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THE INFLUENCE OF FATLIQOURING PROCESS ON PROTECTIVE CHARACTERISTICS OF LEATHER GLOVES

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Abstract: *Appropriate protective gloves are essential for industry workers to avoid hands and wrists injuries. Leather is a common material used by professionals for technical gloves. Mechanical resistance, protection against water and high temperature has to be fulfilled by leather that is intended for using in protective gloves. In this study recipes using various fatliquoring agents with different properties such as lesitin based, lanolin based, polymeric based and water proofing fat liquor were applied to produce technical glove leather and effect of each fatliquoring product on protective performance of leathers were analyzed in terms of physical and mechanical properties including tensile (ISO 3376), stitch tear (ISO 23910), tear resistance (ISO 3377-2), static (ISO 2417) and dynamicwater absorption (ISO 5403-1) and thermal stability such as dry heat (ISO 17227) and heat stability (ISO 11645). For this purpose, chromium tanned split calf leathers were used and retanning of protective leather gloves were performed by using tara and phosphonium combination. Performance testing results obtained from four different retanning processes was compared according to the type of fatliquoring material used in the production. Post-tanning with different types of fatliquoring products have significant effect on the protective performance properties of leather gloves, in terms of mechanical and thermal properties.*

Key words: *safety equipment, protective glove, leather, faliquoring process*

1. INTRODUCTION

Hands and wrists injuries are one of the most common work associated injuries experienced by heavy industry workers. Hand protection by appropriate protective gloves is essential and workers at risk are promoted to wear these gloves to avoid such injuries. Although many fine synthetic materials have come on the market, and a number of studies regarding different types of protective gloves (synthetics, fabrics, other natural fibres etc.) [1, 2] were carried out, leather is still a common material chosen by professionals. Limited published information is available about the properties and effect of production processes on protective characteristics of leather [3-5] and the literature provides no information about the influence of fatliquoring process on leathers as a protective clothing material.

Depending on their application area, several important requirements such as mechanical resistance, protection against water and exposure to heat has to be fulfilled by leather that is intended for using in protective gloves. In this study various fatliquoring agents were applied for glove leather processing, considering the importance of the choice of the fatliquoring chemicals that affects the properties of the final leather. The effects of lesitin, lanolin, polymeric based and water proofing fatliquoring processes on protective characteristics of glove leathers were investigated by determination of strength characteristics, water absorption and thermal resistance properties.

2. MATERIALS AND METHODS

Chromium tanned split calf leathers were used for leather processing trials and retanning of protective leather gloves were performed by using tara and phosphonium combination, which provided optimum protective properties as reported in previous study [4]. To evaluate the influence of fatliquoring process on protective properties, production process was differentiated in post-tanning operations by utilizing various fatliquoring products such as lesitin based, lanolin based, polymeric based and water proofing. Conventional formulation using phosphoric ester based fat liquor was applied throughout the post-tanning processes for the production of protective leather gloves as control trial. Recipe for fatliquoring processes was given in Table 1.

Table 1. *The fatliquoring process of protective leather gloves*

Re-wetting	**%**	**Chemicals**	**°C**	**pH**	**Time**
	200	water	25		
	0.3	HCOOH			
	0.4	nonionic tenside		3-3.5	30’
Washing	200	water	35		10 x 2
Retannage					
	100	water			
	1	synthetic fatliqour			15’
	3	phosphonium			120’
	x	sodium formiate		4	
	5	phenolic replacement syntan			30’
Neutralization	2	neutral syntan		4.5-5	30’
	x	sodium formiate			3*10’
	x	sodium bicarbonate		5.5-6	45
		Drain and washing			
Retannage	100	water	35		
	2	phenolic replacement syntan			20’
	5	tara			180’
Fatliqouring	3	phosphoric ester-based oil substance			
	2	alkyl phosphates with neutral oils			60
	2	**x***			
	x	HCOOH		3.8-4	

Washing	200	water	35	10 x 2

x*; lecithin with emulsifiers; lanolin based natural fatliqour; polymeric fatliquor based on acrylic acid; Waterproofing fatliquor ing agent

Sampling and conditioning of the finished leathers were carried out according to TS EN ISO 2418 (2006) and TS EN ISO 2419 (2006) respectively [6, 7] The effect of aformentioned fatliqouring agents on thermal properties was analyzed by dry heat resistance (ISO 17227) at 200 °C for 15 min, heat stability (ISO 11645) contact at 300 °C for 1 min. Other performance properties such as tensile strength (ISO 3376), stitch tear and tear resistance (ISO 3377-2) [8] were investigated with reference to standard methods respectively. The static and dynamic water absorption behavior of the protective leather gloves was tested according to TS 4123 EN ISO 2417 and TS EN ISO 5403-1 standards respectively [9, 10]. The performance test results obtained from different fatliquoring products were comparatively evaluated with the fatliquoring products given in Table 2. The assays were performed in duplicates and results were given in mean values.

3. RESULTS AND DISCUSSION

3.1 Mechanical analysis

The mechanical properties of glove leather samples fatliquored with different fatliquoring products and comparative UNIDO standard values are reported in Table 2. The glove leather samples fatliquored with different kind of fatliqours provided satisfactory results in terms of tensile strength/tear load/stitch tear values compared to UNIDO requirements except tensile value of the leather treated with polymeric fatliqour.

Table 2: *Mechanical properties of glove leather samples*

	Thickness (mm)	**Tensile**	**Elongation at break %**	**Tear load (N/mm)**	**Stitch tear / Thickness (mm)**
Conventional fatliquoring (control)	1.1	14.93	60.44	80.55	167.96 / 1.08
Lesitin based fatliquoring	1.3	21.01	84.62	114.40	208.58 /1. 28
Lanolin based fatliquoring	1.3	16.69	56.07	91.96	167.09 / 1.23
Polymeric based fatliquoring	1.3	13.07	56.59	96.98	173.86 / 1.13
Water proof fatliquoring	1.1	22.53	65.36	111.59	171.27 / 1.13
UNIDO*	-	**15 N/mm**	-	**30 N/mm**	**50 N/mm**

***UNIDO, 1996, Acceptable quality standards in the leather and footwear industry. ISBN: 92-1-106301-9, Vienna.*

The mechanical strength properties of glove leathers fatliquored with water proof and lesitin based substances were found significantly higher than the values for the lanolin, polymeric and control trials. The leathers fatliquored with lesitin and water proof agents display the highest tensile and tear strength values when compared to all the other samples. No significant difference in strength results was observed between the leathers treated with lanolin and polymeric fatliqours. The highest increase in strength results were found by the use of lesitin fatliquoring substances.

3.2 Water absorption test

Static water absorption (Kubelka) test results of glove leather samples treated with different fatliquoring formulations are presented in Figure 1. The highest static water absorption value was obtained from control leather, whereas lesitin fatliquoring agent provided the minimum water absorption value as 147.45 ml water for 100gr leather at 24h.

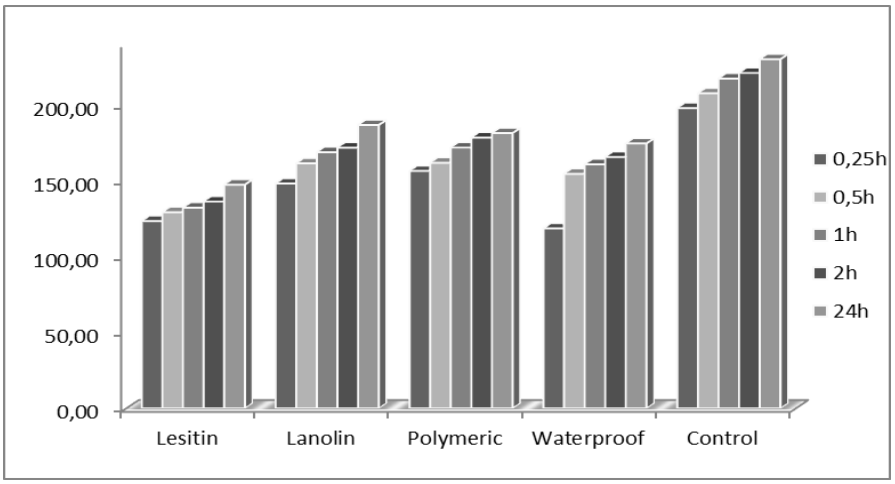


Fig.1: *Static water absorption values for glove leather samples (ml/100gr)*

Different fatliquoring agents had different effects on the dynamic water absorption values of technical glove leathers. The leathers treated with lesitin and waterproof fatliqours had minimum dynamic water absorption, although polymeric based fatliqour lead to highest water absorption. Similar results were found for the control leathers and the leathers treated with lanolin based oil fatliqour (Figure 2).

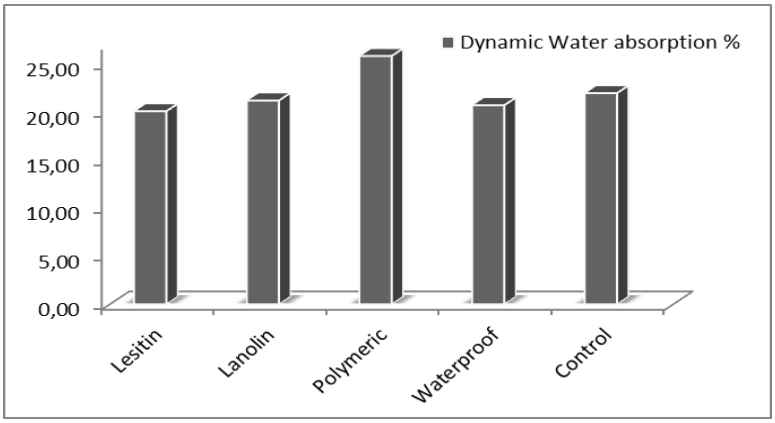


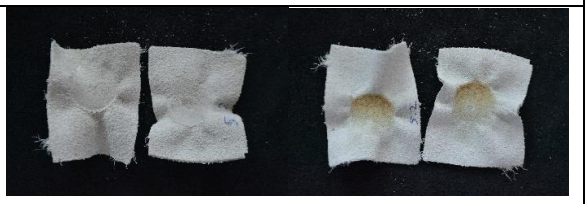
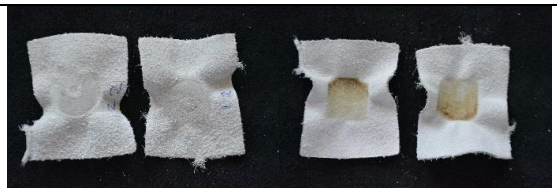
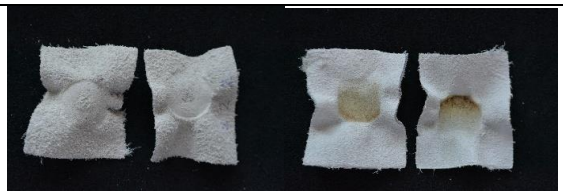
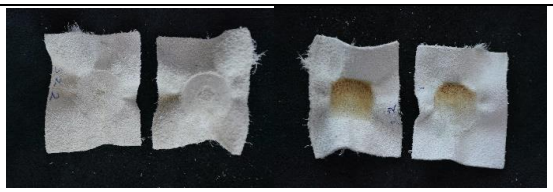
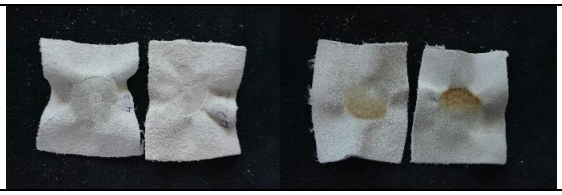
Fig.2: *Dynamic water absorption values for glove leather samples (%)*

3.3 Thermal resistance tests

The thermal resistance is an important parameter of leather meant for protective glove applications. Thermal behaviour of leather samples were evaluated in terms of surface area alteration for dry heat resistance (200°C) and appearance for heat stability test (300°C) (Table 3).

Leather specimens presented similar surface alteration values except the lesitin treated samples and the highest surface alteration value was provided by the samples fatliquored with lanolin. The minimum alteration was determined by the leathers treated with lesitin based fatliqours. All of the leather samples treated with different types of fatliquoring agent showed an acceptable thermal resistance.

Table 3. *Thermal resistance test results for aniline and pigmented finished glove leather samples*

Applications	**Dry heat resistance (200°C)**	**Heat stability test (300°C)**
	Surface area alteration (%)	**Appearance**
Conventional fatliquoring (control)	22.34	
Lesitin based fatliquoring	20.98	
Lanolin based fatliquoring	23.18	
Polymeric based fatliquoring	22.89	
Water proof fatliquoring	22.39	

The leathers treated with different kinds of fatliqours exhibited good and similar heat stability results at 300°C. In general, it was observed that lesitin type fatliqour increased the mechanical and thermal characteristics of leather glove samples as well as water absorption results.

Therefore, it can be said that treatment with lesitin based fatliqour was found more effective than the other fatliquoring products.

5. CONCLUSIONS

Preliminary trials with differentiated fatliquoring process were conducted with products available on the market, in order to determine the effect of fatliquoring process on protective performance of leathers. Protective properties of glove leathers were investigated in terms of water absorption, tensile, tear resistance and thermal resistance tests to establish how these products affect the protective properties of glove leather. The leathers treated with lesitin type fatliqours provided the lowest surface area alteration value when exposed to dry heat at 200°C. The application of lesitin and waterproofing fatliqouring agent decreased the amount of water absorbed by the leather samples. The use of lesitin fatliquor is found to show moderate decrease in thermal stability. It is revealed that all of the process variants using different types of fatliquoring agents produced satisfactory results both in terms of mechanical resistance and heat stability.

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