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## Quality of Leather Using Vegetable Tannins Extract of *Acacia Mangium* Bark from Waste of Industrial Plantation

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**Abstract.** The purpose of this study was to determine the characteristics of leather using vegetable tanning ingredients from the bark of *Acacia mangium Willd.* Tanning agent ingredients are provided in the form of bark powder and extract. The first phase of the preparation of the bark into powder and the second stage is the extraction of tannin from *A. mangium* bark. Extraction using water at 100°C for 30 minutes then evaporated so that tannin extract was obtained. Then the second stage is carried out the tanning process using both materials. Data analysis uses paired two sample for means T-test. The results of statistical analysis showed significant differences in the characteristics of the leather produced. Chemical analysis of leather tanned using *A. mangium* bark obtained moisture content of 16.76%, ash of 3.42%, tannin bound 18.99% and degree of tanning 38.21% while chemical analysis of leather tanned using tanneries *A. mangium* bark extract which is moisture content 16.03%, ash 4.18%, bound tannin 32.41% and 84.82% tanning degree. The physical properties of leather using *A. mangium* bark powder were tensile strength 493.84 kg / cm<sup>2</sup>, elongation 34.94%, zwick strength / lastability 6.66 mm (leather cracked). Compared to the characteristics of leather using tanner *A. mangium* bark extract, tensile strength was 254.32 kg / cm<sup>2</sup>, elongation 44.39%, zwick / lastability strength 8.63 mm (leather not cracked).

### 1. Introduction

Timber production from Industrial Plantation Forests leaves waste in the form of untapped bark. One type of plant developed is, *A. mangium Willd.* The potential of this bark may still be used as a tannin preparation [1]. Some studies say tannins are widely found in plants such as stems, roots, leaves, fruit, and skin. According to [2], tannins are the most important substances in plants, found in the wood, bark, fruit leaves, and roots, which occur naturally, and is used as a leather tanning material [3].

*A. mangium Willd.* which is often referred to as mangium is one type of plant that is widely developed in the industrial plantation forest program. According to FAO, as much as 67% of the total mangium forest in the world is in Indonesia. Harvesters can be carried out at the age of 5-8 years used for pulp making in the paper industry [4]. The utilization of mangium wood has so far experienced a broader spectrum, both for fiber wood, woodworking, and energy wood (fuel and charcoal). Various studies have been conducted to support the expansion of the use of mangium wood in the form of whole wood, particles, fibers or wood derivatives. In addition to the wood, it has also been investigated mangium bark extraction as a tanner. Some studies use acacia plants as tanneries [5, 6, 7, 8]. Extraction aims to attract secondary metabolites with the help of solvents [9]. Tannins can be



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dissolved in water, alcohol, acetone, but insoluble in benzene, chloroform, and organic solvents from petroleum ether [7]. That tannin is a water-soluble compound [10].

The purpose of this study was to determine the characteristics of the leather by using vegetable tanning ingredients from powder and tannin extract from *A.mangium* bark. The quality of the leather with *A.mangium* bark is observed, and likewise, the leather with tannin agent of extract from *A.mangium* bark. Observations in the form of chemical analysis and permitting physical properties of leather.

## 2. Materials and Methods

The ingredients used are aquades, goat skin and *A.mangium* bark. The bark obtained from PT.Arara Abadi. The bark used is a tree that has been ripe for harvest.

### 2.1 Research Equipment

The equipment used was an analytic frame *Kern*, centrifuge *Hettich 320R*, cabinet dryer, disc mill, vacuum rotary evaporator R-1001 VN, 70 mesh sieve, spectrophotometer *Shimadzu UV 1800*, soxhlet, universal testing machine CY-6730, colorflex Ez hunter and calipers.

### 2.2 Preparation of Material tanning agent of *A.mangium* of Bark

*A.mangium* bark material is cut to 0.5 - 1cm in size and dried. Then it was put into a disc mill and filtered with a 70 mesh filter. The material that passes the filter is partly prepared for the extraction process.

**2.2.1 Tannin Extraction.** Tannin extraction was carried out using distilled water. Comparison of ingredients with solvents 1:20. The extraction process was carried out by the heating temperature of 100°C for 30 minutes. The time is calculated after the temperature is reached. Then the mixture is filtered using filter paper to obtain a filtrate. The filtrate is concentrated using a vacuum rotary evaporator so that it is obtained tannin extract. Then, the extract yield was calculated.

**2.2.2 Tanning Process.** Goatskin tanning uses skin tanning modification methods from the Yogyakarta Balai Besar Kulit Karet dan Plastik (BBKKP), namely: The skin used is goatskin. Skin preparation for tanning which consists of soaking until the skin is obtained. The skin is continued with tanning using *A.mangium* bark (not extract) and tannin extract from *A.mangium* bark. Then the skin is overnight for 24 hours. After that, the skin is washed to remove residual tanning substances that are still attached, then drying by means of opposition. The leather is prepared for testing. Testing the characteristics of leather consists of chemical analysis and physical properties. Chemical analysis was carried out based on the testing method on SNI-0234: 2009. Meanwhile, measurement of physical properties of leather refers to ISO 3376: 2011.

### 2.3 Data analysis

Statistical data analysis was performed to compare the two results of the leather analysis. The process of data analysis is done using paired two sample for means t-Test.

## 3. Discussion

The results of the analysis of *A.mangium* bark powder can be seen in Table 1. *A.mangium* bark powder contains tannin at 24.80% and 25.59% in water-soluble ingredients, 2.73% ash content and pH value equal to 6. Tannin content of a large vegetable tanning ingredient of 10% can be used as a tanner [11]. Based on the chemical analysis carried out, *A.mangium* bark powder can be used as a tanner.

**Table 1.** Analysis of *A.mangium* bark

Components	Persentase
Moisture content	10.76 ± 1.50
Water soluble	25.59 ± 4.41
Tannin	24.80 ± 1.31
Ash	2.73 ± 0.53
pH	6 ± 0,0

### 3.1 *A. mangium* Tannin Extract

The extract obtained was calculated as yield, namely the percentage comparison of the extract results with the material used. The yield of tannin extract produced can be seen in Table 2. The yield of tannin extract obtained was 33.63%. In addition to tannin content there is also an analysis of 78.51% water-soluble material, 12.10% moisture content, 3.71% ash and pH 6. This tannin extract is used as a vegetable tanner. Whereas the tannin content of the extract is 48.57%. The use of extracts on plant tanneries allows these substances to penetrate rapidly into the skin because the extracted substances have small molecules and active binding capacity on the skin molecules. This molecule and its binding capacity can be enlarged by changing the density and pH so that it can increase the tanning power of the skin. The pH of the solution affects the solubility of a material [12].

**Table 2.** Analysis of extracts from the *A.mangium* bark

Components	Persentase
Moisture content	12.10 ± 2.95
Tannin	48.57 ± 0.51
Ash	3.71 ± 0.51
pH	6 ± 0,0

Chemical analysis of leather Table 3 shows the tanned chemical analysis data using bark powder and *A.mangium* bark tannin extract.

**Table 3.** The results of chemical analysis of leather with different tanning material forms from the *A.mangium* bark

Parameters	Form of materials		Description
	Powder of bark (%)	Extract tannin (%)	
Moisture content	16,76 ± 1,61	16,03 ± 0,92	ns
Fat	3,55 ± 0,14	3,56 ± 0,18	*
Ash	3,42 ± 2,75	4,18 ± 1,71	*
Water soluble	7,54 ± 0,74	5,58 ± 0,67	*
Raw skin content	49,71 ± 6,13	38,20 ± 3,87	*
Bonded tannin	18,99 ± 9,84	32,41 ± 9,24	*
The degree of tanning	38,21 ± 7,55	84,82 ± 7,36	*
Ph	7 ± 0,0	7 ± 0,0	ns

Description: \* (T count > T table = significant), ns (T count < T table = non significant)

Based on statistical analysis there is a significant difference between the leather chemical properties produced. Tanning with tannin extracts from *A. mangium* bark showed bonded tannins and a higher degree of tanning compared to the use of bark powder directly. Where tannins are bound and tanning levels of leather are 32.41% and 84.82%. When compared with leather tanned with bark powder the results are lower where the tannin content is 18.99% and the tanning degree is 38.21%. Judging from the bound tannin value and the degree of tanning the tanning extract tanning material is better than the use of *A. Mangium* wood powder due to different tannin levels. The extraction process

can have an effect on tannin polymers which can form intramolecular bonds in the intermolecular cross-ring environment with skin collagen. Likewise, the mechanism of vegetable tanning forms the amount of hydrogen bonds between several phenolic hydroxyl groups from tannins with carboxyl and amine compounds in skin collagen.

### 3.2 The Physical Properties of Leather

The results of the measurement of the physical properties of leather with tanning powder with tannin extract from *A.mangium* bark can be seen in Table 4.

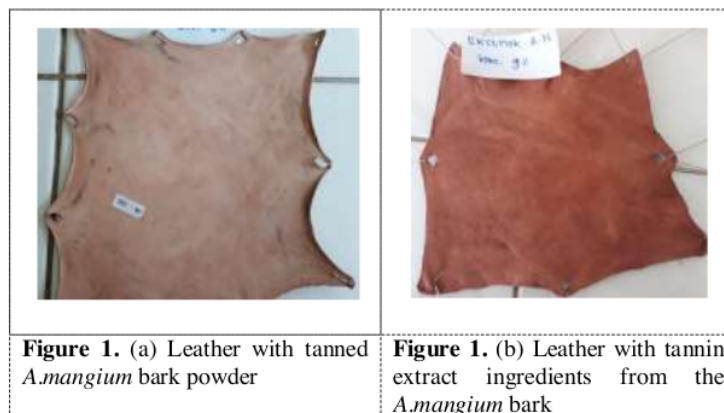
**Table 4.** Results of measurement of physical properties of leather

Parameters	Bark powder	Extract of bark	Description
Tensile strength (kg/cm <sup>2</sup> )	493,84 ± 31,59	254,32 ± 11,26	*
Elongation (%)	34,94 ± 1,32	44,39 ± 6,91	ns
lastibility (mm)	6,66 ± 0,46	8,63 ± 0,39	*
	(cracked nerf)	(nerf doesn't crack)	
Thickness (mm)	0,9 ± 0,1	0,9 ± 0,1	ns
Color	Light Brown	Brown	*

Description: \* (T count > T table = significant), ns (T count < T table = non significant)

Based on the results of the statistical analysis the measurement of tensile strength of tanned skin tanned with bark powder and tannin extract showed significantly different results. Tensile strength using bark powder results in a higher tensile strength compared to the tanned skin using tannin extract. However, it shows that there is a significant effect on leather elongation. Leather with tannin extract produced greater skin elongation 44.39% compared to tanned with bark powder which was 34.94%. Vegetable tanning material directly has limited properties of leather which are rather stiff compared to various treatments such as extracts and tanning combinations [13].

A significant difference is also found in the measurement of zwik skin strength, where the skin is tanned by using *A.mangium* bark powder which produces cracked nerf, while the leather using tannin extract from the bark is not cracked. The tanning process has a strong effect on the physical properties of the skin compared to skin that has not been tanned. In addition to strengthening physical properties, it can also increase the thickness of the skin due to the bonds that occur in the skin resulting in thicker and fuller skin [12]. Leather with vegetable tanners is generally light brown or reddish according to the color of the tanner.



**Figure 1.** (a) Leather with tanned *A.mangium* bark powder

**Figure 1.** (b) Leather with tannin extract ingredients from the *A.mangium* bark

#### 4. Conclusion

The results of research that has been done can be concluded that the use of tannin extracts from *A.mangium* bark produces a leather that is better than the use of bark powder. The bound tannin value and tanning degree using tannin extracting tanneries were higher than leather tanned with bark powder. Based on statistical analysis there are significant differences in the characteristics of leather with tanneries and extracts from *A.mangium* bark. Based on the measurement of physical properties of leather showed results that were not significantly different from the tensile strength of tanned skin. The tanned leather with bark powder produces leather that is cracked while tanning ingredients with extracts produce leather that is not cracked.

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