Preliminary

Mechanical Condensation of Tannin in *Acacia mangium* Bark

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Introduction

Condensed tannin, a natural polyflavanoid, reacts with formaldehyde to form polymerization products. Plomley established the basic principles for the use of tannin extraction from Acacia mearnsii (black wattle) in wood adhesives (1966), and on this basis, wattle tannin adhesives were commercialized in Australia for plywood production in the 1960's (Yazaki *et al.* 1998).

Recently, Yazaki *et al.* found that the bark of Acacia mangium contained more than 50% tannin that could be converted into high quality waterproof wood adhesives (1998). Acacia species is a fast growing, nitrogen-fixing tree planted extensively in Southeast Asia for the production of pulp and paper. In Sumatora and Kalimantan (N. Muhandis, 2000), 50,000 ha of Acacia mangium have been planted and the annual growth of Acacia mangium reaches 12.5 million m^3. Thus, a huge volume of resource for producing waterproof adhesives is being produced. However, because the bark has to be subjected to extraction, it requires a large scale and relative complex chemical system. Therefore, most of the Acacia mangium bark is not presently being used effectively, but is in fact disposed. This paper deals with a method to collect tannin rich bark powder mechanically.

Materials and Methods

Acacia mangium (*Acacia mangium Wild.*) bark samples were collected from breath height of a 10 year-old tree grown in Serpong, Indonesia and were dried at 40°C for three days to 11% moisture content. The dried bark samples were divided into inner and outer parts. The ratio of outer to inner bark was 3 to 1 in weight. After outer bark was ground to pass a 0.5 mm retaining screen in a Wiley mill, the fine bark powder was sieved for one hour. The resulting particle size distribution was 45–63 μm (33%), 63–125 μm (16%), 125–250 μm (15%) and 250–500 μm (36%).

Yields of Extractives

Ten grams of bark powder were mixed with methanol or water in ratios of 1 : 3, 1 : 5 and 1 : 10 in weight, and stirred at room temperature for 10 to 60 minutes. The mixture was vacuuming filtered with filter paper (#100) and washed with 12 g methanol or water three times. The methanol solution was condensed with an evaporator and freeze-dried after adding 30 g of water. The yields of the extractives were calculated on the basis of the weight of the freeze-dried extractives to the weights of completely dried bark powder before extraction.

1.33 g of extractives and 1.85 g of 3.7% formaline were mixed and water was added to make 6 g of mixture. The mixtures were stirred periodically in a test tube at 90°C after adjusting pH to 4 (natural pH), 6 and 8, using NaOH aqueous solution.

Results and Discussion

Effect of particle size on extractive yield

The methanol extractive yield was 49.4% for 45–63 μm fraction, 29.2% for 63–125 μm fraction, 32.5% for 125–250 μm fraction and 32.6% for 250–500 μm fraction. It is worth noting that the extractive yields differed among the fractions. Extractive yield was around 30% in the fractions above 63 μm, on the other hand, around 50% extractive yield was obtained at the fraction less than 63 μm. Furthermore the average adjusted Stiasny value for the extractives was 94.5%, indicating that tannin rich portion in a bark is ground down easily, and gathers into the small particle fraction. By this process, then, tannin in bark was condensed mechanically.

Table 1. Effects of solvent ratio to bark on extractive yield of outer bark

Solvent ratio of solution	63–125 μm		<63 μm	
	Methanol Yield (%)	Water Yield (%)	Methanol Yield (%)	Water Yield (%)
1 : 3	30.8	16.9	52.0	28.1
1 : 5	32.9	16.9	53.7	28.1
1 : 10	29.2	18.0	49.4	28.9

Table 2. Effects of stirring time on extractive yield of outer bark

Solvent time (min)	63–125 μm		<63 μm	
	Methanol Yield (%)	Water Yield (%)	Methanol Yield (%)	Water Yield (%)
10	37.1	16.9	52.8	30.3
30	31.6	17.3	52.8	28.1
60	31.5	18.0	55.1	28.9

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The effect of the bark ratio to methanol or water and the effect of stirring time on extractive yield are shown in Table 1 and 2. It can be seen that same extractive yields were obtained regardless of the ratio of solution and stirring time, indicating that tannin is dissolved easily by methanol. The yield of extraction by water decreased to two-thirds of those using methanol in every condition.

Gelation time

The mixture of extractives, formaldehyde and water was found to gelate. As reported previously (Plomley 1966), the gelation time decreased with an increase of pH. That is, the mixture gelated in 43 min at pH 4 and 90°C, and the gelation time reduced to 14.5 min and 7.5 min for pH 6 and 8, respectively.

References

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