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Tanning of Different Animal Skins/Hides and Study of Their Properties for Textile Application

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The animal skins and hides (wet salted/fresh goat skins, sheep skins and cow hides) were tanned using a rotating drum after it was aged for four days by enclosing it in an air tight environment using polyethylene bags. The properties of goat skins, sheep skins and cow hides studied were based on moisture absorption, thickness, breaking and tearing strength. The results of the analysis indicate that a thick strong leather material was obtained from the cow hides compared to goat and sheep skins. Softer leather was obtained from the sheep compared to goat. Therefore, goat and sheep gave best leather for shoe upper and upholstery while the cow hides gave best leather for sandals and other heavy leather products.

Keywords: Tanning; skins; hides; footwear; upholstery; strength.

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1. INTRODUCTION

Leather tanning covers the treatment of raw materials; it is the conversion of raw hide or skin, a potential to rot into leather, a stable material so that it can be used in the manufacture of a wide range of consumer products Fred [1]. In the tanning trade the outer coverings of large domestic animals are called hides. Hides are large in size, thicker in substance and heavier in weight than skin Sarker [2]. Cattle hides above 25 Ibs. in the wet salted conditions are classed as hides and those below 15 Ibs. as calf skins Hides are from the bovidae family while skins are from capridae including reptiles. Light buffalo hides weighing from 14.5 to 18 Ibs. are called 'Katta' and those weighing from 7 – 14 Ibs are called buff calves or 'Kattais' Example: Cowhide, Buffalo hide, Horse hide, etc Sivabalan and Jayanthi [3]. The outer coverings of small domestic animals and wild animals are called skins Slabbert [4]. Skins are smaller in size, thinner in substance and lighter in weight than hides. Example: Goat skin, Sheep skin, Tiger skin, Crocodile skin, etc.

The leather tanning industry uses hides and skins – by products of the meat and dairy industry – which would otherwise have to be disposed of by other means, such as landfills and incineration Ozgunay [5]; Fred [1]. Leather is the tanning sector's fundamental output. It is an intermediate industrial product, with applications in downstream sectors of the consumer goods industry. Footwear, garment, furniture, automotive and leather goods industries are the most important outlets for tanners' production Li et al. [6].

The processing of hides and skins also generates other by-products which find outlets in several industry sectors such as pet and animal food production, fine chemicals including photography and cosmetics, and soil conditioning and fertilizers Sivabalan and Jayanthi [3].

Leather tanning is one of the oldest human activities. The first rudimental tanning process is mentioned in Assyrian texts and in Homer's Iliad Reeds [7]. In the beginnings, skins obtained from hunting and livestock breeding could be used for clothing or tents, but they became stiff at low temperatures and rotted with heat Highberger [8]. It was probably then that attempts were made to render them more flexible and stronger by rubbing in animals fats. Another process was smoking Sharphouse [9]. Which almost started by accident, and which latter became formaldehyde tanning, as this substance is found in the vapours produced by burning green leaves and branches Sarker [10]; Joytirmay [11]. It was soon discovered that drying carried out by exposure to sun, or could also stop the rotting process by the dehydrating action of salt Geonre [12].

Vegetable tanning was also known in very ancient times, although it is not clear how the tannin contained in the bark of some plants (especially oak) was discovered.

Another method known since the earliest time is tanning based on the use of alum, a mineral that is fairly wide spread in nature, particularly in volcanic areas.

The study was initiated to consider the differences between the hides and skins and their areas of application.

2. MATERIALS AND METHODS

Wet salted/fresh goat and sheep skins; and cow hides obtained at Zaria abatour, Nigeria. The important information about the goat, sheep and cow are: goat (male, brown, Sokoto-breed, 1-year); sheep (female, white, Yankasa-breed, 2-years) and cow (male, white, Fulani-breed, 5-years) respectively. The chemicals used are: 3% sodium sulphate, 3% calcium hydroxide, 2.5% ammonium chloride, 0.5% medium strength bate, 6 sodium chloride salt, 0.7% formic acid and 0.7% sulphuric acid, 4% replacement syntan, Tangan AN and Nitro cellulose. The machines used are: Lastometer machine, cutter and Scissors. The average results of the samples of hides/skins were taken and recorded.

The initial weight of all the samples were taken and recorded before the tanning process of the animal skins and hides began. The following processes were based on the weight.

2.1 Dirt Soaking

The skins were soaked in 200% of water at room temperature in a soaking drum. This was allowed to run for 60 revolutions at rate of 4 rotations per minutes. The water was drained and checked if dirt was washed off the samples.

2.2 Unhairy/Liming

The following were weighed out; 3% sodium sulphate, 3% calcium hydroxide and 200% clean

at room temperature. The chemicals were added to the drum and the skins and hides loaded and the drum closed. The drum was allowed to run at 4 r.p.m. The samples were soaked at intervals for complete unhairy and plunpness (spelling).

2.3 Washing

The liquor was drained off and the skins and hides were washed 2 times in 400% water at room temperature and run for 15 minutes.

2.4 Deliming

2.5% ammonium chloride and 100% water at room temperature was added and run for 50 minutes.

2.5 Bating

To deliming liquor, 0.5% medium strength bate and 50% water at 40°C.

These were added and rum for 45 minutes at pH 9.0. The bating effect was tested by thumb print to ensure no excessive bating is given in order to avoid high softness. They were then washed 2 times in 200% water at room temperature for 15 minutes.

2.6 Pickling

The following 7% sodium chloride salt, 50 %water, 0.7% formic acid and 0.7% sulphuric acid were weighed. Each prediluted with 10 parts of their weight of water and added to the drum and allowed to run for 2 hours. The pH tested to 2.7 using methyl orange.

2.7 Chrome Tanning

7.7% non-self basified chrome was added to pickle, the drum was run for 1 hour and penetration to 100% and pH 2.9 were checked. The material was basified with 0.5% sodium bicarbonate and left overnight. The boil test was carried out at100°C. The leather was washed up in 200% water and aged for 3 days packed in polythene sheet to avoid edges drying out hard.

2.8 Neutralisation

The materials were neutralized in 100% water, 0.5% sodium bicarbonate and 1.0% sodium formate. It was then run for 30 minutes and pH tested to 6.3 with bromocresol green.

2.9 Retanning

The following 4% replacement sytan, Tangan AN and run for 40 minutes. The fullness was checked. 1% dye stuff was added. Fatliqouring the leather in a liquor of 100% water at 60°C and then run for 30 minutes.

2.10 Setting Out

The various skins and hides were set out and allowed to dry.

2.11 Stake, Toggle and Finishing

The samples were stake out and toggled dried. A solution of Nitro cellulose was then applied.

3. TESTING OF THE SAMPLES

3.1 Breaking and Tearing Strenght of Leather Using Lastometer

The round samples were clamped to the lastometer and the rotating spindle was allowed to run until a hole was bored on the material. The machine was stopped and the reading taken. The electronic lastometer (Mod. S077-ET (MUVER)) gives a plot of the strength of leather lastometer

3.2 Water Absorption

The leather samples were weighed and clamped to the water permeability tester filled with water and left for 24 hours. The mass of leather samples taken and the amount of water absorbed was determined.

4. DISCUSSION OF RESULTS

4.1 Mass of Samples and Amount of Impurities

This represents the actual mass in grams (g) of the final leather and gives the amount of impurities removed during the processing. The percentage of impurities removed was found to be 34.7% (sheep skins), 13.1% (goat skins), and 12.8% (cow hides) respectively as shown in Table 1. It has been shown that water constitutes major percentage of fresh skins and hides followed by other impurities.

4.2 Thickness of Samples

This was done using a thickness and load tester. Three readings were taken respectively. The averages taken as final thickness of the samples were 1.0 mm, 1.13 mm and 1.29 mm, respectively as shown in Table 2.

4.3 Water Absorption

It gives the amount of moisture the leather would absorb. This was done using a water permeability tester. The material was clamped for 1 hour, 2 hours and 24 hours and the masses recorded as shown in Table 3.

4.4 Lastometer Results (Breaking and Tearing Strenght (Spelling))

The electronic lastometer readings from the graph in Fig. 1 shows retention for sheep leather to be force of 6.53kg at a displacement of 6.74 mm (i.e. force required to tear or rupture the samples).

The graph in Fig. 2 shows breaking force of goat skin leather to be 28.43 kg at a displacement of 7.72 mm, while tearing strength to be 41.76 kg at a displacement of 8.77 mm.

These results show more strength properties in the goat skin used for this analysis, therefore, the goat skin give shoe upper leather of higher strength than sheep skin. The lastometer model 5077-et (MUVER) which was used cannot be used for analysis of cow hide leather.

Table 1. Mass of samples and amount of impurities

Mass (g)	Average Initial mass (g)	Average final mass (g)	Impurities (%)
Sheep	980	340	34.7
Goat	840	110	13.1
Cow	7400	950	12.8

Impurities (%) = (Initial weight – Final weight/Initial weight X 100)

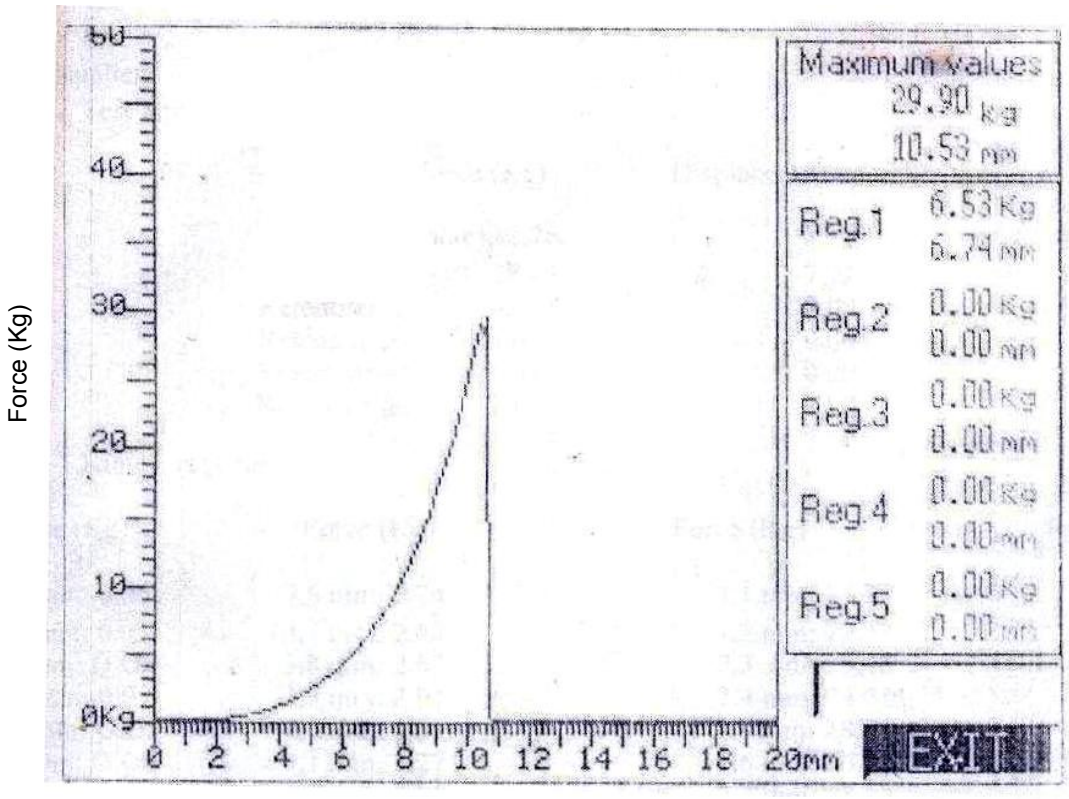
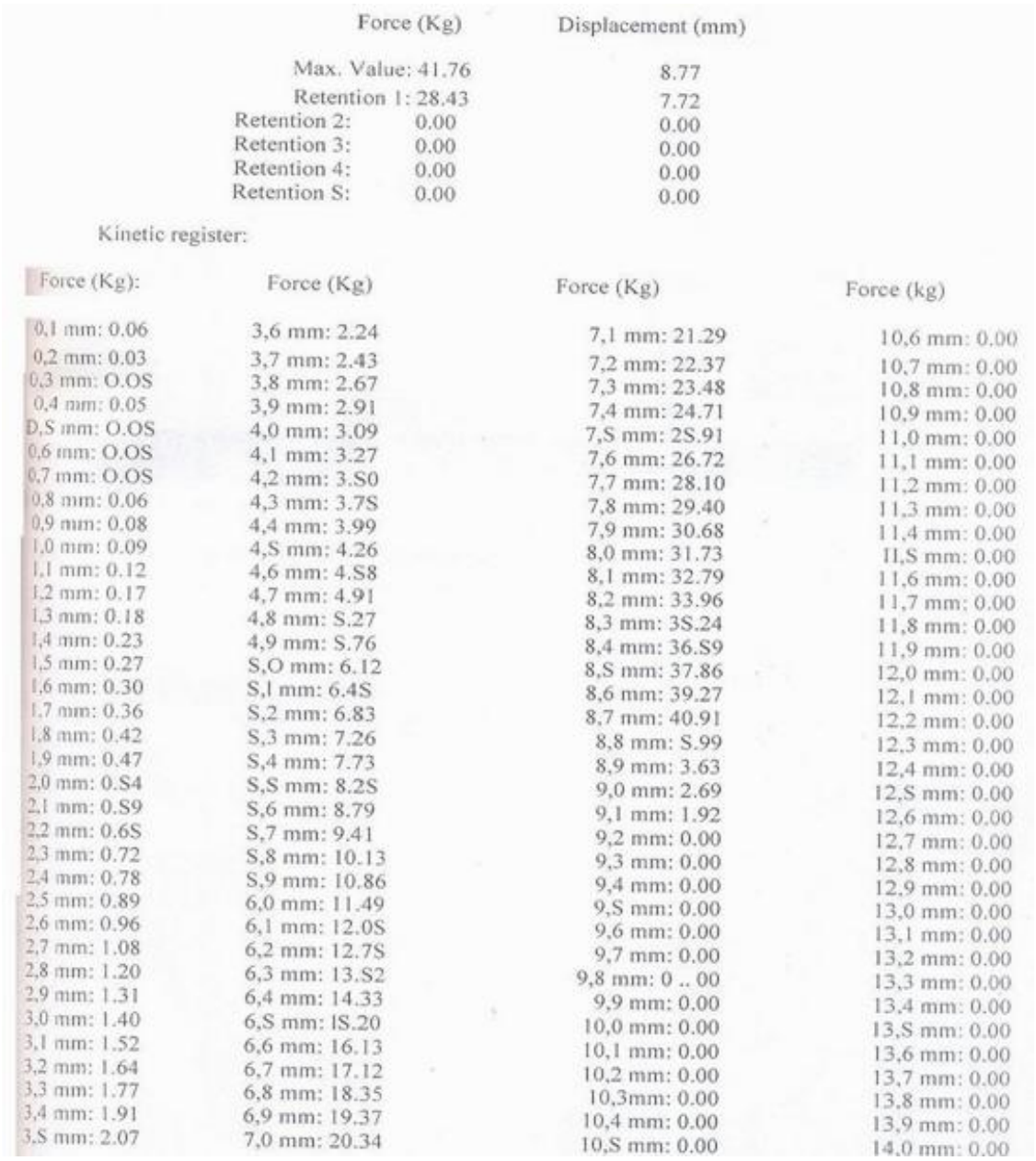


Fig. 1. Graph of force against displacement for sheep skin breaking strength Results of electronic lactometer Mod.S077-ET (MUVER)



	Force (Kg)	Displacement (mm)
Max. Value:	41.76	8.77
Retention 1:	28.43	7.72
Retention 2:	0.00	0.00
Retention 3:	0.00	0.00
Retention 4:	0.00	0.00
Retention S:	0.00	0.00

Kinetic register:

Force (Kg):	Force (Kg)	Force (Kg)	Force (kg)
0,1 mm: 0.06	3,6 mm: 2.24	7,1 mm: 21.29	10,6 mm: 0.00
0,2 mm: 0.03	3,7 mm: 2.43	7,2 mm: 22.37	10,7 mm: 0.00
0,3 mm: O.OS	3,8 mm: 2.67	7,3 mm: 23.48	10,8 mm: 0.00
0,4 mm: 0.05	3,9 mm: 2.91	7,4 mm: 24.71	10,9 mm: 0.00
D,S mm: O.OS	4,0 mm: 3.09	7,S mm: 2S.91	11,0 mm: 0.00
0,6 mm: O.OS	4,1 mm: 3.27	7,6 mm: 26.72	11,1 mm: 0.00
0,7 mm: O.OS	4,2 mm: 3.S0	7,7 mm: 28.10	11,2 mm: 0.00
0,8 mm: 0.06	4,3 mm: 3.7S	7,8 mm: 29.40	11,3 mm: 0.00
0,9 mm: 0.08	4,4 mm: 3.99	7,9 mm: 30.68	11,4 mm: 0.00
1,0 mm: 0.09	4,S mm: 4.26	8,0 mm: 31.73	11,S mm: 0.00
1,1 mm: 0.12	4,6 mm: 4.S8	8,1 mm: 32.79	11,6 mm: 0.00
1,2 mm: 0.17	4,7 mm: 4.91	8,2 mm: 33.96	11,7 mm: 0.00
1,3 mm: 0.18	4,8 mm: S.27	8,3 mm: 3S.24	11,8 mm: 0.00
1,4 mm: 0.23	4,9 mm: S.76	8,4 mm: 36.S9	11,9 mm: 0.00
1,5 mm: 0.27	S,O mm: 6.12	8,S mm: 37.86	12,0 mm: 0.00
1,6 mm: 0.30	S,1 mm: 6.4S	8,6 mm: 39.27	12,1 mm: 0.00
1,7 mm: 0.36	S,2 mm: 6.83	8,7 mm: 40.91	12,2 mm: 0.00
1,8 mm: 0.42	S,3 mm: 7.26	8,8 mm: S.99	12,3 mm: 0.00
1,9 mm: 0.47	S,4 mm: 7.73	8,9 mm: 3.63	12,4 mm: 0.00
2,0 mm: 0.S4	S,S mm: 8.2S	9,0 mm: 2.69	12,S mm: 0.00
2,1 mm: 0.S9	S,6 mm: 8.79	9,1 mm: 1.92	12,6 mm: 0.00
2,2 mm: 0.6S	S,7 mm: 9.41	9,2 mm: 0.00	12,7 mm: 0.00
2,3 mm: 0.72	S,8 mm: 10.13	9,3 mm: 0.00	12,8 mm: 0.00
2,4 mm: 0.78	S,9 mm: 10.86	9,4 mm: 0.00	12,9 mm: 0.00
2,5 mm: 0.89	6,0 mm: 11.49	9,S mm: 0.00	13,0 mm: 0.00
2,6 mm: 0.96	6,1 mm: 12.0S	9,6 mm: 0.00	13,1 mm: 0.00
2,7 mm: 1.08	6,2 mm: 12.7S	9,7 mm: 0.00	13,2 mm: 0.00
2,8 mm: 1.20	6,3 mm: 13.S2	9,8 mm: 0 .. 00	13,3 mm: 0.00
2,9 mm: 1.31	6,4 mm: 14.33	9,9 mm: 0.00	13,4 mm: 0.00
3,0 mm: 1.40	6,S mm: lS.20	10,0 mm: 0.00	13,S mm: 0.00
3,1 mm: 1.52	6,6 mm: 16.13	10,1 mm: 0.00	13,6 mm: 0.00
3,2 mm: 1.64	6,7 mm: 17.12	10,2 mm: 0.00	13,7 mm: 0.00
3,3 mm: 1.77	6,8 mm: 18.35	10,3mm: 0.00	13,8 mm: 0.00
3,4 mm: 1.91	6,9 mm: 19.37	10,4 mm: 0.00	13,9 mm: 0.00
3,S mm: 2.07	7,0 mm: 20.34	10,S mm: 0.00	14,0 mm: 0.00

Table 2. Thickness of samples (mm)

Thickness (mm)	First reading (mm)	Second reading (mm)	Third reading (mm)	Average(mm)
Sheep	1.00	1.03	0.99	1.01
Goat	1.07	1.10	0.95	1.04
Cow	1.36	1.36	1.40	1.37

Average reading (mm) = (1^{st} reading + 2^{nd} reading + 3^{rd} reading)

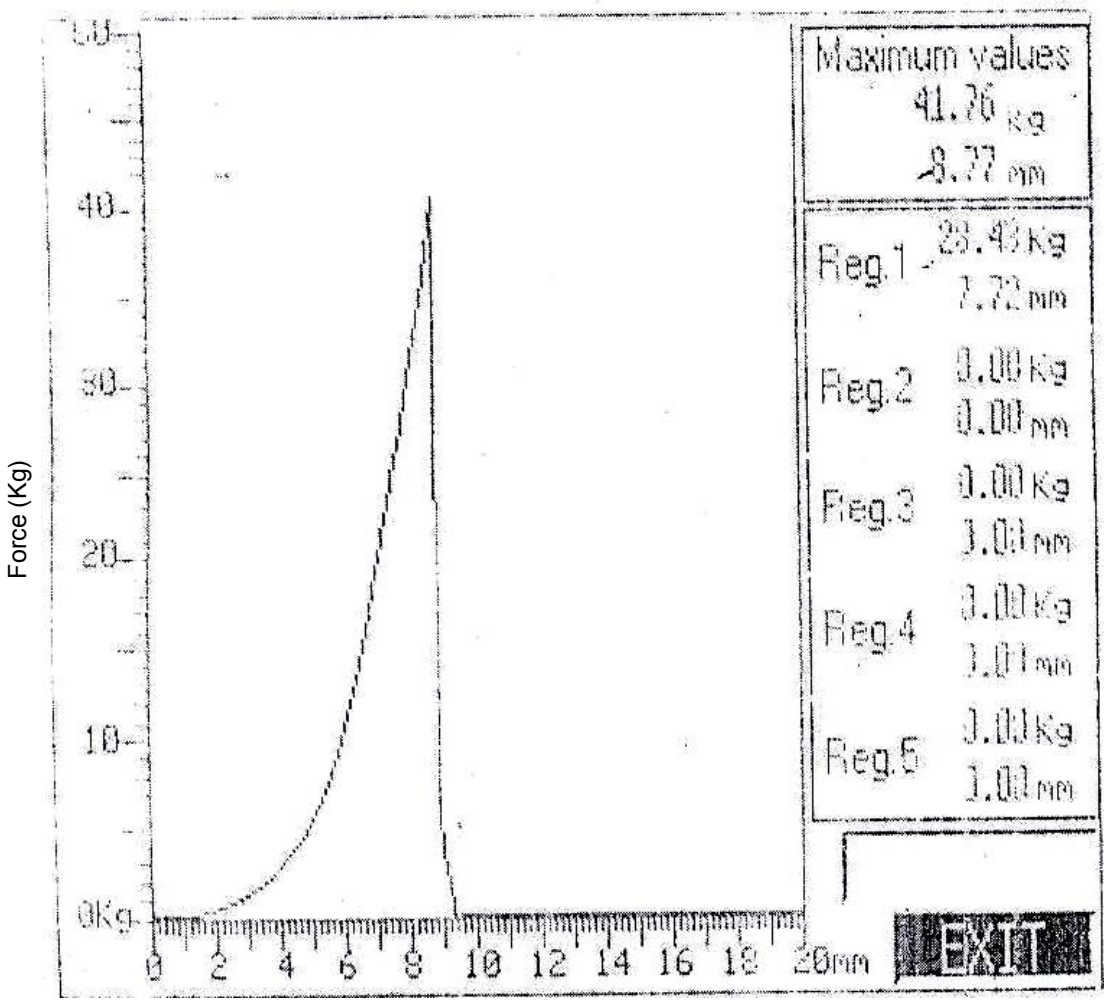


Fig. 2. Graph of force against displacement for goat skin hawing breaking strength

Table 3. Moisture absorption

Mass of samples (g/time)	$M_{0\ (g/t)}$	$M_{1\ (g/t)}$	$M_{2\ (g/t)}$	$M_{24\ (g/t)}$
Sheep	1.130	1.149	1.151	2.44
Goat	0.810	0.830	0.850	1.26
Cow	2.374	2.374	2.410	3.74

Where; M_O = mass before test; M_1 = mass after 1 hour; M_2 = mass after 2 hours; M_{24} = mass after 24 hour

5. CONCLUSION

It can be concluded that cow hides; goat and sheep skins are good sources of leather for shoe production in the textile industry. They give good shoe upper leather. They also give leathers for shoe landing as well. Cow hides known as heavy leather can be splitted into three or more layers; only that one layer would have the grain side. The analysis indicate that a thick strong leather material was obtained from the cow hides compared to goat and sheep skins. Softer leather was obtained from the sheep compared to goat. Therefore, goat and sheep gave best leather for shoe upper and upholstery while the cow hides gave best leather for sandals and other heavy leather products. The quality of the final product usually depends on certain factors such as age of the animal, breed, method of preservation of the skin, sex and method of processing or tanning. The leather obtained from these materials can also be found in consumer goods use such as wallet, straps, belts, bags and upholstery.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Fred OF. The chemistry and technology of leather. 1996;2:222-453.
2. Sarker KT. The theory and practice of leather manufacture. 2nd Edition, Longman Publishers, India. 1995;45:556.
3. Sivabalan V, Jayanthi A. (2009). A study to reduce salt usage in preservation of skins and hides with alternate use of plant extract. J. Agri. Biol. S. 2009;4:43-48. d) D.G. Bailey: Available:http://wyndmoor.arserrc.gov/Pa
4. Slabbert NP. Recycling in the tanning industry. J. Soc. Leather Tech. Chem. 1979;64:89-92.
5. Ozgunay R. Light fastness properties of leather tanned with various vegetable tanning. Journal of American Leather Chemist Association (JALCA). 2007;3.
6. Li Y, Shan ZH, Shao SX, Shi KQ. Mechanism of chrome-free tanning with tetra-hydroxymethyl phosphonium chloride. J. Soc. Leather Tech. Chem. 2006;5:214-216.
7. Reeds R. Science for students of leather technology. 4th Edition. 1996;234-556.
8. Highberger JH. The isoelectric point of collagen. J. Am. Chem. Soc. 1939;61:2302–2303.
9. Sharphouse JH. Theory and practice of modern chamois leather production. J. Soc. Leather Technol. Chem. 1985;69:29-43.
10. Sarker PK. Analytical chemistry of leather manufacture. Indian Leather Technologists Association, Calcutta. 1982;544.
11. Joytirmay D. Practical aspects of manufacture of upper Leather. 3rd Edition, 1998;453.
12. Geonre DM. The chemistry of leather manufacture. 1991;453.

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