

Cassava leaves and peels: Nutritional value and potential productivity in West African dwarf breeds of sheep and goats– A review

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Abstract

Cassava (Manihot esculenta crantz) leaves and peels are recognized as locally available feed resource with a high edible biomass yield for sheep and goat production in Nigeria. They have been successfully used as an alternative feed to overcome the dry season challenge posed by seasonal fluctuations. The nutritional value and potential productivity of cassava leaves and peels as feedstuff for West African dwarf (WAD) sheep and goat production systems were examined and reviewed. Results from literature showed cassava leaves and peels combine a great number of qualities and benefits in terms of nutrient supply and supplementation which supported growth and performance, thereby serving as a promising feedstuff and a source of high-quality feed for West African dwarf sheep and goat production. The crude protein content (%) of cassava leaves and peels ranged from 16.01 - 39.90 and 3.45 - 6.50, respectively while tannin content was more concentrated in leaves (1.17 - 21.60%) compared to peels (0.12 - 0.31%). Average weight gain (g/day) of sheep and goats fed cassava leaves as sole and supplementary feed across literature varied from 30.36 - 48.33 and 23.21-26.25, respectively while sheep and goats fed cassava peels varied from 20.30 - 38.00g/day and 6.55 - 31.90g/day, respectively. Tannin in cassava leaves were found to possess an anthelmintic effect against nematode parasites, reducing gastro-intestinal nematode egg counts to about 52.94 to 78.48%. Haematological and serum biochemical parameters reviewed were within the range for clinically healthy sheep and goats while dressing percentage ranged from 32.57 - 61.00 %. It was therefore concluded that cassava leaves and peels can be used successfully as an adequate source of much needed protein and energy especially when fed as a supplement to other feed materials to improve productivity of WAD sheep and goats.

Keywords: Sheep, goats, cassava, leaves, peels, performance, tannins, hematology, carcass

Feuilles et pelures de manioc : valeur nutritionnelle et productivité potentielle des races naines ovines et caprines d'Afrique de l'Ouest - Une revue



Résumé

Les feuilles et les pelures de manioc (Manihot esculenta crantz) sont reconnues comme une ressource alimentaire disponible localement avec un rendement élevé en biomasse comestible pour la production ovine et caprine au Nigeria. Ils ont été utilisés avec succès comme aliment alternatif pour surmonter le défi de la saison sèche posé par les fluctuations saisonnières. La valeur nutritionnelle et la productivité potentielle des feuilles et des pelures de manioc comme aliment pour les systèmes de production de moutons et de chèvres nains d'Afrique de l'Ouest (NAO) ont été examinées et passées en revue. Les résultats de la littérature ont montré que les feuilles et les pelures de manioc combinent un grand nombre de qualités et d'avantages en termes d'apport de nutriments et de supplémentation qui soutiennent la croissance et la performance, servant ainsi d'aliment prometteur et de source d'alimentation de haute qualité pour la production des ovins et caprins nains d'Afrique de l'Ouest. La teneur en protéines brutes (%) des feuilles et des pelures de manioc variait de

16,01 à 39,90 et de 3,45 à 6,50, respectivement, tandis que la teneur en tanin était plus concentrée dans les feuilles (1,17 à 21,60 %) que dans les pelures (0,12 à 0,31 %). Le gain de poids moyen (g/jour) des ovins et des caprins nourris avec des feuilles de manioc comme aliment unique et complémentaire dans la littérature variait de 30,36 à 48,33 et de 23,21 à 26,25, respectivement, tandis que les ovins et les caprins nourris avec des pelures de manioc variaient de 20,30 à 38,00 g/jour et 6,55 - 31,90 g/jour, respectivement. On a découvert que le tanin des feuilles de manioc possédait un effet vermifuge contre les parasites nématodes, réduisant le nombre d'œufs de nématodes gastro-intestinaux d'environ 52,94 à 78,48 %. Les paramètres hématologiques et biochimiques sériques examinés se situaient dans la fourchette des ovins et caprins cliniquement sains, tandis que le pourcentage d'habillage variait de 32,57 à 61,00 %. Il a donc été conclu que les feuilles et les pelures de manioc peuvent être utilisées avec succès comme source adéquate de protéines et d'énergie indispensables, en particulier lorsqu'elles sont administrées en complément d'autres matières premières pour améliorer la productivité des moutons et des chèvres.

Mots clés: Ovins, caprins, manioc, feuilles, pelures, performances, tanins, hématologie, carcasse

Introduction

Cassava (*Manihot esculenta crantz*) is an important staple food for millions of Nigerians aside from its use as livestock feed, hence, having the capacity to promote the economic development and provide food security (Chidozie *et al.*, 2019). The production of large quantities of under-utilized residues from cassava comprising of peels, leaves and under sized tubers are currently increasing due to the demand for cassava for household and industrial use. Most of these residues are being lost and wasted, which translates to losses of food and nutrition, and also contribute significantly to generated environmental problems, including the production of greenhouse gases. More so, they have been found to be limited by a number of factors, but mainly its characteristic content of anti-nutritional factors, primarily hydrocyanic acid and tannins present in its tissues, which limits the nutritional value (Latif and Müller, 2015). Consequently, proper processing of these residues is essential to diminish the toxic compounds and anti-nutrients to a safe limit for utilization. Cassava leaves and peels in recent times have become an increasingly important ingredient in sheep and goat diets. This is largely due to its high availability and a

continuous demand for alternative energy sources for ruminant production as its efficiency has been shown to reduce feed costs (Fasae *et al.*, 2015). These residues are sources of diverse dietary components such as carbohydrates, proteins, vitamins, minerals and phytochemicals of great importance for health and nutrition as they possess high rumen degradable energy and by-pass protein (Wanapat and Kang, 2013). This paper reviewed the nutritional value and potential productivity of cassava leaves and peels as feedstuff in West African dwarf breed of sheep and goat production systems in enhancing high yields and good quality of meat and milk, and hence, contribute to a more lucrative production system, especially for small-holder farmers.

Cassava leaves

Cassava leaves are sources of major limiting nutrient to ruminants on fibrous crop residues and agro-industrial wastes. They have been identified as a rich source of protein, minerals, and vitamins that exceed some of the other green vegetables and foodstuff (Pereira *et al.*, 2016), and have been used successfully in ruminant rations, due to their high rumen degradable energy and by-pass protein (Wanapat and Kang, 2013). The potential yields of cassava leaves vary considerably depending on the

cultivar, age, harvesting frequency and climate. They have been cultivated as a semi-perennial forage that can be harvested several times per biological cycle of every two or three months (Phengvilaysouk *et al.*, 2008) to serve as source of feed for ruminants. They have continued to be one of the primary sources of feed for ruminant animals through systematic defoliation and after tuber harvest (Odusanya *et al.*, 2017) where they are fed fresh, dried into cassava leaf meal or ensiled to reduce its hydrogen cyanide toxicity. Defoliation schedules for cassava which are appropriate for quality forage production for smallholder small ruminant feeding were also reported to involve those made from 6 months after planting which produced an average leaf yield of 925kg DM/ha with a crude protein content of 20% (Fasae *et al.*, 2009).

The production of cassava into hay also shows its potential to the sustainability of crop- livestock production system. Preserved hay from cassava leaves have been reported to have high nutrient value which can effectively boost the nutrition of small ruminant production, thereby assisting in formulating and processing of simple, adoptable and low-cost feed resource strategy for small ruminants (Wanapat and Kang, 2013). They have been found to maximize and improve the efficiency of the excess cassava leaf utilization as feed. Cassava hay stored for 3 months has also been reported to be of high nutritive value which could allow a continuous supply of feed for small ruminant production during the dry season (Fasae *et al.*, 2009). However, in the rainy season, it is difficult to sun-dry and extending the drying period diminishes the nutritional quality of the product. It was considered that ensiling would be an attractive alternative way to conserve the product (Phuc *et al.*, 1996). As silage, cassava leaves can be stored and utilized for a longer period of time as a protein feed

supplement. Silage making has been found to be an appropriate method to conserve cassava leaf as feed; increasing body weight gain and milk yield in ruminants (Kavana *et al.*, 2005). Other studies showed that the nutritional contents of silage and residues from the extraction of protein concentrate from leaves of five local cassava varieties cultivated in south west Nigeria has the potential to serve as a maintenance ration or supplements to high quality forage and can help in alleviating dry season feed shortage experienced in ruminant production (Fasae *et al.*, 2017).

Cassava peel

Cassava peel is obtained during the processing of cassava tuber to starch. It is a thin skin and leathery parenchymatous covering, usually having some cassava root tuber pieces in their lining, which constitutes approximately 15% to 20% of the tuber (Onyimanyi and Ugwu, 2007). Though it poses a disposal problem, it has the potential to be an important resource if exploited properly by biotechnological systems and its use as animal feed is increasing in Nigeria, gaining wider acceptance as feed for livestock (Fasae *et al.*, 2007; Onyeonagu and Njoku, 2010) both for the ruminant and non-ruminant animals. It has also served as a major supplementary feedstuff for feeding sheep and goats in most rural communities in Nigeria, despite its limitation of lower crude protein content and poorer methods of conservation and storage that further reduces their nutritional quality. Cassava peel contains higher levels of cyanogenic glucosides than root meal, with cyanide levels been approximately 200 to 650 mg/kg for the peel across varieties (Tewe, 1991). The protein content of peel meal is approximately 46 to 65 g/kg, so lower than that of most cereal grains, meaning that if it is used as a replacement for cereals, it is necessary to balance for protein deficiencies.

Nutrient and anti-nutrient composition of cassava leaves and peels

Wide variation has been observed between studies with regards to the nutrient content of cassava leaves and peels (Table 1) which could be attributed to the geographic location, variety, age of the plant and environmental conditions. The reported values for DM concentration of the leaves and peels were sufficient to support a reasonable amount of DM intake when used as a supplementary feed for WAD sheep and goats. Many researchers showed that the protein content of cassava residues could be as low as approximately 3.5 % in peels to about 40% in leaves. The peels have a low protein content and a high and variable fibre content while the leaves are good sources of protein, vitamins, and minerals. However, cassava peels and leaves are deficient in sulphur-containing amino acids (methionine and cysteine) and some nutrients are not optimally distributed within the residues (Oladunjoye *et al.*, 2014).

Moreover, much of the protein in the leaves of cassava is made up of cyanogenic

glycosides; linamarin, lotaustralin, and amygdalin, with linamarin been the most predominant cyanogen (Lykkesfeldt and Moller, 1994). Generally, the level of cyanogenic glycosides produced in these residues vary from about 75 to 350 ppm, but can be up to 1000 ppm or more which is dependent upon the age and the variety of the plant, as well as environmental factors (Vetter, 2000; Fasae *et al.*, 2009). However, cassava leaves and peels could be safely used as feed if they are treated to reduce the cyanogenic potential. The wide range of traditionally processing methods which consist of different combinations of chopping, grating, soaking, wilting, drying, boiling, cooking and fermenting has been observed to reduce their toxicity, improve palatability and convert most of these residues as feed for ruminants (Tweyongyere and Katongole, 2003; Fasae and Olatunji, 2011). Of all these processing methods, drying has been found to be more effective with the only setback that, it takes approximately 3 to 5 days for the peels to properly dry, hence it is more feasible and effective during the dry season of the year (Adesehinwa *et al.*, 2011).

Table 1: Chemical and phytochemical composition of cassava leaves and peels

Parameters	Leaves		Peels	
	Range	Mean	Range	Mean
Dry matter	19.50 - 32.50	26.00	26.70-33.90	30.30
Crude Protein	16.01 - 39.9	27.26	2.5 - 6.50	4.98
Neutral detergent fibre	30.30 - 62.25	51.28	18.1-34.90	26.50
Acid detergent fibre	34.42- 48.40	41.41	12.31 -38.60	25.46
Acid detergent lignin	2.76 - 10.10	6.43	2.10 – 6.98	4.54
Calcium	1.10 -1.40	1.17	0.20 - 0.64	0.52
Phosphorus	0.25 - 0.30	0.28	0.11- 0.31	0.27
Magnesium	0.60- 0.79	0.70	0.22 -0.70	0.46
Hydrocyanic acid (ppm)	78.60 -112.30	95.45	264.30–363.50	313.65
Tannin (%)	1.17 – 21.60	11.39	0.12 - 0.31	0.22

Onwuka (1983); Iyayi and Losel (2001); Fasae *et al.*, (2009); Oni *et al.* (2013); Idugboe *et al.* (2017)

Antinutrient effects of cassava leaves and peels on performance of sheep and goats

The antinutrients content of hydrogen cyanide (HCN) and tannins common in either cassava leaves or peels can have either positive or adverse effects on health depending upon the amount ingested. These compounds especially tannins act against digestibility and absorption of nutrients (Wobeto *et al.*, 2007) and could further act as antioxidants and anticarcinogens as they have been found to interfere with nutrient absorption and utilization and may have toxic side effects. The proportions of these compounds are mostly dependent on cultivars of cassava. Sheep and goats being ruminants, are highly susceptible to HCN toxification due to more efficient hydrolysis of the cyanogenic glycosides in the rumen (Ufaysa, 2019), which makes these residues relatively unsuitable in its raw form as animal feed. The rumen of these animals is neither strongly acid nor alkaline, and it contains a large flora of micro-organisms and considerable quantities of enzymes. The acute lethal dosage of HCN in most animal species is 2 mg/kg with a tolerance level of 2.0 - 4.0 mg HCN/kg BW. High HCN consumption has been reported hazardous in goats ingesting cassava leaves (Soto-Blanco and Górniak, 2010), exhibiting signs of poisoning such as saliva excretion, vomiting, excitement, staggering, paralysis, convulsions, coma or death. Tannins in cassava leaves on the other hand has been found to play an important role which have been used in various forms, as a good source of protein, to improve digestibility and reduce internal parasitic egg counts in ruminants. Tannins in forages protect dietary protein against degradation in the rumen and increase

amino acid supply to the abomasum and the small intestine resulting in improved nutritional status of the animal. They have direct and indirect effects on internal parasites, controlling the parasites by increasing the resistance and the resilience of the animals to gastro intestinal parasites infections through improved protein nutrition (Seng Sokerya and Preston, 2003). Several reports on WAD sheep and goats, similar to other tropical and temperate breeds have ascribed to the fact that the presence of tannins in cassava foliage have an anthelmintic effect against nematode parasites. They form tannin – protein complex which increases rumen by pass protein and interferes with parasite egg hatching and development to infective stage larvae thereby reducing gastro-intestinal nematode egg counts to about 52.94 to 78.48% (Kabasa *et al.*, 2000; Ho and Preston, 2006; Fasae and Adelegan, 2013; Fasae *et al.*, 2015).

Utilization of cassava residues on the performance of West African dwarf sheep and goats

Cassava leaves and peels utilization by West African Dwarf sheep and goats have been found in many studies to positively affect the digestion, growth performance and carcass characteristics (Table 2), as well as digestive organ development and gut microbiome diversity. They have been used successfully as sole or supplemental feed in sheep and goats' diets to enhance the performance. Li *et al.* (2019) attributed the higher degradability of the cassava leaves to their high crude protein content and low fibre, which provides more fermentation substrate for rumen microorganisms, thereby promoting rumen digestion. Besides, the appropriate carbon–nitrogen ratio or the protein structure of cassava leaves is easily digestible.

Table 2: Mean performance characteristics of West African dwarf sheep and goats fed cassava leaves and peels diets

Parameters	Sheep		Goats	
	Leaves	Peels	Leaves	Peels
Dry matter intake (g/day)	434.58 -544.00	341.67-450.39	291.60 -313.40	250.80 -310.01
Weight gain (g/day)	30.36 – 48.33	23.21-26.25	20.30 - 38.00	6.55 - 31.90
Weight gain (Kg/W ^{0.75})	10.57-18.34	6.14 -11.60	13.10- 20.75	1.70 -16.87
Feed conversion ratio	6.70 -17.27	9.75 - 22.71	14.30-19.15	14.94 - 25.47
% DM Digestibility	67.65 -75.91	51.78 - 65.14	54.01- 69.24	39.75 -64.90
Dressing percentage (%)	45.70 - 61.00	32.57 - 49.29	43.80 - 47.80	39.72 - 42.29

Ngi *et al.* (2006); Fasae *et al.* (2011); Ukanwoko and Ibeawuchi (2012); Odusanya *et al.* (2017); Jiwuba *et al.* (2018); Gboshe and Ukorebi (2020).

Though, cassava peels have been reported not be fed alone, as the protein and mineral content cannot support optimum rumen function and productivity in ruminants, its optimal utilization however require sources of readily fermentable protein and by-pass protein as well as micronutrients including sulphur, phosphorus and vitamin B-complex. The supplementation of cassava peels with high protein content such as palm kernel cake, rumen epithelial wastes, cassava leaves occasioned by high dietary protein content and palatability up to 25 - 50% has improved sheep and goat productivity (Bawala *et al.*, 2007; Fasae *et al.*, 2007; Ukanwoko and Ibeawuchi, 2012). The dressing percentage of 39.72 - 54.42 % and 45.70 - 61.00% observed for WAD sheep and goat, respectively fed cassava leaves and peels diets across various studies were comparable to ranges reported in literature for the same breeds of sheep and goats fed varying crop residues (Dauda *et al.*, 2019; Eyoh and Ayuk, 2019), showing the potential of these leaves and peels in improving carcass and meat quality. Dietary inclusion of cassava leaves and peels have also been found to increase milk quality significantly as these residues have been

observed to be source of dissolved carbohydrates and by-pass protein (Anyia *et al.*, 2019).

Haematological and serum biochemical parameters of West African dwarf sheep and goats fed cassava leaves and peels diets

Nutritional management of small ruminants has long been considered as a tool for high production performance. They are known to affect and play major roles in the differences in haematological and biochemical parameters, giving some insight as to their health and production performance potentials (Orheruata and Akhuomobhogbe, 2006). The effect of cassava leaves and peels fed either as sole or supplementary diets on the haematological and serum biochemical parameters of WAD sheep and goats are depicted in Table 3. Values reported suggests the potential of these feed resources in improving the production performance of these animals as most of the values fell within the normal range values for healthy sheep and goats. Mean PCV and RBC values were within the range for clinically healthy WAD goats and sheep, confirming the nutritional quality of these residues to promote performance.

Table 3: Haematological and serum biochemical parameters of West African dwarf sheep and goats fed cassava leaves and peels diets

Parameters	Sheep		Goats	
	Leaves	Peels	Leaves	Peels
Packed cell volume (%)	27.10 -37.00	30.10-36.01	21.50-31.75	24.75 -31.04
Haemoglobin concentration (g/dl)	10.77 -12.00	10.10 -11.20	6.10 - 8.99	29.50-31.50
Red blood cells ($\times 10^{12}/l$)	8.80 -13.80	9.10 -11.89	10.30 -14.52	9.98 - 10.88
White blood cells ($\times 10^9/l$)	7.55 – 13.83	8.30 – 13.80	6.20- 12.60	13.35-15.45
Total Protein (g/l)	41.20 -44.30	52.20-79.00	80.01- 84.30	49.70 -69.77
Urea (mg/dl)	12.01- 20.00	17.21-22.01	12.68-17.69	6.88 - 11.97

Fasae *et al.* (2007); Opara *et al.* (2010); Oni *et al.* (2013); Odusanya *et al.* (2017); Ajagbe *et al.* (2020)

The WBC counts suggested the nutritional status of these residues in enhancing the capacity of the host animal to mount an efficient immune response against invading diseases. This confirms earlier reports that well- nourished WAD sheep and goats have the ability to possess a protective system, providing a rapid and potent defense against any infectious agent, and this is probably the physiological basis for the adaptation of this species in their ecological zone (Daramola *et al.*, 2005). The range reported for urea explain the availability of high-quality protein and proper functioning of the kidney of animals fed diets supplemented with cassava leaves and peels. Low values of urea reported for cassava peels could be an indicative of a dietary insufficiency of the peels when fed as a sole diet.

Conclusion

Cassava leaves and peels combines a great number of qualities that has been observed in several experiments to increase performance thereby serving as a promising feedstuff and a source of high-quality feed for the production of West African Dwarf breeds of sheep and goats. Being a readily available feed resource in many rural communities in Nigeria where most of the sheep and goats are reared, they can be used successfully as an adequate source of much needed protein and energy as well as serve as an anthelmintic in the case of cassava leaves especially when fed as a supplement

to other feed materials to improve productivity of sheep and goats, especially under the smallholder farming systems.

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