https://chemclassjournal.com/
ChemClass Journal Vol. 8 Issue 1 (2024); 146-153
e-ISSN:0198-2734 p-ISSN:0198-5680
doi.org/10.33003/chemclas_2024_0801/012

Investigation of the Tannin and Tanning Potential of *Erythrophleum suaveolens* (Gwaska)

[1]Adeyi A.O., [1]Habila, B., [1]Adeoye D.O., [1]Ayebe B., [1]Abdullahi, S., [2]Abdullahi, M.S. [1]Samuel, B.I. [3]Edache J.J.,

[1]Directorate of Research and Development, NILEST Samaru Zaria
[2]Directorate of Distance Learning

[3]Department of Polymer Processing, Jorah Jemima Salom Nig. FCT, Abuja

Corresponding author: *hbee4yaweh@gmail.com

Abstract

This study is triggered by the need for search of r alternative vegetable tanning materials that is naturally abundant, easily obtainable and offer competitive tanned leather performances. In this study, the physical and chemical properties of leather tanned with *Erythrophleum suaveolens* (Gwaska) were determined. The result of the shrinkage temperature was found to be the same with *Acacia nilotica* (Bagaruwa) tanned leather and the tannin content was found to be 29%. From the result obtained in this research, it is evident that Gwaska is a potential plant for the tanning industry, especially the traditional tanneries in Nigeria. Therefore, the utilization of the findings in this study can serve as a practicable and effective means of alternative and sustainable source of tannins for the tanning industry.

Keywords: Erythrophleum, Gwaska, Leather, Shrinkage, Tannin

Introduction

The active ingredient capable of combining with protein, converting it into non-putrefiable material is known as tannin; and vegetable tannins are part of plant that has the ability to convert animal skin into leather [1]**.** Tanning involves conversion of hides and skins into stable and imputrescible substance known as leather. This is possible by application of some mineral salt or by introducing mineral of vegetable origin [2]. Tannins occur throughout the greater part of the plant kingdom and more prevalent among the higher plant or angiosperm, especially in certain dicotyledonous family. Tannins are characterized by their ability to give colour solution with certain metallic salt and it can combine with aluminium, gelatins and various alkaloids. They have molecular weight ranging from 500-3,000 Dalton [3].

Traditionally, the tannins are extracted with water with solvent in open vat or moderate temperature [4]. In trees with high tannin concentration, large quantity of the material can be collected for economic use [5]. The methods of the tanning using tannin materials obtained from the bark of trees or from leaves, animal oil and certain salt

have found many uses [6]. The origin of vegetable tanning is lost in pre-historic times, primitive people in all part of the globe and from all the ages of the past have developed vegetable tanning system based on the materials available locally. If a raw skin was placed in contact with certain plant (bark, wood, leaves) moistened with water, it was found that the stained portion were protected against putrefaction [1]. The broad availability of plants capable of producing this reaction leads to the establishment of vegetable tannin-based industry. Vegetable tanning and vegetable tanned leathers have been standard of leather production up until the fairly recent development of the chrome tanning industry [5]. The objective of the work is to development a vegetable tanning agent that is environmentally friendly suitable of replacing mineral tannage.

Materials and Methods

Salted goat skins, powdered sample of *Erythrophleum suaveolens* (Gwaska), Calcium hydroxide $Ca(OH)_2$, Ammonium sulphate $(NH_4)_2SO_4$, Analytical balance, Water, hand gloves, Sodium bicarbonate ($NaHCO_3$), Fatliquor, Milling machine Formic acid, tannery and laboratory equipments was obtained from Nigerian Institute of Leather and Science Technology, Samaru Zaria.

Sampling and extraction of E*rythrophleum suaveolens* (Gwaska)

The salted goat skins used in this study was obtained in the tannery and the chemicals were obtained in Nigerian Institute of Leather and Science Technology, (NILEST) laboratories. The bark of *Erythrophlueum suavelens* was obtained, air dried and crushed into powder of 0.5 mm mesh size. 200 g of the powder was measured and leached using the method of international union of chemical analysis (IULTCS) 1966 and the tannin analysis was carried out using the official methods of analysis by IULTCS, [7].

Recipe for shoe upper production

The process was carried out using a Digital Experimental Drum (Italprogetti Drum). The goat skin was soaked in 500 % water to attain rehydration. After the rehydration, the skins were unhaired using 3 % Na_2S based on the weight of the skins for 45 mins. The liquor was discarded and 300 % water was added with 4 % $Ca(OH)_2$ for liming. It was then left overnight to saponify the fat and make it plump. The deliming process was done using 2 % NH_4Cl for 30 mins at a pH value of 8 – 9. Bate powder of 0.5 % was added and run for 15 mins to make it soft, in order to allow easy penetration of other chemicals. From there, the liquor was discarded. Next was drenching and this

was done using 100 % water and 7 % NaCl salt for 20 mins. To obtain pH value of 5.0 – 5.5, formic acid was added to the liquor for 2 hrs and then left overnight. Afterward, the tanning and retanning was carried out using 20%, 25%, 30% and 40% of *Erythrophleum suaveolens* plant. The process was allowed to run for 2 hrs. Fatliquoring was done using 4 % fatliquor for 15 minutes and subsequently, 1 % formic acid was added for fixation. Finally, the leather was hoisted to dryness overnight. The stretching of the leather was done mechanically through staking and toggling.

Determination of phenol content

This was done by preparing different concentrations of tannic acid ranging from 1.0 to 4.0ppm and the absorption value was taken using spectrophotometer

$$\text{Total phenol} = \frac{\text{Conc.(ppm)} \times \text{Extraction Volume}}{\text{Weight} \times \text{Diffusion Factor}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Tannin analysis

The tannin analysis of *Erythrophlueum suavelens* was based on the extract obtained from the bark of the tree. Major aspect of this analysis was carried out using the official methods of analysis: Total Ash (SLTC 2), Moisture content (SLTC 2/3 A), Total Solid (SLTC 2/3 B), Total soluble (SLTC 2/3 C), Total insoluble (SLTC 2/3 F), tan content, non-tan content (SLTC 2/3 D) and pH determination (SLTC 2/3 H).

Physical testing of leather

The following test was carried out on the leather produced; Apparent density, Water vapour permeability, Ball Bust, Tensile strength, Flexing endurance, percentage elongation, Shrinkage Temperature, rough fastness, light fastness, resistance to compression and Kubelka test (IUP 5). Other parameters carried out were:

Thickness measurement: According to IUP 4

Measurement of water absorption: According to IUP 7

Measurement of Shrinkage Temperature: According to IUP 16

Measurement of water vapor permeability and Absorption: According to IUP 15

Chemical analysis

The chemical analysis was carried out in accordance with official method of analysis [7].

Results and Discussion

Table 1: Results for the thickness test (SLP 4)

Region	A(mm)	B(mm)	B(mm)	Mean (mm)
Neck	1.04	1.02	1.00	1.02
Butt	1.00	1.00	0.97	0.99
Belly	0.95	0.95	0.95	0.95

From physical testing analysis in Table 1, the thickness test for the leather sample tanned with the bark of *Erythrophleum suaveolens* shows that the neck region has the highest thickness test value followed by the butt and belly respectively. The report is similar to the work of Pradeep *et al*. [8]. The difference in the thickness value is attributed to the difference in the compactness of fiber in each region.

Table 2: Results of apparent density (IUP 5)

Region	Thickness(mm)	Volume(mm)	Mass(g)	App. Density
Neck	1.02	16.225	1.025	0.063
Butt	0.99	15.74	1.025	0.065
Belly	0.95	15.104	1.022	0.067

Table 2 shows the apparent density value for the leather tanned with *Erythrophleum suaveolens.* The neck region has the least apparent density value followed by butt and belly. The volume affects the apparent density, the higher the volume the lower the apparent density and vice versa. In general, tested samples from the belly of the leather cuts were thinner, lighter and more uneven in structure. This finding is similar to the study conducted by Tomljenović *et al*. [9].

Table 3: Results for identification index (SLP 13)

Thickness reading	**A(mm)**	**B(mm)**	**C(mm)**	**D(mm)**	**Mean(mm)**
Under pressure of 20g	0.94	0.95	0.92	0.91	0.93
Under pressure of 100g	0.9	0.88	0.9	0.88	0.89

Indentation index = 0.05mm

Table 3 shows the results of the indentation index. The higher the thickness value, the higher the indentation index. Leather samples with the highest thickness test have the highest indentation index [10].

Table 4: Result of the absorption of water (SLP 19)

Time (Minutes/Hour)	**15 min**	**30 min**	**1hr**	**2hr**	**4hr**	**8hr**	**24hr**
Kubelka Reading (ml)	2.3	2.3	2.5	2.6	2.8	3	3.5

$Q = 100 \times \frac{V}{M} = 341.5ml$

$Q = 100 \times \frac{V}{V} = 22.24ml$

Table 4 shows the result of the water absorption test. The results shows that there is rapid up-take of the water in the first 30 minutes, and this shows that the leather can absorb some certain level of water and still remain dry touch. The Q is the water absorption in ml of water per 100 ml of leather and P is the water absorption in ml of water per 100 ml of leather.

Table 5: Result of resistance to compression (SLP 12)

Thickness reading	**A(mm)**	**B(mm)**	**C(mm)**	**D(mm)**	**Mean(mm)**
Under pressure of 20g	0.94	0.95	0.92	0.91	0.93
Under pressure of 200g	0.88	0.85	0.88	0.87	0.87

R= Increase of load per unit area ÷ Decrease in thickness per unit area

$R = (200 \times \frac{4}{3.142} \times do) \div (100 \times (do - d1))$

R= 3.94mm

Table 5 shows the result of resistance to compression; which indicates the resistance the leather will have towards compression. The higher the indentation index, the higher the compression resistance.

Table 6: Result of shrinkage temperature (Ts) (IUP 16)

***Erythrophleum suaveolens* tannage**	**Shrinkage temperature (^oC)**
30% *Erythrophleum suaveolens* extract	71
35% *Erythrophleum suaveolens* extract	75
40% *Erythrophleum suaveolens* extract	75

Table 6 shows the shrinkage temperature (Ts), 30% extract of *Erythrophleum suaveolens* had a shrinkage temperature of 71^{o}C, while 35% and 40% extract was found to be 75 ^{o}C respectively.

Table 7: Phenol content in *Erythrophleum suaveolens*

Concentration (ppm)	Absorption(nm)
0.5	0.02
1.0	0.042
1.5	0.063
2.0	0.083

Absorbance of the unknown sample= 0.029

Total phenol concentration = 3.75%

Table 7 shows the phenol content present in *Erythrophleum guaveolen.* The phenol content indicates the presence of polyphenolic tan which helps in tanning.

Table 8: Results of Chemical analysis

Chemical analysis	Result
Total tannin	29.00
Total soluble	53.00
Non-tan	12.00
Moisture content	3.17
Total solid	96.83
Total ash	3.00

Percentage (%) tannins = % total soluble - % non-tan

Table 8 shows the tannin analysis, the percentage non-tans is derived by subtracting the percentage tannins from the percentage soluble matter.

Conclusion

Leather tanned with *Erythrophleum suaveolens* extract has been found to produce leather with better hydrothermal stability, thereby good for shoe

upper leather. Results from the physical analysis of the leather tanned with *Erythrophleum suaveolens* shows some properties and characteristics of Bagaruwa tanned leather.

Therefore, *Erythrophleum suaveolens* (Gwaska) can serve as a viable alternative in the leather industry. The findings underscore the sustainability and economic benefits of utilizing this natural resource for tanning purposes.

Acknowledgement: The authors greatly acknowledge every support from the Directorate of Polymer Technology and also Directorate of Research and Development, NILEST, Zaria.

References

[1] Selvarangan,T and Nayudamma, (1965). Chrome and vegetable tanning combination, Leather science 12(2): pg 249-255.

[2] Sarka, K.T (2005). Theory and practice of leather manufacture. In: Central leather research institute, Neelachal Abasan, Michigan, Pg 41-52.

[3] Bate Smith, E.C Swein T (1962). Flavonoids Bompounds in comparative biochemistry, Academic press, New York, pg 755-809Redbourn, United Kingdom, pg 240-250

[4] Sundra Rao V.S (1997). Manufacture of tanning extract in vegetable tanning material in India, 2nd Edition, Accademic press, pg 102

[5] Muralidharan D (1997). Spectrophotometric analysis of catechins and condense tannins using condense tannins using Ehrlich's reagent. Journal for the Leather technologist and chemist, pg 81,238

[6] Sharphouse, J.H (1983). Leather technician's Handbook, London, Pg 1-25

[7] Society of Leather Technologist and Chemist (1996). Official methods of analysis, 3rd Edition, SLTC Redbourn, United Kingdom, pg 150

[8] Pradeep, S., Sundaramoorthy, S., Sathish, Murali., Jayakumar, G.C., Rathinam, A., Madhan, B., Saravanan, P., & Rao, J.R. (2021). Chromium-free and waterless vegetable-aluminium tanning system for sustainable leather manufacture. *Chemical Engineering Journal Advances*, 7, 100108.

[9] Tomljenović, A., Akalović, Jadranka., Živičnjak, J., Andrijana, B. (2020). Influence of Sampling Location on Physical and Mechanical Properties of Full Grain Leather. *K&O*, 69 (2), 4-11. DOI: 10.34187/ko.69.2.1.

[10] Obiero, D.K., Ombui, J.N, Onyuka, A.S., & Sasia, A.A. (2020). Evaluation of the physical properties of leathers tanned with Plectranthus barbatus Andrews extracts. *African Journal of Biotechnology*, 19(3), 137-141. DOI: 10.5897/AJB2016.15406