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Research Article

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Utilization of Plant Extracts in Semi-chrome Tanning Leather

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Abstract This investigation aims to decrease chromium usage in leather tanning. Therefore, guava bark extract (GBE) were used as a vegetable tanning material to replace chromium salts (CS) and thus decreasing their environmental impact. Fifteen of Barki sheep pelts were used in this work, which divided into 5 groups. Each group contains 3 pelts, which tanned with one of five GBE/CS ratios; 40/0, 30/2.5, 20/5, 10/7.5 and 0/10, respectively. All tanned leathers were tested physically and chemically to determine their quality. The obtained results showed that all tanned leathers were resisted to shrinkage temperature above 70 °C. Also, the tensile strength values were greater than 200 (Kg/cm^2) for all tannedgroups.

Keywords extraction, leather tanning, shrinkage temperature, tannins

Introduction

The leather industry in Egypt has been considered one of the most important industrial sectors in the Egyptian economy, representing about 5% of the total industrial production of the country [1].

Chemically, leather tanning is essentially the reaction between collagen fibers in the skins or hides with tanning materials [2]. While, mineral and vegetable tanning are the most common methods used worldwide [3], semi-chrome tanning is from combined tanning method, which done by tanned pelts with vegetable tanned material and then re-tanned with chromium salts [4].

In Egypt, more than 85% of tanneries are using chromium in tanning process, because of its fast processing, low cost, light color and high stability. In chromium tanning process, 20–40% of applied chromium is usually disposed and discharged directly into sewerage system without treatment [5]. Therefore, the wastewater treatment is one of the major emerging environmental problems in tanning industry [6]. Chrome tanning effluent contains high concentrations of chromium salts, which is toxic, mutagenic and teratogenic [7], as well as, affects severely on the mitotic processes and seed germination if reaches to crops from ground water [8]. Due to the above mentioned disadvantages of chrome tanning, the tanners are now encouraged for using alternative eco-friendly methods of tanning such as vegetable tanning materials [6].

The bark of guava tree (*Psidium guajava L*) contains considerable amounts of tannins and hence is used for tanning and dyeing purposes [9]. In Egypt, guava trees are widely planted especially in Beheira, El-Sharkia, around Alexandria governorates and newly reclaimed lands [10]. According to the recent and the latest statistic of Egyptian Ministry of Agriculture 2014, the total cultivated area of guava in Egypt reached about (40831) feddans [11].

Therefore, this study aims to evaluate guava bark extract (GBE) as a tanning agent in semi-chrome leather tanning, in order to decrease chromium salts (CS) in leather tanning, and thus its harmful environmental impact.

Material and Methods

Plant collection and prepare the aqueous extract:

Figure 1: Guava bark (Psidium guajava L).

Guava bark (*Psidium guajava*) was brought from Al-Maamoura agricultural area in Alexandria Governorate, North of Egypt (Fig. 1).

After collection, plant material was packed in perforated bags to avoid the effect of heat and humidity. Packs were transported directly to the Faculty of Agriculture, Al-Azhar University, Cairo. Transported plant material was dried for five days in an open and shaded place without using any thermal drying method. Extraction was made according to Nasr *et al* [12], using hot water (70 °C) for 60 min without chemical addition.

Tannins identification:

Tannins identification included different analyses; ferric chloride test, lead acetate test, pH and total phenols and non-tannins.

Ferric chloride test:

Two milliliters from GBE was diluted with distilled water in separate test tube and 2 to 3 drops of 5% ferric chloride ($FeCl_3$) solution was added. A green – black or blue coloration indicated the presence of tannin [13].

Lead acetate test:

To the test solution, a few drops of 10% lead acetate solution were added. Precipitate formation indicated the presence of tannin [14-15].

pH:

The pH of the extracts was determined in 10% GBE solution at the standard laboratory temperature (23 ± 1 °C) according to ASTM [16].

Total phenols and tannins

Total phenols and tannins content were determined by the Folin–Ciocalteu method using a spectrophotometer. The total phenols were estimated as tannic acid equivalent [17].

Leather tanning:

Fifteen of male Barki sheep skins were collected from slaughterhouse in Alexandria regions. The skins were cured by salting and then transported to El-Shafie tannery. All skins were common in beam house steps; starting from soaking to pickling step, thereafter the skins were divided randomly into five groups, three skins in each group, and tanned with GBE/CS ratio as presented in Table 1.

Table 1: Addition of tanning materials in different experimental groups

Group	Treatments	Tanning Material (%)*	
		GBE	CS
1	40% GBE/ 0% CS	40	0
2	30% GBE/ 2.5% CS	30	2.5
3	20% GBE/ 5% CS	20	5
4	10% GBE/ 7.5% CS	10	7.5
5	0% GBE/ 10% CS	0	10

*The percentage was calculated based on pelt's weight. GBE, Guava Bark Extract; CS, Chromium Salt.

Leather testing:

Qualitative and operational properties of obtained leathers were assessed according to indices of chemical analysis, physico-mechanical investigation of the finished leather. Thickness, tensile strength, elongation, shrinkage temperature, pH, ash and moisture were investigated according to standard procedures [16].

Result and Discussion

Tannins identification in guava bark

After extraction, GBE properties were determined and the obtained are results present in table (2). The positive results for both ferric chloride test and lead acetate test indicated the presence of tannins and hydrolysable tannins [14]. The ratio of total tannins and total phenols was 24% and 19% respectively, while pH value is 5.11ml mol/L. These results indicated to the suitability of GBE for using in leather tanning [9].

Table 2: Tannins identification in guava bark

Value	Parameter
Ferric chloride test	+ (Greenish blue color)
Lead acetate test	+ (Gelatinous brown color)
Total Tannin	24%
Total phenol	19 %
pH	5.11

Shrinkage temperature

Shrinkage temperature is the temperature at which the leather sample starts to shrink in water or other heating medium. Thus, it is one of the most important parameters in characterizing the thermal stability of leather. Table 3 shows the obtained shrinkage temperatures for each tanned leather group. The results clarified that there are a positive relation between chromium concentration and shrinkage temperature of tanned leathers. Moreover, tanned leathers with 20% of GBE or less were comparable in the shrinkage temperature values, while the corresponding values for the higher concentrations of GBE were less than 100 ^{o}C. The obtained results of this study were in agreement with that obtained by previous investigations [3-4, 18].

Table 3: Shrinkage temperature values for experimental tanned leather

Group	Treatments	Shrinkage temperature ^{o}C
1	40% GBE/ 0% CS	75.3
2	30% GBE/ 2.5% CS	87
3	20% GBE/ 5% CS	100.6
4	10% GBE/ 7.5% CS	102.6
5	0% GBE/ 10% CS	104

Leather testing:

Table (4) shows the physical and chemical properties of tanned leathers. The highest thickness values were observed with Treatment 30% GBE/ 2.5% CS, while other leathers were insignificant differed. About other physical properties, Tensile strength gave different results between treatments. It was the highest value of tensile strength when treatment 10% GBE/ 7.5% CS, while it was the lowest value when treatment 30% GBE/ 2.5% CS.

With respect to elongation property, the values were increased when treatment 10% GBE/ 7.5% CS and decreased by using only chrome tanner without any extracts. Generally, all tanned leather groups were comparable in values, the tanned leather with was surpass in both thickness, tensile strength and elongation values. Thence, it considered the highest quality. The obtained values of physical properties were in agreement with those obtained by **[12, 19-22]**, while the obtained values of chemical properties were comparable with those obtained by [4, 12, 23].

Table 4: Physical and chemical properties for experimental tanned leathers

Group	Treatment	Physical properties			Chemical properties		
		Tensile strength (Kg/cm^2)	Thickness (mm)	Elongation (%)	Moisture (%)	Ash (%)	pH
1	40% GBE/ 0% CS	274.67	1.37	64.81	15.12	2.10	3,9
2	30% GBE/ 2.5% CS	212.45	1.67	74.6	16.23	3.57	4.2
3	20% GBE/ 5% CS	270.98	1.12	60.55	15.99	3.73	3.9
4	10% GBE/ 7.5% CS	299.82	1.17	75.56	14.31	4.09	3.8
5	0% GBE/ 10% CS	261.23	1.38	39.74	14.94	7.10	4.2

Conclusion

It could be concluded that guava bark extracts with hot water (70 °C) for 60 min produces aqueous extract that can be used in leather tanning production as a re-tanning agents. Using guava bark extract with concentration 10% of pelts weight in semi-chrome tanning, decreases chromium addition with 25% and increases elongation and tensile strength values of tanned leathers. Thence, it improves the leather quality and decreases the environmental impact for chromium salts.

References

[1]. Afify, M., Arafa, A., and Maksoud, N. A. (2013). Evaluation of some health hazards among Egyptian leather tannery workers. J ApplSci Res [Internet], 9(4), 2959-64.

[2]. Vivre, K., Hannu, S., Allan, W. and Pekka, K. (2000). The Finish background report for EC documentation of best available techniques for tanning industry. www.vyh.fi/eng/orginfo/publica /electro/fe426/fe426.htm.

[3]. Anthony, D. (1998). New tannages for the new millennium. J. American Leather Chemists Asso., 93: 168-182.

[4]. Musa, A. E., and Gasmelseed, G. A. (2013).Eco-friendly vegetable combination tanning system for production of hair-on shoe upper leather. Journal of Forest Products &Indus, 2(1), 5-12.

[5]. Hafez, A. I. (2004). Techno-economic study of the two-stage/two-pass RO membrane system for chromium recovery. Part 4. In 1st International Conference on Green and Advanced Engineering Technology, Cairo, Egypt (pp. 195-204).

[6]. Sathiyamoorthy, M., Selvi, V., Mekonnen, D., and Habtamu, S. (2013). Preparation of eco-friendly leather by process modifications to make pollution free tanneries. Journal of Engineering, Computers & Applied Sciences (JEC&AS), 2(5), 17-22.

[7]. Bielicila, A., Bojanowiska, I and Wisniewsk, (2005). Two faces of chromium- pollutant and Bioelement. Polish Journal of Environmental Studies Vol. 14, No. 1, 5-10.

[8]. Mole, S. (1993). The systematic distribution of tannins in the leaves of angiosperms: a tool for ecological studies. Biochemical Systematics and Ecology, 21(8), 833- 846.

[9]. Pelegrini, P. B., Murad, A. M., Silva, L. P., dos Santos, R. C., Costa, F. T., Tagliari, P. D., ... and Franco, O. L. (2008). Identification of a novel storage glycine-rich peptide from guava (*Psidium guajava*) seeds with activity against Gram-negative bacteria. Peptides, *29*(8), 1271-1279.

[10]. Samson, F.A. (1980). Tropical fruit. Tropical Agriculture Series, pp. 214. Longman ISBN, London, New York (c.f. M.Sc. Zaghloll Ali, 1994, Alex.Univ. Egypt.

[11]. Singer, M. A. A. (2017). Physiological Studies on Flowering and Fruiting Of Guava Trees. Middle East J, 6(1), 143-151.

[12]. Nasr, A. I., Abdelsalam, M. M., &Azzam, A. H. (2013).Effect of tanning method and region on physical and chemical properties of barki sheep leather. Egyptian Journal of Sheep and Goat Sciences, 65(1242), 1-16.

[13]. Ciulci I (1994). Methodology for the analysis of vegetable drugs. Chemical Industries branch, Division of Industrial Operations. UNIDO, Romania. pp.82.

[14]. El Sissi, H. I., and El Sherbeiny, A. E. A. (1967). Local plants as potential sources of tannins in Egypt, part III. Qualitas Plantarumet Materiae Vegetabiles, 14(1-2), 28-36.

[15]. Singh, K. L., and Bag, G. (2013). Phytochemical analysis and determination of total phenolics content in water extracts of three species of Hedychium. Int J PharmTech Res, 5(4), 1516-21.

[16]. ASTM (2010).American Society for Testing and Materials.Books of standards.

[17]. FAO (2000). Quantification of tannins in tree foliage. FAO/IAEA Working Document,Vienna.

[18]. Duki, A., Antunes, A. P. M., Covington, A. D., and Guthrie-Stachan, J. (2013, May).The stability of metal-tanned and semi-metal tanned collagen.In XXXII Congress of IULTCS. Istanbul, Turkey: IULTCS.

[19]. Suresh, V., Kanthimathi, M., Thanikaivelan, P., Rao, J. R., and Nair, B. U. (2001).An improved product-process for cleaner chrome tanning in leather processing. Journal of Cleaner Production, 9(6), 483-491.

[20]. Thanikaivelan, P., Rao, J. R., Nair, B. U., and Ramasami, T. (2002).Zero discharge tanning: a shift from chemical to biocatalytic leather processing. Env.sci& techno., 36(19), 4187-4194.

[21]. Azzam, A.H. (2003). Application of some untraditional methods for skin preservation in some desert areas. J. Agric. Sci. Mansoura Univ., 28 (7): 5215-5223.

[22]. Nasr, A. I., Taha, M. G., Yosef, H. Y., and El-Shaer, M. A. (2017).The utilization of sodium lignosulphonate extracted from Egyptian rice straw in leather tanning process. *MajalahKulit, Karet, danPlastik*, *33*(2), 57-64.

[23]. Haron, M. A., Khirstova, P., Gasmelseed, G. A., and Covington, A. (2012).Potential of vegetable tanning materials and basic aluminum sulphate in Sudanese Leather Industry (Part II).Suranaree Journal of Science and Technology, 19(1), 31-41