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Effect of Vegetable Tanning on the Physical Properties of Leathers from Three Nigerian Goat Breeds

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ABSTRACT

Assessment of physical and grain properties of bagaruwa (*Acacia nilotica*) tanned leathers obtained from three Nigerian breeds of goats was done using skins for seventy two, 2-3 years Red Sokoto, West African Dwarf and Sahelian goats. The study was laid out in a completely randomized design. The parameters investigated were thickness, percentage elongation, flexing endurance and grain properties. The results indicated significant differences ($P < 0.05$) between the leathers from the three goats' breeds in all the physical and grain properties except in the force at burst. Sahelian (SAH) breed had the highest leather thickness (1.29mm ± 0.09), which was significantly thicker ($P < 0.05$) than leathers of both West African dwarf (WAD) and Sokoto red goat (SRG). Both SAH and SRG had significantly higher ($P < 0.05$) percentage elongation (85.38% ± 0.3.90 and 84.13% ± 3.68 respectively) than WAD (65.78% ± 2.19). Flexing endurance (%) was similar for the three breeds, but SAH leather had significantly higher ($P < 0.05$) load of crack and distension at both crack and burst than both WAD and SRG. The present study suggests that the use of vegetable tanning produced leathers with acceptable physical and grain properties from the three goat breeds. It further revealed that WAD and SAH breeds of goat have good leather physical and grain properties and could equally become valuable like SRG in the leather global market.

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Key words: Leather; Leather quality; Breed; Tanning

INTRODUCTION

Goats are the largest group of ruminant livestock in Nigeria totaling about 345 million (FDLPCS, 1991). Predominantly found in the coastal and central Nigeria is the West African Dwarf goats which are trypanotolerant (Hamayun *et al.,* 2006). The Sokoto Red goat is the predominant and most widely distributed breed in the Northern savannah belts of Nigeria (Ngere *et al*., 1984). It is usually deep red in colour, about 60 cm long with mean male and female weights of 27 and 25kg, respectively. Both West African Dwarf and Sokoto Red goats are raised primarily for meat and are known to be well adapted to the stressful tropical environment. In Nigeria, goats are kept not only for meat; the skin is also valuable, especially in leather manufacturing (Attah *et al*, 2004) and for other utilities such as parchment, drumheads and sounding boards musical instruments. The increase in disposable income, especially in the developed economies has fueled the international demand for high quality leather products making the market to grow at 3% per annum (Chemonics International Inc., 2002). Skins obtained from Sokoto red goats are of high quality and are well known as in the tannery trade (Wilson, 1991). It is exported to industries in America and Europe. A recent projection (Chemonics International Inc., 2002) showed that the potential income from export of leather products in Nigeria could reach $140 million annually.

Tanning is a processing mechanism which prevents the collagen fibrous protein in animal skin from putrefaction to produce a hydrothermally stable product commonly known as leather (Sharphouse, 1995). Traditionally, the origin of leather making started with the use of plant materials that are essentially high in tannin contents and which leach out to penetrate skins for the conversion of skin proteins into non- putrescible materials. *Acacia niltica* "Bagaruwa" is one of the indigenous plants with high tannin that is well recognized as tan in Nigeria and other sub Sahara African countries. Its tannin content depends on the parts of the plant from which the extracts are obtained but essentially, the pods are higher in tannin content more than other

parts of the plant. A range of 12 -50 % tannin content was reported for a typical "bagaruwa" tree and this consists of about 30% Catechol and 70% pyrogallol (Fagg and Mugedo, 2005). However, a minimum of 15% usage of vegetable tanning materials was documented to secure full penetration of the skin (Bikley, 1992).

A number of factors such as breed, sex, age at slaughter and plane of nutrition have been reported to influence the leather property of animal skin (Wang and Attenburrow, 1993). Although, some previous studies exist on the leather properties of goats skin of Europe, Asia and few parts of the African continent but there appear to be little or no comparative study on the physical properties of Nigerian indigenous goat breeds. Information on leather properties such as the load and distension at grain crack and burst which are measures of leather's grain layer strength and distention under multidirectional stress are generally not available. Information on leather grain properties is an essential step to harness the full potentials of the Nigeria tanning industry. This study evaluated the physical and grain properties of vegetable tanned leathers from three Nigerian goat breeds.

Materials and Methods

Source of Skin: A total of seventy two (72) goats of 2-3 years of age were slaughtered at the slaughter slab of College of Agriculture Zuru, Kebbi state, Nigeria, which is located between longitude $4^{o}45'E$ - $5^{o}25'E$ and latitude $11^{o}35'N$ – $11^{o}55'N$. It has an annual mean temperature of $37^{o}C$ and average relative humidity of 85% (May – October) and 41% (November – April) during the raining and dry seasons respectively. The goats belong to three breeds of Nigerian goats namely Sahelian, Sokoto Red and West African goats in equal ratio (i.e. 24 per breed). The skins obtained from the slaughter goats were appropriately tagged after flaying of the animals.

***Pretanning Operation*:** The skins were cured using salt immediately after flaying so as to prevent putrefaction.

***Tanning operation*:** Tanning of the skins was done at National Institute of Leather and Science Technology (NILEST), Samaru Zaria, Nigeria. The skins were subjected to vegetable tanning using *Acacia nilotica*- "Bagaruwa". The recipe for the tanning is indicated in Table 1.

Physical Analysis of Leather: The assessment of the physical properties of the leather was done in the Quality Control Laboratory of NILEST. Samples for the test were collected from official sampling position on all the tanned leather according to Sampling method and sampling location were according to ISO-2418 (2002). The physical properties tested are percentage elongation, flexing endurance, thickness and grain properties with respect to crack and tear. Percentage elongation was carried out using tensometer (Model: 9019 GAF 2620) while the flexing endurance was undertaken with upper material flexing machine (Model: STM 101 Class F) which operates at 87 flexing per minute for a maximum of ten minutes. The percentage elongation was obtained after exposing the leather samples to two dimensional pull. Thickness gauge (Model: REF S 4/9) was used to measure leather thickness while electronic lastometer (Model: 5077-ET- MUVER) was used to measure the grain properties (i. e. load and distension at grain crack and burst) of the leather. The load and distension at grain crack and burst were taken as measures of leather's grain layer strength under multidirectional stress.

Statistical Analysis: Data collected was subjected to Analysis of Variance (ANOVA) appropriate for a Completely Randomized Design using Statistical Package for Social Sciences (SPSS, 2007) Version 16.

Results and Discussion

Least square means of the Average thickness, percentage elongation and flexing endurance of leathers of West African Dwarf (WAD), Sahelian (SAH) and Sokoto Red Goats (SRG) are presented in Table 2. Significant differences ($P < 0.05$) were observed among breeds in leather thickness and percentage elongation. SAH was significantly superior ($P < 0.05$) to the WAD

goat in leather thickness and percentage elongation. SRG was also significantly better ($P < 0.05$) than the WAD goat in leather percentage elongation. The results on flexing endurance showed that only 5.83% of the total samples exposed to flexometer showed signs of cracks. No significant difference ($P > 0.05$) was observed among the three breeds of goats in flexing endurance.

Least square means of the grain properties of leathers of West African Dwarf (WAD), Sahelian (SAH) and Sokoto Red Goats (SRG) are presented in Table 3. The results on grain properties of the leathers indicated that significantly ($P < 0.05$) different loads (forces) were required to cause a crack on the leathers from the various breeds. However, the additional load (forces) required to tear or burst already cracked leather were not significantly different ($P > 0.05$) among the three breeds. Leather from Sahelian goat breed required a significantly higher load ($P < 0.05$) to crack than leathers from both WAD and SRG which are not significantly different from each other (Table 3). Significant differences ($P< 0.05$) were observed among the three breeds of goats in the extent of leather distension before its eventual cracking or bursting. Sahelian and Red Sokoto goats showed the highest and lowest distension, respectively (Table 3).

Although, leather thickness may be influenced by factors such as specifications and mechanical actions (Sharphouse, 1995) but the specie or genotype of animal from which the leather originates determines its thickness to a larger extent. The results obtained on leather thickness in the present study were higher than the minimum value (0.7mm) recommended by BASF (1984) for light leather within which leathers from goat are categorized. This implies that leather obtained from the three breeds were of good thickness. The leather thickness of SAH and WAD breeds of goat in the present study were particularly higher than 0.98mm ± 0.02 and 0.87mm ± 0.02 reported respectively for male and female Lori goat breed of Iran (Salehi *et al*., 2013). The leather thickness of Sokoto Red Goat in the present study was similar to that of Salehi *et al*.

(2013) in their measurement of physical properties of Iranian Lori goat breeds. Leather thickness for goat breeds in this study supported the earlier claim by Oliveira *et al.* (2007) that goat leathers are thicker than leathers obtained from sheep. Leather elongation for WAD goat was within the acceptable range (40 -80%) reported by Salehi *et al.* (2013). Although both SAH and SRG leathers were slightly higher in percentage elongation but this may be normalized by retanning the leather crust with chrome. Improvement in the thermal stability and grain properties of vegetable tanned leathers using chrome re-tanning had been earlier reported by several authors (Mitchel, 1981; Tuck, 1981; Musa and Gasmelseed, 2013). Distension at crack and tear obtained in the present study were generally lower than the values reported for indigenous and crossbred Ethiopian sheep by Tsegay *et al.* (2012) but the distension value obtained for SAH was above the minimum recommended limit of 7mm expected of good leather (De-Britol, *et al.*, 2002). The values obtained on the load at crack were comparable with the values reported by Salehi *et al*., (2013).

Conclusion

Variations exist in the leather properties of skins from West African Dwarf, Sokoto red and Sahelian breeds of Nigerian goats. Sahelian goat produces leathers that are thicker than the obtainable leathers from both West African Dwarf and Sokoto red goats. Percentage elongation of West African Dwarf leather was lower than the values obtained from both Sokoto red and Sahelian goats. However, it can be concluded that the use of vegetable tanning helped to produce leathers with acceptable physical and grain properties from the three goat breeds. Retanning using chrome may help to improve the thermal stability of the leather fromWAD, SAH and SRG for future use.

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Table1: Recipe for the tanning process

Process	Reagent/Products	Inclusion level (%)	Duration	Remarks
Soaking	Water	200	24hrs	To rehydrate the skin
	Bactericide	0.5		To inhibit bacterial growth
Washing			10mins	To remove dirt, dung, blood and curing agent
Draining				To remove water
Unhairing	Sodium sulphide	3	1 hr	To dissolve sodium sulphide
	Water	100		and effect depilation
Liming	Lime	15		
	Water	100	30mins	Agitation
	Water	200	24hrs	To completely immerse skin for pulping
Fleshing				To remove unwanted flesh and then wash
Deliming	Ammonium sulphate	2	1hr	To remove from the pelt
Bating	Bate powder	0.5	1hr	To remove scud and then wash
Drenching	Salt	6	20	To prepare for acid introduction
	Formic acid	0.4 (1:10)		
	Sulphuric acid	0.1 (1:10)	1hrs	Agitation
Tanning	Bagaruwa (Tannin)	30	2hrs	Add into drench liquor
	Bactericide	0.2	24hrs	
Checking				For penetration and fullness and then rinse
Piling			24hrs	
Drying			24hrs	

Table 2. Average physical properties of leathers obtained from three Nigerian goat breeds.

	SRG	WAD	**SAH**
Thickness (mm)	0.98^{b} ± 0.04	1.04^{b} ± 0.03	1.29^{a} ± 0.09
Percentage Elongation	84.13^{a} ± 3.68	65.78^{b} ± 2.19	85.38^{a} ± 3.90
Flexing Endurance (%)	95.17	95.17	95.17

Means with the same superscript are not significantly different (P > 0.05) from each other. SRG, WAD and SAH represent Sokoto Red, West African Dwarf and Sahelian goats, respectively

Table 3. Grain properties of leathers obtained from three Nigerian goat breeds.

	Crack		**Burst**	
	Load (kg)	Distension (mm)	Load (kg)	Distension (mm)
SRG	24.43^{b} ± 1.13	4.11^{c}± 0.08	16.24^{a} ± 1.47	4.02^{c} ± 0.07
WAD	23.38^{b} ± 0.83	6.11^{b} ± 0.46	12.02^{a} ± 2.03	5.65^{b}± 0.51
SAH	29.42^{a} ± 1.91	8.29^{a}± 0.54	16.10^{a} ± 2.19	8.17^{a} ± 0.53

Means with the same superscript are not significantly different (P > 0.05) from each other. SRG, WAD and SAH represent Sokoto Red, West African Dwarf and Sahelian goats, respectively