Enhancement of Waterproofing Properties of Finished Upper Leather Produced from Bangladeshi Cow Hides

Abrar Shahriar, Fatema-Tuj-Zohra, A. B. M. Wahid Murad and Sobur Ahmed

***Abstract*—Waterproofness property of leather can be enhanced by modifying different steps involved in pre-tanning to finishing operations. In this study three sets of experiment were conducted where tanning and finishing techniques differed to analyze the improvement of the waterproofness property. Use of surfactants and hydrophilic agents were avoided to improve this property. Moreover, different waterproof fatliquors were used and changing of the finishes in each experiment was performed to improve and evaluate the waterproofness of leathers. Waterproofness and other physical characteristic properties were assessed following standard methods. Leather samples of experiment-3 where extensive finishing was done, showed the best result of waterproofness which is significantly higher than the minimum requirement of shoe upper leather. All other physical properties except water vapour permeability of leather samples of experiment-3 were excellent as compared to other experiments. Scanning Electron Microscopy (SEM) image of the leather sample was also analyzed.**

***Index Terms*—Waterproofness, Surfactants, Retanning, Fatliquoring, Finishing.**

I. INTRODUCTION

Leather is the second export earning sector next to readymade garments in Bangladesh. Leather products confer high aesthetic value as well as functional and social value as a commodity. Because of high thermal conductivity of leather goods such as garments, gloves and shoe uppers are of maximum utility of cold humid countries and therefore unless these leathers are highly hydrophobic, they are not of much use [1]. Furthermore, leather which has absorbed too much water loses its ability to insulate against heat and cold [2]. Uptake of water by waterproof leathers which are used for footwear should not be more than 25-30% [3]. However, additional water vapour permeability and reversible water-uptake of some degree to remove perspiration from body should be allowed by the leather. Therefore, almost all types of leathers, except a few (like chamois), are made waterproof to varying degrees. In order to prevent the wetting of leather, it is necessary to be aware of the process of leather wetting. Generally, it takes place in four-steps [3]:

i) Water spreads over and wets the leather surface;

ii) Water penetrates into the leather;

iii) Water wets the fibre network (i.e. internal surface of leather);

iv) The leather soaks by water due to the attractive interaction between water and leather network.

Apart from collagen backbone, there might be some degree of involvement of tanning agents, dye molecules, salts, and other materials in these interactions.

The chain of process steps must be interrupted to prevent the wetting of leather and to make the leather waterproof. There are many polar functional groups in collagen fibers such as –OH, –COOH, $–NH_2$ and –CONH–. The chemical compounds to be added mostly are hydrophilic and have good water affinity. Therefore, to improve water resistance property several leather making processes and leather surface modifications are applied [3][4][5]:

1. Sealing the leather with an impermeable layer, i.e. a heavy polymer finish. A foil or thin laminate of waterproof synthetic material can be attached to the surface of the leather by adhesive, also [6]. The film prevents spreading of water; as a result, the leather cannot be wetted under static condition. However, the water vapour permeability drastically reduced by such film even it produced using most modern technologies [6][7].

2. Closed waterproofing- closing the spaces between the leather fibers with water-repellent substances [4][5]. It might be achieved in two different ways: firstly, leather impregnation by incorporation of water-insoluble substances, for example, solid fats, and molten waxes; secondly, using hydrophilic waterproofing [8]. Grease impregnation is a long-established system, and gives a special look and feel to the leather. However, the filling of the gaps with grease prevents the penetration of water into the fibre network, but the leather becomes extremely heavy and completely blocks any air and water vapour permeability. In the second case waterproofing of leather is achieved by application of certain surfactants (e.g. hydroxycarboxylic acid derivatives, alkenyl-succinic acid derivatives, hydroxyethylation fatty acid, etc.), which bind to the leather and can absorb a certain quantity of water [9]. The problem with closed waterproofing is that it (partially) seals the pores and, therefore, frequently impairs the water vapour permeability and water vapour absorption of the leather.

3. Open waterproofing- creating a hydrophobic net around the fibers without filling spaces- is smartest approach to make waterproof leather [3][4][5]. The fibers and fibrils are bind through its functional groups and forms hydrophobic layer by using low surface energy (less than 30 mN/m) waterproof agent. Water vapour can penetrate

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into the fibre network, while water droplets possess high surface tension and cannot spread over the hydrophilic fibre and wet the internal surface. Wettability with water are reduced or almost completely eliminated through increasing the interfacial tension between leather fibers and water by depositing water repellents in the leather substance.

There are many other factors that influence the waterproofness of leather not only chemical substances used in leather manufacture (salts, tensides, tanning agents, retanning agents, dyestuffs, fatliquoring agents and finishing agents). Both initial quality of skin or hide and each operation involved in producing the finished leather have significant influence on the waterproofness degree of finished leather [10][11]. Leather finishing is the process where a set of operations (chemical and mechanical) are performed in a sequential manner under a system during which finishes are applied to the leather surface with the aim of improving its appearance, feel, waterproofness and general suitability to intended use. These operations deal with the art of enhancing the quality of leather so as to make it suitable for making products [12]. The final uses of different leather are wide and include shoe uppers, garments, gloves, leather goods, furniture and automotive upholstery and so on [13].

The choice of waterproofing system depends on the degree of water resistance required, the purpose of leather, and price. Extreme hydrophobicity is required for military footwear leather [14]. Waterproof leathers are commercially of high interest because these leathers are sold at a relative high price due to requirement of specialty products.

The aim of this work was to evaluate the waterproofing behaviour of the upper leather upon various combinations of pretanning, tanning, retanning, fatliquoring and finishing agents. Extensive work has been performed in this research to develop process for the production of valueadded quality waterproof finished leather using domestic cow hides.

II. Choice of Chemicals

The hides and skins tanning with chromium salts (i.e. wet blue leather) induce the collagen fibre to be resistant against bacterial attack and increase resistance to temperature (Figure 1).

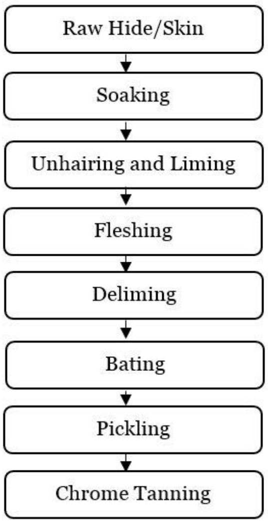


Fig. 1. Flow chart of wet blue leather production

However, this process does not possess the physical and aesthetic properties required to the products made from leather. Therefore, after chrome tanning obtained wet blue is converted to usable leather (Figure 2) in a series of chemical and mechanical operations (i.e. retanning, dyeing, fatliquoring, drying, finishing, etc.). The choice of retanning and fatliquoring chemicals depends on the desired properties (softness, touch, fullness, grain firmness or looseness, smell, adhesion properties, water uptake or release, and waterproofness) of the final leather.

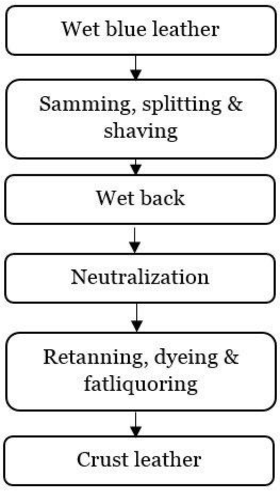


Fig. 2. Flow chart of crust leather production

Various retanning agents were developed to give the chrome tanned leather fullness with selective filling of the structure and to provide tight and uniform grain surface [9][15][16]. In general, retanning agents can be inorganic mineral substances (chrome, aluminium, zirconium salts) or organic materials (vegetable or synthetic). The synthetic retanning organic agents can be divided into three main groups: 1) syntans (condensation products of aromatic compounds like phenol, naphthalene sulphonic acid with formaldehyde or urea); 2) resins (condensation products from formaldehyde with amino and amido compounds like urea, melamine, and dicyandiamide); 3) polymers, mainly acrylic (polymerization products from acrylic acid derivatives). Syntans are better soluble in water than vegetable tannins, because they molecules are smaller.

Therefore, vegetable tannins more difficult penetrate to leather matrix, and leather tanning process runs longer.

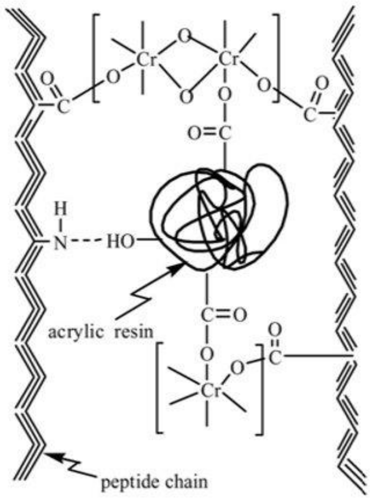


Fig. 3. Interaction of acrylic resin with peptide chain and chromium

The wide use of acrylic acid derivatives is related to the presence of many carboxylic acid side groups that can give tanning property both reacting with multiple chrome centers on the leather and chemical bounding to the collagen groups. Acrylic resin interaction mechanism with chrome tanned leather is presented in Figure 3. Synthetic retanning materials are used for filling and softening, as auxiliaries during fatliquoring and sometimes as replacements of tannins in combination with vegetable extracts. The filling improves the tightness and fineness of the leather grain with mellow surface. The retanning agents play important role in the final degree of leather waterproofness. Melamine- dicyandiamide resin, acrylonitrile resin, styrene maleic copolymer, chestnut can significantly to lower water absorption of leather [17]. Fatliquoring agents are one of the important leather chemicals that have great effect on leather performance. It can penetrate into the interwoven structure of the collagen fibres, prevent the leather fibers from putrefaction, make the fibres stick together and improve their physical and mechanical capabilities [18]. The fatliquoring is the main step in the production of hydrophobic leather. Generally, fatliquoring substances are divided into hydrophobic (emulsified) components and hydrophilic (emulsifying) components.

Multifunction fatliquoring agents can offer more new capabilities for leather. Besides fatliquoring function, they can enhance segment mobility of molecular chain of collagen fibers, and contribute higher level of softness, flexibility, waterproofness, perspiration resistance, etc. [19][20]. Not only waterproofing but also repellent properties to the leather confer silicone derivatives and fluorcarbonated resin. Silicones may be applied from hydro-carbon solvents on the dry leather by dipping or spraying or a silicone emulsion may be applied in the drum on the wet leather by a fatliquoring. Silicones have very high interfacial tensions relative to water and these are not very temperature sensitive. However, silicones are not very effective as solo agents. Fluorocarbons are applied from solvent solutions and have equally high water repellency and also oil repellency [21].

III. Mechanism of Waterproofing

A liquid will wet a surface only if it is of lower surface energy or surface tension than that of the surface. If the surface tension is very much lower than the substrate, spontaneous spreading of the liquid can be observed. If the liquid has a higher surface tension than the substrate, the surface will not be wet and the liquid will bead. Looking closely at a droplet of liquid resting on a surface the contact angle (θ), formed between the liquid and substrate can be measured. If the contact angle is less than 90°, the liquid has wet the surface. If the contact angle is greater than 90° the liquid has not wet the surface and the substrate will show hydrophobic nature and waterproofness.

Fluoropolymers and fluorinated chrome complexes are two types of product used to waterproof leather. They act by making the fibres themselves water repellent rather than by filling the interstices. The repellency arises from the presence in the molecule of long fluorocarbon chains, which are inherently chemically inert and hydrophobic.

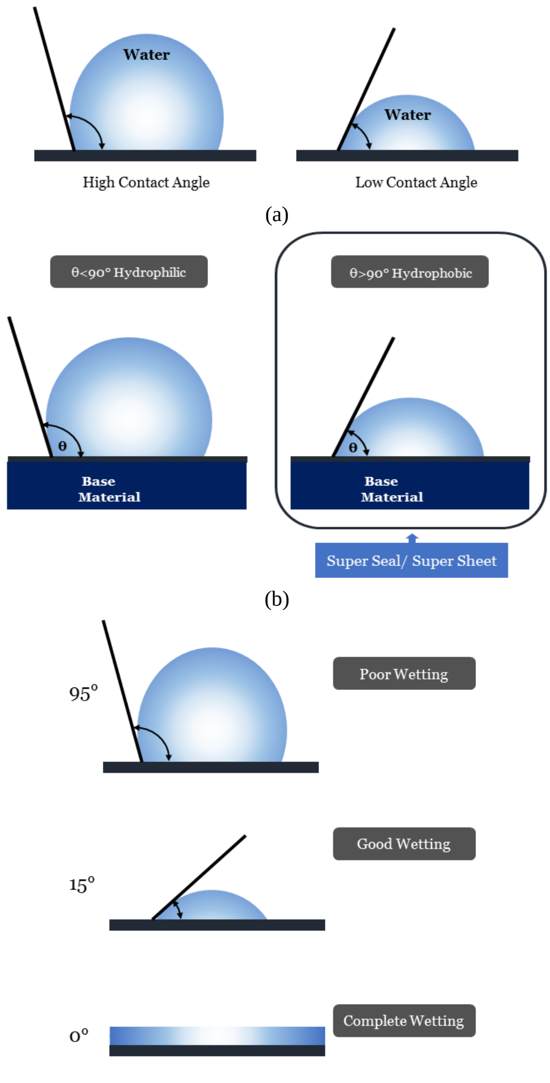


Fig. 4.a) High and low contact angle, b) Hydrophilic and hydrophobic nature of material and c) Poor, good and complete wetting of material w.r.t. contact angle.

Both types of product derive their fluorination from perfluoro alcohols or acids. Acrylics impart retanning and fatliquoring properties, such as temper and strength. These products are compatible with waterproofing fatliquors and other waterproofing materials, such as fluorocarbons or silicones.

IV. Experimental

A. *Materials*

All pieces of cow hides were collected from the Posta hide market, Lalbagh, Dhaka, Bangladesh in three installments. Various chemicals of reputed company (commercial grade) were purchased from Hazaribagh, Dhaka for the production of wet blue, crust and finished leather.

B. *Methods*

Use of wet blue as a starting material is not advisable as there would be a possibility of presence of wetting agents, detergents and surfactants that would create problems in gaining waterproofness. The approaches of the modified process to achieve good waterproof properties are- i) Avoiding the use of surfactants and hydrophilic fatliquors; ii) Use of syntan to achieve the objectives of retanning without affecting the permeability properties; iii) Use of waterproof fatliquors in installment; iv) Thorough washing of the leathers at the end of the processes to remove any neutral salts that might be present; v) Optimization of finishing process to achieve the desired level of waterproofness. The process of crust leather production from domestic cow hides consists of soaking, liming, deliming, bating, pickling, tanning, retanning, dyeing, fatliquoring, fixing and so on. The finishing process started with surface preparation of crust leather, coating with sprayer and ended with ironing or plating.

Tanning, retanning and finishing experiments conducted as described below:

1) *Experiment 1*

TABLE I: Process of wet blue for water proof leather from cow hides

Chemical percentage (%) based on raw weight

Process	% Chemicals	Chemicals	Time of drumming
Soaking	300	Water	30 minutes
	0.1	Busan 40L	
	0.3	Pelvit DPH	
	0.8	Soda ash	
	0.2	Sodium sulphide	After 30 minutes running, pH was checked 9.5. Then rested for 60 minutes and it was run 5 minutes per hour for 12 hours. Then washed for 10 minutes.
Liming	100	Water	10 minutes
	1.0	Ebrolin EH	
	2.0	Sodium sulphide	After 30 minutes running, it was kept in rest for 60 minutes.
	2.0	Lime	
	2.0	Sodium sulphide	After running 30 minutes, it was kept in rest for 60 minutes and run 5 minutes per hour for 10 hours.
	2.0	Lime	
After 10 hours of liming	Added 200	Water	Run for 15 minutes, then after 60 minutes rest it was run 5 minutes per hour for 20 hours. The pelts were washed for 15 minutes by lattice door with running water.
Limed pelt was unloaded from drum for fleshing. After fleshing pelt weight was taken for next processes.			
Chemical percentage (%) based on pelt weight			
Process	**% Chemicals**	**Chemicals**	**Time of drumming**
Wash		Water	Washed for 10 minutes in closed door and drained water.
Deliming	60	Water	After running 90 minutes deliming was checked with phenolphthalein indicator.
	3.0	Ammonium sulphate	
	0.5	Sodium meta bi sulphate	
Bating	0.5	Bate PBW 1	,60 minutes
	0.4	Napolin T-106	
Wash			Washed for 60 minutes by lattice door running water.
Pickle	80	Water	10 minutes
	8	Salt	
	0.3	Impropal CO	
	0.5	Sodium formate	10 minutes
	0.5	Formic acid	20 minutes
	1	Sulphuric acid	Added in 3 installments at 30 minutes intervals and then ran for 150 minutes
	0.5	Hypo	30 minutes. pH checked 2.6-2.9 and kept rest for overnight. In the next morning ran for 10 minutes.
Tanning	4	Chromitan B	60 minutes
	.3	Atlasol 177C	
	4	Chromitan B	
	0.5	Sodium formate	120 minutes. Check penetration.
	40	Water at 35^{0}C	
	0.6	Tan base	90 minutes
	0.1	Busan 30L	After running 30-60 minutes pH was checked 3.7-3.9 and check shrinkage temperature (Ts). Then drained, unloaded and piled.
The wet blue was kept at least two weeks for ageing, then samming, splitting and shaving is carried out to achieve the required thickness and weight was taken for crust process.			

TABLE II: PROCESS OF WATERPROOF CRUST LEATHER FROM WET BLUE COW HIDES

Shaving thickness was maintained for full pieces 1.0-1.1 mm and for sides 1.1-1.2 mm. All chemicals were taken on the basis of shaved weight.

Process	**% Chemicals**	**Chemicals**	**Time of drumming**
Wetback	200	Water	
	0.2	Atlasol 177C	10 minutes
	0.5	Formic acid	30 minutes. Drain. pH 3.0-3.2
Rechroming	80	Water	
	2.0	Novaltan PF	30 minutes
	0.2	Formic Acid	10 minutes pH 2.8-2.9
	4.0	Chromitan B	40 minutes
	0.6	Atlasol 177C	30 minutes
	3.0	Icatan 204	
	0.5	Sodium bi carbonate	After running 30 minutes pH was checked 3.8. Then drained.
	150	Water	
	1.25	Sodium bi carbonate	After running 30 minutes pH was checked 5.5. Then drain washed for 25 minutes and drained.
Dyeing and Fatliquoring	80	Water at NT	
	1.0	Perfectol HQ	10 minutes
	5.0	Derugan NF	45 minutes
	4.0	Relugan D	30 minutes
	0.2	Ukatan GM	10 minutes
	3.0	Black 5TN (Dye)	
	2.0	Pietan MD	
	2.0	Pietan DA	60 minutes. Penetration was checked.
	100	Water at 50ºC	20 minutes
	3.0	Butan 1908	
	6.0	Perfectol HQ	60 minutes
	6.0	Perfectol WX-2	
	0.1	Boron SAF	
	0.1	Busan 30L	
	3.0	Intan EMS	30 minutes
	3.0	Formic acid	Add in 10+10+40 min. Drain wash well.
	150	Water at 50ºC	
	1.0	Black 5TN	20 minutes
	1	Formic acid	(5+15) minutes
	1.0	Black 5TN	20 minutes
	1.5	Formic acid	(5+20) minutes. Drain wash well.
Capping	100	Water at 40ºC	60 minutes
	3.0	Chromitan B	Wash 3 times for 10 minutes, drain and horse up
	0.5	Sodium formate	
Setting out, vacuum dry, natural hang dry, condition, staking, toggling and plating was carried out.			

TABLE III: PROCESS OF WATERPROOF FINISHED LEATHER FROM COW CRUST LEATHER

Process	**Chemicals**	**Parts**	**Remarks**
Season coating	Fondo BE	200	Spray 3 Cross Iron/ Plate with Sand blast (Micro Hair cell) Spray 3 Cross
	Master soft S	100	
	Resin binder	200	
	PU Binder	100	
	Protein binder	100	
	Pigment	50	
	Water	500	
Top coating	Solvent Lacquer	100	Spray 2 Cross Roto press 110ºC/30Bar
	Butyl Acetate	50	
	Silicon	01	

2) *Experiment 2*

TABLE IV: WATER PROOF CRUST FROM WET BLUE COW LEATHER (REF. TABLE I.)

Shaving thickness was for pieces 1.0-1.1mm. Chemical percentage (%) based on shaved weight

Process	**% Chemicals**	**Chemicals name**	**Time of drumming**
Wet back	300	Water at 40ºC	
	+0.3	Eskatan GLH	10 minutes
	+0.3	Acetic acid	30 and drain wash
Retanning	100	Water at 35ºC	
	+2.0	Black dye liquid	10 minutes
	+0.2	Formic acid	10 minutes
	+2.0	Novaltan PF	20 minutes
	+4.0	Tanesco HN	20 minutes
	+4.0	Chromitan B	
	1.5	Sodium Formate	
	0.5	Eskatan GLH	90 minutes

	2	Relugan RF	30 minutes
	100	Water at room temperature	
	1.5	Sodium Formate	15 minutes
	0.5	Sodium bicarbonate	Added in 3 installments at 10 minutes intervals and then ran for 40 minutes
The pH was checked as 4.2. Leather was left for overnight in the drum. Next morning the drum was run for 10 minutes and then drain washed.			
Process	**% Chemicals**	**Chemicals**	**Time of drumming**
Fatliquoring	150	Water at room temperature	
	+2.5	Sellasol NG	30 minutes
	+1.5	Sodium formate	
	0.2	Sodium bicarbonate	40 minutes. Then pH checked 4.5/4.6 and drain washed.
	100	Water at 40ºC	
	2.0	Intan EMS	10 minutes
	5.0	Atlasol AR	30 minutes
	4.0	Syntan DF585	
	2.0	Perfectol HQ	30 minutes
	4.0	Tanigan OS	
	2.0	Basyntan AN	
	1.0	Ukatan GM	
	1.0	Lipsol SB	30 minutes
	4.0	Basyntan AN	
	2.0	Tanigan OS	
	2.0	Retan CB	
	2.0	Tafigal P	
	1.0	Ukatan GM	
	4.0	Retingan R7	30 minutes
	4.0	Black dye 5TN	60 minutes. Dye penetration was checked.
	2.0	Intan EMS	30 minutes
	150	Water at 50ºC	
	0.5	Formic acid	30 minutes. Then half bath was drained.
	50	Water at 55ºC	10 minutes
	3.0	Tafigal P	20 minutes
	3.0	Eupilon WAS1	
	2.0	Perfectol HQ	
	3.0	Dermaphob WA-71	
	0.1	Busan 30L	60 minutes
	4.0	Intan EMS	30 minutes
	3.0	Formic acid (1:5)	Added in 3 installments at 10 minutes intervals.
	2.0	Novaltan AL	60 minutes. Drain washed.

Process	% Chemicals	Materials/ Chemicals	Time of drumming
Top Dyeing	200	Water at 50ºC	
	1.0	Eupilon WAS1	10 minutes
	1.0	Formic acid (1:5)	20 minutes
	1.0	Black 5 TN	15 minutes
	1.0	Formic acid	15 minutes
	1.0	Black 5 TN	15 minutes
	2.0	Formic acid (1:5)	Added in 2 installments at 10 minutes intervals.
	0.4	Invederm SN	20 minutes. Drained well.
Capping	150	Water at 40ºC	
	1.0	Eupilon WAS1	10 minutes
	1.0	Formic acid (1:5)	10 minutes
	3.0	Chromitan B	70 minutes
Drain washed until clean, then drained and piled up.			

TABLE V: PROCESS OF WATERPROOF FINISHED LEATHER FROM COW CRUST LEATHER

Process	Chemicals	Parts	Remarks
Season coating	Fondo BE	200	
	Master soft S	100	Spray 3 Cross
	RA 2312	100	
	Alpaphobe T	50	
	RU 73989	50	Roto press with Sand blast at 100ºC/30Bar (Micro hair cell)
	RU 3901	70	Spray 3 Cross
	Lucido 965	100	
Top coating	Solvent Lacquer	100	Spray 2 Cross
	Butyl Acetate	50	Roto press 110ºC/30Bar
	Silicon	01	

3) Experiment 3

TABLE VI: PROCESS OF WATERPROOF CRUST LEATHER FROM WET BLUE COW HIDES (REF. TABLE I).

Shaving thickness was maintained 1.0-1.1 mm.All chemicals were taken on the basis of shaved weight.

Process	% Chemicals	Materials/ Chemicals	Time of drumming
Wetback	200	Water	60 minutes. Drain.
	0.3	Acetic acid	
Rechroming	100	Water	
	0.5	Formic Acid	30 minutes pH 2.9-3.0
	2.0	Relugan GT 50	30 minutes
	5.0	Chromitan B	
	2.0	Basyntan AN	40 minutes
	2.0	Relugan RF	40 minutes
	0.5	Sodium Formate	
	+0.5	Sodium bi carbonate	After running 60 minutes pH was checked 4.0. Then run 5 minute/hour for overnight. Next day drained.
	300	Water	10 minutes. Washed and drained.
Neutralization	100	Water at 35ºC	
	2.0	Butan 7810	15 minutes
	0.75	Sodium bi carbonate	
	0.75	Sodium Formate	45 minutes
	1.0	Tanigan PAK-S	30 minutes. pH was checked 5.5. Then run 5 min/2 hour for night. Then drained.
	300	Water	10 minutes. Drained.
Retanning, Dyeing and Fatliqouring	100	Water at 40ºC	
	2.0	Densodrin CD	30 minutes
	3.0	Relugan RE	40 minutes
	4.0	Basyntan AN	30 minutes
	5.0	Relugan D	
	6.0	Basyntan AR	
	3.0	Relugan RV	
	5.0	Basyntan IS	10 minutes
	1.0	Tamol M	
	2.0	Dye	60 minutes
	5.0	Densodrin HP	
	2.0	Densodrin CD	
	1.0	Densodrin OF	
	0.3	Preservative	60 minutes
	100	Water at 50ºC	10 minutes
	3.0	Formic Acid	2x10+40 minutes. pH was checked 3.6 and then washed with running water and drained.
Samming and setting out, vacuum dry at 50-60ºC for 30 second, hang dry, condition, staking, toggling and plating or ironing.			

TABLE VII: PROCESS OF WATERPROOF FINISHED LEATHER FROM COW CRUST LEATHER

Process	Materials/ chemicals	Parts	Remarks
Adhesion coat	Dye	50	1 pass roller coat
	RU 73989	100	
	RA 2354	50	
	Water	300	
Season coat	BI 596	50	Spray 3 Cross Roto press with Sand blast at 100ºC/30Bar (Micro hair cell) Spray 2 Cross
	Water	500	
	RA 2354	50	
	RA 2312	100	
	FI 50	50	
	AlpaphobeT	50	
	SFT WR-9	50	
	RU 73989	50	
	RU 3901	70	
	RPU 069	30	
	WT 713985	20	
	Silicon	1.5	
	Pigment	50-100	
Top coat	EM finish KN	70	(Nitrocellulose and wax was mixed with water separately and then mixed together to spray) Spray 2 Cross, Dry well and Roto press for 110ºC/30 Bar
	NEA 635/M	30	
	Water	50	
	Wax CF	5	
	Silicon	2	
	Water	50	

V. RESULTS AND DISCUSSIONS

During processing, the hides were well opened up in the liming to ensure penetration of the waterproofing chemicals. The hydrophilic products such as salts, dyes and certain types of surfactants (e.g. wetting agents, etc.) were tried to avoid as they have a negative effect on waterproofing. The wet-blue leather was neutralized throughout the cross section otherwise the emulsifiers would de-activate at the low pH and produced incomplete hydrophobing. In the form of a micro emulsion, waterproofing fatliquors ensured deep penetration, access to the fibril level and coating the individual fibrils. The regularity of dyeing, retannage and tannage influenced the distribution of fluorochemical and subsequent performance of waterproofing. The finishing materials and the finishing procedure had been selected according to the condition of the leather, the nature of finish to be produced and the desired quality of the intended waterproof finished leather. The most important things were also considered as the available facilities and the cost involved.

The morphological structure of developed waterproof leather is shown in Figure 5.

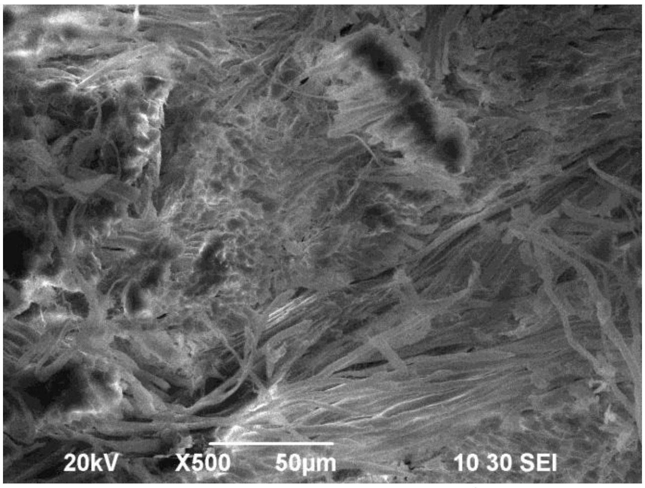
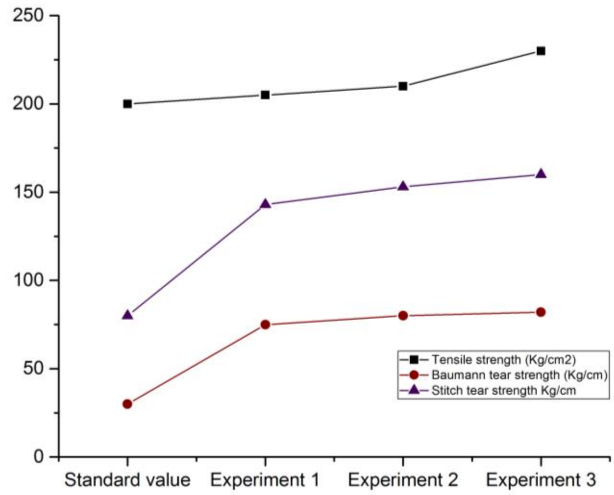


Fig. 5. Scanning Electron Microscopic photograph of developed water proof leather

In order to observe the performance of finishing formulation, an attempt has been made in this work and performed physical tests as per SATRA and IUP methods. For all these tests, sampling and conditioning has been carried out according to international method [22]and [23]. Samples were conditioned at 20°C and at 65% relative humidity for at least 24 hours prior to all measurements.



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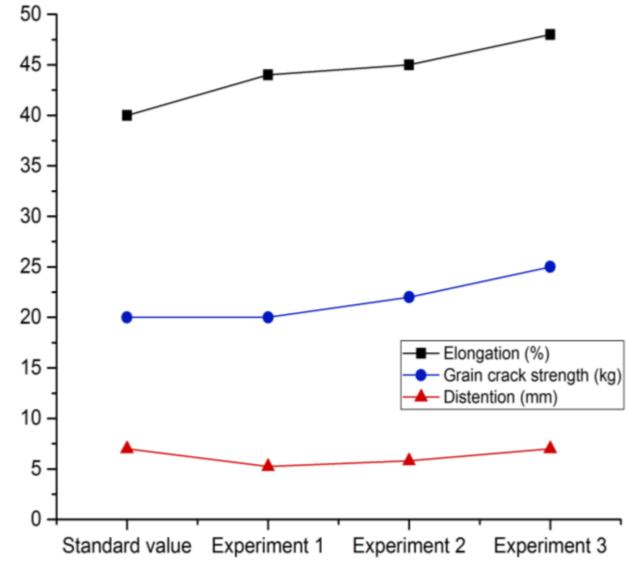

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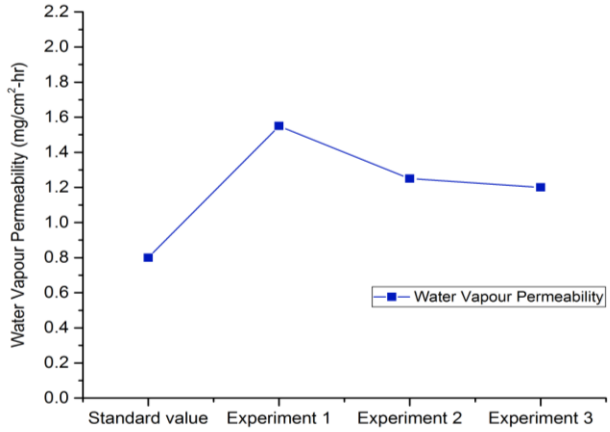
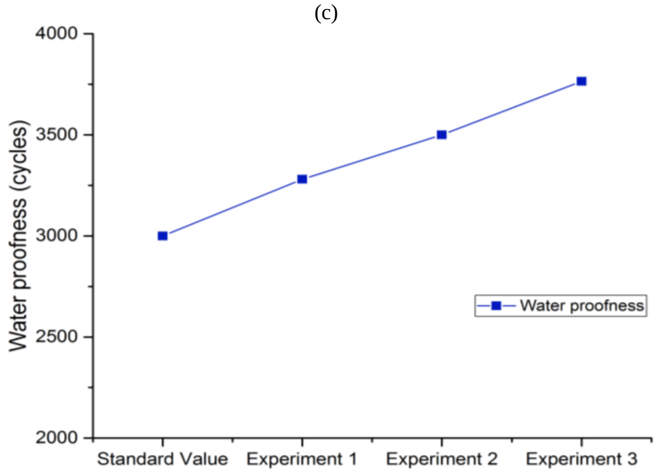


(c)



(d)

Fig. 6. Graphical representation of standard value and the readings from Experiment 1, 2 and 3 of a) Elongation, Grain crack strength and Distention, b) Tensile strength, Baumann tear strength and Stitch tear strength, c) Water vapor permeability, d) Waterproofness.

VI. Conclusions

Development of modern economic technology for the production of quality waterproof finished leather is very essential to increase export business and national income. Obviously, implementation of the developed economic process will enhance the total finished leather production and reduce crust leather export which will indeed increase national income, boost up job opportunities and engage

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more people in the production line besides the export earnings. In this work, different types of crusting and finishing procedure of traditional technology and latest technology were studied on domestic cow hides. Out of these three experiments all physical properties are higher than the standard value of standard upper leather. However, the waterproofness is highest in case of experiment 3 and water vapour permeability is highest for experiment 1. It also proves that as waterproofness increased water vapour permeability decreased.

The process of waterproofing leather has been important for high performance footwear many years. Today, however, changing lifestyles and the significance of the leisure sector mean that waterproofing forms a vital part of the high performance leather market.

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