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Production of Tannin Formaldehyde Wood Adhesive For Water-Proof Particle Boards

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ရေစိုခံနိုင်သော သစ်စပြားများပြုလုပ်ရန်အတွက် တင်နင်ဖေါ်မယ်ဒီဟိုဒ် သစ်သားကပ်ကော်ထုတ်လုပ်ခြင်း

ဒေါ်ခင်မေလွင်၊ B.Sc. (I.C) (Rgn.),
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လက်ထောက်သုတေသနအရာရှိ၊ သစ်တောသုတေသနဌာနခွဲ

စာတမ်းအကျဉ်းချုပ်

သစ်ခေါက်သည် ဘေးထွက်သစ်တောထွက်ပစ္စည်းတစ်ခု ဖြစ်ပါသည်။ ယေဘူယျအားဖြင့် သစ်ခေါက်တွင် ပါဝင်သော extractive များမှာ အရေအတွက်များပြား၍ ရှုတ်ထွေးစွာ ပါဝင်လျက် ရှိပါသည်။ ယင်း extractive များတွင် Phenol compound များပါဝင်ပါသည်။ ဥပမာအားဖြင့် flavanoids, stilbenes နှင့် tannin စသည်တို့ ဖြစ်ကြပါသည်။ Tannin သည် Phenolic ပစ္စည်းများကဲ့သို့သော ဓါတ်ပြုမှုများ ပြုမူဆောင်ရွက်နိုင်စွမ်းရှိပါသည်။ ယင်းသည် formaldehyde နှင့် ဓါတ်ပြု၍ resin ကို ရရှိစေပါသည်။ ၄င်း resin ကိုအချို့နေရာများတွင် ရေစိုခံနိုင်သော ကော်အဖြစ် အသုံးပြုကြပါသည်။ သစ်ခေါက်နမူနာ (၅) မျိုးမှ tannin ကိုထုတ်ယူပြီး tannin formaldehyde adhesive ပြုလုပ်ပါသည်။ ၄င်းကော်များကို အသုံးပြုပြီး ကျွန်းလွှစာမှုန့်များကို သစ်စပြားများအဖြစ် ပြုလုပ်ပါသည်။ ထုထည်တိုင်းတာပြီး သိပ်သည်းခြင်း တွက်ချက်ပါသည်။ ခံနိုင်ရည်အားကိုလည်း စမ်းသပ်ခဲ့ပါသည်။ ရရှိသော အချက်အလက်များကို နှိုင်းယှဉ်သောအခါ Black Wattle Tannin သည် ရေစိုခံနိုင်သော သစ်စပြား ပြုလုပ်ရန် အကောင်းဆုံးဖြစ်ကြောင်း တွေ့ရပါသည်။

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Abstract

One of the byproducts of the forest industry at plant site is bark residue. Barks generally are much richer than wood in quantity and complexity of extractives. The extractive material contains phenolic compound, for example, flavanoids, stilbenes, tannins and so on. The tannins have attracted interests as a source of phenolic substances which may be reacted with formaldehyde to form resins. Some of them have potential uses as water proof adhesive. In this project, tannins were extracted from the barks of five timber species by water extraction and five different tannin formaldehyde adhesive particle boards were prepared with teak saw dust. The volume of the boards were measured and their densities calculated and the durability tested. When compared to each other, Black Wattle tannin gave the best result.

Contents

1. Introduction

Vegetable tannins are polyphenols with molecular weight in the range of 500 to 3000, presented in vegetable tanning materials and in its extract. The materials are obtained in the form of wood, bark, fruit and leave from various plants. Chemical processing of bark is limited and the principal chemical products produced commercially from them are based on bark's phenolic content. Barks generally are much richer than wood in quantity and complexity of extractive components, the most important being monomeric tannin, phlobaphenes and phenolic acids. (Anderson, 1975). The phenolic substances are contributed mainly in heart wood and bark and also minute amounts in xylem. Phenolic compounds effectively prevent microbiological attack due to its fungicidal properties. Basically phenolic compounds are divided into five groups, hydrolyzable tannins, flavanoids, lignans, stilbenes and tropolones (Franz. 1968). Many plants produce tannins but properties and yield vary and, as a result, only few are used commercially. The commonly available tannin materials in Myanmar are nut of the Panga (*Terminalia chebula* Retz.), bark of Black Wattle (*Acacia mollissima* Klotz.), Su Byu (*Acacia arabica* Linn.), Ngu (*Cassia fistula* Linn.), Byu (*Rhizophora candelaria* DC.), Thit-e (*Castanea sativa* Miller.), Zin Byun (*Dillenia pulcherrima* Kurz.) and so on.

Tannin has been used extensively in leather tanning industries. In recent years, it attracted interest as a source of phenolic substances, which may be reacted with formaldehyde to form resin. Some of them have potential uses as waterproof adhesive. Their main point of interest is that they are highly reactive and cheaper than phenol which is the most important raw material for water-proof particle board and plywood adhesive. (Plomley, et.al. 1957).

Future growth and development of the particle board industry may depend largely on sources of phenolic adhesive other than petroleum. Further, it would be desirable that a low cost raw material be a renewable source of phenolics. Use of phenolic components of bark extracts in preparing adhesive components used in plywood and particleboard manufacture has been proposed from time to time. Such preparations are based on the reaction of bark phenolic components with an aldehyde, usually formaldehyde.

One of the byproducts of the forest industry at plant site is bark residues. Sawdust is also a scrap byproduct of saw mills and furniture plants. A recent survey indicated that bark was the least utilized of all types of residues.

This study attempts to investigate the amount and quality of tannin extracted from the barks of some species, which could be applied as bonding agents for particle board.

2. Materials and Methods

2.1 Materials

The bark of the following five species were collected for testing.

Sr.No	Species	Botanical Name
1.	Black Wattle	*Acacia mollissima* Klotz.
2.	Byu	*Rhizophora candelaria* DC.
3.	Ngu	*Cassia fistula* Linn.
4.	Thit-e	*Castanea sativa* Miller.
5.	Kuthan	*Hymenodictyon excelsum* Wall.

2.2 Methods

2.2.1 Sample Preparation

The barks were collected, cleaned and dried in the sun light and then were ground by cutting equipment to 60 mesh powder.

2.2.2 Tannin Extraction

Water is the simplest solvent for tannin extraction.

The bark powders were put into the muslin bag and boiled with water in a steel pot. When the colour becomes dark, the liquid was poured into the second pot. Some more water was put again in the first pot and boiled again. This process was repeated 3-4 times until the liquid become clear. Then the second pot was evaporated and dried in the oven at 108°C. The dry flours were found to be tannin after examination.

2.2.3 Adhesive Preparation and Board Making

The glue mix was prepared as follows

Glue mix.

Constituents	**Parts by mass**
Tannin extract	45
Water	55
Caustic soda (50% aqueous)	4
Glacial acetic acid	3
Formaldehyde (40% aqueous)	11

A solution of tannin, containing 45% by mass of solids was prepared by dissolving dried tannin powder (45 parts) in water (55 parts) and adding caustic soda solution (4 parts, 50% by mass) to adjust the p^H level to 9-5. The mixture was refluxed at 105°C for 60 min. and cooled to ambient temperature. Glacial acetic acid (3 parts) was added slowly with stirring to lower the p^H to 7-0. The viscosity of this solution was in the range 100-150 c.p.at 25°C.

To the extracted solution was added formaldehyde solution (11 parts, 40% by mass) and mixed thoroughly before spraying the adhesive resin on the wood saw dust in the blender. The effective pot - life of the resin was 3-4 hr. under these conditions and 30% of adhesive were used on the mass of dry teak saw dust. The boards were pressed at 135°C for 30 minutes by hot press at 330 psi.

2.2.4 Adhesive test

After trimming and sanding, the boards were left to post - cure for 24hr. before being conditioned at 20°C and a relative humidity of 60% for 24 hr. prior to testing. The thickness of each panel was measured at several positions and the sample boards were weighed for determination of density.

The sample boards were also prepared for determination of hardness. Duplicate samples were also prepared to be tested after soaking in cold water at 20°C for 24 hr. while the others were tested after soaking in boiling water (100°C) for 2 hr.

3. Results

The tannin contents obtained from the bark of different species are shown in Table I.

Table I. Tannin content in tested barks

Sr.No	Species	Tannin %
1.	Black Wattle	69.7%
2.	Byu	42.0%
3.	Ngu	21.5%
4.	Thit-e	12.0%
5.	Kuthan	18.0%

The average results of physical test conducted on particleboards with tannin formaldehyde adhesive are summerized in Table II and Table III.

Table II. The average density of particleboard under the condition of 135°C press temperature, 30 minutes press time and 10 mm thickness.

Board No.	Species	Density
1-5	Black Wattle	884.4 Kg/m^3
6-10	Byu	878.5 Kg/m^3
11-15	Ngu	770.4 Kg/m^3
16-20	Thit-e	651.2 Kg/m^3
21-25	Kuthan	642.8 Kg/m^3

Table III. The average hardness of particle boards

Board No.	Bark Species	Hardness Lb/in^2		
		Before Soaking	After 2 hr. in Boil Water	After 24 hr. in Cold Water
1-5	Black Wattle	740	460	640
6-10	Byu	260	not resistant	not resistant
11-15	Ngu	100	40	70
16-20	Thit-e	180	not resistant	not resistant
21-25	Kuthan	150	not resistant	not resistant

4. Discussions

The results indicate that the density of particle boards which are made by using Black Wattle tannin are highest. The boards made by Byu tannin are lower than Black Wattle in density but it is higher than the others.

The hardnesses of the Black Wattle board is 740 lb/in^2. The Black Wattle board appears to be sufficiently durable for exterior application. The hardness of Ngu board is considerably lesser than Black Wattle boards.

Black Wattle particleboard can resist to water, high relative humidities, and temperature as low as 100°C. Ngu adhesive also can resist to water at high temperature but lower than Black Wattle. The particleboards made of other tannin formaldehyde adhesive are less resistant to warm, moist or humid condition than the boards made of Black Wattle tannin formaldehyde adhesive.

5. Conclusion

Since Black Wattles have a higher reactivity than other tannin, it could be possible to increase the production rate of particle board, as tannin formaldehyde resins of Black Wattle need shorter assembly and pressing times than most phenol formaldehyde formulations. Hot post - curing improved the bond strengths of particleboard made with Black Wattle based glue.

Particle boards prepared by using tannin formaldehyde adhesive of Black Wattle showed good water - proof ability and suitable for exterior cladding for temporary buildings, as floor underlays, as ceiling materials and in the general construction. The Black Wattle is an exotic species in Myanmar. It has been introduced in small scale in Southern Shan State during 1968 to 1972. As Black Wattle bark can produce the best tannin, which is required in making particle boards, it is suggested that more of Black Wattle plantations should be established in Myanmar.

Appendix I

Black Wattle.	
Botanical Name	*Acacia mollissima* Klotz.
Family	MIMO SACEAE.
Native	Australia
Introduced	1965
Source of supply	Southern Shan State (1) Taunggyi (2) Kalaw (3) Pindaya (4) Pinlong (5) Kyaing Tone
The tree	A large tree, exceeds 45 ft in height at 5-6 years old tree. Reaches 3 ft 5 inches in girth at 4 ft 6 inches above the ground. Grows in 4000 ft above sea level and 50"-60" annual rainfall.
Uses	Tannin extract from the barks. The woods are used for pole, fuelwood and charcoal. It is also fairly good pulpwood.
Bark yield	Round about 4 tonnes/acre.

Appendix II

Tannin (Hathway, Jurd,1962) can be divided into three classes.

(1) Gallotannins
(2) Ellagtannins
(3) Condensed tannins

Fig (1) Gallotannins are polymeric esters of gallic acid or digallic acid with sugars, such as glucose.

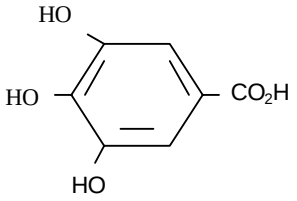
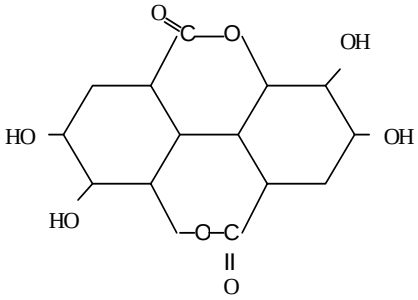
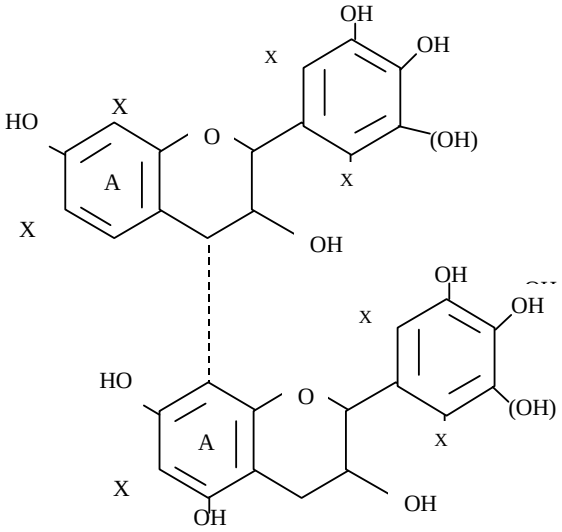


Fig. (2) The ellagtannins give the insoluble ellagic acid on hydrolysis.



The condensed tannins are polymer of hydroxylated flavanoid constituents. The phenolic hydroxyl groups are highly reactive and they induce reactive centres in the ortho- and para-position of the benzenoid nuclei as shown in Fig (3).



X = Highly Reactive Centre
x = Reaction Centre

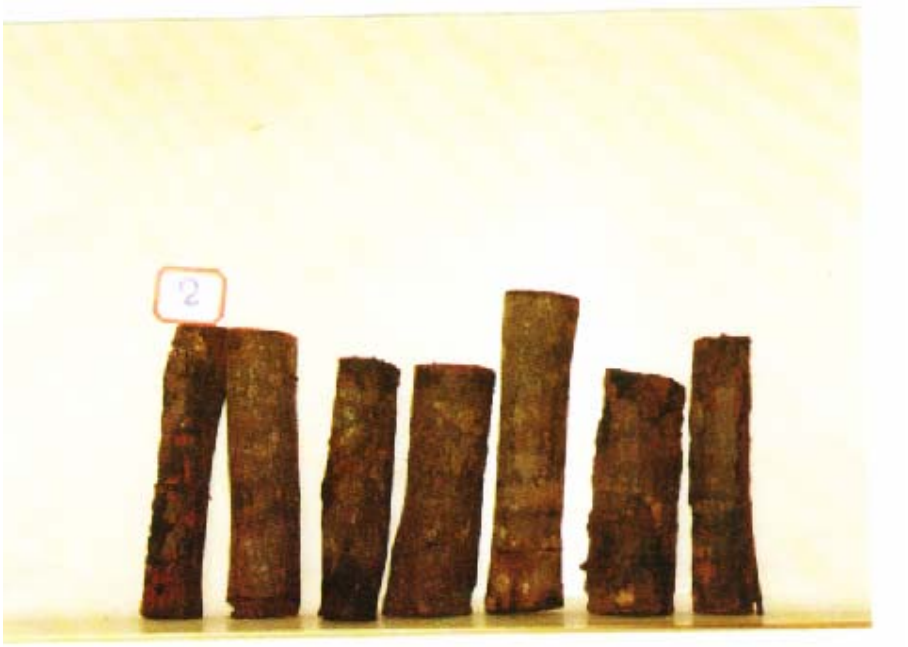


Fig. (1) Black Wattle Barks.

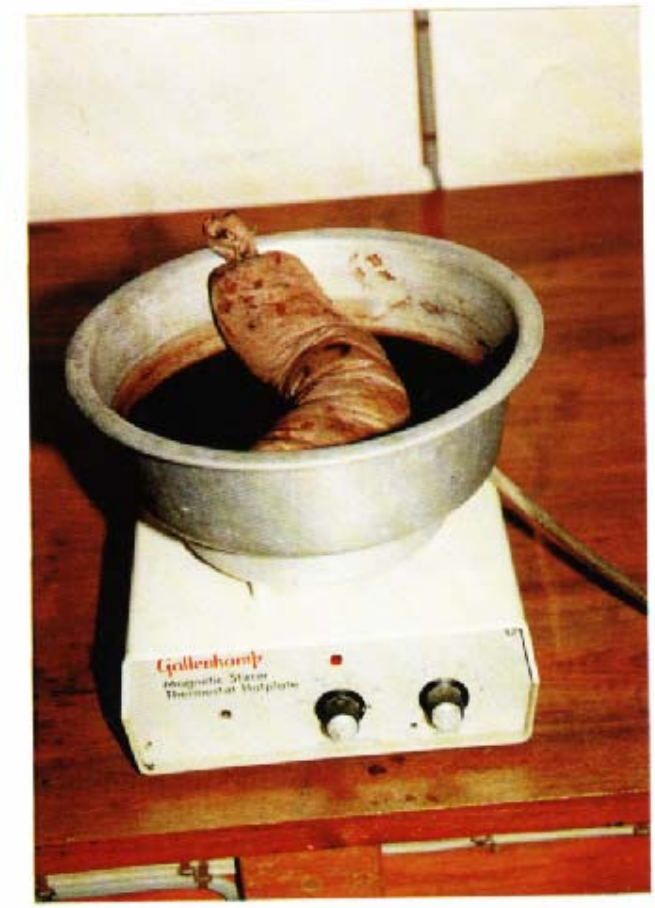


Fig. (2). Tannin Extraction

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