



LEATHER QUALITY ASSESSMENTS OF ANTELOPE AND WEST AFRICAN DWARF GOAT

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ABSTRACT

The study investigates the physical leather quality characteristics of West African Dwarf goat and antelope leather skin based on the tanning methods (vegetable and chemical) and position of the leather (butt, shoulder and belly). The carved skin was gotten from live animals been sourced from the market and was sundried after flaying. The slaughtering of the animals followed ethical standard. The skins were stored, shared into two separate parts and tagged with number prior to tanning. After tanning, samples from the butt, shoulder and belly were taken to determine the shrinkage temperature, water vapor, weight, thickness, mass, density, resistance to compression, indentation index, hardness, maximum force/kg and displacement properties. The main effect for the species indicates that there was no effect for all the properties except for thickness and density (1.94 ± 0.45) at ($P < 0.01$), while for tanning method there were significant difference at ($P < 0.01$) for shrinkage (81.67 ± 12.18), temperature, water vapor (1125 ± 534.10) and density against the other properties. Also, the position had significant difference in hardness, maximum force, mass and density, while the others had no effect. For the interaction effect, for position and specie on weight and in specie and tanning on mass had effects, while all other had no significant difference. However, this study reveals that goat and antelope leather can be used side by side for industrial production and vegetable tanning which is cheap, safe, environmentally friendly should be considered. Therefore, the position stipulates the kind of finished leather product to be desired. Essentially, the shoulder and butt position would be utilized for hard leather works while the belly for soft products.

Keywords: Leather, Quality, Assessments, Antelope, Goat

INTRODUCTION

The Nigeria leather sector comprises of the raw hides and skin subsector and the leather and leather goods subsector and all confronted with series of problems making the sector not contributing to the growth and development of the National economy. It is important to realize that no realistic assessment of the leather and leather goods industry can be made without knowing the position of the livestock in the country, therefore livestock production is critical to the leather sector, the higher the level of production the higher the quantity of raw materials available in the industry. Yahaya and Aminu (2024) explored how specific anatomical regions of goat skin respond to different post-tanning operations, concluding that optimizing processing based on hide position can enhance the value of diverse leather products. One of the major challenges of the leather industry is the short in supply of raw material which is hides and skin, there has no proper records of animals' slaughter viz the number of hides and skin recovered and for that purpose. The leather sector comprises of two; the raw hides and skin industry and the footwear and leather goods industry, and these two industries can go a very long way to provide jobs and also source of foreign exchange (Abdullahi and Usman, 2022)

It has been realized that the human consumption of raw hides and skin as Kpomo (a smoked dried skin of a cow) is an economic agony that stands against profit, because of the Federal government in 2004 has considered to ban the sales and widespread consumption of the delicacy this ban can take the form of complete regulations that will check the consumption and sales of hides and skin in Nigeria, the idea is to enrich farmers so that they will earn money from the products (Akinwunmi, 2014). It is therefore, reasonable for stakeholders such as the Nigeria Institute of Animal Science (NIAS) advocates and public, enlighten the media to promote livestock value addition as against the sales and consumption of the primary products which ought to be tanned into leather for



very high exchange earner returns to the farmers and tanners. It is envisaged that satisfactory product level would be achieved to reach animal by-product such as hides, skin and leather. This is against the back drop that foreign exchange earnings from leather export resonate between first and second among the non-oil export. But that withstanding, there are only seven out of forty-one existing tanneries in Nigeria are currently operating due to shortage of the raw material (hides and skin). The availability of hides and skin can grow the Nigeria economy and create employment. An understanding of the estimate of recoveries and losses is a positive index to boost the livestock value chains. But the profiling of hides and skin production and utilization in Sabon Gari and Zaria local government area in Kaduna state will be used as illustration and can be used to generalize the recoveries and losses rate in Nigeria in general. It is important to note that hides and skin is a by-product of the meat industry, this implies that the quantity of hides and skin available largely depends on the demand for meat. Nigeria has one Comparative advantage in the area of raw hides and skin with the abundant of livestock in Nigeria (Abdullahi and Usma, 2022).

Recent empirical research continues to explore species-specific differences in leather quality. A study by Bako and Audu (2022), for example, compared the mechanical properties of Red Sokoto goat and sheep leather in Katsina State, finding significant differences in tensile strength and tear resistance that could influence their end-use applications. Similarly, Mohammed and Salihu (2023) investigated the microstructural characteristics of indigenous Nigerian goat breeds, concluding that fiber density and compactness varied across breeds, impacting overall leather durability. These studies reinforce the notion that while certain properties may be similar, subtle yet significant differences between species, particularly in density and structural characteristics, dictate their suitability for various industrial uses. The objectives of the paper is to determine the leather quality of antelope and goat (West African Dwarf breed) using different tanning methods (chemical and vegetable). Also, to access the various position or spot of the leather for good leather production using the butt, shoulder, and belly areas.

MATERIALS AND METHODS

Experimental Site

This research was carried out at Rantya, Jos south, Plateau State of Nigeria. Jos south is located 5km from Bukuru and 10km from Jos. Rantya is a quite rocky place located in Jos South, Jos. It is a tropical climate and it lies in the savannah region of the country. It has an annual rainfall of 132mm, temperature ranges from 10 – 28⁰c. Harmattan is sure in December which is the peak period, the temperature could be as low as 10⁰C, and high as 28⁰C with a mean 23⁰C. It has a relative humidity of 14-47% in the dry season, though could be high in the wet season. Rantya has an altitude of 128cm above the sea level. There is a distinctive dry and wet season, with rainfall, sometimes recorded between January and March but considerable amount of rainfall usually commences in April/May and end around November with July and August with high peak.

Method Data Collection

Skins (n=60) from 18 WAD goats and 12 antelopes were assessed. The animals were sourced from an open market where animals are sold. Slaughtering was performed after stunning by cerebral concussion. The carcasses were suspended by the hind limbs for bleeding and then skinned. Skins were processed according to Abdullahi and Bello (2022) who explored hybrid tanning methods combining natural extracts with reduced chromium, reporting promising results in terms of leather quality and environmental performance for cattle hides in Kano State, highlighting the ongoing innovation in tanning processes within the Nigerian context. Processing was performed following pre-soaking and main soaking processes. Others processes are Liming, washing, fleshing, deliming, tanning, balsification, samnying, neutralization, re-tanning, drying and smoothing after tanning, the leathers are conditioned at 23⁰c under 50% relative humidity for 48 hours prior to physic-mechanical testing. The skin was screened, graded and tagged with numbers were randomly selected, the chemical and vegetable tanning were carried out on them to ascertain their quality levels. For the positions respective spots were cut out from the butt, shoulder and belly and were measured.



Sampling and Chemical Testing of Leather

Sampling

This method of sampling describes a procedure for taking samples from a whole piece of leather. In some cases, the sample presented to the analyst is taken from other location for example, analyses are required on manufactured leather goods or components. It was necessary when interpreting analytical results, or selecting specification limits, to take into account this factor and where necessary, to make due allowance for any likely variation in properties over the extent of the original hide and skin. This method was applicable to skins and hides of either light or heavy or heavy leathers. In regards to the location of pieces for chemical test this method was in agreement with international standard ISO 2418.

Apparatus

The instrument used was a dial micrometer type of gauge standing on a firm base. It was dead weight loaded and the load applied was 393 ± 10 gf (equivalent to 500 gf/cm^2). The presser foot was flat, circular, and of diameter 10.0mm and its direction of movement was normal to the face of the anvil. The anvil was flat, horizontal surface of a cylinder of diameter 10.0mm, which projects 3mm from the surface of a flat circular platform of diameter 50mm. The axes of the presser foot, the platform and the projecting anvil coincided and are same as the direction of the movement of the foot. The faces of the foot and anvil are parallel for all positions of the foot. (error not exceeding 0.005mm). The dial gauge was graduated to read to 0.01 mm directly. It has a dial of sufficiently large size to give an open scale and a suitable pointer, close to the scale to minimize errors due to parallax. The readings of the gauge are to be accurate to 0.01 mm all along the scale.

Procedure

The leather was placed on the gauge with the grain side up, the load was then applied. A gently application was carried out and the reading taken after five seconds after the full load was reached. When the greatest possible accuracy was required, pre-conditioning the leather was carried out. Bako and Audu (2022), for example, compared the mechanical properties of Red Sokoto goat and sheep leather in Katsina State, finding significant differences in tensile strength and tear resistance that could influence their end-use applications.

Measurement of Shrinkage Temperature

Scope

This method was intended for use with any type of leather whose shrinkage temperature lies below 100°C . The thickness of the leather was measured in accordance with the method given under the measurement of thickness. The thickness been less than 3mm, the specimen was cut in a rectangle of 50mm length and a 3mm breadth, the thickness exceeding 3mm was cut in rectangle 50mm by 2mm.

The specimen was supported with hooks, punched two small holes at position 5mm from the ends and on a line parallel to and equidistant from the sides of the rectangle.

Apparatus

The apparatus used for wetting the specimen consist of a desiccator or other glass vessels which can be evacuated, a vacuum pump capable of reducing the pressure in the vessel to less than 30mm of mercury within two minutes, and a test tube in which the specimen can be immersed in 5ml of water; the test tube was supported approximately upright in the vessels during the evacuation.

Conditioning

Scope

This method describes the conditioning to be given for testing the specimens prior to physical testing.

Procedures

About 48hrs preceding its use for the test, each specimen was kept for physical testing in a standard atmosphere of temperature $20 \pm 2^{\circ}\text{C}$ and relative humidity $65 \pm 2\%$. The specimen was supported so that air has free access to its surfaces and a suitable fan was placed to keep the air in a continuous rapid motion. Mohammed and Salihu (2023) investigated the microstructural



characteristics of indigenous Nigerian goat breeds, concluding that fiber density and compactness varied across breeds, impacting overall leather durability.

RESULTS AND DISCUSSION

Effects of Breeds on Method and Position on Leather Quality of Antelopes and WAD Goats

Table 1 reveals that there is no statistically significant variation ($P>0.05$) in shrinkage temperature, water vapour permeability and weight but shows marked difference in thickness. The shrinkage temperature for both species has about similar shrinkage, 79.58-84.79°C, despite species difference indicating comparable collagen stability. Water vapor permeability indicates that between the species indicates that the moisture regulation has no regulation (1009.00-557.00). Been that antelope having a finer grain balance and West African Dwarf goat with compactness. For the weight, being that they both have uniform water bonding capacity of collagen and parallel absorption rate of 1.87-1.91kg. Thickness between the breeds indicates that West African Dwarf goat does have thinner but denser leather compound to antelope with thinner and finer.

Table 1: Effect of Breed, Tanning Method on Leather and Position on Leather Quality of Antelopes and WAD Goats

Treatment			No.	Shrinkage (°C)	Water vapour (g)	Weight (kg)	Thickness (mm)
Overall			60	81.67±12.18	1125±534.10	1.90±0.65	1.94±0.45
Goat			36	79.53±12.01	1202.20±511.80	1.91±0.73	2.02±0.50
Antelope			24	84.79±12.02	1009.00±557.00	1.87±0.58	1.83±0.44
LOS				NS	NS	NS	**
Tanning							
Vegetable			27	70.11±2.29	70.11±306.60	2.12±0.73	1.87±0.51
Chemical			23	91.12±12.02	1253.00±560.20	1.87±0.53	2.00±0.45
LOS				***	**	**	NS
Position							
Butt			20	81.05±12.54	1128.00±0.66	2.28±0.66	2.19±0.42
Shoulder			20	82.60±14.07	891.00±491.00	1.99±0.56	2.09±0.37
Belly			20	81.35±10.22	1357.00±550.00	1.41±0.41	1.56±0.39
LOS				NS	**	**	***
SPP	TNN						
Goat	Veg	18	69.72±2.49	1061.00±473.00	2.17±0.82	0.78±0.16	
Goat	Che	18	89.44±9.21	1343.00±523.00	1.65±0.53	0.58±0.12	
Ant.	Veg	9	70.89±1.69	783.00±407.00	2.02±0.74	0.86±0.10	
Ant.	Che	15	93.13±6.07	1143.00±602.00	1.78±0.36	0.67±0.14	
LOS				NS	NS	NS	NS
TN	POS						
Veg	But	9	69.54±2.47	1017.00±509.00	2.71±0.64	2.15±0.48	
Veg	Sho	9	69.00±2.27	784.00±448.00	2.21±0.66	2.00±0.43	
Veg	Bel	9	71.78±1.72	1104.00±424.00	1.44±0.45	1.48±0.40	
Che	But	11	90.45±8.90	1218.00±454.00	1.93±0.43	2.22±0.39	
Che	Sho	11	93.78±8.83	978.00±529.00	1.80±0.40	2.16±0.31	
Che	Bel	11	89.18±6.79	1564.00±572.00	1.40±0.39	1.62±0.40	
LOS				NS	NS	NS	NS
SPP	POS						
Goat	But	12	79.33±12.24	1191±464	2.50±0.23	2.38±0.23	
Goat	Sho	12	79.83±14.34	967±454	1.93±0.50	2.17±0.38	
Goat	Bel	12	79.58±10.16	1448±535	1.31±0.42	1.51±0.38	
Ant.	But	8	83.63±13.37	1032±510	1.97±0.44	1.91±0.50	
Ant	Sho	8	86.75±13.46	776±554	2.07±0.67	1.96±0.34	
Ant.		8	84.00±10.36	1220±581	1.57±0.36	1.62±0.43	
LOS				NS	NS	**	NS
SP	TN	POS	6	69.17±2.04	1156.00±489.00	3.02±0.39	2.41±0.16
Gt.	Veg	But	6	68.17±1.94	889.00±527.00	2.13±0.48	2.03±0.41
Gt	Veg	Sho	6	71.83±2.14	1140.00±434.00	1.37±0.50	1.50±0.46
Gt.	Veg	Bel	6	89.50±8.80	1227.00±481.00	1.96±0.54	2.35±0.30
Ant	Che	But	6	91.50±11.04	1046.00±400.00	1.74±0.46	2.31±0.32
Ant	Che	Sho	6	87.33±8.85	1757.00±460.00	1.25±0.35	1.53±0.33
Ant		Che	3	70.33±2.31	741.00±506.00	2.12±0.67	1.63±0.50
Bel			3	70.67±2.08	573.90±83.40	2.33±1.06	1.92±0.56
Gt.	Veg	But	3	71.67±0.58	1034.00±486.00	1.57±0.36	1.43±0.34
Gt.	Veg	Sho	5	91.60±9.91	1207.00±474.00	1.88±0.31	2.07±0.47
Gt.	Veg	Bel	5	96.40±2.07	896.00±696.00	1.88±0.34	1.98±0.20
Ant	Che	But	5	91.40±2.51	1332.00±656.00	1.57±0.40	1.73±0.47
Ant	Che	Sho		NS	NS	NS	NS
Ant	Che	Bel					
LOS							

KEYS: Gt. = Goat, Ant = Antelope, Bel = Belly, But = Butt, Sho = Shoulder, Veg = Vegetable
 Che = Chemical



Effect of Tanning Method on the Leather

The result reveals that there is significant variation ($P < 0.05$) in shrinkage temperature, water vapour and weight but showed no difference in thickness between the tanning methods used. The shrinkage temperature for tanning methods indicates that there was significance variation 70.11-91.12°C due to denser collagen fiber network, enhancing chromium cross linking that allows more uniform distribution of chemical agents. While the constant for thickness been that it has no effect on the leather is due to the fact that both leather have thicker individual figure but more porous than goat and thinner figures but denser packing.

The Main Effect of Position on Strength and flexibility

The result reveals that there is significance variation ($P > 0.01$) in water vapour, weight and thickness, but with no marked difference in the shrinkage temperature across the position (butt, shoulder and belly). Due to the butt being typically thickest and densest, that leads to lower water vapour permeability but higher durability. In as much as, their porosity or fiber structure that does not affect their breathability. For shoulder, the area has intermediate in its thickness and breathability; been that antelope have finer and more uniform fibers. For the belly, it has more flexible and thinner fiber that has more water vapour permeability but lower strength.

The Interaction between Specie and Tanning Method

From this study, results reveals that species does not dictate leather quality since there was no significant variation between species and tanning method (vegetable versus chemical). Infact, despite biological differences between goat and antelopes their leather properties are statistically similar that is either method (vegetable and chemical) can be used without altering these key leather traits.

The Interactions between Tanning Methods and Position

This results shows that tanning method (vegetable versus chemical) does not have influence on the leather quality of their position (butt, shoulder and belly) which could be as the results of complete and even diffusion of tanning eliminating natural positions based differences and mechanical softening or finishing could homogenize properties during post tanning treatments.

The Interactions of Specie and Positions

These results shows that species (Antelope and WAD goat) does not have any effect on the position (butt, shoulder, belly) of the leather quality due to the weight as a result of the anatomical position and specie, suggesting that selection of both is important for specific leather application.

The Interaction of Specie, Position and Tanning Method

This result indicates that since there was no statistically significant variation among the parameters confirms that the tanning penetration was consistent throughout the l

Table 2: Interaction of Specie, Position and Tanning Method

Treatment	n	Mass (kg)	Density (g/mm)	Resistance to C(g/cm)		
Overall	60	1.90±0.65	0.70±0.17	2.50±0.97		
Specie						
Goat	36	1.91±0.73	0.68±0.17	2.55±1.00		
Antelope	24	1.87±0.53	0.74±0.45	2.41±0.95		
LOS		NS	**	NS		
Tanning						
Vegetable	27	1.91±0.78	0.80±0.14	2.55±0.10		
Chemical	23	1.87±0.46	0.74±0.45	2.46±0.95		
LOS		***	*	NS		
Position						
Butt	20	2.28±0.66	0.76±0.19	2.85±1.00		
Shoulder	20	1.99±0.56	0.69±0.17	2.33±1.01		
Belly	20	1.41±0.41	0.66±0.13	2.32±0.86		
LOS		***	*	NS		
Spp	Tnn					
Goat	Veg	18	2.17±0.82	0.78±0.16	2.54±1.16	
Ante.	Che	18	1.65±0.53	0.56±0.12	2.57±0.85	
Goat	Veg	9	2.02±0.74	0.86±0.10	2.57±1.00	
Ante.	Che	15	1.78±0.36	0.67±0.14	2.32±1.00	
LOS		NS	NS	NS		
Spp	Pos					
Veg	But	12	2.49±0.71	0.75±0.20	2.96±0.96	
Veg	Sho.	12	1.93±0.49	0.65±0.17	2.63±1.11	
Veg	Bel	12	1.31±0.42	0.63±0.12	2.07±0.74	
Che	Butt	8	1.97±0.44	0.77±0.18	2.69±1.06	
Che	Sho	8	2.07±0.67	0.76±0.15	1.87±0.65	
Che	Bel	8	1.57±0.36	0.70±0.14	2.68±0.95	
LOS		*	NS	NS		
Tnn	Pos					
Veg	But	9	2.7±0.65	0.92±0.11	3.28±1.11	
Veg	Sho	9	2.21±0.66	0.80±0.14	2.23±1.10	
Veg	Bel	9	1.44±0.45	0.70±0.09	2.13±0.67	
Che	But	11	1.93±0.43	0.63±0.13	2.51±0.78	
Che	Sho	11	1.80±0.40	0.61±0.14	2.40±0.98	
Che	Bel	11	1.40±0.39	0.62±0.15	2.47±0.99	
LOS		NS	NS	NS		
Sp	Tnn	Pos				
Gt.	Veg	But	6	3.02±0.39	0.91±0.13	3.17±1.24
Gt.	Veg	Sho.	6	2.13±0.48	0.76±0.15	2.5±1.25
Gt.	Veg	Bel.	6	1.37±0.50	0.66±0.76	1.94±0.75
Ant	Che	But	6	1.96±0.54	0.50±0.10	2.75±0.68
Ant	Che	Sho	6	1.74±0.46	0.54±0.12	2.76±1.06
Ant	Che	Bel	6	1.25±0.35	0.60±0.15	2.20±0.78
Gt.	Veg	But	6	2.11±0.67	0.93±0.04	3.49±0.99
Gt.	Veg	Sho.	6	2.38±1.06	0.86±0.14	1.70±0.53
Gt.	Veg	Bel.	6	1.57±0.36	0.76±0.04	2.52±2.80
Ant	Che	But	6	1.88±0.31	0.68±0.156	2.21±0.85
Ant	Che	Sho	6	1.88±0.34	0.69±0.13	1.97±0.75
Ant	Che	Bel	6	1.57±0.40	0.65±0.15	2.78±1.22
LOS		NS	NS	NS		

Keys: Gt. = Goat, Ant= Antelope, Bel= Belly, But=Butt, Sho= Shoulder, Veg= Vegetable
 Che = Chemical



Effect of Species

The study shows that there is no statistically significant variation ($P > 0.005$) in mass and resistance to compression but showed a marked difference in density, showing that the species has a strong influence on how compact or highly packed the leather fibres are. Therefore, density is a stronger or distinguishing factor or indicator in leather quality between two species. Mass and compression to resistance remain stable, which means that it has little or no contribution to quality variation.

The Main Effect of Tanning

The study reveals that density and mass are significantly influenced by both species and tanning method, making them important indicators of leather quality. While in contrast, resistance to compression remains stable across both the species and tanning method, hence it is not a major factor difference.

The Main Effect of Position

This study indicates that there is a significant difference ($P > 0.01$) in both density and mass of leather quality. This means that the anatomical position of the hide affects how compact (density) and how heavy (mass) the leather is. Therefore, mass and density are important indicators of leather and strength and quality. However, resistance to compression is less relevant for distinguishing leather quality across the butt, shoulder and belly in antelope and WAD goat due to it been consistent.

The Interaction between Species and Tanning Method

This study indicates that lack of significant interaction suggest that species and tanning methods acts independently with respect to mass, density and resistance to compression. Therefore, leather quality in terms of these three properties is not affected by how the species and tanning methods combine has no special advantage or disadvantage.

The Interactions between Species and Positions

This result reveals that the interactions between species and position had a significant effect of the mass of the leather. This indicates the impact of the body position (butt, shoulder, belly) on mass differs between WAD goats and antelope. Therefore, both species and positions together influence leather mass and cannot be considered in isolation when assessing the growth traits. However, density and resistance to compression are stable across species-positions combinations, implying that these properties are not sensitive to where on the animal the leather is taken or which species it is from.

Table 3: Interactions between Species and Positions

Treatment	n	Ind.Index (1/100gmm)	Hardness (N/mm ²)	Maximum Force (Kg)	Displacement (mm)
Overall	60	0.03±0.02	66.25±0.02	57.85±20.44	11.95±3.14
Specie					
Goat	36	0.03±0.02	66.50±6.21	57.42±22.71	12.10±3.10
Antelope	24	0.03±0.02	65.83±7.23	58.48±16.93	11.73±3.31
LOS		NS	NS	NS	NS
Tanning					
Vegetable	27	0.03±0.01	69.30±5.64	53.93±2279	9.54±2.73
Chemical	23	0.04±0.02	63.73±6.31	61.05±18.03	13.92±1.80
LOS		NS	***	NS	***
Position					
Butt	20	0.04±0.02	64.08±7.31	67.46±17.95	11.90±3.50
Shoulder	20	0.04±0.01	65.55±5.81	67.38±11.24	12.06±3.46
Belly	20	0.02±0.01	69.07±5.81	38.69±16.43	11.90±2.54
		NS	**	*	NS
Spp Tnn					
Goat Veg	18	0.03±0.02	68.87±4.13	52.32±25.58	10.12±2.49
Ant. Che	18	0.04±0.01	64.13±2.09	62.53±18.77	14.08±2.21
Goa Veg	9	0.03±0.01	70.15±8.10	57.15±16.73	8.39±2.97
Ant Che	15	0.03±0.02	63.24±5.41	59.28±17.59	13.74±1.20
LOS		NS	NS	NS	NS
Spp Pos					
Veg But	12	0.05±0.01	63.70±7.29	71.09±18.29	11.52±4.08
Veg Sho	12	0.04±0.01	65.33±5.38	69.15±9.97	12.65±2.29
Veg Bel	12	0.02±0.01	70.47±3.66	32.2±12.99	12.13±2.71
Che But	8	0.03±0.02	64.66±7.79	62.01±17.09	12.46±2.55
Che Sho	8	0.03±0.01	65.87±6.79	64.75±13.17	11.18±4.77
Che Bel	8	0.03±0.02	66.96±7.87	48.7±17.56	11.55±2.38
LOS		NS	NS	NS	NS
Tnn Pos					
Veg But	9	0.04±0.02	68.74±5.77	62.53±3.34	9.26±3.41
Veg Sho	9	0.03±0.01	69.22±3.71	65.06±11.78	9.55±3.35
Veg Bel	9	0.02±0.01	69.93±7.45	34.20±18.54	9.82±1.07
Che But	11	0.04±0.02	60.27±6.27	71.50±11.69	14.06±1.60
Che Sho	11	0.04±0.01	62.54±5.58	69.29±10.96	14.12±1.85
Che Bel	11	0.03±0.02	68.36±0.02	42.37±14.32	13.60±2.06
LOS		NS	NS	NS	NS
Sp Tn Pos					
Gt Veg But	6	0.05±0.01	67.78±3.38	65.70±25.40	9.02 ±4.18
Gt Veg Sho	6	0.03±0.01	68.28±4.18	66.24±11.25	11.14±0.61
Gt Veg Bel	6	0.02±0.01	70.55±4.93	24.96±10.19	10.19±0.70
AntCheBut	6	0.05±0.01	59.61±8.10	76.44±4.56	14.02±2.02
AntCheSho	6	0.04±0.02	62.39±5.03	72.06±8.48	14.15±2.40
AntCheBel	6	0.02±0.01	70.39±2.26	39.08±10.4	14.06±2.59
Gt Veg But	3	0.02±0.02	70.66±9.81	36.10±21.60	9.73±1.50
Gt Veg Sho	3	0.03±0.02	71.11±1.83	62.69±15.05	6.37±4.61
Gt Veg Bel	3	0.02±0.01	68.67±12.55	52.70±18.60	9.07±1.45
AntCheBut	5	0.04±0.02	61.07±15.33	65.57±15.33	14.10±1.13
AntCheSho	5	0.03±0.01	62.07±6.80	65.96±13.61	14.07±1.17
AntCheBel	5	0.03±0.02	65.93±5.12	46.32±18.65	13.04±1.22
LOS		NS	NS	NS	NS

KEYS: Gt. = Goat, Ant= Antelope, Bel= Belly, But=Butt, Sho= Shoulder, Veg= Vegetable
 Che = Chemical



Effect of Specie

The table reveals that since there is no significance difference ($p>0.01$) in indentation index, hardness maximum force and displacement means that no claims can be laid confidently that one type of leather performs better than the other.

Effect of Tanning

The result reveals that the leather does not significantly ($p>0.01$) influence the indentation index and maximum force, irrespective of whether chemical or vegetable tanning is used. This suggests that the initial mechanical resistance peak force capacity of the leather is largely unaffected by some of the leather or tanning method applied. However, the significant effect observed in displacement and hardness indicates that both the leather deforms under pressure and how hard it surface is. These properties are more sensitive to the structure differences in the leather fibres, which are likely influenced by both the biological makeup of the skin and the specific reactions and fibre changes induced by chemical or vegetable tanning.

Effect on Position

This result shows that the leather quality of antelope and WAD goat has a significant effect on indentation index and maximum force while displacement and hardness are significantly affected by position. The significant differences indicate that the type of animal plays an important role in determining how resistant the leather is to penetration and the amount of force it can withstand before deformation. This implies that intrinsic qualities vary from animal to animal.

The Effect of Interactions

The results reveals that the interaction effects among species (antelope and west African dwarf goat), tanning method (chemical and vegetable) and position on the skin (butt, shoulder belly) are statistically insignificant for all the properties (maximum force, indentation index, hardness and displacements). Therefore, combine influence of species and tanning, specie and position, tanning and position or all three factors together does not produce any unique or amplified effect on the mechanical properties. More so, the variation in mechanical properties is likely driven more by main effects. The individual influence of specie, tanning or position rather than by these factors with each other. Specie, tanning and position can be considered as contributing independently to the properties of the leather.

CONCLUSION AND RECOMMENDATIONS

Based on the result obtained, the following conclusions were made:

- i. Antelope leather skin can be used to substitute goat skin and antelope can be domesticated and their leather would be used for finished leather products.
- ii. Vegetable tanning should be encouraged since its cheaper, safe and less pollutants to the environment and health hazard (carcinogenic) to humans.
- iii. Preferred position of the leather is designated for specific leather work or products. Therefore, certain areas or position would be accommodative for a particular product.

The following recommendations were drawn from the results of this study;

- i. more interest should be channeled towards antelope production as this would reduce so much pressure on goat production and competition with man.
- ii. The more use of vegetable tanning method to be encouraged as this will curb the health hazard in finished products and cheaper.

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