

Tests on the effectiveness of concentrated borate wood preservative

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ABSTRACT

- **Tests were carried out to examine the toxicity of concentrated borate wood preservative to termites, fungi and mammals.**
- **The results showed that the preservative treated timber had high resistance to termite or decay**
- **its acute oral toxicity belonged to low grade.**
- **The concentrated borate solution is an environmentally sound preservative and can be used in non-pressure treating.**

1. INTRODUCTION

➤ **Recent** study on wood preservatives in China was mostly focused on vacuum/pressure treatment, such as Copper Chrome Arsenate (CCA), and new generation preservatives like Alkaline Copper Quaternary (ACQ), Copper Azole (CuAz), copper naphthenate, and so on.

➤ **Brushing or dipping** is the simplest method of wood preservative treatment and is used on a large scale on many occasions due to its simplicity and rapid treatment time.

➤ **The preservatives in non-pressure treating**, in general, consists of borate and phosphate mixture (called BP mixture for short), organophosphate, synthetic pyrethroid, quaternary ammonium salt and boron preservative.

➤ **BP mixture containing pentachlorophenol is banned.** The application of organic preservatives is limited due to their high price, single-spectrum and low solubility.

➤ **Boron preservative** has been paid a lot of attention owing to their advantages such as low price, high permeability, no colour, no odour and high resistance to insects and fungi.

➤ **Boron preservative solution** with low boron content can not be used for brushing at present.

➤ In order to meet domestic needs, recently the authors started to develop a **concentrated borate solution** as a wood preservative, and which is called as **SGB preservative** for short.

➤ **Laboratory tests on the toxicity of SGB preservative** to termites, fungi, and mammals have been carried out.

2. MATERIALS AND METHODS :

★ 2.1 Preparation of SGB preservative

The SGB preservative is a concentrated borate solution. Its basic physical and chemical properties are presented in Table 1

H₃BO₃[%]	42.4%
Specific gravity*25.2	1.296
Color	Light yellow
pH	7 – 8
Solubility in Water	Mixable with water
Viscosity	Slightly sticky

★ 2.2 Toxicity test on to termites

Test materials:

Wood sample: *Pinus massoniana* Lamb

Dimension: $25 \times 25 \times 6 \text{mm}^3$

Termite: *Coptotermes formosanus*

Reagent: mixing SGB preservative with water in a dilution ratio of 1:1, 1:2, 1:3, 1:4 and 1:5 (m/m), respectively.

★ Test methods

- The laboratory test on termite was carried out by following American Wood Preservers' Association Standard AWPA EI-97
- Wood samples were treated with preservative by brush treatment twice, and then air dried before being testing.



2.3 Toxicity test on fungus

Test materials:

Wood sample: (*Eucalyptus urophylla*) sap wood,

Dimension: 20×20×10mm³

Fungus: *Coriolus versicolor*

Reagent: A series of diluted water solutions of SGB preservative were prepared: 0.125%, 0.25%, 0.5%, 1.0% and 2.0%, respectively.

★ Test methods

The test was done by following the method described in Chinese Standard LY/T 1283-1998, *Standard Method for Laboratory Evaluation to Determine Resistance to decay fungus.*

★ 2.4 Toxicity test on mammal

Test materials:

- Mammal: SPF grade SD mice
- Weighing: 180~220g
- Number: 10 mice including 5 males and 5 females
- Randomized grouping test.

★ Test methods

- The test was carried out by following the method described in Chinese Standard GB15670-1995, *Toxicological Testing Methods for Pesticide Registration*.
- Fasted (not cut-off water) for 12h
- The animals were given test substance with a dose of 10ml/kg body weight by intra-gastric administration
- Observed for 14days.

3. RESULTS AND DISCUSSION

3.1 Toxicity test on termite

The results can be seen in Table 2.

- At the end of experiments, termite resistance grade of control samples was **zero**, and most of timberworks (e.g. frame houses) were damaged.
- With the decrease of concentration of SGB in the treating solution, retention of SGB and B₂O₃ content in treated wood decreased accordingly.
- When wood samples measuring 25mm × 25mm × 6mm were brushed with a 1:1 mixture of SGB to water, the preservative retention of SGB attained 75.55Kg/m³ and the B₂O₃ content was 16.62 Kg/m³.

- All the treated wood samples suffered a significant decrease in termites' feeding compared to the controls.
- Wood treated with SGB at a dilution ratio of 1:1 and 1:2 in water were strongly resistant to termite attack with a termite resistance grade of 10, i.e. no termite feeding on the treated wood.
- Wood treated with SGB at a dilution ratio of 1:3, 1:4, and 1:5 in water were not very resistant to termites. The average termite grade for these samples was 7.

Table2: The resistance of wood treated with SGB solutions to termite

SGB: water (m/m)	Retention [kg/m³]	B₂O₃ content [kg/m³]	Termite resistance grade
1:1	75.55	16.62	10
1:2	57.93	12.74	10
1:3	34.84	7.67	10
1:4	23.72	5.22	7
1:5	22.13	4.87	7
0:1	0	0	0

- According to the Chinese Industry Standard LY1636-2005, *Classification and Requirements of Preservative-Treated Wood*, 4.5 Kg/m³ B₂O₃ content in treated wood for Commodity class C2 (indoor, resistant to termites) is required.

- In this experiment, B₂O₃ content used for treating wood samples were all above 4.5 Kg/m³, therefore, the treated wood was highly resistant to termites.

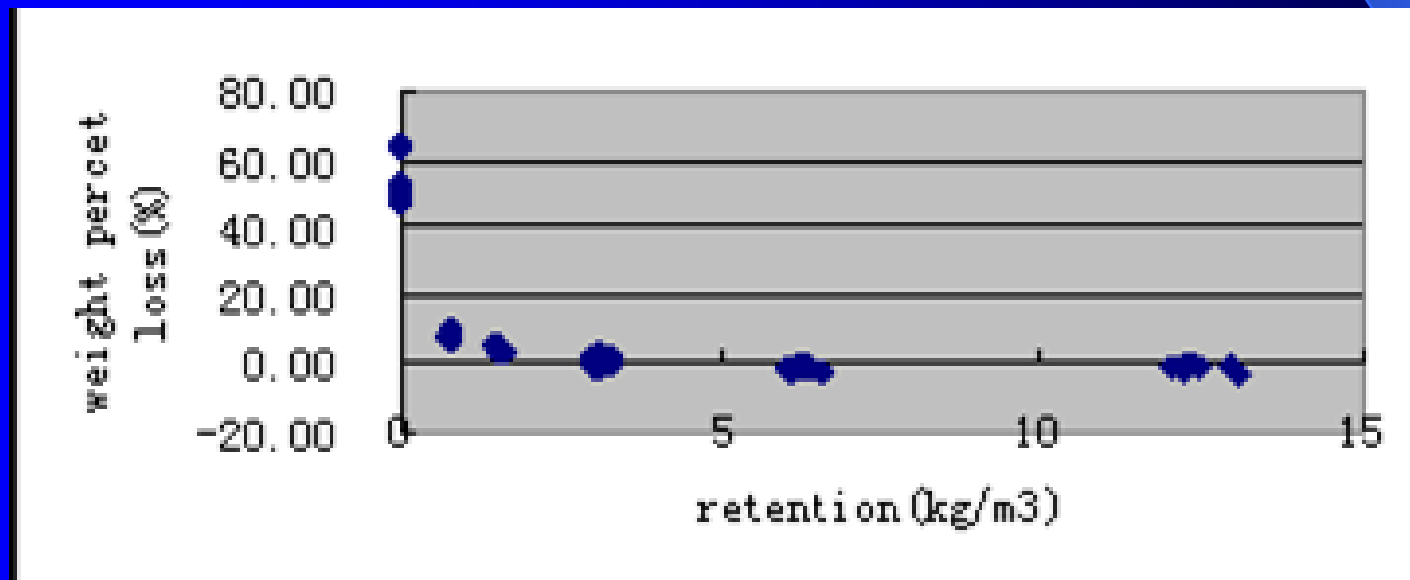
- B₂O₃ content in SGB can reach above 22%, so adequate retention in wood could be obtained easily when brushing treatment is applied.

3.2 Toxicity tests on fungus

- **Figure 1** showed that the weight loss of the control wood is 52%, while the weight loss of all SGB treated wood is less than 10%.
- The results indicate that SGB preservative can enhance the resistance of wood to fungus.
- **The retention level** of treated wood increased with the increasing concentration of SGB water solution, but the weight loss decreased accordingly.
- When wood was treated with 0.5% SGB water solution, at a retention level below 3.119 Kg/m³, the weight loss was still less than 3%. So the lethal dose of SGB preservative to fungus is the retention level 3.119 Kg/m³.

- The lethal concentration of SGB to fungus is far lower than it is to termites, and therefore wood treated with non-pressure treating of SGB preservative could have greatly enhanced resistance to fungus.

Figure 1: Relationship between weight percent loss and retention



3.3 Toxicity tests on mammal

- Acute oral toxicity tests on mammal (Table 3) showed that the animals appeared spiritless after being exposed to SGB for 5 hours.
- Animals were still spiritless 4 days later whilst the male was lost weight.
- The heart rate of the animal was approximately normal 7 days later and all the tested animals survived at dose of 5050 mg/kg of SGB fed after 14 days at the end of the test.
- According to Chinese national standard GB15760-1995 *Acute Oral Toxicity of Pesticide Classification Standards*, if a dose of more than 5,000 mg/kg of pesticide used in acute oral toxic tests could not cause death to the animals, then it is not necessary to try to use a higher dose any more.
- A dose of more than 5050 mg/kg of SGB used in this acute oral test on SD mice did not cause death of the animal, so the acute oral toxicity of SGB belongs to 'low grade'.

Table3: Rat body weight changed after being exposure to SGB preservative

Dose [mg/kg]	Sex	Day 0 weight	Day 4 weight	Day 7 weight	Day 14 weight	Death number
5050	Female	211.8±6.4(5)	216.4±12.1(5)	219.8±13.4(5)	235.6±13.4(5)	0
	male	205.0±5.4(5)	192.2±20.0(5)	192.4±17.0(5)	217.4±10.6(5)	0

- This study indicated that SGB is an environmentally sound preservative and less harmful than other commonly used wood preservatives due to its high toxicity to termite and fungus, and low toxicity to mammals

4. CONCLUSION

- (1) When wood was brushed with a mixture of SGB preservative and water (1:1 and 1:2, mass ratio respectively), it was very resistant to termites.
- (2) Wood treated with SGB preservative at a retention level more than 3.119 Kg/m³ could be highly resistant to decay fungi.
- (3) Acute oral toxicity of SGB wood preservative to mammal belongs to low grade.
- (4) SGB preservative is an environmentally sound preservative and less harmful than other commonly used wood preservatives due to its high toxicity to termite and fungus, and low toxicity to mammals, and it is used in non-pressure treatment.