

Nutritive value, growth performance and haematological parameters of West African dwarf sheep fed preserved pineapple fruit waste and cassava by- products

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Abstract

Twelve West African dwarf sheep, aged between 6 to 8 months and weighing 9 to 10.5 kg were randomly allocated to four treatments consisting of ensiled pineapple fruit waste and cassava root meal (CRM+PFW); sun-dried pineapple fruit waste (PFW); ensiled cassava peels and pineapple fruit waste (CP+PFW); cassava peel and cassava root meal (CP+CRM), to determine the performance, digestibility and haematological parameters in a completely randomised design in a 56 day feeding trial. The results revealed that there were differences ($p < 0.05$) in the daily weight gain of the animals. Animals fed CP+PFW had significantly ($p < 0.05$) higher daily weight gain than other treatments. Daily DM intake also followed the same trend. Daily weight gain observed for CRM+PFW, PFW, CP+PFW, CP+CRM were 23.57g/day, 59.28g/day, 66.43g/day and 40.71g/day, respectively. Sun-dried pineapple fruit waste diet induced ($p < 0.05$) the highest water intake of 1.93litre/day. All the haematological and serum biochemical indices were influenced ($p < 0.05$) by the treatments. Packed cell volume (PCV) ranged from 28% to 37%, while haemoglobin concentration (Hb) ranged from 9.5g/dl to 12.5g/dl. Albumin and total protein values ranged significantly ($P < 0.05$) from 32.7 to 37.8g/dl and 41.7 to 78.2 g/l respectively. It was concluded that animals on CP+PFW had the best growth performance, hence, ensiled pineapple fruit waste +cassava peels can be recommended to sheep farmers for better intake and performance especially during the austere periods.

Keywords: Sheep, Pineapple waste, ensiling, cassava peel

Introduction

One of the problems of ruminant animal production in the tropical humid zone of West Africa is the seasonal variation in the availability and nutritional value of natural grasslands. This results in seasonal pattern of wet season live-weight gain and dry season live-weight loss. An option to increase productivity of livestock should be an improvement of the nutritional status of the animals, based on locally available feed resources like agro-industrial by-products. Some of such agro industrial products are pineapple wastes, and cassava processing

wastes. Pineapple waste is the by- product of the pineapple processing industry and it consists of residual pulp, peels and skin. It is rich in cellulose, hemicelluloses and other carbohydrates. They can pose a serious environmental pollution problem if not utilized. Pineapple wastes have been documented (Otagaki *et al* 1951; Muller, 1978; Kellems *et al.*, 1979) as a non – forage material that can be conserved by sun-drying, artificial drying or ensiling process to produce silage. Silage production is preferred in the tropics as it is less dependent on weather conditions than sun-drying for hay. Moreover, artificial

drying is expensive and not easily available to farmers. Silage can be kept for months or years (Oduguwa *et al.*, 2007) and can be used at any time and when required, especially during period of drought. Ensiling will enable prolonged storage of such potentially unstable material which is a major advantage of using silage (Suksathit *et al.*, 2011).

However, it is difficult to ensile pineapple waste because of its high moisture content and corrosive nature. It is best ensiled with hay or wilted grass (Sruamsiri *et al.*, 2009). Molasses or a source of starch usually has to be added to ensure satisfactory fermentation. Cassava peels and cassava root meal are potential sources of starch/carbohydrates that can provide the necessary conditions for natural fermentation by anaerobic bacteria. This research therefore focuses on the nutritive value, performance and haematological indices of growing West African dwarf sheep fed pineapple peels preserved either by ensiling or sun-drying in combination with cassava by-products.

Materials and Methods

Experimental Site

The experiment was carried out at the Small Ruminant Unit of Teaching and Research Farm, Federal University of Agriculture, Abeokuta (7°15'N, 3°25'E) during the early rainy season (April to May) in the southern Nigeria.

Experimental animals and their management

Twelve West African dwarf sheep, aged 6 to 8 months which weighed between 9.0 and 10.5kg were used for the study. They were administered *Pestes des Petit Ruminants* (PPR) vaccine, broad spectrum antibiotics (Kepro-oxytet 20 % LA injection), dewormed with Albidol and dipped in Asuntol powder solution^R to eliminate

possible ecto- and endoparasites. At the end of 3 weeks each for adaptation and adjustment periods, the sheep were randomly divided into 4 dietary treatments of 3 animals per treatment balanced for body weight. They were maintained on Guinea grass (*Panicum maximum*), *Leucaena leucocephala*, concentrate supplement, sun-dried pineapple fruit waste and water was given *ad-libitum* for the 3 weeks of adjustment period in order to estimate their feed intake and water consumption before the commencement of the experiment.

Silage making

Fresh pineapple fruit wastes were sourced from CHI Industries, Ajao Estate, Lagos, Nigeria. The wastes were exposed to sun light for about 26 hours to reduce the moisture content. The first set of silages made up of wilted pineapple fruit wastes and dried cassava root meal were mixed at a ratio of 4:1 in black polyethylene bags. The second set of silages was made of wilted pineapple fruit wastes and cassava peels at the ratio of 4:1 in black polyethylene bags.

The ingredients were weighed individually on a concrete floor and thoroughly mixed with spade as much as possible to prevent selection of feed ingredients.

The consolidation was done manually to compress the mixed ingredients rapidly which lasted for few minutes for each bag of silage. They were stalked in big drums and left for 60 days in an open-sided room with ambient temperature of 35 ± 2°C. At day 60 of ensiling, the containers were opened and the physical properties such as mouldiness, odour, colour changes were determined by rating the qualities using scale of 1-5 using the modified method of Hassan, (2004).

Experimental design

The experimental animals were allocated by weight into four groups of three growing sheep per treatment. Each animal was

treated as a replicate. The four experimental diets consisting of ensiled cassava root meal and pineapple fruit waste (CRM+PFW); sun-dried pineapple fruit waste (PFW); ensiled cassava peels and pineapple fruit waste (CP+PFW); cassava peel and cassava root meal (CP+CRM), were arranged in a Completely Randomized Design (CRD).

Data collection

Body weight

The experimental sheep were adjusted to the feed for two weeks prior to the commencement of data collection. They were weighed before commencement of the experiment and fortnightly after. Each weighing was done after 10-12 hours withdrawal of feed.

Collection of faeces and urine

Urine and faeces were collected separately from each animal daily throughout the 14 days of experiment in metabolic cages. Total faecal and urinary outputs per animal were weighed daily. The faecal samples collected were oven dried at 80°C until constant weight was reached. The urinary outputs were collected in sample bottles with plastic covers with 20% dilute tetraoxosulphate VI acid (H₂SO₄) and then stored in a deep freezer at -20°C for subsequent analysis.

Feed intake and water consumption

About 1.0-2.0kg of the diets was given to each animal daily. Feeds refused (orts) were measured independently and recorded every morning to determine the feed intake. About 3.0 litres of water were also given every morning. Water consumption was estimated by subtracting the left over from the previous day supply throughout the experiment.

Chemical analysis of the diet and faecal samples

Experimental diets and faecal samples were analysed for moisture content, dry matter,

crude protein, ether extract, crude fibre, ash and nitrogen free extract content (A.O.A.C, 1995), while the fibre fractions such as neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined according to Goering and Van Soest (1970) procedure.

Blood parameters

On the last day of the trial, 5mls of blood samples were collected before morning feeding via jugular vein into 2 tubes, one containing an anticoagulant (EDTA) and the other with no anticoagulant. These were taken to the laboratory for the determination of the haematological parameters such as packed cell volume (Baker and Silverton, 1985), red blood cells, white blood cells, (Baker and Silverton, 1985). Serum biochemical indices viz total protein, total glucose, urea, albumin, cholesterol (Werner *et al.*, 1976) were also determined.

Statistical analysis

The data obtained from performance characteristics such as weight gain, feed intake, water intake and blood parameters were subjected to One-Way Analysis of Variance using MSTAT-C (Scott *et al.*, 1989). The treatments means when significant were separated using Duncan's Multiple Range Tests (Duncan, 1955).

Results and Discussion

These cassava-based silages (Table 1) were made in accordance with Ashaolu (1988) who suggested that good quality silage could be obtained when the peel and the tuber are chopped for easy compaction. The moisture contents were between 320.00 to 378.00g/kg. This indicated that moisture content of about 40% will ensure good fermentation even if the peels were not chopped to uniform lengths (Ashaolu, 1988). The silages were light brown in colour retaining the original colour of the

Table 1: Physical and chemical properties of the silages

Parameters	Silage 1	Silage 2
	CRM + PFW	CP + PFW
Colour	Light brown	Light brown
Odour	No off-odour	No-off odour
Mouldiness	Relatively low	Low
Palatability	Less palatable	Palatable
Moisture (g/kg)	378.0	320.0
Dry matter (g/kg)	622.0	680.0

CRM+PFW –Ensiled cassava root meal and pineapple fruit waste (1:4)

CP+PFW- Ensiled cassava peels and pineapple fruit waste (1:4)

feedstuffs prior to ensiling. This shows good preservation resulting from lactate fermentation which has been found acceptable to most farm animals (Langer, 1990; Ashaolu, 1988).

The chemical composition of these two silages as shown in Table 2 revealed that the ether extract, ash, crude fibre and crude protein fell within the same range. CRM+PFW was relatively low in fungal growth which depicts its mouldiness. The palatability as measured by the relish with which an animal consumes plant part was taken as an index of the dry matter intake with CP+PFW having higher value of $131.63 \text{ g W}^{0.75}$ than $106.34 \text{ g W}^{0.75}$ in

CRM+PFW. The crude protein value of sun-dried pineapple fruit waste was found not to be in consonance with earlier value reported by NIHORT (2004). However, the crude protein of CP+CRM obtained in this study was the highest (46.10g/kg) followed by PFW (44.50 g/kg), CP+PFW (35.10g/kg) and CRM+PFW (34.00g/kg). Ash content and the crude fibre were highest in CP+CRM and PFW which were found to be 69.10 g/kg and 248.10 g/kg respectively. All the test ingredients were moderately rich in ether extract (24.5-40.9g/kg). The nitrogen free extract values ranged from 473.30 g/kg to 675.90g/kg

Table 2: Chemical composition of experimental diets (g/kg DM)

Parameters	CRM+PFW	PFW	CP+PFW	CP+CRM
Dry matter	622.00	871.80	680.00	910.00
Ether extract	24.90	40.90	24.50	25.50
Ash	42.30	34.10	40.20	69.10
Crude fibre	47.50	248.10	49.00	93.40
Crude protein	34.00	44.50	35.10	46.10
NFE	473.30	504.20	530.40	675.90
ADF	660.00	908.33	641.67	341.67
NDF	650.00	730.97	733.30	506.67

CRM+PFW –Ensiled cassava root meal and pineapple fruit waste (1:4)

PFW –sun dried pineapple fruit waste

CP+PFW- Ensiled cassava peels and pineapple fruit waste (1:4)

CP+CRM – Dried cassava peel and cassava root meal (4:1)

Table 3: Performance of West African dwarf sheep fed preserved pineapple fruit waste and cassava by-products.

Parameters	CRM+PFW	PFW	CP+PFW	CP+CRM	SEM
Initial live weight (kg)	9.0	10.5	10.0	9.0	1.02
Final live weight (kg)	9.33	11.33	10.93	9.57	0.98
Average live weight (kg)	9.16	10.91	10.46	9.26	0.79
Metabolic weight ($W^{0.75}$ kg)	5.26	6.00	5.82	5.32	0.47
Total weight gain (kg)	0.33	0.83	0.93	0.57	0.2
Daily weight gain(g/day)	23.57 ^{bc}	59.28 ^{ab}	66.43 ^a	40.71 ^b	4.79
Daily dry matter intake (g/ $W^{0.75}$ kg)	106.34	112.64	131.63	98.3	8.07
Daily water intake (g/litre)	0.6 ^c	1.93 ^a	0.99 ^b	0.66 ^c	0.129

a,ab,bc Means with different superscript at the same row are significantly different at ($P<0.05$)

CRM+PFW –Ensiled cassava root meal and pineapple fruit waste (1:4)

PFW –sun dried pineapple fruit waste

CP+PFW- Ensiled cassava peels and pineapple fruit waste (1:4)

CP+CRM – Dried cassava peel and cassava root meal (4:1)

which depicted proportion of high soluble carbohydrates made up of sugars and soluble starches.

There were significant differences ($P<0.05$) in the weight gain across the treatments which ranged from 23.57g/day to 66.43g/day (Table 3). CP+PFW gave the highest daily weight gain of 66.43g/day which may be adjudged to have more balanced protein and caloric density in the diet. Larsen and Amaning-Kwarteng (1976) reported that sheep will utilize ensiled cassava peel better than sun-dried peels. The differences observed in the performance may be attributed, in part, to the low level of hydrocyanic acid in ensiled cassava-based diets. When ensiled cassava peels were fed to WAD sheep, 81.0g/day weight gain was achieved (Ashaolu, 1988). This report is also similar to that of Okeke and Oji (1988) who showed that there was favourable consumption and digestibility of cassava peels when used as an energy supplement in an ensiled mixture. CP+PFW elicited a daily weight gain of 66.43g/day which could have resulted from the better digestibility and utilization of high nitrogen free extract and crude protein portions. This shows that the protein quality

of sun-dried pineapple fruit waste was not inferior to other feedstuffs. The low daily weight gain observed in feeding CRM+PFW may be due to the corresponding relatively low palatability of the diet as indicated by DM intake.

Preservation of pineapple fruit waste by ensiling with cassava root meal did not confer appreciable increase in the growth rate of the WAD sheep. There is an inverse relationship between the moisture content and water intake– as moisture content decreased, water intake increased. The values for water intake ranged from 0.6 litre /day – 2 l/day. The highest water intake was recorded in animals fed dried pineapple fruit waste. Table 3 shows that water intake increased with increasing level of pineapple fruit waste and this was higher than the value recommended for young sheep during wet climate (0.5-1.0 litre day⁻¹). High levels of water consumption are required under tropical conditions for temperature regulation. Much water may also be required for fibre fermentation in the rumen and to convey catabolites from the body (Nguyen *et al.*, 2001)

Despite the high digestibility of DM content shown in CP + PW, the protein digestibility was also significantly higher ($P<0.05$) than other diets. This is supported by Arigbede *et al.* (2002) who found that the level of dietary protein in the ration did not

Table 4: Apparent digestibility coefficient (%) of experimental diets offered to West African dwarf sheep

Constituents	Treatments				SEM
	CRM+PFW	PFW	CP+PFW	CP+CRM	
DM	59.90 ^c	64.90 ^b	70.60 ^a	60.60 ^c	0.45
EE	62.90 ^c	78.60 ^a	71.60 ^b	61.40 ^d	0.42
ASH	63.60 ^a	50.90 ^c	52.90 ^b	66.40 ^a	1.71
CF	61.50 ^b	58.40 ^b	65.90 ^b	80.00 ^a	4.53
CP	67.30 ^b	63.70 ^b	85.00 ^a	61.00 ^b	4.36
NFE	71.50	81.30	77.90	81.00	3.89
ADF	59.30	66.60	60.30	62.00	2.98
NDF	58.60 ^b	73.80 ^a	58.00 ^b	54.00 ^b	4.35

^{a,b,c,d} Means with different superscripts are significantly different (P<0.05)

DM –Dry Matter; EE –Ether Extract; CF –Crude Fiber; CP –Crude Protein; NFE –Nitrogen Free Extract; ADF –Acid Detergent Fiber; NDF –Neutral Detergent Fiber. CRM+PFW –Ensiled cassava root meal and pineapple fruit waste (1:4)

PFW –sun dried pineapple fruit waste; CP+PFW – Ensiled cassava peels and pineapple fruit waste (1:4)

CP+CRM – Dried cassava peel and cassava root meal (4:1)

affect DM digestibility. The higher apparent digestibility observed in animals fed with CP+PFW could be as a result of silage process on the crop residue which would have reduced the level of anti-nutritional factors in the diet e.g Tannin and make protein available in the diet. Meanwhile, the result obtained from the animals fed with CRM + PW could be due to the low protein content present in the diet as a result of proportion of PW to CRM which has very low protein content than cassava peels. The highest daily weight gain shown in the animals fed with CP+PFW indicated the high digestibility of the diet. High DM intake of the animals fed with CP+PFW could also contribute to the high daily weight gain of the animals.

The concentration of the haematological and serum biochemical indices examined among various treatments were significantly different (P<0.05). Haematological parameters as determined by packed cell volume (PCV), red blood cell (RBC), haemoglobin (Hb) and white blood cells (WBC) indicated varying results. The values of PCV and Hb fell within the normal range (PCV: 24-50%, Hb: 8-16g/dl) according to Kaneko (1989).

The significant differences observed for the Hb, RBC and PCV in the present study could largely be due to the plane of nutrition of the animal (Edozier and Switzer, 1997). Rekwot *et al.* (1997) reported that PCV, Hb, RBC and WBC of animals tended to improve as a result of increased level of dietary protein. According to Babayemi *et al.* (2003), a lower value of Hb in any animal could be used as an assay of nutritional anaemia.

The high values of WBC in animals fed CRM+PFW and CP+CRM as compared with others need further investigation in terms of their components. Although it was reported by Wilkins and Hodges (1982) that WBC count increased from birth to peak at about the third or fourth month, then decreased to levels seen at birth, perhaps, the high values may be due to high neutrophils, key players in the body defence against bacterial infection, basophils components that play its significant role in some types of immunologic hypersensitive reactions or due to eosinophils that are involved in certain allergic reactions and detoxification or increase in lymphocytes and monocytes which indicate viral and bacterial/protozoa infection (Robert *et al.*, 1993).

Table 5: Haematological and serum biochemical parameters of West African dwarf sheep fed preserved pineapple fruit waste and cassava by-products.

Parameters	CRM+PFW	PFW	CP+PFW	CP+CRM	SEM
Packed cell volume (%)	28 ^{bc}	35 ^{ab}	37 ^a	30 ^b	1.78
Haemoglobin (g/dl)	9.5 ^c	11.8 ^{ab}	12.5 ^{bc}	10.8 ^{bc}	0.42
White Blood cell (x 10 ³ /μl)	19.5 ^a	11.4 ^c	11.2 ^c	13.85 ^b	1.92
Red Blood cell (x10 ¹² g/l)	5.35 ^b	7.55 ^a	7.67 ^a	5.45 ^b	0.17
Glucose (mg/dl)	60.0 ^c	66.7 ^b	78.8 ^a	77.2 ^a	1.22
Albumin (g/l)	32.7 ^b	36.8 ^a	37.8 ^a	34.0 ^b	0.92
Total protein (g/l)	41.7 ^c	57.4 ^b	60 ^b	78.2 ^a	1.29
Urea (mg/dl)	27.6 ^a	20.1 ^b	18.5 ^b	12.5 ^c	0.83
Cholesterol (mg/dl)	88.0 ^b	77.9 ^d	100.2 ^a	80.1 ^c	2.48

a,b,c Means with different superscript at the same row are significantly different at (P<0.05)

CRM+PFW -Ensiled cassava root meal and pineapple fruit waste (1:4)

PFW -sun dried pineapple fruit waste

CP+PFW - Ensiled cassava peels and pineapple fruit waste (1:4)

CP+CRM - Dried cassava peel and cassava root meal (4:1)

The RBC values for animals on PFW and CP+PFW fell slightly below the normal range (8-16 x 10¹² g/l). Greenwood (1977) established that such values might result from utilization of excessive centrifugal force, shrinkage of erythrocytes due to excessive EDTA anticoagulant or haemolysis. Decrease in red cell count as observed in animals on CRM+PFW and CP+CRM is referred to as microcytic hypochronic anaemia. This is associated with deficiency of iron or failure of the available iron to be utilized for the formation of Hb. Excess blood loss, copper and pyridoxine deficiencies may also result in this condition. The total protein (TP) value in CRM+PFW fell below the physiological ranges (58.9 – 78g/l) while that of PFW, CP+PFW and CP+CRM were within the acceptable range. This indicates that the higher the values of the TP the better the quality of the test ingredients (Akinmutimi and Oke, 2002). Babayemi *et al.* (2003) also reported that the TP of an animal is a reflection of the state of the animal. A report in Zebu heifers had indicated that level of protein intake had no significant effect on the total plasma protein, as it was not consistently different between low and high protein groups

(Oyedipe *et al.*, 1984). Practically, plasma proteins partake in nutrition by functioning as a pool for amino acids and other tissue protein (Babayemi *et al.*, 2003).

CP+PFW gave the highest albumin value (37.8g/l) which was significantly different (P<0.05). This shows higher ability as a clotting factor and hence prevents haemorrhage (Robert *et al.*, 1993). This report is contrary to Jain (1986) who established that the level of albumin tended to remain constant throughout life after reaching a maximum at about three weeks of age. Lower values for albumin than what was obtained for animals on the diets have the major physiochemical functions of just maintaining colloidal osmotic pressure, which is required to maintain blood volume.

There was significant difference (P<0.05) in serum urea concentrations of animals among treatments. The value obtained for animals on CRM+PFW was higher (27.6mg/dl) than that of the normal range (10-26mg/dl). Urea could only be elevated due to an imbalance of amino acids. This may indicate that CRM+PFW had somewhat lower biological value. According to Wilson *et al.*, (1972), increased catabolism of amino acids when

proteins of lower biological values are fed is responsible for high value of dietary ether extract.

Conclusion

High dry matter intake which induced the highest weight gain indicated that WAD sheep prefer ensiled cassava peels and pineapple fruit waste to other diets.

It may then be concluded that appreciable growth performance can be achieved by feeding sun-dried pineapple fruit waste as sole feed to WAD sheep. The combination of ensiled pineapple fruit waste with cassava root meal however produced animals with best performance

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