Indonesian Journal of Chemistry and Environment
Vol. 5, No. 1, June 2022, pp. 9 ~ 16
e-ISSN: 2599-3186

Fatliquor Development from Hemp Oil to Produce High Quality Natural Finished Leather

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Article Info

Article history:

Received Jun 6th, 2022
Revised Jun 22th, 2022
Accepted Jul 11th, 2022

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ABSTRACT

Fatliquors are very important in the manufacture of leather. Leather treated with fatliquor become more flexible and softer by the separation of leather fibers in the wet state so that they do not stick too much during drying, also the physical properties, such as tensile strength, softness, tear strength and stability of the leather become influenced simultaneously. The step of fatliquoring is carried out during leather processing operation after tanning. Variety of fatliquors is synthesized so far from various vegetable oils. In this study, for the first time, fat-liquor, named as, "Hempfat" is synthesized from oil extracted from hemp seeds. As hemp oil consists of high amount of omega-6, omega-3 fatty acids possessing antioxidant activities, so accepted as beneficial to health for public, also possess high kinetic stability and increased protective effect during increase or decrease of temperature. On high temperatures, trans-fatty acids are not formed. So, the developed fatliquor, "Hempfat" and the leather developed from it were evaluated on physical and chemical grounds, both found to possess the excellent properties of a fatliquor as leather fatliquoring agent in making good quality finished natural leather.

Keyword: Hemp, Fatliquor, Leather

1. INTRODUCTION

Hemp belongs to the cannabis family (Cannabaceae), i.e., annabis sativa L. (The Biology of Cannabis sativa L., 2021). This plant is commonly known from its mind and mood relaxing activity, so it can be used as relaxing agent (Hodgson, 2012). The oil of Hemp seed's contains fatty acids which are required to maintain healthy blood vessels, tissues, and nerves (Borhade, 2013). Hemp plant is also reported as a suitable renewable energy resource (Poisa & Adamovics, 2010). Hemp oil is obtained from the seeds, when it pressed in cold, result in green color from dark to clear light liquids that having a grassy to sharp flavor. High quantity of omega-6 and omega-3 fatty acids among some minor compounds such as tocopherols, polyphenols and phytosterols, claimed to possess antioxidant activities due to these bioactive compounds. Therefore, those oil is accepted as health benefit commodity for public these days (Liang et al., 2015). When the fatliqour exposed with differential scanning calorimetry (DSC), it showed a power over high kinetic stability and increased protective effect during the increase or decrease of the temperature (Oomah et al., 2002). The formation analysis of trans-fatty acids during cooking indicated that high temperatures do not change the configuration of the fatty acids and there is no trans-fatty acids formed (Möllenken, 1998). The optimum ratio of Omega-3 to Omega-6 unsaturated fatty acids is found to be 1:3, which found to be perfect for absorption in human body as also suggested by the experts of the World Health

Organization. Hemp oil showed the acidity 1.13 to 1.23%, iodine number 152 to 154, linoleic 55%, oleic acid 16%, alpha-linolenic 15% and gamma-linolenic acid 2% (Sova et al., 2018).

Sulphated oil, such as fatliquors are very essential for the manufacture of leather. The step of fatliquoring is carried out during leather processing operation after tanning. Fatliquors make the emulsion in water and penetrate in the leather up to a certain extent. Leather treated with sulfated oil become more flexible, softer by the separation of leather fibers in the wet state so that they do not stick too much during drying and properties, such as tensile strength, softness, wet water permeability and stability of the leather become influenced simultaneously. Variety of fatliquors is synthesized so far with vegetable oils also (Pervez et al., 2015).

This article reported the synthesis of fatliquor from hemp oil. This fatliquor was named as "Hempfat" and the leather treated with this were evaluated based on its studies on physical and chemical grounds.

2. RESEARCH METHOD

2.1 Chemicals and Reagents

The chemicals used for synthesis/analysis of "Hempfat" were of analytical grade, BDH while the chemicals used for leather processing are of lab grade and purchased from a local chemical supplier.

2.2 Chemical investigation on Hemp Oil

Chemical investigation on hemp oil, provided by Head Office, PCSIR, Islamabad was carried out as per standard test methods based on Society of Leather Technologists and Chemists, as expressed in Table 1, where the results are tabulated.

The hemp oil, provided by Chairman, PCSIR, MoST, Pakistan was tested for chemical parameters, i. e., pH Value, Total Fat, Water Content, Saponification Value, Acid Value, Concentration, Iodine Value and Alkalinity as per standard test methods, The Society of Leather Technologists and Chemists, (SLTC 1996, 1996a, 1996b, 1996c, 1996d, 1996e and 1996f), to check the suitability to manufacture a good fatliquor from it. Results of its examination are expressed in Table 1.

The hemp oil found to be soluble in Ethyl Acetate, Acetone, Chloroform, and n-Hexane while insoluble in Methanol, Ethanol, and Water.

2.3 Synthesis of Fatliquor

The hemp oil, is synthesized as per old conventional method, i. e., 200 g is kept in a lead lined jacket where sulphation is carried out at the temperature ranging from 15-20 0C, followed by the addition of 25% H_2SO_4 (S.G 1.740) 98% gradually to the oils with constant stirring for two hours approximately to bring the oil in uniform and smooth form and is continued till QC check of one drop of reaction mixture makes milky emulsion in water. The sulfated product is allowed to stand overnight and then washed with salt solution and finally neutralized with 10% sodium sulphate solution (Commercial) until an emulsion in water becomes neutral to pH 6.5 to 7.0.

2.4 Chemical investigation on Fatliquor developed from Hemp Oil

Chemical investigation on fatliquor, "Hempfat" is carried out as per standard test methods based on Society of Leather Technologists and Chemists. The developed fatliquor, i.e., sulphated hemp oil is found to be soluble in methanol, ethanol, distilled water, tap water but insoluble in ethyl acetate, acetone, chloroform, and n-hexane

2.5 Application of Fatliquor, "Hempfat" on Wet Blue Leather

The synthesized fatliquor, applied in concentration of 6.0%, on two samples of wet blue leather, one is from goat skin and the other one is from sheep skin. Pictures of leather obtained after application on goat and sheep wet blue with the developed fatliquor are given in Table 3.

2.6 Chemical Investigation of the Processed Leather

Chemical study is carried out on the resultant finished natural samples of goat and sheep leather, on the Determination of pH of Aqueous Leather Extract (SLTC, 1996a), Hexavalent Chromium (SLTC, 2017), Fat Content (SLTC, 2018), Volatile Matter (SLTC, 2005 b) and Formaldehyde in Leather (IULTCS, 2018) according to standard test method, as expressed in Table 4.

2.7 Physical Investigation of the Processed Leather

Physical parameters, i. e., Tensile Strength & % Elongation at Break (IULTCS, 2011), Tear Strength (IULTCS, 2016), Bursting Strength (IULTCS, 2015a), Water Vapor Permeability (ASTM 2018) and Softness (IULTCS, 2015b) were carried out as per standard test methods; and the results are expressed in Table 5.

3. RESULTS AND ANALYSIS

3.1. Chemical Investigation on Hemp Oil

The hemp oil, provided by Head Office, PCSIR, Islamabad, is analyzed for some chemical parameters as per standard test methods, based on Society of Leather Technologists and Chemists, to check whether it is suitable to make a fatliquor or not, so the results, as expressed in Table 1, showed positive.

Table 1. Chemical investigation on Hemp Oil

S. No	Name of Tests.	Method Used	Results
01.	pH Value	SLC 308	5.42 pH
02.	Total Fat	SLC 319	90%
03.	Water Content	SLC 307	3.67%
04.	Saponification Value	SLC 303	187.5
05.	Acid Value	SLC 304	2.13
06	Concentration	Lab developed; based on SLC 307	96.33%
07.	Iodine Value	SLC 305	152
08.	Alkalinity	SLC 312	0.44

3.2. Synthesis of Fatliquor, "Hempfat"

The fatliquor, "Hempfat"is manufactured from hemp oil, as is shown in Figure 1.

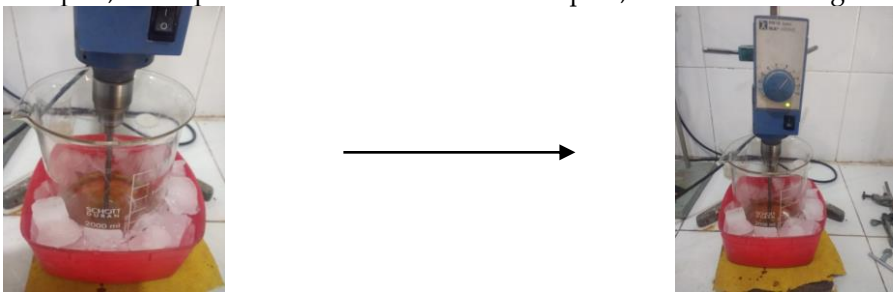

Figure 1. Sulfation of hemp oil with Sulphuric acid with continuous agitation

3.3. Chemical Investigation on Fatliquor, "Hempfat" from Hemp Oil

On chemical investigation of prepared fatliquor, as per standard test methods, expressed in Table 2. It showed the property of a good fatliquor, which would be used in making soft leather, as is represented by, the results of pH Value, Total Fat Content, Water Content, Concentration and Iodine no. (SLTC, 1996g, 1996a, 1996b, 2005a), as per standard methods.

Table 2. Chemical investigation on Fatliquor, "Hempfat"

S. No	Name of Tests.	Method Used	Results
01.	pH Value	SLC 120	6.17 pH
02.	Total Fat Content	SLC 319	70.1 %
03.	Water Content	SLC 307	29.9 %
04.	Concentration	Lab developed	72.26 %
65.	Iodine no.	SLC 305	99.6

3.4. Application of Fatliquor on Wet Blue Leather

Application of Fatliquor on two samples of Wet Blue Leather, one is goat skin and the other one is sheep skin. The process was carried out in 6.0% hemp fatliquor to result the fatliquored leather, as shown in Figure 2.

Figure 2. the Procedure of Leather Processing

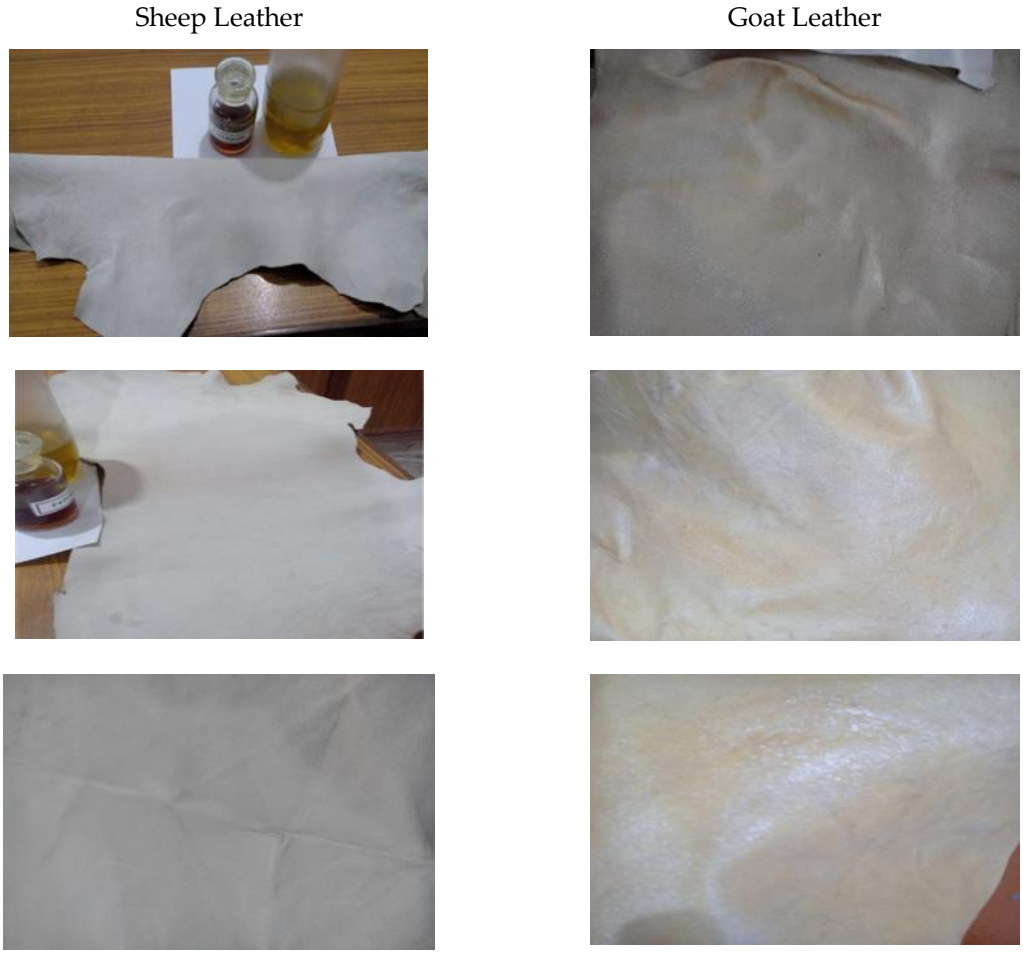

Figure 3. Natural Leather obtained after Application on Sheep and Goat Wet Blue

3.5. Chemical Investigation of the Leather Processed from Fatliquor

Chemical analysis of the processed leather proved a safe and non-hazardous fatliquor, as represented by its Chemical Investigation values, expressed in Table 4. All values as per standard method were following the limit of required value, indicating that the leather would be safe for consumer/workers.

Table 4. Chemical Investigation of the Processed Leather

S. No.	Test	Method	Results, Goat Leather	Results, Sheep Leather
1.	pH	SLC 13	4.3	4.4
2.	Hexavalent Chromium	SLTC, 2017	NA	NA
3.	Fat Content	SLTC, 2018	6.5%	7.0%
4.	Volatile Matter	SLTC, 2005 b	6.8%	6.9%
5.	Formaldehyde in Leather	*IULTCS, 2018*	NA	NA

3.6. Physical Investigation of the Processed Leather

Physical analysis of the two samples of fatliquored-goat and sheep leathers, resulted in a better propertied on its Physical Investigation values, as listed in Table 5. The Physical parameters, i.e., Tensile Strength & % Elongation at Break (IULTCS. 2011), Tear Strength (IULTCS. 2016), Bursting Strength (IULTCS. 2015a) and Softness (IULTCS. 2015b), provided the better level.

Tensile strength is the ability of a material to withstand a longitudinal pulling force, relates to strength and performance. Result of Tensile Strength is 22.74 N/mm2 and 12.29 N/mm2 for goat leather which are above the minimum value (12-20 N/mm2) and found more in goat than sheep leather. Also the percentage of elongation at break for Goat Leather is 64.85% while 46.96% for sheep shoe upper leather. Both values are above the minimum value (30-40%). Tear Strength is 53.12 N/mm and 34.02 N/mm for goat and sheep leather respectively, which could be explained further that these values are above the minimum requirement, i. e., 15-30 N/mm. Bursting Strength is found to be 341.94 N for goat and 229.88 N for sheep leather while distention is 13.20 mm for goat and 14.39 mm for sheep leather showed a good property indicating stability. Regarding Softness, both leather samples have excellent results, very far above from the minimum requirements.

Table 5. Physical Investigation of the Processed Leather

S. No.	Test	Method	Results, Goat Leather		Results, Sheep Leather	
1.	Tensile Strength ($N/mm^{2)}$	IUP 6, ISO 3376	22.74		12.29	
2.	% Elongation at Break (%)		64.85		46.96	
3.	Tear Strength (N/mm)	IUP-8, ISO 3377-2	53.12		34.02	
4.	Bursting Strength	IUP—36, ISO 3379	**Force**	**Distention**	**Force**	**Distention**
			341.94 N	13.20 mm	229.88 N	14.39 mm
5.	Softness, (20 mm ring) (mm)	ISO 17235	6.2		6.5	

4. CONCLUSION

Regarding the results of the developed fatliquor, "Hempfat", it is claimed that for the first time, fat-liquor is synthesized from the oil extracted from hemp seeds, which possesses the excellent properties of a fatliquor as leather fatliquoring agent in making good quality finished natural leather carrying better properties of tensile strength, tear strength, stability and softness of the leather.

ACKNOWLEDGEMENTS

We are thankful to the Mr. Barkat Ali Solangi, Principal Scientific Officer, Mr. Asad Raja, Research Technical Assistant, Leather Technology Division of PCSIR, Leather Research Centre, Karachi for their technical support and co-ordination in this research work

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