

# The effect of modification of hydroxy group of alkanol and benzyl alcohol to hydroxyalkoxy group on nematicidal activity against pine wood nematode

JUNHEON KIM<sup>✉</sup>, SUJIN LEE, JOON OH PARK<sup>1</sup>

National Institute of Forest Science, Seoul 02455, Republic of Korea, ✉junheonkim@korea.kr

<sup>1</sup>Present address: Urban Forest Clinic, Boryeong, Chungnam

Pine wood nematode (PWN), *Bursaphelenchus xylophilus* causes devastating damage to pines worldwide. Control and prevention of pine wood disease (PWD) in Korea is primarily trunk injection of abamectin and emamectin benzoate. Previously we found the nematicidal activity of 2-(1-undecyloxy)-1-ethanol (monochoamol), which is reported to be aggregation pheromone of its vectors, *Monochamus* species, was as same to that of abamectin. Since then, we tried to develop new agent for controlling and preventing PWD using alkyloxyalkanols (ROR'OH) and benzyloxyalkanols (BzOROH). We synthesized ROR'OH and BzOROH by substituting hydroxy group (-OH) to hydroxyalkoxy group (-OROH) and tested their nematicidal activity against PWN. As controls, monochoamol and abamectin were also tested. The substitution -OH group to -OROH affected the nematicidal activity increasingly. The nematicidal activity was different according to total carbon chain length in compounds, although the compounds have same molecular formula. It may be due to the different position of oxy group in the compound of alkyloxyalkanol LC<sub>50</sub> values of C10OC4OH, C6OC8OH, C10OC2OH and C12OC2OH were as same as that of monochoamol. Substitution of hydroxy group of benzyl alcohol enhanced the nematicidal activity of new compound. Here, we will report the nematicidal activity changes by substitution -OH of alkanol and benzyl alcohol to -OROH.

## INTRODUCTION

- 1) Pine wilt disease, caused by the pine wood nematode (PWN; *Bursaphelenchus xylophilus*), is a major threat to global pine forest ecosystems in locations, including Japan, Korea, China, Taiwan, Portugal, and Spain.
- 2) *Monochamus* species are known as efficient vectors of PWN in many countries: *M. alternatus* and *M. saltuarius* in Korea and Japan, *M. carolinensis* in the US, and *M. galloprovincialis* in Europe.
- 3) Abamectin and emamectin benzoate, which both belong to the family of avermectins, are primarily used as trunk-injection agents for the control of PWN. These agents are known to be effective against PWN and safe for the environment. However, resistance of nematodes and insect pests to avermectins has been reported, although PWN has not yet been reported to show resistance.
- 4) Previously, 2-(1-Undecyloxy)-1-ethanol (monochoamol), an aggregation pheromone of *Monochamus* spp. showed as same nematicidal activity as abamectin.

The continuous use of a single pesticide may induce resistance to those agents in PWN.

To avoid the development of resistance and to achieve efficient control of PWN, the alternating use of diverse agents is recommended.

To develop novel nematicidal agent and to find potential alternatives to currently used PWN control agents, we investigated the nematicidal activity of alkyloxyalcohols and benzyloxyalcohols which -OH group in alkyl alcohol and benzyl alcohol was substituted with -OROH group

## MATERIALS AND METHODS

### Collection of pine wood nematodes

PWN which maintained for over 10 year at NIFOS was used.

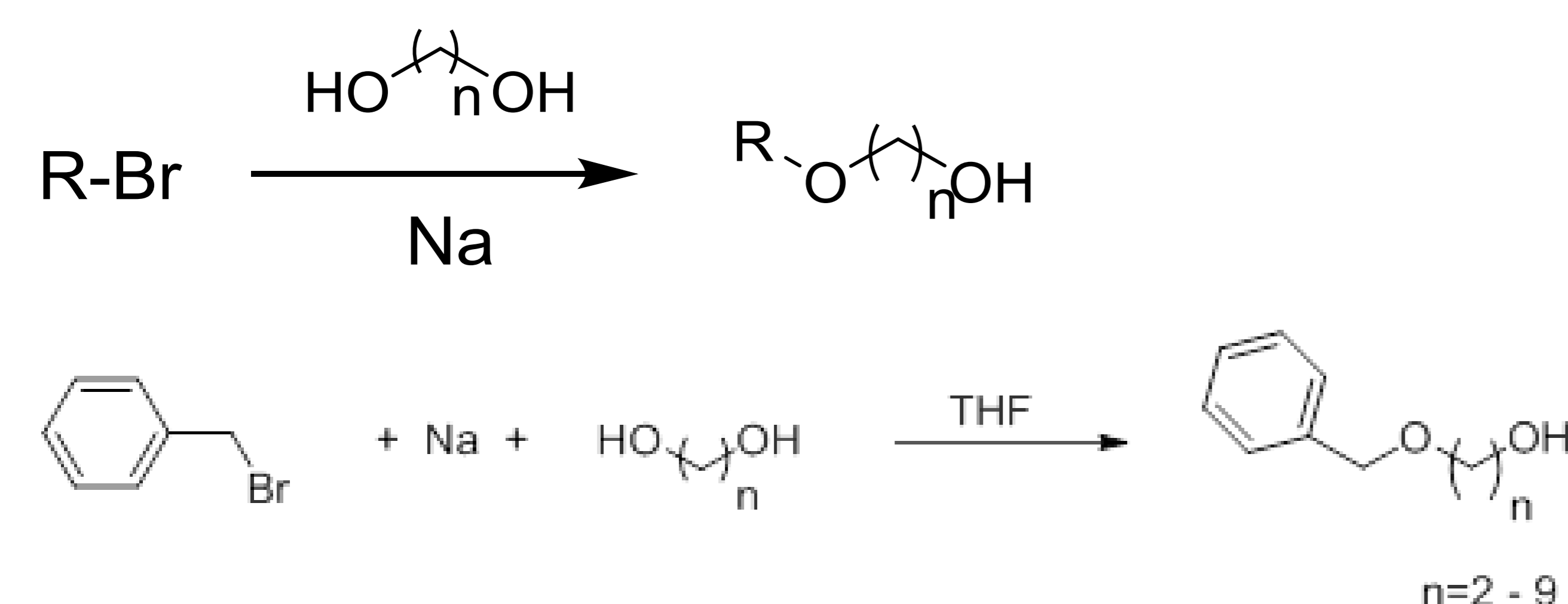
To keep vital activity, PWN which newly infected in pines was added every year.

PWN was extracted by Baermann funnel method

The PWN were cultured on a lawn of *Botrytis cinerea*

### Chemicals

Authentic compounds used for bioassay were synthesized



## Nematicidal activity

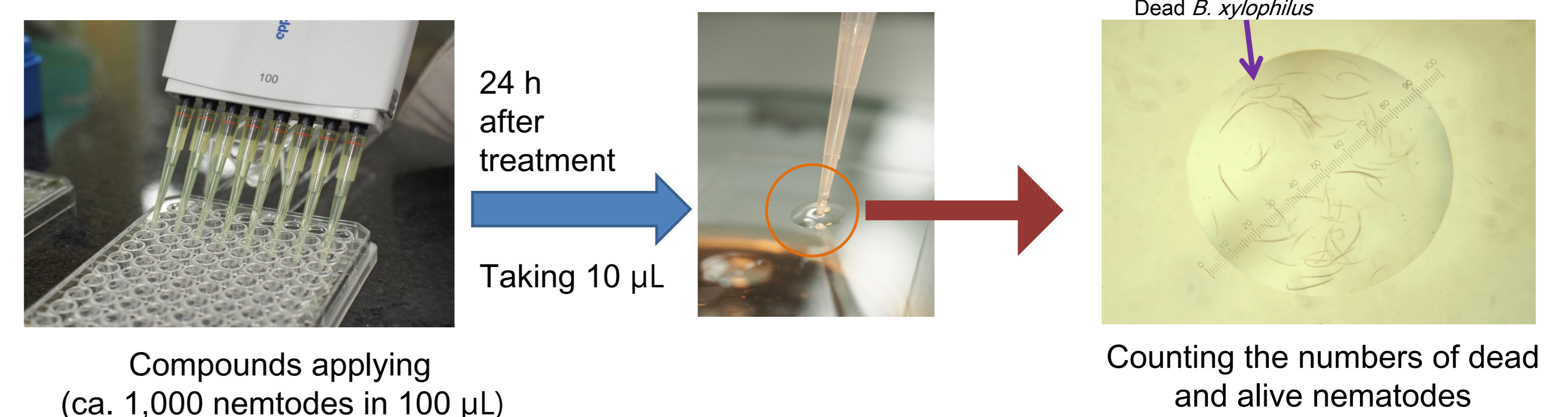


Fig 1. Procedures of nematicidal activity of test

## Statistical analysis: Probit analysis (SAS)

## RESULTS

Table 1. LC<sub>50</sub> and LC<sub>90</sub> values of alkyloxyalcohols, monochoamol, and abamectin against pine wood nematode, *Bursaphelenchus xylophilus*

Compound	LC <sub>50</sub> (ppm, 95% CL)	LC <sub>90</sub> (ppm, 95% CL)	Compound	LC <sub>50</sub> (ppm, 95% CL)	LC <sub>90</sub> (ppm, 95% CL)
C4OC4OH	878.2	5106.0	<b>C8OC6OH</b>	55.1 (46.2 - 64.7)	184.0
C5OC4OH	675.4	4725.0	C9OC6OH	333.7	10840.0
C6OC4OH	652.7	5948.0	C3OC8OH	380.7	2621.0
C7OC4OH	529.4	5973.0	C4OC8OH	239.2	1272.0
C8OC4OH	276.5	2534.0	C5OC8OH	107.9	487.3
<b>C9OC4OH</b>	65.5 (53.5 - 80.5)	236.6	<b>C6OC8OH(B)</b>	48.0 (35.2 - 64.0)	152.6
<b>C10OC4OH(A)</b>	43.1 (32.4 - 56.4)	188.4	C7OC2OH	238.5	1085.0
<b>C11OC4OH</b>	65.4 (51.7 - 82.7)	287.1	C8OC2OH	100.2	143.2
C3OC6OH	869.3	2952.0	C9OC2OH	58.7 (54.7-62.5)	134.7
C4OC6OH	718.8	2938.0	<b>C10OC2OH(C)</b>	42.8 (39.6-45.4)	69.8 (65.7-75.9)
C5OC6OH	448.0	1545.0	<b>C12OC2OH(D)</b>	42.6 (36.1-49.0)	231.6
C6OC6OH	390.2	1932.0	C13OC2OH	192.6	1005.2
C7OC6OH	131.2	1176.0	<b>C11OC2OH</b>	46.1 (40.9-51.3)	120.7 (104.4 -145.7)
Abamectin	2.2 (1.87-2.55)	13.1 (11.4-15.9)	<b>(monochoamol)</b>		

Table 2. Nematicidal activity of benzyloxyalkylalcohols and LC<sub>50</sub> and LC<sub>90</sub> values of benzyloxyoctanol and benzyloxynonanol against pine wood nematode, *Bursaphelenchus xylophilus*

Treatment	Mortality at Each Concentration (% Mean ± SE)				
	2000 <sup>1</sup>	1000	500	100	50
Benzyl alcohol	31.0 ± 3.9	-	-	-	-
BzOC2OH (1)	-	30.6 ± 4.2 <sup>d</sup>	13.9 ± 6.3 <sup>e,f</sup>	2.5 ± 0.6 <sup>e</sup>	-
BzOC3OH (2)	-	43.3 ± 4.6 <sup>c,d</sup>	25.9 ± 2.5 <sup>d,e</sup>	4.9 ± 0.7 <sup>e</sup>	-
BzOC4OH (3)	-	53.2 ± 4.2 <sup>c</sup>	33.0 ± 4.0 <sup>c,d</sup>	5.3 ± 0.4 <sup>d,e</sup>	-
BzOC5OH (4)	-	57.4 ± 4.7 <sup>b,c</sup>	37.7 ± 3.0 <sup>c,d</sup>	8.8 ± 1.1 <sup>c,d,e</sup>	-
BzOC6OH (5)	-	71.5 ± 7.5 <sup>b</sup>	45.4 ± 3.0 <sup>b,c</sup>	12.8 ± 1.2 <sup>c,d</sup>	-
BzOC7OH (6)	-	60.2 ± 5.3 <sup>b,c</sup>	47.6 ± 3.2 <sup>b,c</sup>	16.2 ± 4.3 <sup>c</sup>	-
BzOC8OH (7)	-	100 <sup>a</sup>	56.0 ± 4.3 <sup>b</sup>	28.9 ± 2.9 <sup>b</sup>	5.2 ± 0.5 <sup>a</sup>
BzOC9OH (8)	-	100 <sup>a</sup>	85.1 ± 1.9 <sup>a</sup>	39.2 ± 2.4 <sup>a</sup>	5.0 ± 0.5 <sup>a</sup>
Control	-	0 <sup>e</sup>	0 <sup>f</sup>	0 <sup>g</sup>	0 <sup>b</sup>
Statistical value	-	F <sub>8,36</sub> = 159.1 p < 0.001	F <sub>8,36</sub> = 67.0 p < 0.001	F <sub>8,36</sub> = 42.43 p < 0.001	F <sub>2,12</sub> = 48.83 p < 0.001
Treatment	LD <sub>50</sub> (95% CL) <sup>1</sup>	LD <sub>90</sub> (95% CL)	χ <sup>2</sup> (df)		
BzOC8OH (7)	246.1 (228.5-265.2)	1004.6 (893.1-1145.6)	193.1 (18)		
BzOC9OH (8)	158.0 (81.4-168.9)	490.0 (444.9-545.3)	71.5 (18)		
Abamectin	1.7 (1.51-1.94)	11.8 (10.2-13.9)	147.1 (18)		

<sup>1</sup> LC<sub>50</sub> and LC<sub>90</sub> values are in ppm and 95% CL are confidence limits.

## DISCUSSION

- ✓ The nematicidal activity was different according to total carbon chain length in compounds, although the compounds have same molecular formula. This may be due to the different position of oxy group in the alkyloxyalkanols (ROR'OH).
- ✓ Some compounds which substituted -OH of alkanol and benzyl alcohol to -OROH increased the nematicidal activity, although their nematicidal activity was much lower than commercial nematicide, abamectin. However, the results would give the possibility for a new pesticide structure.

## REFERENCE

- Kim J., Lee S.-M., Park C.G. 2016. *Bursaphelenchus xylophilus* is killed by homologues of 2-(1-undecyloxy)-1-ethanol. Scientific Reports, 6, Article ID 29300. doi: 10.1038/srep29300
- Kim J., Lee J., Park J.O., Youn K.A. 2021. Nematicidal activity of benzyloxyalkanols against pine wood nematode. Biomolecules, 11, 384. doi: 10.3390/biom11030384