World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Research Article)

Check for updates

Assessment of tannins extracts of *Acacia nilotica ssp Adansonii* pods and *Azadirachta indica* bark on leather processing

Mahdi Haroun *

Department of Industries, College of Applied and Industrial Sciences, University of Bahri P.O. Box13104-Khartoum, Sudan.

World Journal of Advanced Research and Reviews, 2022, 16(03), 187–192

Publication history: Received on 13 October 2022; revised on 29 November 2022; accepted on 01 December 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.16.3.1218

Abstract

Despite the fact, world leather industries are built on chromium tannage system, there is a growing interest of metal free tannages (chrome). This is primarily owing to the rising demand for chromium free tanning in the leather industry. The goal of this research paper was to evaluate the influences of vegetable tannins materials on the retannage of leather, by using *Acacia nilotica* ssp *Adansonia* pods (hydrolysable tannins) and *Azadirachta indica* bark (condensed tannins), and estimating the absorption and physico-mechanical properties of leather. The results indicated that this system of free chromium tannage give us products with tear strength of 80 N/mm, tensile strength of 55.5 N/mm^2, and elongation at break (75.3%). A vegetable re-tanning produced strong leather with durable properties. On other hand, vegetable pre-tanning (condensed tannins) probably stiffens the fiber network of collagen molecules, blocking the bigger molecules from diffusing into the fibers of collagen.

Keywords: Vegetable; Pretannage; Retannage; Mechanical property; Physical property

1. Introduction

Leather is long course of production comprise chemical and mechanical process. 85% of world tanning process is by using chrome tanning system. Most efforts were focused in finding appropriate alternatives for chrome tanning taken in consideration pollution reduction due to discharge of tannery effluents, which contain a reasonable chromium content in the waste water and in the solid wastes. In certain cases, such attempts were designed at cost-reduction [1]. However, the method has substantial benefits as its versatility & high thermal stability of end products gained, very important characteristics for shoe upper leather [2].

With regard to Sudan, any effort to lessen the practice of chromium has several benefits. Firstly, the chromium ores in Sudan have not yet been confirmed as being commercially exploitable so that the chrome requirements of tanneries are met through imports. The effluents from some of the Sudanese tanneries contain high amounts of chrome exceeding the standards set for discharges into streams/sewers system [3, 4]. The accessibility of imported chromium is also unbalanced and costly.

Recent studies commenced efforts on new tanning system to substitute the chromium tanning system. The system of wet-white tanning look as anew option to metal tanning system, mainly for kids' shoes, furniture, and automotive leather. This system is principally built on glutaraldehyde and a syntan pre-tannage [5,6]. At the end of pretanning, the system is tracked by thickness adjustment, retanning using polyphenols (*Acacia nilotica* ssp *Adansonia* pods and *Azadirachta indica* bark as vegetable tanning materials and other organic tannage, dyeing and finally fat-liquoring.

* Corresponding author: Mahdi Haroun

Department of Industries, College of Applied and Industrial Sciences, University of Bahri P.O. Box13104-Khartoum, Sudan.

Utilization of polyphenolic materials for retanning is considered normal practice to get firm properties [7,8]. In this research work, the influences of *Acacia nilotica* ssp *Adansonia* and *Azadirachta indica* tannins as retanning materials for the making wet-white leather was evaluated.

2. Material and methods

Tanning techniques was done in laboratory drums with following specification (200 mm wide and 400 mm diameter (height) (Table 1). Pickled pelt (skin or hides) was used as raw material with appropriate amount of chemical estimated on pickled pelt weight %. Shaving machine was used to prepare pickled pelts to a thickness of 1.4 mm. From the same area near the back-bone, small batches of leather were used throughout all experiments.

2.1. Up take of Vegetable Extracts

The penetration of the vegetable tannins materials the pickled pelts was considered for *Acacia nilotica* ssp *Adansonia* pods (hydrolysable tannins) and *Azadirachta indica* bark (condensed tannins). In each trial of experiment, approximately 200 grams of shaved pieces cleaned with 400% w/w of (H_2O) at 30ºC for 15 min, 2 % & 1 % w/w sodium formate and sodium bicarbonate was used respectively for neutralization of the pH to 5.8 in 300% of water at 30ºC and during 30 min. Then washing process was conducted with 400% w/w of water at 40 ºC for 15 min, after that 15% w/w of the tannins from *Acacia nilotica* ssp *Adansonia* pods in one case and *Azadirachta indica* bark in the other in 300% w/w of water at 35 ºC. Samples from the retannage process were taken at different interval of 3, 20, 35, 60 & 120 minutes, and assessed to determine the optical density (absorbance) in a spectrophotometer UV-VIS according the specific method analysis [9] and Physical and Mechanical Properties [1].

2.2. Assessment of Vegetable Extract on leather

The influence of vegetable tannins on the physico-mechanical properties of leather was investigated for *Acacia nilotica* ssp *Adansonia* pods (hydrolysable tannins) and *Azadirachta indica* bark (condensed tannins): in each experimental trails, approximately 150g samples from shaved, were give in to subsequent process as shown in the Table 1.

2.3. Physical and Mechanical Properties

The samples for physico-mechanical analysis were reserved in a standard atmospheric condition forty-eight hours prior their usage in a machine specified for physico-mechanical testing (Relative humidity 65% ± 2% Temperature 20 ± 2° C) [1].

Table 1 Preparation of white leather for physical testing

Chemical materials	Percentage, %	Temperature, Cº	Time, minutes	Control
Water	50	30	20	Be=7
Sodium Chloride	6			
Adding of pelts				
			15	pH 2.5
Glutaraldehyde	3		60	
	3		120	
Sodium Format	1.5	40	60	pH 4.0
Sodium Bicarbonate	1.0			
Synthetic tannin	10		120	
Overnight run 5 minutes each two hours				
			40	pH 4.3
Drain				
Washing	100	30	20	
Drain, squeeze, & shave				

2.3.1. Measurement of Tensile Strength and Percent Elongation

A dumbbell shape is a design required for the sample which is prepared for tensile strength testing which is cut from the backbone parallel perpendicular. Sample dimension is done by using vernier caliper's & thickness gauge. The flesh and grain side are kept for measurement of the width in millimeters [10]. Tensile machine (Instron 1026, Instron, UK) with jaws established 50 mm away was used for the measurement of the strength properties. Running of machine will continue until the point of brokenness and highest load were reached. Then tensile strength load is calculated in Newtons using the following formula [10].

$$\text{Tensile strength } = \frac{\text{Maximum breaking load}}{\text{Cross sectional area}}$$

2.3.2. Percent Elongation at Break

The Percent of Elongation at Break was measured according to the society of leather technologist and chemists [10].

$$\text{Elongation, \% } = \frac{\text{Final free length} - \text{Initial free length}}{\text{Initial free length}}$$

Table 2 Post-tanning of leather

Process	Materials	Quantity (%)	Temperature, °C	Time (min)
Washing	Water	400	30	15
Drain				
	Water	150		
Neutralization	Sodium Bicarbonate	1.0	30	30
	Sodium Format	2.0		
pH (5.5) & drain				
Washing	Water	400	35	15
		Drain		
Retanning	water	300	35	120
	Vegetable extract	15		
Add				
Dyeing	Water	60	30	55
	Dyestuff	3		
Fat liquoring		5	55	60
Add				
Fixation	Formic acid	1.5	55	35
pH (5.5) & drain				
Washing	Water	400	30	15
Squeeze, Dry, & stacked				

3. Results and discussion

3.1. Vegetable Extract Penetration

Tanning effect principally depends on the thermodynamic stability of the cross-linking bonds & degree of cross-linking between the collagen molecules [11]. Hides and skin of animal commonly have a considerable size dimension (thickness); hence, diffusion of tannins materials (penetration) is likewise vital for describing the course of interaction. Only complete penetration and uniform distribution of tanning materials along the hide's cross-section will lead to a satisfactory tanning effect.

Shaved retanning samples of tannin extract removed for analysis at 5, 15, 25, 50 and 100 minutes of process time for evaluating the absorbance. The results are shown in Figures 1 and 2 respectively.

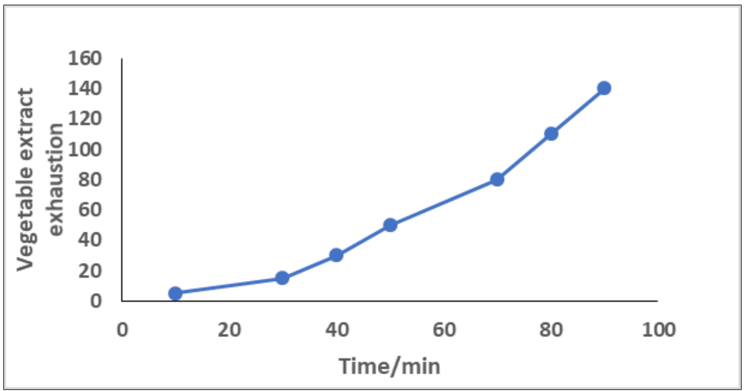

Figure 1 Absorption of *Acacia nilotica* ssp *adansonii* extract by leather

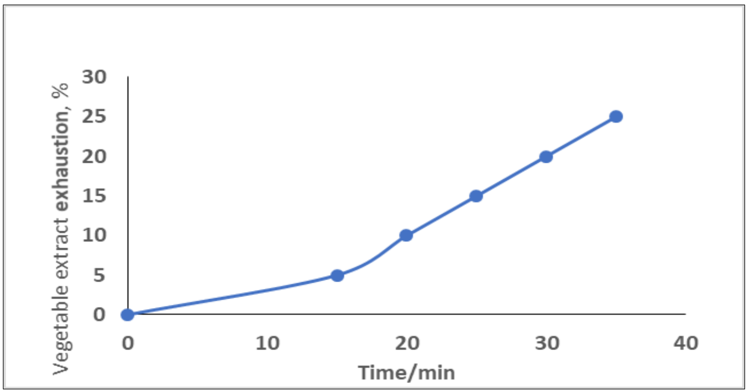

Figure 2 Absorption of *Azadirachta indica* extract by leather

Both figures shows that the absorption or the uptake of vegetable tannins was high and fast in the *Acacia nilotica* ssp *adansonia* pods compared to that of *Azadirachta indica* bark, this indicates that hydrolysable tannins of *Acacia nilotica* ssp *adansonia pods* has a better reactivity and absorbability due to small particle size compared to condensed tannins of *Azadirachta indica bark*. Therefore, *Azadirachta indica* condensed tannins it seems that it needs more time for complete absorption by the leather sample.

3.2. Vegetable extract Effect on Physical and Mechanical Properties

After completion of the retanning process the samples of leather was subjected to the physico-mechanical process to assess the properties of leather. *Acacia nilotica* ssp *Adansonia* retanned samples are tighter in grains, filled, & soft when in comparison with *Azadirachta indica* bark retanned leathers; these retanned leathers, have the ability to receive finished operation at higher temperature having better physico-mechanical characteristics, and penetrability at higher temperatures to yield dissimilar forms of retanned leathers proposed for various uses (Table 3) [11-16]. Alternatively, *Acacia nilotica* ssp *adansonia* used as pretannage agent and *Azadirachta indica* as retanned similarly produced leathers with better penetrability (as sign by the improved rate of permeability and intake of water (Table 3).

On the other hand, the tear strength of *Acacia nilotica* ssp *adansonii* vegetable retanning showed higher values compared with *Azadirachta indica* bark vegetable retanning. This is owing to the separation criteria of fibres bundles in the case of *Acacia niloticassp Adansonia* retanned leather, while retanned leather of *Azadirachta indica* displays stiffen bundles of fibers. Finally, *Acacia nilotica* ssp *Adansonia* retanned leather would show higher softness coupled with a lower strength (Figure 1) whereas, *Azadirachta indica* tanned leather would display a low softness with a high tear strength, in same time *Azadirachta indica* tanned leather exhibit higher elongation property (Table 3).

Table 3 Physical and mechanical properties of *Acacia nilotica* ssp *Adansonia* and *Azadirachta indica* tanned skin

Properties	***Acacia nilotica* ssp *Adansonia***	***Azadirachta indica***
Tear strength, %	80	30
Softness, mm	3.5	1.5
Water vapour permeability mg/cm^2 /h	7	3
Water uptake during water vapour permeability mg/cm^2 /h	170	120

Tensile strength and percentage elongation of the *Acacia nilotica* ssp *adansonii* pods (vegetable tannins) *Azadirachta indica* bark are given in Table 4. Tensile strength increased pointedly when using vegetable tannins as retanning agent. A rise in the physico-mechanical could be understood by repetition of cross links of covalent bond designed in the time of tanning course. However, at a higher concentration of vegetable retanning a decline in the tensile strength was observed, might be owing to the raised toughness (revealed by the declining of elongation) consequences in fiber stiffness; accordingly, its disruptions more easily at a decreased load. Skin collagen and vegetable pre-tanning materials its bound volume measurements offer clarification of the amplified physico-mechanical of the pre-tanning of vegetable.

Table 4 Physico-mechanical properties of combination vegetable tanning

Properties	***Acacia nilotica* ssp *Adansonia***	***Azadirachta indica***
Tensile Strength (Mpa)	55±5	25±5
Elongation at break, %	75±3	35±4

The current research work hence shows that vegetable combination tanning via home-grown *Acacia nilotica* ssp *Adansonia* pods (Hydrolysable tannin) and *Azadirachta indica* bark (Condensed tannin) could be simply adopted in Sudanese tanneries and those in the subregion. Their practice will decrease introductions of chromium and will reduce the consequent contamination. Estimated cost in this research work might similarly display substantial benefits for foreign handlers of *Acacia nilotica* ssp *Adansonia* pods who might not have contact to native *Azadirachta indica* tanning agent.

4. Conclusion

The potential of vegetable tanning materials in the Sudanese leather industry was investigated. The system of adding of the tanning agents was revealed to be vital with the greatest results from samples tanned first with the hydrolysable tannins (*Acacia nilotica* ssp *Adansonia)* then re-tanned with Condensed tannins *(Azadirachta indica* bark). On other hand, tanning first with *Azadirachta indica* bark does not expand the tanned leather strength properties since *Azadirachta indica* pre-tanning stiffens the fiber network of collagen, stopping penetration of the high molecular weight *Acacia Nilotic a*ssp *Adansonia* tannins particles from diffusing into collagen fibres. Another possibility is that the free amino acid side chains of collagens are exhausted on pre-tanning with *Azadirachta indica*, reducing the number of collagens–vegetable tannin cross-links when vegetable tannins are introduced. In conclusion, we have presented evidence for the possible chemical modifications of collagen brought about by vegetable tanning combination. This will further add to our understanding of the tanning of leather that might confirm the mechanism of vegetable tanning as postulated by Das Gupta [17].

Compliance with ethical standards

Acknowledgments

The authors wish like to express their deep appreciation to the University of Bahri, Khartoum, Sudan and the National Center for Research for their continuous support of this research.

Disclosure of conflict of interest

Authors have declared that no conflict of interests exists.

References

[1] Adewoye, R.O. and Bangaruswamy, S. *Acacia nilotica*(bagaruwa)-chromium combination tannage–a boon to the leather industry. J. Soc. Leath. Tech. Ch., 2000; 73:141-143.

[2] Tegtmeyer, D., Kleban, M., Chromium and leather research – A balanced view of scientific facts and figures, IULTCS, IUR-1 Aug, pp. 1-10; 2013.

[3] Aloy, M., Folachier, A., and Vulliermet, B. Tannery and Pollution. 1st ed. Centre Technique Du Cuir, Lyon, France, 100p. 1976.

[4] Lawal, F.A. and Singh, K. Analytical studies of waste water effluents on some tanneries of Kano and Sokoto States for possible environmental pollution. Bull. Chem. Soc. Nigeria. 1981; 6:68-75.

[5] Sreeram, K.J., Ramasami, T., Resour Conserv Recycl, 2003, 38:185-212, https://doi. org/10.1016/S0921-3449(02)00151-9.

[6] Di, Y., Heat, R.J., Long, A., Hartnung, K., J Soc Leath Tech Ch, 2006; 90: 93-101.

[7] Zhongbing, L., Xuepin, L., Bi, S., J Soc Leath Tech Ch, 2003; 87: 173-178.

[8] Pu., S., Wang, Y., He, Q., Liao, X., Zhang, W., Shi, B., Int J Quantum Chem, 2012; 112: 2832- 2839, https://doi.org/10.1002/qua.23300. 2839, https://doi.org/10.1002/qua.23300.

[9] Kanth, S., Kannan, P., Usharani, N., Jayakumar, G., Deepa, S., Chandrasekaran, B., J Am Leather Chem As, 2010; 105, 1: 16-24.

[10] Society of Leather Technologists and Chemists, (SLTC). Official Methods of Analysis. 3rd ed. SLTC. Redbourn, UK, 250p. 1996.

[11] Bienkiewicz, K. Physical Chemistry of Leather Making. Robert E. Krieger Publishing Company, Melbourne, FL, USA, 541p. 1983.

[12] Thomas, A.W. and Foster, S.B. Basic principles for tanning leather with chromium sulphate. Am. Chem. Soc., 1926; 6(3): 480-489.

[13] Burton, D., Danby, J.P., and Sykes, R.L. Hydrothermal stability of combination tannage. J. Soc. Leath. Tech. Ch. 1953; 37:229-237.

[14] Gustavson, K.H. The Chemistry of Tanning Processes. 2nd ed. Academic Press, New York, NY., 150p. 1956.

[15] Selvarangan, T. and Nayudamma, A. Chrome and vegetable tanning combination Leather Sci., 1965; 12(2): 249-255.

[16] Metz, B., Kersten, G.F.A., Hoogerhout, P., Brugghe, H.F., Timmermans, H.A.M., de Jong, A., Meiring, H., ten Hove, J., Henninks, W.E., Crommelin, D.J.A., and Jiskoot, W. Factors affecting the reaction of Amino groups with Formaldehyde. J. Biol. Chem., 2004;279 (8): 6235-6243.

[17] DasGupta, S. New postualion for Vegetable Aluminum combination tanning. J. Soc. Leath. Tech. Ch., 1977; (3):91-97