African Journal of Biotechnology Vol. 6 (8), pp. 982-986, 16 April 2007
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2007 Academic Journals

Full Length Research Paper

Introduction and evaluation of the wood preservative potentials of the poisonous Sternbergia candidum extracts

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Accepted 1 March, 2007

The ability of *Sternbergia candida (SB Candidum* Mathew*.)* extract to suppress attack by *Postia placenta* (Fries) M. Larsen et Lombard (Mad 698), (a brown-rot) and *Trametes versicolor* (L.ex Fr.) Quel. (a white-rot) was investigated. The extract was dissolved from Sterinbergia Candidum's bulb and leaves in 96% ethyl alcohol. Poisonous extract impregnated into wood blocks of Turkish oriental beech (*Fagus orientalis* L.*)* and Scots pine (*Pinus sylvestris* L.). Extract dosages were 0.25, 0.75, 1.50 and 3.00%. Treated blocks were exposed to *P. placenta* and *T. versicolor* attack for 12 weeks by the soil block method. Only extract dosages of 0.25 and 0.75% were found efficacious in suppressing attack. A tukey studentized test found both dosages significant at 5% level. In conclusion, the poisonous extracts could be used as effective wood preservative when concentration was adjusted.

Key words: Poisonous plant extracts, *Sterinbergia candidum*, decay fungi; *Postia placenta*; *Trametes versicolor*.

INTRODUCTION

Throughout the course of history, wood has remained one of the most important renewable natural resources available to mankind. It is-a natural, cellular, renewable resource, has excellent strength-to-weight properties, a relatively low price and is easily produced composite material of botanical origin-possesses unique structural and chemical characteristics that render it desirable for broad variety of end uses (Hingston et al., 2001).

On the other hand, one of the major objections of the use of wood for many purposes is of course the question of its long-term resistance to the natural processes of degradation (Yalinkilic, 2000; Richardson, 1978). When timber is used as a construction material, it is generally treated with a chemical preservative to prevent damage by these aggressive biodeteriogens (Craig et al., 2001).

A large number of preservative compounds have been introduced on to the market; however many of them has not gained acceptance either because of chemical toxicity, low efficacy, high cost, or corrosiveness (Murphy, 1990). Some contaminants are potentially included in wood preservatives such as chromated copper arsenate (CCA), arsenic, creosote consisting of various polycyclic aromatic hydrocarbons (PAHs), chlorophenols (CPs), pentachlorophenol (PCP), heavy metals including Hg, Cu and Ni, polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/DFs) as impurities in CPs, and organochlorine insecticides such as drin compounds and chlordane compounds (Sakai et al., 2001; Yasuhara et al., 2003;

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Asari et al., 2004; Baldrian, 2003). The persistence of these chemicals in the environment has resulted in a widespread existence throughout the food chain (Wang et al., 2001; Margaret et al., 1999; Hingston et al., 2001). Wood preservatives are also subject to increasingly stringent environmental legislations, particularly within the European Union where they fall under the control of the new Biocidal Products Directive.

There is an increasing awareness of the potential of natural products, which may lead to the development of much-needed new preservatives (Tagboto and Townson, 2001). As a consequence, various environmentally friendly treatments or naturally durable plant species are being evaluated (Yalinkilic et al., 1998). Because of the restriction of certain wood preservatives containing heavy metals such as CCA in some European countries, Japan, and the USA and environmental concerns about broad-spectrum biocides, there is an increasing incentive to develop of environmentally benign wood preservatives for a long time. A great interest has been focused on some wood preservatives that are relatively cost-effective chemicals and have minimal toxicity to mammals and the environment. Ability of wood and natural plant extractives to protect wood against wood degrading fungi and insects has been one possible approach for developing new wood preservatives (Kartal et al., 2004).

Onuorah (2000) studied the ability of heartwood extracts of two very durable tropical hardwood species which are *Milicia excelsa* (Welw.) C. C. Berg. Syn *Chlorophora excelsa* (Welw.) exctracts against *Lenzites trabea* (a brown rotter) and *Polyporus versicolor* (a white rotter). He reported that the extracts dosages of 48.056 and 96.11 kg/m^3 were found efficacious in suppressing fungal attack. Chang et al. (1998) reported antifungal activities of α-cadinol, α-cedrol, hinokiol, sugiol, ferruginol, helioxanthin, savinin, and taiwanin C that were isolated from Taiwania heartwood. Among all this, α-cadinol has been demons-trated to possess the highest antifungal effectiveness. In a similar study, Kondo and Imamura (1986) investigated the antifungal compounds in heartwood extractives of *Chamaecyparis obtusa* and they deduced that the main antifungal compounds of *C. obtusa* were cadinane skeletal sesquiterpenoids. Digrak et al. (1999) studied the antimicrobial activities of valex of mimosa bark, gallnut powders, *Salvia aucheri* Bentham var. *aucheri* and *Phlomis bourgei* Boiss. The results indicated that mimosa bark extracts had the greatest antibacterial activity.

Due to Turkey's varied climate and geographic conditions, a vast number of trees, shrubs and herbaceous plants grow in the country. Of the 11 000 plant species existing in Europe, 9 500 grow in Turkey, of which 3 000 are endemic (Kizmaz, 1997). The *Sternbergia candida* (*S. candidum* Mathew.) is an endemic and poisonous plant too. The objective of this study was to determine the efficacy of extracts from *S. Candidum* in suppressing *P. placenta* and *T. versicolor* attacks on treated *Fagus oriantalis* L. and *Pinus sylvestris* L.

MATERIALS AND METHODS

Preparation of extract and wood specimens

S. candida (locally called a type of gravel daffodil) is a plant with scented flowers that only grows naturally in the Mugla-Fethiye/Turkey region. It flowers early in the season. In the south west part of the Toros Mountains, the *S. candida* opens its flowers under Cedrus Libani (Lebanon Cedars) in March. It is the only white flowering member of the Sternbergia family.

The poisonous extracts used for study were obtained from *S. candida* Mathew and T. The plant was collected in Mugla-Fethiye-Babadag mountain with an altitude of 1750 – 1935 m. in April. The collected samples were air dried and kept in the Herbarium of Muğla University-Turkey). After the harvest, *S. candida* samples were exposed to open laboratory room conditions five days for drying. Bulb and leaves of plant shredded into 1 - 2 mm size particles and blended with 100 ml ethyl alcohol for each 10 g then, placed into alcohol bath at 50°C for 5 h. The extract was filtered through a glass funnel fitted with glass wool and the funnel and flask rinsed with a small quantity (about 30 ml) of fresh ethyl alcohol. The extract solution was evaporated to constant weight in a vacuum oven (rotary evaporator) at 50°C. Then extract was diluted by distilled water and freezed in the deep freezer, then, the distilled water sucked by freeze dryer to separate the extract. Wood specimens measuring 19 (tangential) x 19 (radial) x 19 (longitudinal) mm were prepared for decay test, from air dried sapwood of *Fagus orientalis* L. and *Pinus sylvestris* L. according to the requirements of ASTM D 1413- 76. They were conditioned and weighed (T_1) before impregnation.

Impregnation of wood specimens

Wood specimens were impregnated in vacuum desiccator with the extract of *S. candida*. Vacuum was applied for 30 min. at 760 mmHg before supplying the solution into the treatment chamber followed by another 30 min at 760 mmHg diffusion period under vacuum. The carrier solvent used was 100 ml distilled water for each extract concentration (0.25, 0.75, 1.50 and 3.00%). The total number of treated specimens was 80 in other words, 5 replicate by 4 different concentration levels by 2 different sapwood specimens by 2 fungi. The impregnated wood specimens were weighed (T_2), air dried for one week at ambient temperatures, and then dried in an oven at 60°C for 3 days. For calculation of the amount of preservative absorbed by wood specimen, that is the retention, as kilograms per cubic meter (kg/m^3) were as follows:

$$\text{Retention, kg/m}^3 = (G \times C/V) \times 10 \quad (1)$$

Where $G = (T_2 - T_1)$ = amount grams of treating solution absorbed by the wood specimen (g), T_1 = initial weight of the conditioned wood specimen before impregnation (g), T_2 = weight of the wood specimen immediately after impregnation and wiping (g), C = grams of preservative in 100 g of treating solution, and V = volume of wood specimens (cm^3).

After the wood specimens were impregnated and weighed to obtain the amount of absorption, they were spaced on trays and exposed to room conditions for 72 h. Afterwards, all such blocks were placed in the conditioning chamber for 21 days to enable them to achieving equilibrium moisture content (EMC). Finally, weights of the specimens were measured (T_3).

Table 1. Weight loss of Turkish oriental beech (*Fagus orientalis* L.) and Scots pine (*Pinus sylvestris* L.) treated with Sternbergia extract to *Postia placenta* and *Trametes versicolor* after 12 weeks exposure.

Treatment with *Sternbergia candida* extract	Concentrations (%)	Retention level (kg/m^3)	Weight loss (%)	
			Postia *placenta*	Trametes versicolor
Turkish oriental beech *(Fagus orientalis* L.)	0.25	1.40	2.62**	21.74**
	0.75	3.92	1.94**	25.49 **
	1.50	8.84	6.40**	25.29 **
	3.00	17.53	6.48 **	30.27**
Control	-	-	24.87	37.25
Scots pine *(Pinus sylvestris* L.)	0.25	1.12	1.96 **	7.77 NS
	0.75	2.96	1.79 **	7.96 NS
	1.50	5.76	7.82 NS	9.96 NS
	3.00	10.43	6.85 NS	10.15 NS
Control	-	-	4.79	11.92

**Significant at 5 % level
NS: Non significant.

Decay test

Prepared culture bottles filled with 120 cm^3 of soil mixture and 62 g distilled water were added to each bottle. This amount of water to be added was calculated according to "Water Hold Capacity" and "Water required" formulas from ASTM D 1413 - 76. Bottles were sterilized in an autoclave for 30 min. at 121°C. After the sterilization soil culture bottles were thoroughly cooled. Approximately cutted 10-mm in diameter fungus inoculums sections from a Petri dish culture. Placed the part of inoculums in contact with an edge of the feeder strip on the soil. Inoculated with the fungal species, and incubated at 27°C and 72.0% relative humidity for 3 weeks. Then wood specimens were subjected to a modified decay resistance test. Five replicates of each wood specimen were dried to constant weight and steam-sterilized at 100 ± 2°C for 20 min. After cooling, wood specimens were placed in the culture bottles under air laminar flow condition to avoid contamination. Screwed bottles cap loosen one-quarter turn. Then they were exposed to *Postia placenta* and *Trametes versicolor* fungi, in a modified soil-block test according to ASTM D 1413-76. For incubation period of 12 weeks, blocks were helded at temperature of 27°C and a relative humidity (RH) of 75 %. At the end of the incubation period, blocks were removed from the test bottles and the mycellium was carefully brushed off the samples. Tested specimens were then re-weighed after 4 weeks of seasoning in order to reach equilibrium moisture content, in the open laboratory (T_4). Weight loss was calculated from the conditioned weight of the wood specimen immediately before and after testing, as follows:

$$\text{Weight Loss (\%)} = (100\ [T_3 - T_4] / T_3) \quad (2)$$

Where T_3 = weight of wood specimen plus remaining preservative after conditioning and before exposure to the test fungi (g), and T_4 = weight of the wood specimen after test and after final conditioning (g).

RESULTS AND DISCUSSION

Percent weight loss caused by two decay fungi and results of statistical analysis are given in Table 1 and in Figures 1 and 2. The weight losses of untreated Scots pine specimens were remarkably lower than untreated beech specimens after 12 weeks of fungi exposure. Untreated beech wood was severely attacked by *T. versicolor* and *P. placenta* with the large weight losses, whereas, the values of weight losses for all treated specimens decreased in significant level confirming the effectiveness of extract solution in enhancing decay resistance. Results of a tukey-studentized test revealed that, beech wood impregnated by Sternbergia extract at concentrate levels of 0.25, 0.75, 1.50 and 3.00%, were effective in suppressing the attack of two fungi (Figure 1). Also, Scots pine impregnated by Sternbergia extract at

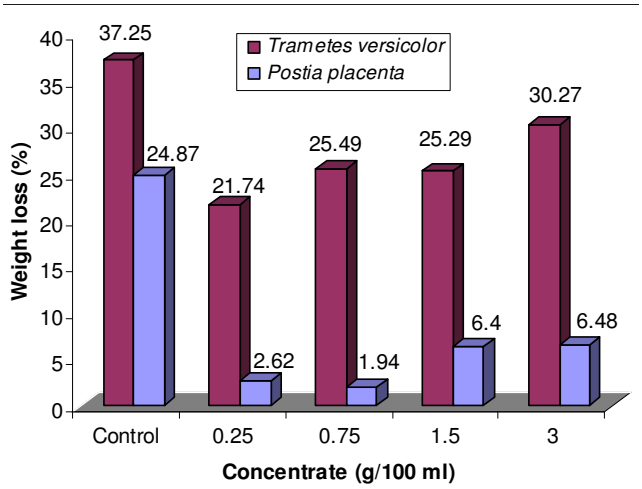

Figure 1. Effectiveness of Sternbergia extract on Turkish oriental beech (*Fagus Orientalis L*). to *Postia placenta* and *Trametes versicolor*

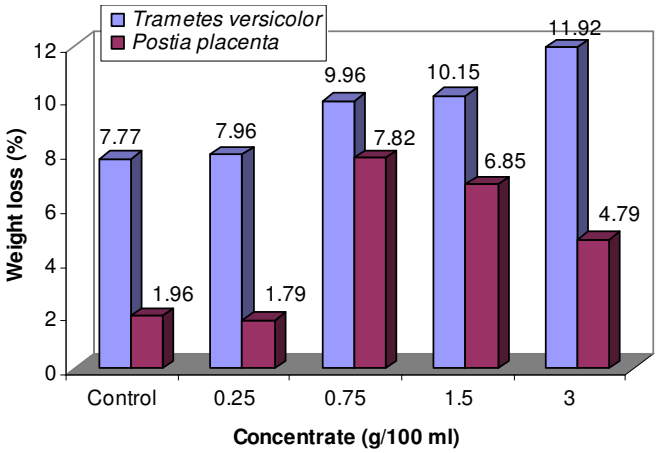

Figure 2. Effectiveness of Sternbergia extract on Scots pine (*Pinus sylvestris* L.) to *Postia placenta* and *Trametes versicolor.*

concentrate levels of 0.25 and 0.75% were effective in suppressing the attack of P. *placenta* (Figure 2). The weight loss of both wood specimens caused by *P. placenta* fungi was the lowest, treated with at extract concentrate level of 0.75%. On the other hand, it can be seen from the same table that the efficacy of the extract is found to decrease with increasing concentration levels. This was probably due to decreased saponin derivates and alcholoids of the extract which losses its toxic effect against fungal decay (Sen et al., 2002). Because, at the low concentrations, effective substance can easily be dissolved in solutions and affects the fungi. Yet, at high concentrations, the amount of nutritive material such as such as sugar, protein, etc., increase In addition, the extract of Sternbergia was not effective preservative on the Scots pine at any levels against *T. versicolor*. At all levels of extract loading, the fungus, *T. versicolor* judging from the relative weight loss appeared to have tolerated each of the fungi better than the *P. placenta*.

Conclusion

Decay resistance of beech and Scots pine wood impregnated with 0.25, 0.75, 1.50 and, 3.00 % concentration of Sternbergia extract against to *P. placenta* and *C. versi-color* were studied. Results showed that *C. versicolor* was more harmful fungus on both woods with respect to than *P. placenta*. Beech wood impregnated with 0.25, 0.75, 1.50 and 3.00% concentration of Sternbergia extract were resistant to decay caused by *P. placenta*, while Scots pine wood treated with only extract dosages of 0.25 and 0.75 % were resistant to decay by caused by *P. placenta*. The weight losses of both woods were the lowest when impregnated with 0.75 % concentration of Sternbergia extract against the degradation of *P. placenta*. *T. versicolor* caused somewhat higher degradation than *P. placenta* for untreated (control) and nearly all extract treatments.

In conclusion, development of more environmentally acceptable preservatives, which is a priority in the wood preservation industry today, has opened the door to plant based wood preservatives. The plant extracts can offer substantial advantages for wood protection, providing decay resistance against fungi at low cost, low mammalian toxicity, and ease of handling and treatment. In addition to above benefits according to Kizmaz (1997), in Turkey the production of endemic medicinal and aromatic bulbous plants in their natural sites for sustainable management aims to:

- enhance the living standards of forest villagers through employment in production areas,
- decrease the damage made by villagers on the natural resources in forests,
- sustain cultivation and production of rare and endangered medicinal and aromatic plants by limiting their production even in the face of high domestic and foreign demand,
- conserve the biological and genetic diversity of important natural resources by limiting production, and
- improve the economic value of medicinal and aromatic plants by offering only high quality produce for export.

ACKNOWLEDGEMENTS

This manuscript is prepared from the outcome of the project titled “Development of environmentally-friendly wood finishes and preservatives from wood and plant extracts”. This project is supported by Mugla University “Scientific Research Projects Fund”. Project number: BAP-TEF 02/27.

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