
Effects of polyvinyl alcohol on leachability and efficacy of boron wood preservatives against fungal decay and termites attack

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INTRODUCTION

- Several products are used currently:

- boric acid (H_3BO_3),
 - sodium tetraborate decahydrate ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$),
 - disodium octaborate tetrahydrate ($\text{Na}_2\text{B}_8\text{O}_{13} \cdot 4\text{H}_2\text{O}$)

- Boron preservatives have been described as valuable alternatives for non-ground contact applications

Borate treatments:

Advantages ↔ Weakness

- + **Low cost**
- + **Low environmental impact**
- + **Effective against insects and fungi**
- + **Low mammalian toxicity**
- **Leachability**
- **Classified as toxic for reproduction in Europe**

Borate fixation systems

- **Wood bulking resins**
- **Water repellents**
- **Paint or coating**
- **Fixed borate via chemistry**

Objectives of study

- To investigate the effect of PVA on boron fixation to develop new formulations for wood preservation**
- To evaluate the efficacy of these treatments against fungal decay and termites attack**

MATERIALS AND METHODS

➤ Material

Scots pine sapwood (10 x 15 x 50 mm)

➤ Impregnation procedure

Double impregnation process using a vacuum of 5 mbar for 30 min. for each impregnation: DOT was impregnated in a first time followed by additive impregnation in a second time.

✓ DOT tested at 3 concentrations (1, 2 and 4% Boric Acid Equivalent (BAE) with or without Polyvinyl alcohol additives

✓ Elvanol® 90-50 tested at 2 concentrations

- 2.5 or 4% of Polyvinyl alcohol, Elvanol® 90-50 (DuPont, France)

➤ Leaching procedure

Boron leachability was carried out according to ENV 1250-2 standard

➤ Boron determination

- Boron analysis was performed with a Varian SpectrAA 220 FS atomic absorption spectrometer using standard solutions comprised between 100 and 1000 mgL⁻¹

- Boron retention was estimated by difference between the quantity of boron present in wood after the first impregnation and quantity of boron measured in cumulate leachates

➤ Biological tests

- Decay resistance was evaluated with *Poria placenta* after 12 weeks according to a procedure adapted from EN-113 standard

- Resistance of treated wood against termites were carried out using the European standard EN 117

➤ Boron complexation biological efficacy test was conducted using an inhibition zone test

Scots pine sapwood samples (10 x 15 x 50 mm)



Impregnation procedure



Conditioning



Leaching ENV 1250-2



Biological evaluation

Leachates analyses

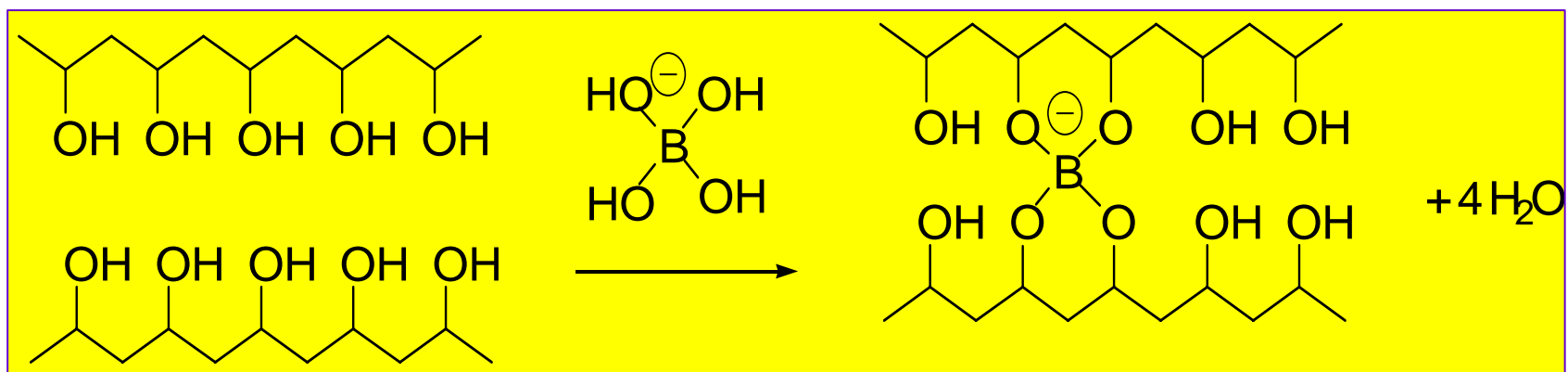
RESULTS

Boron retention of Scots pine sapwood blocks before and after leaching

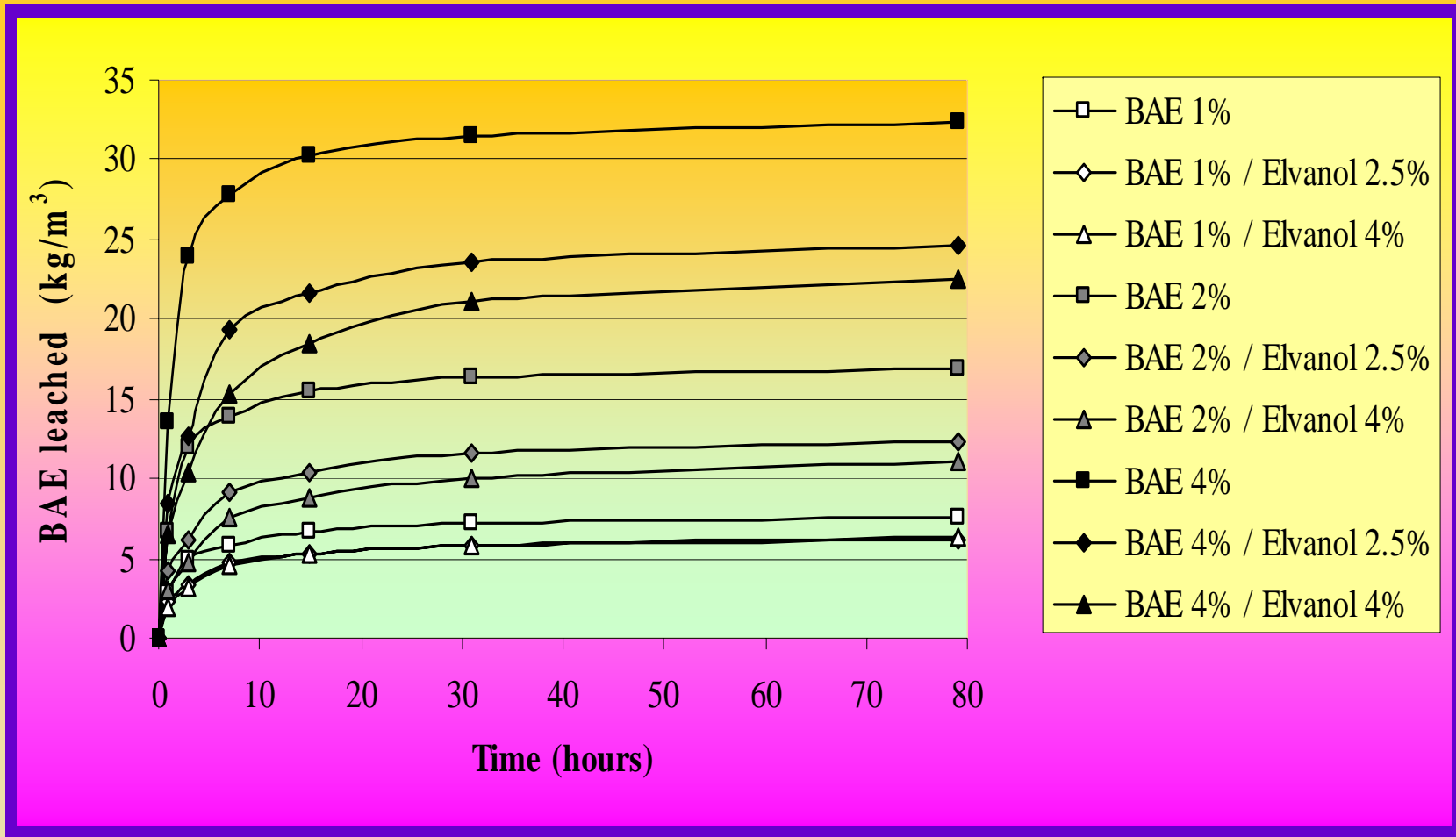
Treatment		BAE (kg/m ³)		BAE retained (%)
BAE (%)	Additive	before leaching ^a	after leaching ^b	
1	None	7.65	0.04	0.52
1	Elvanol 2.5%	8.12	2.05	25.25
1	Elvanol 4%	8.19	1.80	21.98
2	None	16.98	0.04	0.24
2	Elvanol 2.5%	16.95	4.62	27.26
2	Elvanol 4%	16.2	5.11	31.54
4	None	32.52	0.18	0.55
4	Elvanol 2.5%	32.15	7.61	23.67
4	Elvanol 4%	32.18	9.61	29.86

^a obtained from solution uptake.

^b calculated by difference between the quantity of boron from solution uptake after the first impregnation and the quantity of boron measured in cumulate leachates.



Complexation of borate ions with polyvinyl alcohol



Effect of polyvinyl alcohol on boron leachability from treated blocks

Growth of *Poria placenta* after one month on pine blocks treated with 4% BAE with or without Elvanol additives after leaching



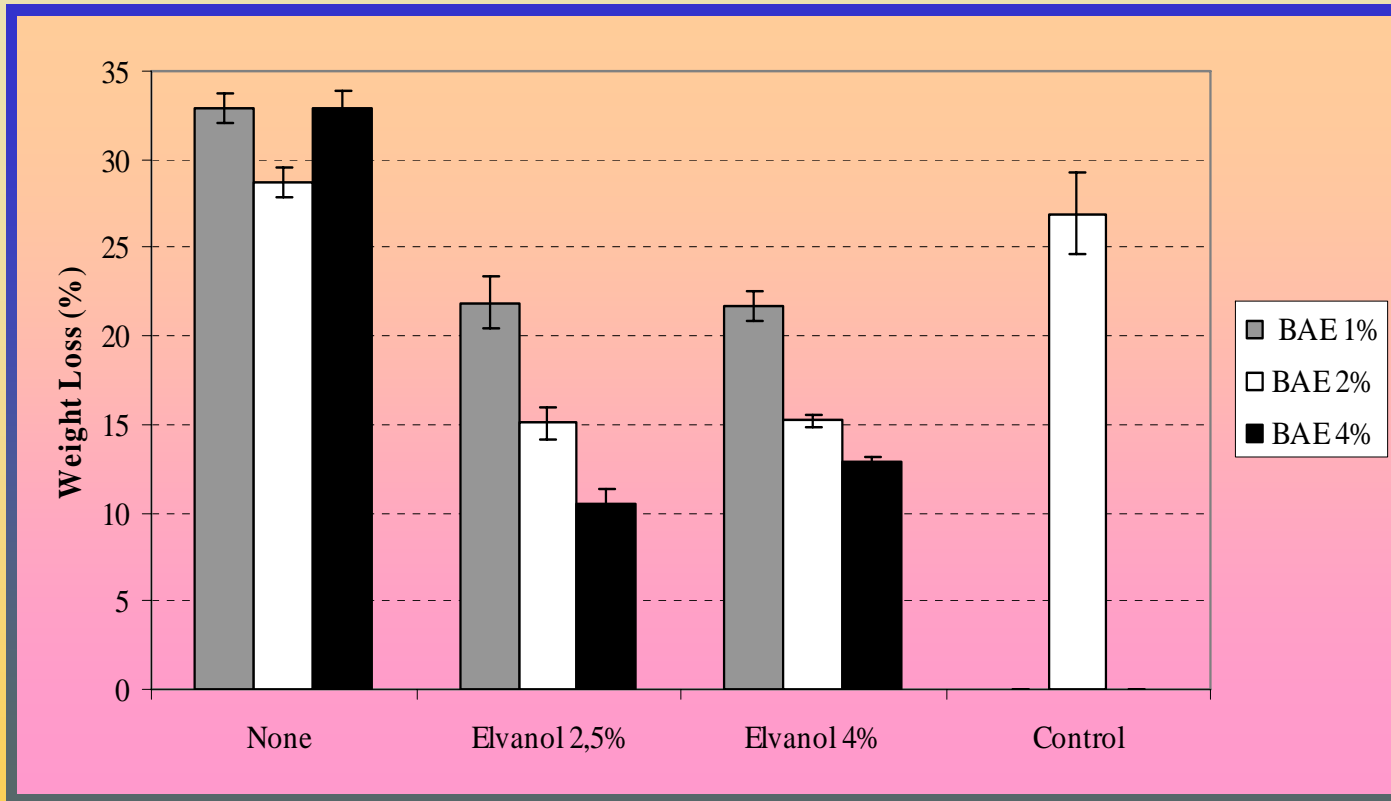
Without

With Elvanol (2.5%)

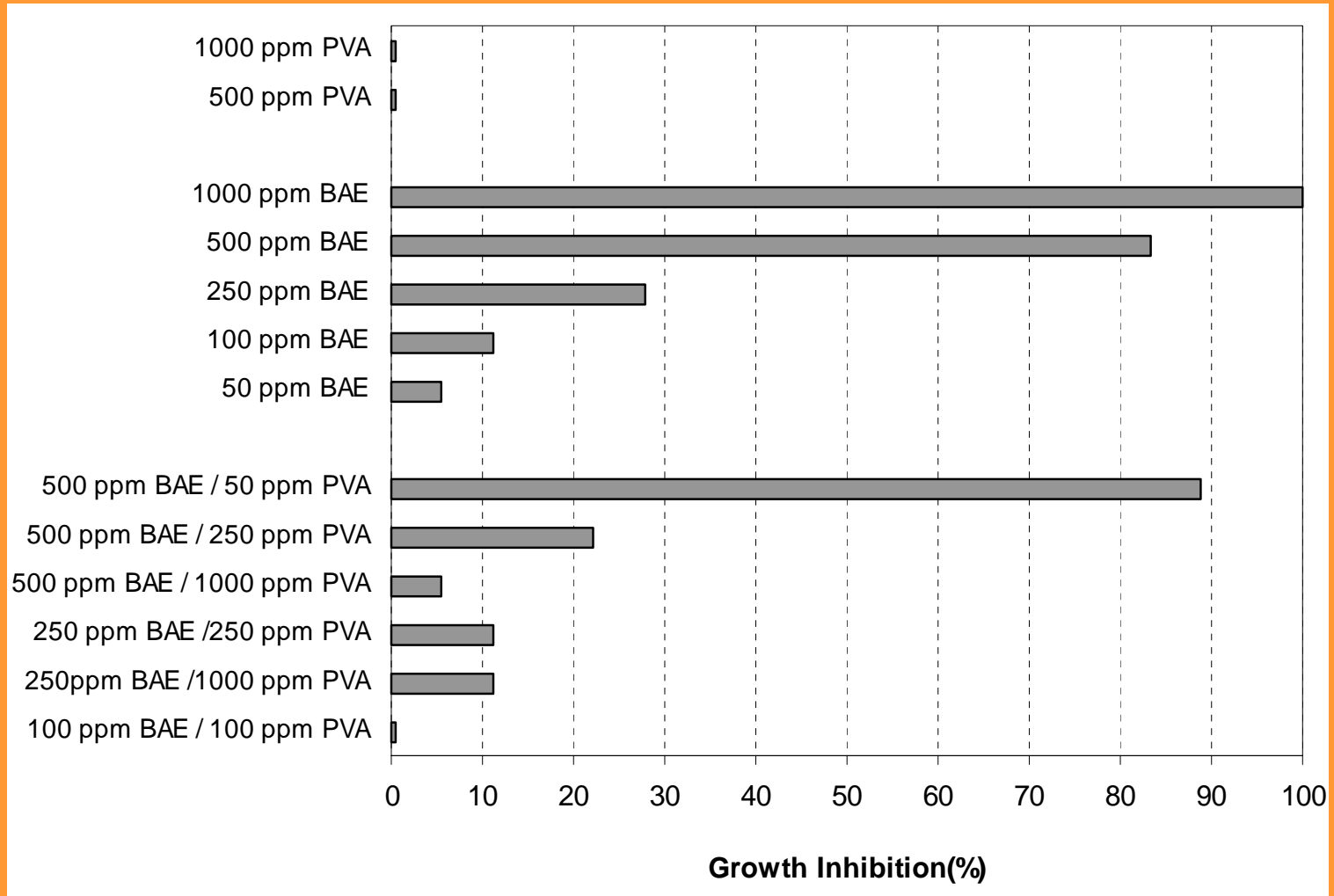


Without

With Elvanol (4%)



Weight losses of Scots pine sapwood blocks treated with different concentrations of BAE and PVA and leached according to ENV 1250-2 after 12 weeks of fungal exposure



Effect of different BAE concentrations with or without Elvanol® 90-50 on the growth of *Poria placenta*

Weight loss, percentage of termites survival and attack rate of Scots pine sapwood blocks after termite exposure

Treatment		WL (%)	Survival (%)	Rating
BAE (%)	Additive			
1	None	38.3 ± 6.2	78.3 ± 5.2	4
1	Elvanol 2.5%	41.2 ± 3.0	61.6 ± 8.9	4
1	Elvanol 4%	6.9 ± 3.9	0	3
2	None	35.5 ± 11.4	79.0 ± 9.1	4
2	Elvanol 2.5%	27.4 ± 3.9	39.2 ± 21.8	4
2	Elvanol 4%	3.2 ± 0.6	0	2
4	None	47.5 ± 4.5	76.0 ± 2.4	4
4	Elvanol 2.5%	10.2 ± 1.5	0	3
4	Elvanol 4%	2.9 ± 0.1	0	1
Control		35.1 ± 5.7	65.8 ± 12.4	4

Conclusions

- ✓ Elvanol® 90-50, a fully hydrolyzed polyvinyl alcohol, allows a reduction of boron leachability.
- ✓ Wood specimens treated successively by DOT and PVA were more resistant to fungal decay as demonstrated by the more or less important inhibition of mycelium development during the first weeks of the decay tests.
- ✓ Efficacy of the treatment was however not sufficient to secure the full protection for the wood blocks after 12 weeks of fungal exposure.

Conclusions

- ✓ **Growth inhibition assays performed with DOT and PVA alone or mixtures of these latter ones indicated that biological activity of complexed boron is lower than that of its free form explaining the leak of efficacy observed.**
- ✓ A significant improvement of wood resistance against termites attack for the samples treated with DOT in the presence of PVA was detected, confirming its ability to prevent boron depletion.
- ✓ Even if the protection against fungi was not completely achieved, the gathered data clearly indicated a reduction of boron leachability leading to a significant improvement of wood durability against termites.

Acknowledgement

- ❖ The authors would like to thank Mr. Stéphane Parant from UMR UHP SCRSMC for his assistance during utilization of the atomic absorption spectrometer.
- ❖ The authors also gratefully acknowledge the financial support of the CPER 2007-2013 “Structuration du Pôle de Compétitivité Fibres Grand’Est” (Competitiveness Fibre Cluster).
- ❖ Finally, the authors would like to thank the Agence Universitaire de la Francophonie (AUF) for the post-doctoral fellowship granted to the first author

Thank you

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