

MANGROVE BARK: A RENEWABLE RESIN SOURCE FOR WOOD ADHESIVES.

Roland E. VETTER¹, Ana Paula Ribeiro BARBOSA¹

ABSTRACT — From four solutions tested to extract tannins from mangrove bark for wood adhesives, hot water is recommended. Hot water extracted 21.4% of formaldehyde-hydrochloric acid reactive polyphenols on oven-dry bark basis.

Key words: wood adhesives, wood extractives, tannin, mangrove.

Casca de Mangue: Recurso Renovável de Resina para Adesivos para Madeira

RESUMO — De quatro solventes testados para extrair taninos de casca de mangue para adesivos para madeira, água quente é a mais recomendada. Água quente extraiu 21.4% de polifenóis da casca seca reativos em formaldeído-ácido clorídrico.

Palavras chaves: adesivos para madeira, extrativos de madeira, tanino, mangue.

INTRODUCTION

Today not only the oil crisis but also ecological movements in the 1990's urge research to substitute petroleum products by renewable natural resources.

Tannin based resins for wood adhesive preparation were studied since the 1950's (DALTON, 1950). Research on use of tannins for particle board adhesives in Brazil were done by PASTORE (1978) and BARBOSA (1990) with material from the bark of wattle (*Acacia mearnsii* de Wild.). In the Amazon region the bark of mangrove (*Rhizophora mangle* L.) might be a resource for tannin adhesives. Getting started with research of mangrove bark extracts in adhesives it is worth to know more about the amount of polyphenols in mangrove bark. In this study different solutions were used to make extracts from mangrove bark.

MATERIAL

The material was milled from the

bark of the species *Rhizophora mangle*, which grows in the eastern part of the Amazon region. The water content of the bark used for the extractions was 24.9%. The extractions were made with different solutions:

- hot water
- ethanol absolute
- 0.5% aqueous NaOH (weight/volume)
- 2% aqueous Na₂CO₃ (weight/volume, oven-dry bark basis)

METHOD

The bark samples for extraction were not dried to prevent possible condensation of phenolic components before extraction. Humidity was determined with separate bark samples in an oven at 105°C for 6 hours. Samples of 2 grams (oven-dry bark basis) were extracted with 100 ml solution for one hour at 90°C and decanted through a paper filter. Extraction was repeated with the same sample and another 100 ml solution, again filtered and washed.

¹ Instituto Nacional de Pesquisas da Amazônia - INPA, Coordenação de Pesquisas em Produtos Florestais, Caixa Postal 478, 69011-970 - Manaus, Amazonas, Brasil.

After cooling down, the filtrate and the washings were made up to a 500 ml volume. Each sample extract was analyzed for formaldehyde-hydrochloric acid reactive polyphenols (Stiasny-method; DOAT, 1978):

1. 100 ml of the 500 ml solution were pipetted into an Erlenmeyer flask, 10 ml of 40% formaldehyde solution (volume/volume) and 5 ml concentrated hydrochloric acid were added. After refluxing for 30 minutes the reaction mixture was cooled down and filtered through a filter of medium porosity. The precipitate was washed with 100 ml distilled water, and dried for 2 hours and weighed.

2. Another 100 ml of the extract's solution were dried in an oven at 105°C and weighed.

The approximate molecular weight of commercially available *Acacia mearnsii* tannin for adhesives and the mangrove bark extracts were determined by high pressure liquid chromatography (HPLC) with a stainless steel column, 50 cm x 4.6mm ID, packed with Licrospher Si 100-10, tetrahydrofuran (THF) as solvent and standards of polystyrene (MW 3000, MW 600). Flow rate was 60 ml per hour and detected by UV (270 nm).

RESULTS

The weight of the oven-dry extracts - calculated on oven-dry bark basis - represents the amount of solids which are

soluble in the specific solutions, polyphenolic as well as non-polyphenolic components (Tab.1). The resulting content of formaldehyde-hydrochloric acid reactive polyphenols ("Stiasny-phenols") was calculated in percent oven-dry bark and in percent soluble solids (Tab. 1).

The polyphenol amount varies just in a small range using different solutions (between 21.4% and 26.8%). The amount of total extractives (soluble solids) varies from 24.2% to 57.1%, but the content of non-polyphenolic components was higher with more soluble solids extracted (Fig. 1). The commercially available "tannin powder" from TANAC SA., Montenegro-RS, Brazil is extracted from plantation grown *Acacia mearnsii*. This product was also analyzed for formaldehyde-hydrochloric acid reactive polyphenols (Stiasny-method). The content of "Stiasny-phenols" was 87.7% (oven-dry basis), which lies in the same range as the hot water extract of mangrove bark (88.7%; Tab. 1).

The elution volume of the tannin samples, both of *Acacia mearnsii* and *Rhizophora mangle*, was 3.5 ml and for the MW600- and MW3000-standards, 3.6 and 3.2 ml, respectively, which means that the molecular weight of the samples ranges between 600 and 3000.

Table 1. Percentage of extractives (oven-dry bark basis).

Solution	Soluble solids	Polyphenols	Polyphenols
	Solids	/ o.d. bark	/ o.d. Soluble Solids
Hot Water	24.2	21.4	88.7
Ethanol	36.6	22.8	62.5
0,5% NaOH	57.1	23.2	44.8
2% Na ₂ CO ₃	41.3	26.8	64.9

Soluble Solids (%)

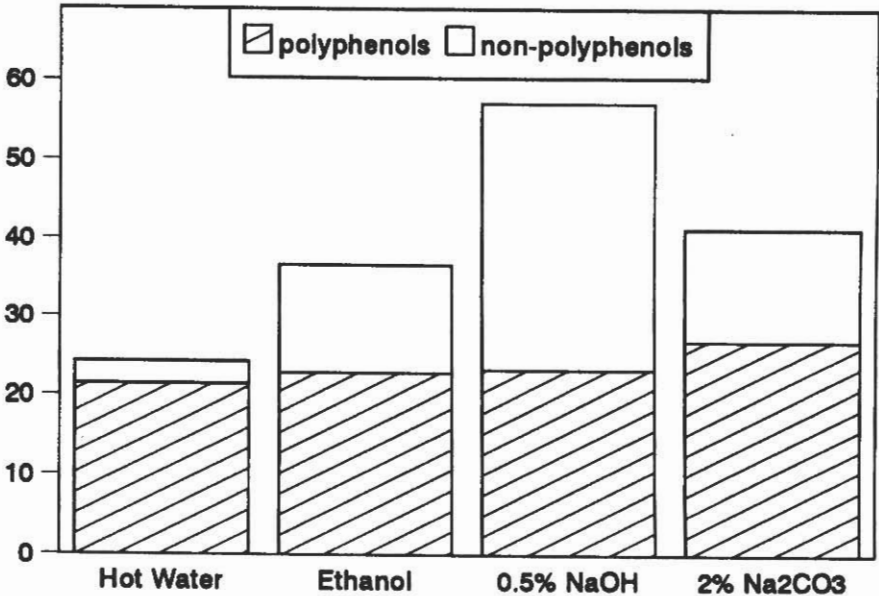


Figure 1. Percentage of extractives (oven-dry bark basis)

DISCUSSION

Though the amount of “Stiasnyphenols” extracted from mangrove bark with the sodium carbonate solution is 25% above that of the hot water extract, it must be considered that the properties of the tannin adhesive depend basically on the reaction of the polyphenols with formaldehyde. The amount of the non-phenolic components in the sodium carbonate solution extract is more than three times higher than that in the hot water extract, which, in turn, affects the polymerization of the adhesives resulting in an inferior quality of the end product. Therefore it is recommended to use hot water to extract polyphenolic components from mangrove bark, even if the overall amount is lower than that achieved with the sodium carbonate

solution.

The provenance of a natural product should always be taken into account to recommend or not its utilization. The utilization of mangrove bark must not be recommended if it leads to a possible devastation of natural mangrove forests which represent an indispensable protection for the Northern Brazilian coast line against the forces of the ocean. Products from forests under sustainable management and from plantations are considered as renewable resources and, therefore, to be recommended.

Literature cited

- BARBOSA, A. P. 1990. *Modificação química de taninos de acácia negra (Acacia mearnsii) para aplicação como adesivos*. M.Sc.Thesis, UFRJ, IMA, Rio de Janeiro. viii + 196 p.

- DALTON, L. K. 1950. Tannin-formaldehyde resins as hot-press plywood adhesives. *Tectona* xliii: 137-150.
- DOAT, J. 1978. Tannin in tropical woods. *Bois. For. Trop.* 182: 34-37.
- PASTORE Jr., F. 1978. *Tannin adhesives*. M.Sc.Thesis. The City University, National College of Rubber Technology, London. 118 p.

Aceito para publicação em 18.10.1995