Sensory Evaluation of Meat of West African Dwarf Goats Fed Crop By-Products in Cross River State, Nigeria

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Abstract

Twenty-four, five months-old West African dwarf (WAD) bucks divided into four groups were fed either; cassava peel plus urea, cassava peel plus broiler litter, cassava peel plus cassava forage and cassava peel plus sweet potato forage for 90 days. One animal/treatment was selected and slaughtered. Meat samples (800g) from the thigh and forearm muscles were cooked either by boiling (100 - 160^{0}C), oven-drying (250^{0}C) or micro-waving (180 - 200^{0}C) for 35 minutes. Ten untrained panelists evaluated each sample for colour, flavour, tenderness, juiciness, number of chews, remains after chew and overall acceptability on a 4–point scale. Results showed that cooking methods had significant ($P<0.05$) effect on the overall acceptability of goat meat. This study indicated that consumers preferred boiled buck meat of WAD goats raised on cassava peel plus cassava foliage to those raised on the other sample diets.

Keywords*:* Cassava peel, Organoleptic properties, Goat meat, Cooking methods

1. Introduction

Africa is currently plagued with food crisis, due partly to a steady growth in human population and an alarming drop in per capital food production especially in the last decade. The inability of countries such as Nigeria to feed themselves and to check the increasing prices of food stuffs has compounded the poverty level and reduced the quality and quantity of the average animal protein intake. Compared to North America, Western and Eastern Europe whose average animal protein intake per day is 66, 53 and 39 grams, respectively; Nigeria still ranks among countries with the least average consumption of animal protein (Egbunike, 1997). Despite its rich variety of animal protein sources it has been unable to meet the animal protein requirement in sufficient quantity for her citizenry (Ibe, 2000).

Against the 35g recommended for proper growth, reproduction, health and survival the daily intake of animal protein in Nigeria averages 4.82g per head (Tewe, 1997). Ibe (2004) noted that many Nigerians consume less than 10g of animal protein daily as against the minimum of 28g capital/day considered consistent with a balance diet. FAO (1986) also proposed that of the estimated 89.5g of protein essential for normal daily functioning of the human body, 34g should consist of animal protein. Animal protein is important in human nutrition because it contains essential amino acids which are more balanced and readily available to meet human dietary requirements than protein of plant origin (Oyenuga, 1978). However, literature suggests that consumption of meat may sometimes be viewed as a status symbol (Ososanya, 2004). The classification of countries as either developed or developing, two major criteria are often used; per capital income and per capital animal protein consumption. Hence there is need to intensify efforts in livestock production.

Goatry represents a means of boosting the output of animal protein in Africa. The West African dwaft goat is highly prolific and has high adaptive potential in the sub-saharan agro-ecological zone. Therefore, raising goats on locally available feed materials such as crop by-products could enhance productivity and lower the cost of livestock production. Rapid growth of human and livestock populations on a fixed land space in Sub-Saharan Africa has exacerbated pressure and demand for food and feed. Such pressures promote severe competition for resources and drive agriculture progressively, towards intensification (Smith *et al*., 1997).

Increases in crop production, in countries like Nigeria, yields more residues and by-products (straws, haulms, stovers, cobs, vines, peels, brans, leaves and chaff) post harvest (Alhassan, 1988). These potential feed resources described as non-conventional feeds, crop by-products, agro-industrial by-products or crop residues could have fundamental applications in farming systems that produce both crops and livestock (Henning *et al*., 2006).

Small ruminant animals, especially the West African dwarf (WAD) goat can attain high productivity levels while consuming lignocellulosic materials as described by Pidgen and Bender (1978). These materials are characterized by low levels of protein, soluble carbohydrates, minerals (Van Hao & Ledin, 2001) and nitrogen, poorly degraded in the rumen but usually high in fiber (Osuji *et al.,*1995). Therefore, exploring the feed values of fibrous crop by-products that abound in our environment could be paramount in improvement of ruminant nutrition in sub-saharan Africa.

Ahmed *et al.* (2010) reported that goat meat is of higher quality than sheep or cattle meat because it is lower in saturated fats and relatively higher in total unsaturated fat content. In addition to being a lean meat with favourable nutritional qualities ideal for health conscious consumers, it is lower in calories and cholesterol than traditional meats and constitutes 63 percent of world consumption of red meat (Correa, 2008).

The organoleptic attributes of goat meat that can be evaluated are flavour (goatiness, juiciness, and after taste of juice), texture (tenderness and stringiness) and colour (grey and pink) (Sheridan *et al.,* 2003). Rodrigues and Teixeira, (2009) used attributes such as toughness, juiciness, flavour intensity, flavour quality, odour intensity, fibre presence, sweet intensity and overall acceptability.

The objective of this work was to evaluate sensory qualities of the meat from post- growth trial West African dwarf goats fed different crop by-products varied preparation methods.

2. Materials and Methods

2.1 Collection of Experiment Samples

A total of 24 animals were used for the experiment. Each treatment had six bucks. At the termination of the growth trials (90 days) based on the following feeding diets; cassava peel plus urea (CSP+U), cassava peel plus broiler litter (CSP+BL), cassava peel plus cassava forage (CSP+CSF) and cassava peel plus sweet potato forage (CSP+SPF). One animal per treatment was randomly selected. They were fasted for 24 hours except for drinking water (Omojola and Attah, 2006) and then weighed at a predetermined slaughter live weight of 9kg.

They were slaughtered by severing the jugular veins and carotid arteries with a sharp knife without stunning. The animals were held by the hind limbs, upside down for 30 minutes, to bleed. Post slaughter, they were singed to remove the fur, washed, eviscerated and separated into wholesale cuts.

2.2 Preparation of Meat Sample

The thigh and forearm muscles from the slaughtered WAD bulks were then deboned and washed. A bulk cut of 800g meat sample per treatment, with the skin intact, was then cut into 2.5 - 30cm size-pieces with a kitchen knife and seasoned with 0.4% of iodized common salt.

Three cooking methods: boiling (A) oven drying (B) and microwaving (C) were utilized. Boiling was by gas cooker in a pot at 100-160^{0}C for 35 minutes. Oven drying by an electric oven at 250^{0}C for 35 minutes (Saisho-toast plus, model S909) and microwaving was by an electric microwave oven (West Point WMG20) at a temperature range of 180 - 200^{0}C for cooking time of 35minutes. After cooking the pieces of meat samples were placed in properly sealed plastic containers, labeled according to the meat samples and cooking methods and secured in a cooler for about one hour to ensure that the internal temperature cooled to room temperature (25-32^{0}C; Fabiyi, 2005).

2.3 Sensory Evaluation

Each piece of meat was placed according to the four (4) treatments (CSP+U, CSP+BL, CSP+CSF, and CSP+SPF) and the three (3) cooking methods (A, B and C), respectively in a well lit room with sufficient space for independent work by each panelist. Ten (10) untrained consumer-panelists, within the age range of 25 - 40 years, representing the core users of the products, were used for the sensory evaluation. The samples were served to the panelists after one hour to prevent possible changes such as the samples drying-out or developing off-flavour which could occur during holding. The Panelists' evaluated each sample for colour, flavour, tenderness, juiciness, number of chews, remains after chewing and overall acceptability; and entered the scores in a questionnaire based on a 4–point scale; where 4 = very desirable, 3 = slightly acceptable, 2 = unacceptable and 1 = very unacceptable.

Post chewing of a sample, panelists were required to chew crackers biscuits and rinse their mouths with water to prevent taste bud carry-over effect (lingering taste from previous sample).

2.4 Statistical Analysis

Analysis of variance (ANOVA) using general linear model (GLM) procedures (SAS, 1999) for a split-plot design was used to determine the treatment effects and where significant difference occurred the Duncan Multiple Range Test was used to separate the means (Steel and Torrie, 1980).

3. Results

Table 1 summarizes the effects of different cooking methods on the organoleptic or sensory parameters of meat of WAD bucks fed cassava peels treated with urea (T_1 = CSP+U); broiler litter (T_2=CSP+BL); supplemented with cassava forage (T_3 =CSP+CSF) and sweet potato forage (T_4 = CSP+SPF).

Table 2 presents the overall acceptability of West African dwarf goat meat samples cooked by different cooking methods. Figure 1 shows at a glance the pictorial representation of the overall acceptability of WAD goat meat samples based on the combination of the various sensory parameters.

4. Discussion

Table 1 shows that, based on the judgment of the panel, the colour of the meat samples, from all the treatments groups, were significantly affected ($P<0.05$) by the cooking methods (boiling, oven drying and microwaving). Cooking methods affected ($P<0.05$) both individual and differently the meat samples from WAD bucks fed the different diets. The panelists' preference based on visual appraisal of colour for each cooking method were in the following order: boiled meat - T_1 (CSP+U) > T_3 (CSP+CSF) > T_4 (CSP+SPF) > T_2 (CSP+BL); oven-dried meat - T_3 (CSP+CSF) > T_4 (CSP+SPF) > T_2 (CSP+BL) > T_1 (CSP+U); micro-waved meat - T_1 (CSP +U) > T_2 (CSP+BL) > T_3 (CSP+CSF) > T_4 (CSP+SPF).

The acceptable cooking methods that portrayed desirable meat colour for T_1 (CSP+U) and T_2 (CSP+BL) meat samples were in the order microwaving > boiling > oven drying while that of T_3 (CSP+CSF) and T_4 (CSP+SPF) were in the order of boiling > microwaving > oven drying.

The overall results on colour revealed that the most desirable colour for meat sample was in the order of T_3 (CSP+U)> T_1 (CSP+U)> T_2 (CSP+BL) > T_4 (CSP+SPF) with mean values of 26.33 > 26.00 > 24.33 > 23.33 respectively, while the most acceptable cooking methods that gave a better eye appeal among the meat samples were in the other of microwaving > boiling > over drying with mean values of 27.00 > 25.50 > 22.50, respectively. The alteration of colour of the meat samples caused by the different cooking methods in this study agrees with the report of Ikeme (1990) who explained that, cooking is a technique where heat energy in the form of high temperature is applied to alter the colour of meat'.

The acceptable flavour of the meat samples were not significantly affected ($P>0.05$) by boiling and oven drying. On the contrary, microwaving of the meat samples significantly affected ($P<0.05$) the flavour of the meat. The taste panelists exhibited desirable acceptance of flavour for the meat samples when microwaved in the order of T_2 (CSP+BL) > T_1 (CSP+U) > T_3 CSP+CSF)> T_2 (CSP+SPF) The individual meat samples were subjected to different cooking methods and were significantly affected ($P<0.05$). All the meat samples T_1 (CSP+U), T_2 (CSP+BL), T_3 (CSP+CSF) and T_4 (CSP+SPF) gave acceptable flavour in the order of microwaving > boiling> oven drying.

The overall results on flavour revealed that the most desirable meat samples were in the order of T_2 (CSP+BL) > T_1 (CSP+U) > T_3 CSP+CSF) T_4 (CSP+SPF), with mean values of 25.33 > 25.00 > 24.33 > 23.33 respectively, while the most desirable cooking methods that gave a better flavour were in the order of microwaving> boiling > oven drying with mean values of 27.25 > 24.25 > 22.00, respectively.

While boiling did not significantly (P>0.05) affect the tenderness of meat samples, oven-drying and micro-waving did significantly (P<0.05) affect meat tenderness. The effects of the different cooking methods on T_1 (CSP+U) and T_4 (CSP+SPF) were significantly (P<0.05) different and were in the order of boiling > micro-waving > oven-drying while that of T_2 (CSP+BL) and T_3 (CSP+CSF) were in the order of boiling > micro-waving > over-drying. The overall effect of cooking on tenderness revealed that the boiled meats were more tender than those micro-waved or oven-dried. This observation supports the report by Ikeme (1990), who posited that boiling meat in water tendered it because the process hydrolyses the connective tissue (collagen) to form tender protein (gelatin) contrary to the effect of oven-drying and micro-waving.

Sampled meat juiciness were significantly (P<0.05) affected by all the cooking methods. The cooking methods for T_1 (CSP+U), T_2 (CSP+BL), T_3 (CSP+CSF) and T_4 (CSP+SPF) gave juiciness in the order of boiling > microwaving > oven drying. Besides adjudging the boiled meat samples as the most tender, the taste panelist also identified boiled meat samples as the juiciest. This observation agrees with the report of Bruwer *et al.* (1987) who explained that the more tender the meat, the more rapidly juices are released when chewed. The reduced juiciness of micro-waved and oven-dried meat samples could be attributed to the application of dry heat at high temperature.

All the cooking methods affected the number of chews significantly (P<0.05). The number of chews for boiled meat samples were in the order of T_4 (CSP+SPF) > T_2 (CSP+BL) > T_1(CSP+U) > T_3(CSP+CSF); similarly the number of chews of oven dried meat samples were in the order of T_4 (CSP+SPF) > T_1 (CSP+U) > T_2 (CSP+BL) > T_3 (CSP+CDF) while that of microwave meat samples were in the order of T_2 (CSP+BL) > T_4 (CSP+SPF) > T_1 (CSP+U) > T_3 (CSP+CSF).

The ranking of the (highest) number of chews based on method of cooking was in the order oven-drying > micro-waving > boiling. This may be attributed to non-solubility of the connective tissue-protein in the meat and the drying-up of juice in the meat due to high temperature (Paul *et al.,* 1993).

The cooking methods affected the remains-after-chew significantly (P<0.05). The remains-after-chew for boiled meat sample were in the order; T_3 (CSP+SPF) > T_1 (CSP+U) > T_2 (CSP+BL) > T_4 (CSP+SPF); that of oven dried meats were; T_2 (CSP+BL) > T_3 (CSP+CSF) > T_1 (CSP+U) > T_4 (CSP+SPF) and that for micro-waved meats were; T_1 (CSP+U) > T_3 (CSP+CSF) T_4 (CSP+SPF) > T_2 (CSP+BL). The acceptability of remains-after-chew of the meat samples, based on cooking method, showed that boiling was most preferred followed by micro-waving then oven drying. This agreed with the findings of Bruwer *et al.* (1987), that the more tender the meat the less residues remain in the mouth after chewing.

Table 2 shows the preferential ranking of the meat sample and cooking methods. In terms of cooking methods, boiling appeared to be preferred to micro-waving and oven-drying, respectively. The interactions between meat sample and cooking methods indicated that boiled CSP+CSF was the most preferred while oven-dried CSP+SPF was the least. This could suggest that supplementation with cassava foliage improve the organoleptic properties of buck meat.

Figure 1 illustrates the interactions (meat sample x cooking method) of all the sensory parameters (colour, flavour, tenderness, juiciness and remains-after-chew) as reported by the taste panel. It indicates that preference was in the order of; boiled, micro-waved and oven-dried meat samples between and within treatments.

5. Conclusion and Recommendation

The consumer preference on buck meats, of WAD goats on different cassava peel-based diets, prepared using the three cooking methods preferred boiled meat samples to micro-waved or oven dried samples in terms of colour, flavour, tenderness and juiciness. This study therefore recommends that to improve consumer acceptance of goat meat, the animals should be fed cassava peel diet supplemented with cassava foliage and meat should be cooked by boiling (100 – 160^{o}C).

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Table 1. Effects of different cooking methods on the organoleptic or sensory parameters of meat from WAD bucks fed treated and forage supplemented cassava peels

Cooking methods	Sensory parameters					
	Colour					
	T_1 (CSP + U)	**T_2 (CSP + BL)**	**T_3 (CSP + CSF)**	**T_4 (CSP + SPF)**	**Mean**	**±SEM**
Boiling	28[a]	22[d]	28[a]	24[c]	25.50	0.15
Oven drying	21[d]	22[d]	24[c]	23[c]	22.50	0.15
Microwaving	29[a]	29[a]	27[b]	23[c]	27.00	0.15
Mean	26.00	24.33	26.33	23.33		
±SEM	0.15	0.15	0.15	0.15		
Flavour						
Boiling	25[c]	24[c]	24[c]	24[c]	24.25	0.16
Oven drying	22[d]	21[d]	22[d]	23[d]	22.00	0.16
Microwaving	28[a]	31[a]	27[b]	23[d]	27.25	0.16
Mean	25.00	25.33	24.33	23.33		
±SEM	0.16	0.16	0.16	0.16		
Tenderness						
Boiling	23[a]	24[a]	25[a]	25[a]	24.25	0.19
Oven drying	19[c]	17[b]	19[b]	16[c]	17.50	0.19
Microwaving	16[b]	18[c]	21[b]	17[c]	18.00	0.19
Mean	19.33	19.66	21.66	19.33		
±SEM	0.19	0.19	0.19	0.19		
Juiciness						
Boiling	24[a]	25[a]	24[a]	21[c]	23.50	0.16
Oven drying	18[c]	18[c]	18[c]	16[d]	17.50	0.16
Microwaving	22[b]	19[c]	23[a]	19[b]	20.75	0.16
Mean	21.33	20.66	21.66	18.66		
±SEM	0.16	0.16	0.16	0.16		
Number of chews						
Boiling	221[d]	235[d]	204[e]	259[d]	229.75	4.52
Oven drying	352[a]	317[b]	315[b]	376[a]	340.00	4.52
Microwaving	297[c]	318[b]	284[c]	309[c]	302.00	4.52
Mean	290.00	290.00	267.66	314.66		
±SEM	4.52	4.52	4.52	4.52		
Remains after chewing						
Boiling	24[a]	20[b]	24[a]	18[c]	21.50	0.24
Oven drying	15[d]	15[d]	18[c]	14[d]	15.50	0.24
Microwaving	19[b]	18[c]	19[b]	19[b]	18.75	0.24
Mean	19.33	17.66	20.33	17.00		
±SEM	0.24	0.24	0.24	0.24		

[a,b,c,d] Means bearing different superscripts along the same row and column respectively are significantly different ($P<0.05$); ***Scale used by Panel:*** 4 = very desirable; 3 = slightly acceptable; 2 = unacceptable; 1 = very unacceptable.

Values and mean of ten panelists.

Where;

CSP+U = Cassava peel plus urea

CSP+BL = Cassava peel plus broiler litter

CSP+CSF = Cassava peel plus cassava forage

CSP+SPF = Cassava peel plus sweet potato forage

Table 2. Overall acceptability of goat meat based on different cooking methods by taste panelists

Meat samples and Cooking methods	Sensory parameters							
	Colour	**Flavour**	**Tenderness**	**Juiciness**	**Remains after chew**	**Total**	**%**	**Ranking**
Boiled Meat								
CSP+U	28	25	23	24	24	124	9.50	2
CSP+BL	22	24	24	25	20	115	8.81	5
CSP+CSF	28	24	25	24	24	125	9.58	1
CSP+SPF	24	24	25	21	18	112	8.58	7
Oven-dried Meat								
CSP+U	21	22	19	18	15	95	7.28	10
CSP+BL	22	21	17	18	15	93	7.13	11
CSP+ CSF	24	22	19	18	18	101	7.74	9
CSP+SPF	23	23	16	16	14	93	7.13	12
Micro-waved Meat								
CSP+U	29	28	16	22	19	114	8.74	6
CSP+BL	29	31	18	19	18	115	8.81	4
CSP+ CSF	27	27	21	23	19	117	8.97	3
CSP+SPF	23	23	17	19	19	101	7.74	8
Total						**1305**	**100**	

Values and mean of ten panelists

Where;

CSP+U = Cassava peel plus urea

CSP+BL = Cassava peel plus broiler litter

CSP+CSF = Cassava peel plus cassava forage

CSP+SPF = Cassava peel plus sweet potato forage

Ranking: 1 = Best --- 12 = Least

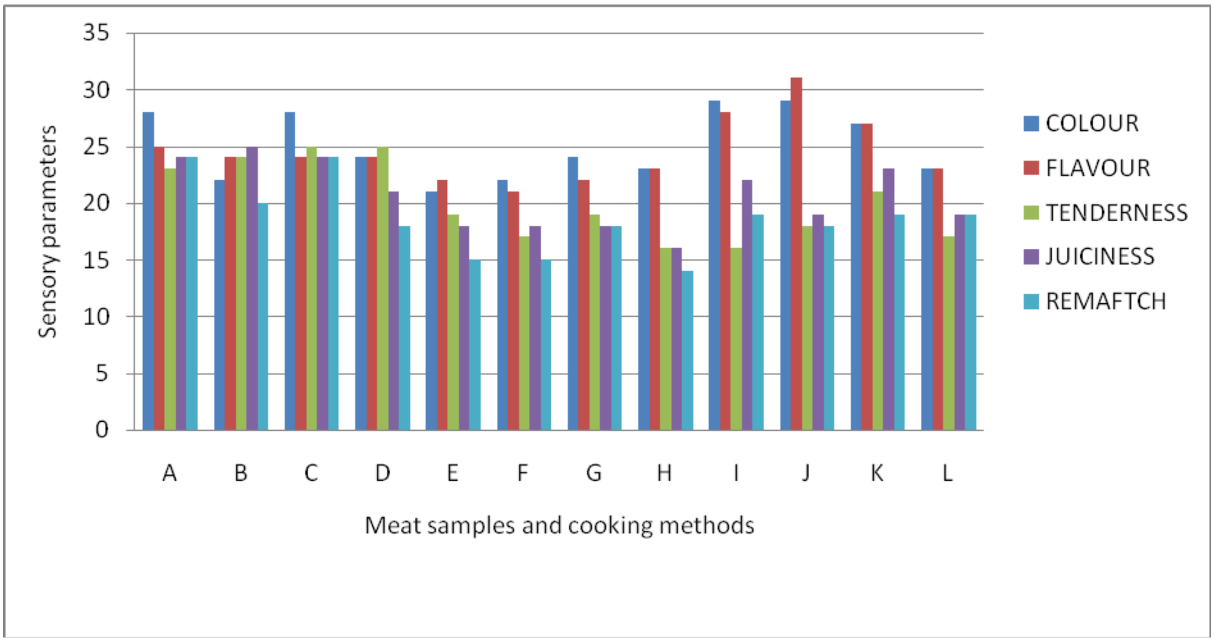

Figure 1. Pictorial presentation of overall acceptability of goat meat samples based on various cooking methods