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# Efficacy of *Erythropleum suaveolens* (potrodom) and *Distemonanthus benthamianus* (bonsamdua) Water Extractives on the Durability of Five Selected Ghanaian Less Used Timber Species

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## ABSTRACT
Conventional wood preservatives are not only toxic to target bio-deterioration organisms but also to man, other organisms and the environment. In an effort to find preservatives that are less or non- toxic to man, other organisms and the environment, efficacy of branch bark and heartwood water extracts (0.65g/ml) of *Erythropleum suaveolens* (potrodom) and *Distemonanthus benthamianus* (bonsamdua) respectively were tested on five selected less used timer species (LUS): *Sterculia oblonga* (ohaa), *Antiaris toxicaria* (kyenkyen), *Canarium schweinfurthii* (bediwonua), *Celtis zenkeri* (esa-kokoo) and *Cola gigantea* (watapuo) following a modified EN 252. Regardless of extract retention in selected LUS, potrodom extract improved their durability more than that of bonsamdua. Improved durability of immersed and brushed selected LUS was ranked as follows: *C. gigantea* > *C. zenkeri* > *S. oblonga* > *A. toxicaria* > *C. schweinfurthii*. Though extracts showed reduced efficacy with time, indications were that they could be employed to control pests in low durability woods.

**Keywords:** Branch, eco-friendly, bio-deterioration, preservatives.

## 1. INTRODUCTION
Conventional wood preservatives are not only toxic to target bio-deterioration organisms but also to man, other organisms and the environment especially when they take very long to bio-degrade to less or non- hazardous products when outside wood[1]. One ready source of eco-friendly preservatives is extractives from naturally durable timber species which in abundance are responsible for wood durability[3]. It appeared the efficacy of branch bark and heartwood water extracts of *Erythropleum suaveolens* (potrodom) and *Distemonanthus benthamianus* (bonsamdua) respectively had not been adequately tested in the search for eco-friendly botanical preservatives in Ghana.

Thus, the aim to test by non-pressure impregnation the efficacy of branch bark and heartwood water extracts (0.65g/ml) of *E. suaveolens* and *D. benthamianus* respectively on five selected (around 50cm dbh from lat 06º 43´ N and long 01º 36´ W) less used timer species (LUS): *Sterculia oblonga* (ohaa), *Antiaris toxicaria* (kyenkyen), *Canarium schweinfurthii* (bediwonua), *Celtis zenkeri* (esa-kokoo) and *Cola gigantea* (watapuo) following a modified EN 252[2].

## 2. MATERIALS AND METHODS
Preparation of extracts: Branch bark of *E. suaveolens* and heartwood of *D. benthamianus* were air-dried, chopped into chips and milled into granules. Granules were further milled to particles of 40-60 mesh size. Extracts were removed from equal weights (200g) of particulate meals of each species in equal volumes of distilled water (5000ml) by gentle warming on hot plate at 40-60ºC[3-4] for three hours. Extract from each species was kept in a conditioning room to maintain concentration.

Preparation of samples and experimental design: Freshly sawn lumber from selected LUS was air-dried for three months to 25-30 % MC[1]. True heartwood (near pith) and sapwood (near bark) samples of 60 x 25 x 12.5 mm were sawn from lumber for impregnation. Experiment was in the Complete Randomised Design (CRD) where visual durability ratings, percentage hardness loss or percentage mass loss was a single-factor (efficacy response) with its corresponding control, potrodom-extract-impregnated and bonsamdua-extract-impregnated values as levels of each single-factor (treatments). Four heartwood and four sapwood samples from each selected LUS were immersed in extracts, and the same number brushed with extracts and another left untreated as controls.

Initial Data: Each sample was labelled and weighed. Hardness of sample was taken with Proceq Pilodyn [0 being no penetration (highest hardness) and 40, the deepest penetration (lowest hardness). Samples were rated visually on a scale of 0 to 4 (0 being no termite attack, 1: slight attack, 2: moderate attack, 3: severe attack and 4: failure)[2]. Initial moisture content, of samples was measured once with the Pin-type hygroscopic dielectric moisture meter.

Impregnation of samples and pre-burial Data: Four sapwood or four heartwood samples were immersed in 2500ml of extracts for one week and another brushed liberally three successive times with extracts and allowed to dry for a day in-between brushing on ambient conditions. After, samples were held in a sieve for excess extract to thoroughly drain for 90 minutes and extracts retention in them determined by:

$$\{(q2\text{-}q1)/V\}\ [5] \qquad (1)$$

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Where $q1$ is the mass of air-dried un-impregnated sample, $q2$ is the mass of air-dried impregnated sample and $v$ is the volume of air-dried un-impregnated sample. Samples were then close-stacked and kept wrapped for two hours to enable extractives fix. After, samples were lined on polyethylene sheets spread in the laboratory for drying for 5 days under the ventilation of ceiling fans to bring them back to the moisture content 25-30 %. After drying, weight and hardness of samples were taken as before.

Burial of samples: Impregnated samples were buried whole at random on a 9m² land to a spacing of 30cm between samples. Surrounding soil was pressed tight to each sample to make good contact with the surfaces so that each sample was firm in the ground.

Post-burial data and analysis: Percentage mass and hardness losses of samples were calculated on air-dried mass and hardness instead of oven-dry[6] mass and hardness of stakes. Mass Losses (%) of samples:

$$\{(I\text{-}R)/I\}\ \text{x}100\% \qquad (2)$$

Where $I$ is initial mass of samples and $R$ is the final air-dried mass of samples. Hardness losses (%) of samples:

$$\{(Rh\text{-}Ih)/Ih\}\ \text{x}100\% \qquad (3)$$

Where $Ih$ is initial hardness of samples and $Rh$ is final air-dried hardness of samples. Differences between means of treatments of each single factor for each impregnated LUS were analyzed (ANOVA) at 5% significance level using GraphPad Prism 5 (2008 edition).Treatment column totals which depicts durability of individual impregnated LUS and total areas under treatments which indicates the overall performance of extracts regardless of the kind of impregnated LUS were also generated.

## 3. RESULTS AND DISCUSSIONS

**Table-1:** Retentions [g/mm3] x 103 of extracts in heartwoods and sapwoods of LUS

| Impregnation | Pot. Heart | Pot. Sap | Bon. Heart | Bon. Sap | Sum |
|---|---|---|---|---|---|
| Immersion | 1.1450 | 1.2250 | 2.5260 | 1.3690 | 6.2650 |
| Brushing | 0.1053 | 0.1160 | 0.1260 | 0.1547 | 0.5020 |
| Sum | 2.5913 potrodom extract | | 4.1757 bonsamdua extract | | |

**Table-2:** Cumulative area under treatments

| | Heartwood | Sapwood | Sum |
|---|---|---|---|
| **visual durability rating** | | | |
| potrodom | 23.13 | 25.01 | *48.14* |
| bonsamdua | 29.63 | 28.25 | 57.88 |
| **percentage hardness loss** | | | |
| potrodom | 0824.10 | 1052.40 | *1876.50* |
| bonsamdua | 1021.30 | 0955.20 | 1976.50 |
| **percentage mass loss** | | | |
| potrodom | 497.70 | 559.20 | *1056.90* |
| bonsamdua | 628.50 | 568.60 | 1197.10 |
| Sum | 3024.36 | 3188.66 | |

**Table-3:** Durability ranking of LUS impregnated with extracts

| | Heartwood Sapwood | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Extract** | **CS** | **CG** | **CZ** | **AT** | **SO** | **CS** | **CG** | **CZ** | **AT** | **SO** | **sum** |
| **Visual durability rating** | | | | | | | | | | | |
| potrodom | 3 | 1 | 1 | 4 | 2 | 5 | 1 | 3 | 4 | 2 | 26 |
| bonsamdua | 4 | 3 | 2 | 4 | 1 | 4 | 2 | 1 | 4 | 3 | 28 |
| **Percentage hardness loss** | | | | | | | | | | | |
| potrodom | 4 | 1 | 5 | 3 | 2 | 4 | 1 | 3 | 2 | 5 | 30 |
| bonsamdua | 4 | 1 | 5 | 3 | 2 | 3 | 2 | 1 | 4 | 5 | 30 |
| **Percentage mass loss** | | | | | | | | | | | |
| potrodom | 4 | 1 | 3 | 5 | 2 | 5 | 1 | 2 | 4 | 3 | 30 |
| bonsamdua | 5 | 3 | 2 | 4 | 1 | 3 | 2 | 1 | 4 | 5 | 30 |
| **Sum** | 24 | 10 | 18 | 23 | 10 | 24 | 9 | 11 | 22 | 23 | |
| **Durability (Sapwood+heartwood)** | **CS=48** | | **CG=19** | | **CZ=29** | | **AT=45** | | **SO=33** | | |

Immersed and brushed heartwoods and sapwoods of *A. toxicaria*, *C. schweinfurthii*, *C. zenkeri*, *C. gigantea* and *S. oblonga* retained dissimilar amounts of potrodom and bonsamdua extracts (Tab-1). From table-1, altogether, Immersed and brushed heartwoods and sapwoods of LUS retained bonsamdua extract (4.1757) more than that of potrodom (2.5913).

From table 2, grand cumulative areas under treatments of 2981.54 and 3231.48 for potrodom and bonsamdua extracts respectively, potrodom extract improved the durability of LUS more than that of bonsamdua. Improved durability of immersed and brushed selected LUS was ranked as follows: *C. gigantea* > *C. zenkeri* > *S. oblonga* > *A. toxicaria* > *C. schweinfurthi* (Tab-3).

Discussion: Heartwoods and sapwoods of LUS immersed generally retained more of extracts than that brushed because in immersion wood of LUS made a longer contact with extracts than in brushing. Brushed and immersed LUS retained extracts dissimilarly because they are of varying nature. Altogether, immersed and brushed heartwoods and sapwoods of LUS retained bonsamdua extract (4.1757) more than potrodom extract (2.5913) possibly because bonsamdua extract components may have bonded very well in large amounts with the extractives of impregnated LUS, a phenomenon Lui[7] and Hyvonen *et al.*[8] have reported. Potrodom extract improved the durability of LUS more than that of bonsamdua because potrodom extractives were more bio-active than that of bonsamdua to the extent that even possible denaturing and degradation of some proportion of it still left enough to protect impregnated LUS. Irvin [9] reported that the bark of potrodom contains several alkaloids including erythrophleine and other alkaloid derivatives such as cassaine horscassaidine and homophleine, which impart high durability. Catechin, a tannin isolated exclusively from the bark as well as the wax of potrodom with greater amount of hexacosonol is able to close the pores of wood and thus prevent water exchange with the environment for prolonged durability[10].

## 4. CONCLUSION

Bark extracts of tropical timber species as that of potrodom could be employed to control the pests of low durability wood species. The use of botanical extracts is promising if it will be deeply researched.

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