matter intake, body weight gain, feed conversion ratio and DM digestibility, and is hence recommended for enhanced Yankasa sheep production.

Conflicts of interest

The authors declare no conflicts of interest regarding publication of this paper.

Authors' contribution

P.C. J. designed the study, wrote the protocol and wrote the first draft of the manuscript. K.I. performed the chemical, feacal and urine analyses. L.C. J. reviewed the experimental design, performed the statistical analysis and provided the test ingredients (maize and casava composites). FOA guidance and monitoring of experiment and critical revision on the initial draft and approval of the final manuscript. All the authors read and approved the final manuscript.

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