

# OPTIMIZATION OF CHAMOIS LEATHER TANNING USING RUBBER SEED OIL

by

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## ABSTRACT

Chamois leather is a popular leather article in the market, as it has unique uses for filtration, cleaning and drying. It can be produced by a chamois tanning process using rubber seed oil. Optimum condition for the tanning needs to be applied in order to obtain good quality leather and to produce the leather efficiently. In this research, optimizations of rubber seed oil offer and oxidation time in chamois tanning were investigated. The objectives of the research were to determine the optimum condition of rubber seed oil offer and oxidation time for tanning process. The experiment was conducted by tanning of goat pickle pelt using 10, 20, and 30% of rubber seed oil for 5, 7, and 9 days of oxidation times. The chemical, physical, and organoleptic properties of the oil tanned leather were measured. This study shows that the chemical, physical, and organoleptic properties of rubber seed oil tanned leather fulfilled the quality requirements for the chamois leather. The optimum conditions for the tanning were an oil offer of 20% and oxidation time of 9 days. The chemical properties of the leathers were pH of 8, ash content of 1.1%, and oil content of 6%. Their physical properties were thickness of 0.8 mm, tensile strength of 21.3 N/mm<sup>2</sup>, elongation at break of 148%, tear strength of 90 N/mm, and water absorption of 271% (2 hours). The organoleptic properties of the leathers, i.e. softness, color, and odor, were considered good to excellent.

## RESUMEN

La piel de gamuza al aceite es un artículo de cuero popular en el mercado, ya que tiene aplicaciones únicas para la filtración, la limpieza y el secado. Puede ser producida también por un proceso de curtido de gamuza con aceite de semillas del caucho. Condiciones óptimas para el curtido deben aplicarse a fin de obtener un cuero de buena calidad y para producir el cuero de manera eficiente. En este estudio, la optimización en la oferta del aceite de semillas del caucho y el tiempo de oxidación en el curtido de la gamuza fueron investigados. Los objetivos de la investigación fueron determinar las condiciones óptimas de oferta del aceite de semillas del caucho y el tiempo de oxidación para el proceso de curtido. El experimento fue realizado curtiendo una piel piquelada de cabra con 10, 20, y 30% de aceite de semillas del caucho en 5, 7 y 9 días como tiempo de oxidación. Las propiedades químicas, físicas, y organolépticas del cuero curtido al aceite fueron medidas. Este estudio muestra que las propiedades químicas, físicas y organolépticas del cuero curtido con aceite de semillas del caucho cumplen los requisitos de calidad para la piel de gamuza al aceite. Las condiciones óptimas para el curtido fueron una oferta de aceite del 20% y el tiempo de oxidación de 9 días. Las propiedades químicas de los cueros fueron pH 8, contenido de ceniza de 1,1%, y el contenido de grasas de 6%. Sus propiedades físicas mostraron un espesor de 0,8 mm., resistencia a la tracción de 21,3 N/mm<sup>2</sup>, elongación a la rotura de 148%, resistencia al desgarro de 90 N/mm, y la absorción de agua de 271% (2 horas). Las propiedades organolépticas de los cueros, es decir, la suavidad, el color y olor, se considera de buena a excelente.

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## INTRODUCTION

Rubber seed oil is potential to be used in production of chamois or oil tanned leather.<sup>1</sup> It is a drying oil extracted from rubber (*Hevea brasiliensis*) seeds, which are in Indonesia, one of the biggest natural rubber producers in the world, have not been utilized optimally. Their utilization for the chamois tanning will increase added value of the seeds.

Chamois leather has specific properties, such as it has low density, excellent softness and comfortable.<sup>2</sup> Its main uses are as washing agent with advantages of high water absorption capacity and easy release the water and dirt from the leather. It has specific uses, such as in high quality gasoline filtration, cleaning and drying optical equipment, spectacles, mirror, and vehicles, etc. Other uses are for the production of gloves and orthopedic leather.<sup>3,4</sup> The leather is a well known leather article in the market,<sup>3</sup> since the leather demand in the global market increases steadily.<sup>5</sup>

Nowadays, conventional oil tanned leather is produced by using fish oil as its tannage. Tanning using the fish oil faces odor and color problems, which is caused by oxidized fish oil residue attaching on the chamois leather. The odor cannot be removed completely from the leather. Therefore, to overcome the problem, the use of fish oil in the chamois tanning should be reduced or substituted.

Rubber seed oil is one of the vegetable oils expected to substitute fish oil in the tanning. The oil did not produce high intensities of odor and color residues on the leather.<sup>1,6</sup> Its iodine value, one of the requirements for an oil tannage, is similar with that of fish oil. Other characteristics, such as acid value, free fatty acid content, saponification value, peroxide value and density of the oil are similar with those of fish oil. FT-IR spectrum of the rubber seed oil shows that the oil has the same functional groups with fish oil.<sup>1</sup>

Chamois leather must meet certain quality requirement. The quality of chamois leather depends on its tanning process. This paper reports the effects of rubber seed oil offer and oxidation time on the properties of chamois leather, and optimum conditions for the tanning.

## EXPERIMENTAL

### Material and equipment

Materials used in the research were goat skin pickled pelt, rubber seed oil, sodium chloride, Relugan<sup>®</sup> GT50, sodium formate, sodium carbonate, and Eusapon<sup>®</sup> S. Equipment used were tanning drum, stacking, paddle, sammying machine, shaving machine, toggle, buffing machine, thickness gauge, pH meter, shaker, grinder, oven, burner, tensile strength meter, Kubelka glass apparatus, and other glass apparatus.

The rubber seed oil used in the experiment was one type, i.e. a liquid material extracted from rubber (*Hevea brasiliensis*) seeds. The seeds were sun dried for 3 days, 5 hours each day, and then were dried in an oven at 70 °C for 1 hour. Oil of the rubber seeds was extracted by using a hydraulic press at 65 °C. Viscosity of the oil was 67.3 centistokes.

Relugan GT 50 is 50% solutions of glutaraldehyde used as pretanning, self-tanning and retanning agent for all types of leather. The product is manufactured by BASF. Eusapon S (formerly Amollan<sup>®</sup> S) is a surface-active wetting-back and degreasing agent for leather and fur skins. It is manufactured by BASF.

### Tanning

The tanning process consisted of pH adjustment, pretanning, oil tanning, oxidation, washing, staking, toggling, drying, and buffing. Procedure of the tanning was shown in Table 1.

### Leather analyses

Chemical properties, i.e. pH, ash content, and oil content, were measured by using SLC 13, SLC 6, SLC 4, respectively.<sup>7</sup> Physical properties, which were tensile strength and elongation at break, tear strength, and water absorption, were analyzed using SLP 6, SLP 7, and SLP 19, respectively.<sup>7</sup> Organoleptic properties, i.e. softness, color and odor, were tested by two experts.

## RESULTS AND DISCUSSION

### Chemical properties

Chemical properties of rubber seed oil tanned leather analyzed were pH, ash content and oil content. The results are shown in Table 2.

### pH

The pH values of rubber seed oil tanned leather were in the range of 7 to 8, as shown in Table 2. They fulfilled the quality requirement for chamois leather according to Indonesia National Standard (SNI), i.e. maximum pH of 8.<sup>8</sup> The pH value of chamois leather was affected by washing in its manufacturing; a good washing will produce a leather with reasonable pH.

### Ash content

Ash content in leather indicates mineral content in the leather. Leathers resulted in from this research had ash contents of 0.9 – 1.2% as demonstrated in Table 2. The ash contents of the leathers met the quality requirement for chamois leather, i.e. maximum of 5%.<sup>8</sup> As content in the leather is affected by minerals contained in the leather, such as potassium, calcium, iron, phosphor; commonly they are in the skin or leather as chloride, sulfate, carbonate, or phosphate salts. Besides those minerals, in general, there are also small amount of SiO<sub>2</sub>, Zn, Ni, As and Fe in leather.

TABLE 1

### Procedure of chamois tanning using rubber seed oil

Process	Chemical	Amount	Duration	Remark
pH adjustment	Water	200%	10 mins	Drum at 8 rpm Measure pH at 3 and °Be at 8
	Sodium chloride	10%		
	Formic acid			
Pretanning	Relugan GT50	1.5%	4 x 15 mins, then 1 h	Dilute with water 3 times Drum at 12 rpm
Fixation	Sodium formate	1%	4 x 10 mins	Dilute with water 20 times
	Sodium carbonate	1%		Measure pH at 8
	Drain			
Aging			Overnight	Cover with plastic
Shaving				Shave both sides
Washing	Water	1000%	3 x 15 mins.	
	Drain			
Oil tanning	Water	200%	10 mins	Drum at 8 rpm
	Sodium carbonate	0.5%		
	Rubber seed oil	10, 20, and 30%		
Oxidation			5, 7, and 9 days	Hang at room temperature
Washing	Sodium carbonate	3%		Stake Repeat 3 times
	Eusapon S	0.2%		
	Water	300%		
	Drain			
Toggling and drying			1 day	
Buffing				Buff both sides

### Oil content

Oil content in oil tanned leather is a residue of oil after the leather washing and oil which is not attached to the collagen. Oil contents in leather obtained from this experiment were 2.3 – 6.0% as shown in Table 2. The oil contents were met the quality standard, i.e. maximum of 10%.<sup>8</sup> Excess oil in oil tanning can be removed by washing with warm alkaline water. In the washing, oil residue released from the leather by mechanical treatment, such as by setting out. Therefore, oil left in the leather depends on the process. Moreover, oil content in the leather is affected by beam house processing, such as liming. Liming is to dissolve epidermis and hydrolyze fat as well as materials that will not be used in tanning, so that during the liming some fats are discarded from the pelt.

### Physical properties

#### Thickness

Leather thickness is one of the parameters used in determining quality of chamois leather. It indicates fullness of the leather. Initial thickness of skin or hide can be adjusted during the leather production, such as by shaving. Final thickness of chamois leather can be adjusted by buffing of the leather. Thickness of chamois leather required is 0.3 to 1.2 mm.<sup>8</sup> Leather thicknesses produced from this trial were 0.69 to 0.81 mm and 0.76 mm in average. Therefore, they fulfilled the requirement.

#### Tensile strength

This experiment demonstrated in Figure 1 shows that tensile strength slightly increase when the pelt is tanned

TABLE 2

## Chemical properties of rubber seed oil tanned leathers

Rubber seed oil (%)	Oxidation time (days)	pH	Ash content (%)	Oil content (%)
10	5	7.5	0.9	2.3
10	7	7.6	1.0	3.4
10	9	8.0	1.1	4.5
20	5	7.4	0.9	4.6
20	7	7.8	1.1	3.2
20	9	8.0	1.1	6.0
30	5	7.1	0.9	5.1
30	7	7.6	1.2	5.1
30	9	7.7	1.2	3.9

with rubber seed oil. Tensile strengths of the leathers were 13 to 21 N/mm<sup>2</sup>. Those values were higher than those for chamois leather, i.e. 7.5 N/mm<sup>2</sup>.<sup>8</sup> Since there is no chemical modification of the collagen structure, oil tanning reaction should retain all the strength properties of the raw pelt. All this may change if the pelt is tanned with an unsaturated fatty acid, compared to the conventional process with unsaturated triglyceride esters.<sup>9</sup>

In this trial, the oxidized rubber seed oil matrix might undergo interaction with collagen matrix, so that the pelt became slightly stronger and more stable structure. Collagen-oil linkages occur in two phases; oil penetrates into skin or hides mechanically, and then oxidized. The oil oxidation leads to peroxide formation, which in turn reacts with amino acid of collagen. Besides tanning, tensile strength is also affected by fiber composition in the leather. Consequently, tensile strength of coupon, which has stronger and more compact collagen

network, will be higher than that of skin or hide from shoulder or belly. Leather's tensile strength is also affected by its thickness; thin leather has loose collagen fiber, so it has a lower tensile strength and elongation.

*Elongation at break (%)*

This experiment shows that elongation at break of the leathers were 120 - 150% as demonstrated in Figure 2. They met the requirement for chamois leather, i.e. more than 50%.<sup>8</sup> Generally, it shows also the increasing of oil offers from 10% to 30% has decreased the leathers' elongation at breaks, whereas the increasing of oxidation times from 5 days to 9 days has increased their elongation at breaks. In generally, the chamois leathers' elongation at break for perpendicular direction to backbone is higher compared with that for parallel direction. It might due to the skin stretching on perpendicular direction when the animal alive is more intensive than that on parallel direction.

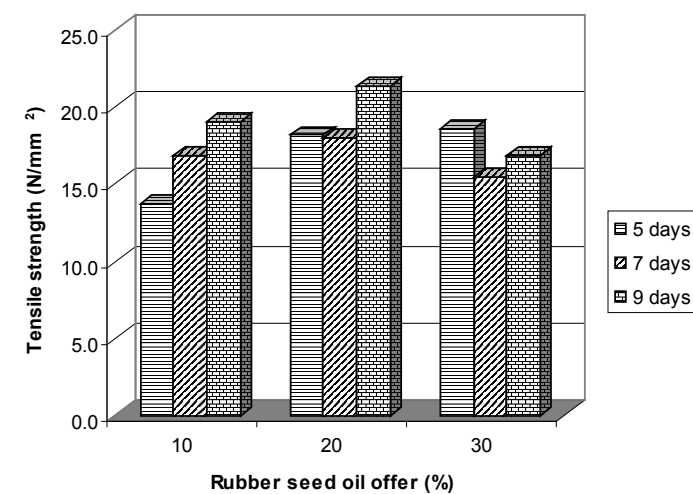


Figure 1. Effects of oil offer and oxidation time on the tensile strength of rubber seed oil tanned leather

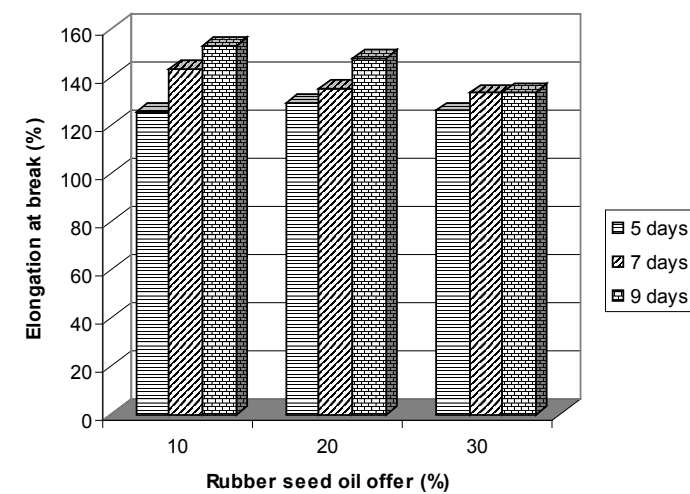


Figure 2. Effects of oil offer and oxidation time on elongation at break of rubber seed oil tanned leather

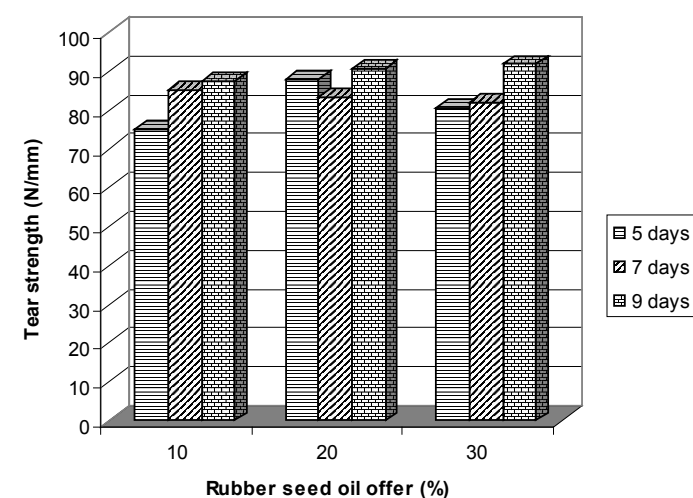


Figure 3. Effects of oil offer and oxidation time on tear strength of rubber seed oil tanned leather

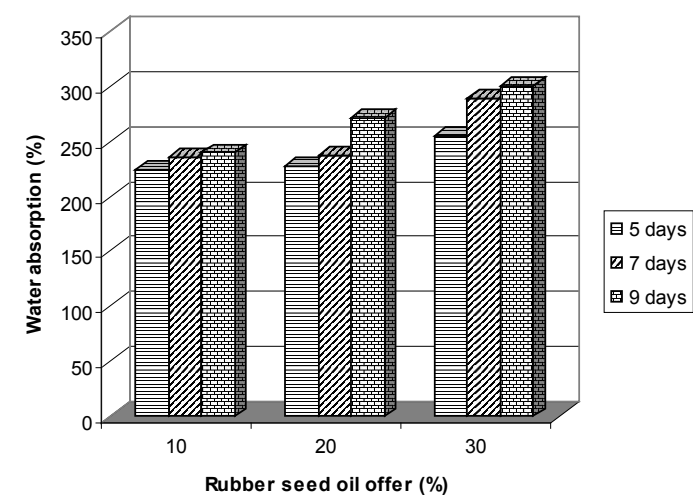


Figure 4. Water absorption for 2 hours of rubber seed oil tanned leather

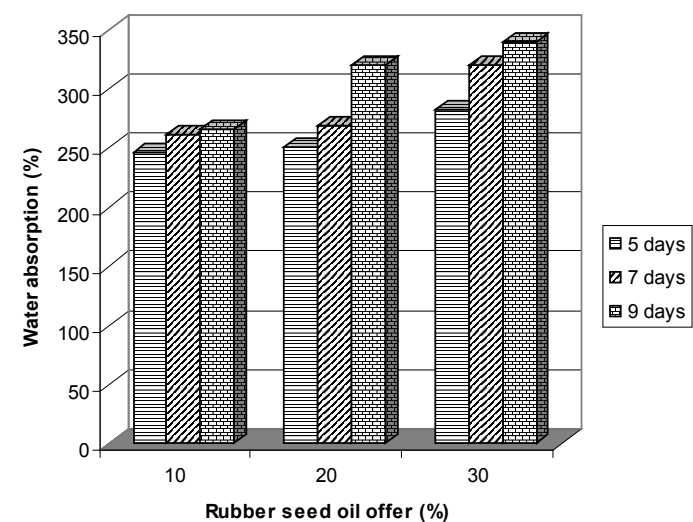


Figure 5. Water absorption for 24 hours of rubber seed oil tanned leather

*Tear strength*

Leathers resulted from this experiment had tear strengths of 70 – 90 N/mm as depicted in Figure 3. It shows that tear strengths met the requirement, i.e. higher than 15 N/mm.<sup>8</sup>

According to this result, generally, in the range of oil offers and oxidation times used in this trial, the increasing of oil offer from 10 to 30% and oxidation time from 5 to 9 days increased the tear strengths of the leathers. It indicates that the oil tanning caused the leather more elastic.

*Water absorption*

Water absorption is an important parameter for chamois leather, since it relates to its function as washing, drying or filtering agents. One of chamois leather advantages is its high water absorption capacity. The water absorption (retention) properties arise from the effect of the oil matrix holding the protein structure apart, allowing it to interact with water.<sup>9</sup> The water absorptions for 2 hours were 225 to 300% and for 24 hours were 240 to 340%, as demonstrated in Figures 4 and 5. In general, those water absorptions were higher than that required, i.e. minimum of 100% and 200%, respectively.<sup>8</sup> This result also shows that the increases in water absorptions from 2 hours to 24 hours were 20 to 50%.

Based on their water absorption capacities, oil tanning using 20% oil offer for 9 hours oxidation time was similar with that using 30% oil offer for 7 or 9 hours. Therefore, the condition was an optimum treatment in this trial, since it gave the most efficient treatment among the others.

*Organoleptic properties*

Organoleptic properties are main parameters in chamois leather quality assessment. The organoleptic properties are softness, color, and odor. The organoleptic properties of rubber seed oil tanned leather resulted from this experiment are given in Table 3.

According to Table 3, leather softness is affected by its oil offer and oxidation time in tanning; the higher oil offer and oxidation time, the better the softness. In contrary, the higher oil offer and oxidation time, the higher the color and odor intensities. An optimum condition for both factors should be determined to obtain chamois leather with good quality and optimum production cost.

Leather softness resulted in by the oil tanning trial using 20% rubber seed oil offer for 9 days oxidation time closed to that using 30% rubber seed oil offer for 7 or 9 days. Color and odor resulted in by 20% oil offer were better than those by 30% oil offer, and not much different from 10% oil offer, for all oxidation times. Therefore, tanning using 20% rubber seed oil offer for 9 days oxidation time was the optimum condition in the trial.