

The Efficacy of Wood Vinegar Against *Oncomelania hupensis lindoensis* Snails Vector of Schistosomiasis

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Abstract— The eradication of *Oncomelania hupensis lindoensis* snail as the vector of schistosomiasis disease in its endemic areas is essential. The snail eradication is performed mechanically and chemically. Chemical eradication is conducted by using molluscicide, but the use of synthetic molluscicide is toxic to the environment. As an alternative solution, the eradication of infectious snail vector requires eco-friendly technology using wood vinegar. Wood vinegar is poisonous for infectious snails but, on the other hand, is advantageous for soil and plants around the habitats of the infectious snails. The objective of this study is to determine the lethal concentration of the wood vinegar against *Oh. lindoensis*. The type of research was true experimental. The amount of sample was determined based on Federer formula to generate 6 treatment concentrations with 4 repetitions. There were 2 control groups namely positive control and negative control in which positive control used Baylucide and negative control did not get any treatment. The concentrations of wood vinegar being used were 300 mg L⁻¹, 900 mg L⁻¹, 1800 mg L⁻¹, 3600 mg L⁻¹, 7200 mg L⁻¹, and 21600 mg L⁻¹. The result showed that the final test generated an LC₅₀ value of 9696.2 mg L⁻¹ and LC₉₀ value of 210087.4 mg L⁻¹. It can be concluded from this study that wood vinegar is effective in killing *Oh. lindoensis* snail and it can be used as an alternative molluscicide against *Oh. lindoensis* snail.

Keywords: wood vinegar, schistosomiasis, *oh. lindoensis*, molluscicide

I. INTRODUCTION

Schistosomiasis is caused by a parasitic trematode worm, *Schistosoma japonicum*, through its intermediate host, a freshwater snail *Oncomelania hupensis lindoensis* from the *Pomatiopsidae* familia [1]. This snail was first discovered around grass that grew on abandoned rice fields in the Lindu Plateau in 1971 [2]. At present *Schistosomiasis* mainly inhabits the highland areas in Central Sulawesi such as around Lake Lindu, Napu Valley and Bada Valley [2]. Humans and mammals are the definitive host where these worms live in their veins, breed sexually and develop into mature *Schistosoma*. The presence of *Schistosoma* causes pathological abnormalities in the host.

Oncomelania hupensis lindoensis snail is an intermediate host for the *Schistosoma japonicum* worm. The *Schistosoma japonicum* worm ejects miracidium which then swim actively in water and penetrate the body surface of the snail with the help of lysis substances produced by miracidium. In the snail's body, the miracidium will turn into the parent sporocyst, then produce seed cells that will grow into the child's sporocyst then produce a lot of cercariae. Cercaria will be released by the snail onto the surface of the water and will enter the definitive host through water [3]. *Oncomelania hupensis lindoensis* snail usually dwell in humid areas which are neither too wet nor dry. Snail's habitats such as the Lake Lindu area consist of two types, namely cultivated area and virgin area (uncultivated area) [1]. There are several types of habitats where the snails live, including rice fields, plantations, grasslands, and forests. Rice fields are dominated by grasses and legumes, while plantations are dominated by cocoa and coffee. The type of soil in the snail habitat is dominated by sandy soil texture where it covers 60.84% of rice fields and 73.81% of plantations. Meanwhile the clay texture in the rice fields and plantations are 4.53% and 5.51% respectively.[4] The soil texture is sandy clay and it contains potassium minerals, sodium, calcium, magnesium, and ferrum. Meanwhile the pH of the water is 8.5 and it contains potassium, calcium, magnesium, sodium, ferrum, and copper [3].

Eradication of snails is important to suppress the snail population as low as possible in all foci of snails in the *Schistosomiasis* endemic regions and to achieve 0% infection rate in the residential areas. Mechanical eradication is done by making a dry channel in the focus area, stockpiling the focus area, permanently changing the focus area into rice field, plantation or fish pond. On the other hand, Chemical eradication is done using molluscicide. The molluscicide currently used is niclosamide (Baylucide[®], Bayer, Leverkusen, Germany). However, the use of synthetic molluscicides has disadvantages. It tends to be toxic to the environment, fish, microscopic biota (zooplankton and phytoplankton), and vegetation around the habitat where *Schistosomiasis* snail lives [5].

Wood vinegar is the result of smoke condensation in the combustion process of wood or carbon-rich materials and other compounds such as cellulose, hemicellulose and lignin. Wood vinegar contains various chemical components such as phenols, aldehydes, ketones, organic acids, alcohols and esters.[6] These chemical components can function as antioxidants, antimicrobials and give a distinctive color and flavor effect to the product's smoke.[7] The chemical components of wood vinegar such as acetic acid serve to accelerate plants' growth, and prevent plant diseases. Methanol also functions to accelerate plants' growth, while phenols and its derivative function to prevent pests and plant diseases.[8][9]. Therefore, wood vinegar is very potential to be developed to fertilize plants that grow in the snail habitats that also poison to *Oh. lindoensis*. Wood vinegar is an alternative solution to eradicate transmissible snail vectors because it an environmentally friendly technology. In addition to being deadly to transmissible snails, wood vinegar is beneficial to the land and plants that live in the habitats around the transmitting snail.

II. METHOD

A. Snail Material

The study was conducted at the Biological Resources Laboratory of National Institute of Health Research and Development Unit of Donggala in April 2017. The type of research employed in this study was true experimental.[10] *Oh. lindoensis* samples were taken from Dodolo Village, North Lore Sub District, Poso Regency.

Snail samples were taken from the focus of snails in the Dodolo Village area of North Lore Sub District, Poso Regency. Snail collection was done randomly. Snail samples were taken using tweezers and small plastic bottles were used to store snails and soil around them.

B. Wood vinegar Material

Wood vinegar was obtained from the Agricultural Laboratory of Tadulako University. Wood vinegar used was the wood vinegar grade 3 made from coconut shell.[11] Wood vinegar was made by the distillation method by burning 50 kg of coconut shell in a tank, the smoke was condensed in a condenser, then from the condenser, the condensed wood vinegar dripped. Wood vinegar was obtained as much as 5 L with a concentration of 100%.

C. Molluscicidal activity

The test was conducted to determine the effectiveness of wood vinegar in killing snails. Two tests were carried out, the preliminary test and the final test. In the preliminary test, wood vinegar was divided into 6 groups of concentration treatments namely 10000 mg L⁻¹, 20000 mg L⁻¹, 30000 mg L⁻¹, 40000 mg L⁻¹, and 50000 mg L⁻¹, and were repeated 4 times as determined by the Federer formula [12].

$$(n - 1) (r - 1) \geq 15$$

Where, n = number of treatments (concentration), r = number of repetitions. Each treatment contained 25 snails with 4 times repetitions. The controls used were positive control in the form of Baylucide of 1 ppm and negative control in the form of water. Each control was repeated four times. In the final test, the concentration of wood vinegar

used was based on the values of LC₅₀ and LC₉₀ from the results of the preliminary test (LC₅₀ = 3500 mg L⁻¹ and LC₉₀ = 146000 mg L⁻¹). In this study, the wood vinegar was not replaced during the experiment. The tools and materials used were petri dishes, tweezers, cover wires, *Oh. lindoensis* snails, Baylucide. 25 snails in a sample bottle were transferred using tweezers to a petri dishes containing wood vinegar with 6 different treatment concentrations, then covered with wire to prevent the snail from coming out of the petri dish. Observations were made at 1 hour, 3 hours, 6 hours, 9 hours, 24 hours. During the test, no food was given to snails. The number of dead snails was calculated at each observation hour. Criteria for the death of the snails was that snails did not move or respond to any stimulation. To determine LC₅₀ and LC₉₀ from wood vinegar, probit analysis was used. This study did not require ethical approval because it did not use animals or humans as required by the National Institute of Health Research and Development (NIHRD).

III. RESULT

Based on the results of the preliminary test (LC₅₀ = 3500 mg L⁻¹), the wood vinegar test concentrations used were 300 mg L⁻¹, 900 mg L⁻¹, 1800 mg L⁻¹, 3600 mg L⁻¹, 7200 mg L⁻¹, 21600 mg L⁻¹.

TABLE I. PERCENTAGE OF *OH.LINDOENSIS* MORTALITY AT VARIOUS CONCENTRATIONS OF WOOD VINEGAR

Concentration (mg L ⁻¹)	Number of Snails	Average Mortality	Mortality Percentage
Control -	25	0	0
Control +	25	25.00	100
300	25	2.25	9
900	25	4.00	16
1800	25	7.00	28
3600	25	7.75	31
7200	25	8.25	33
21600	25	18.00	72

The highest average number of deaths (72%) was obtained at the concentration of 21600 mg L⁻¹ and the lowest at a concentration of 300 mg L⁻¹ (Table 1). The higher the concentration of wood vinegar, the higher the average number of *Oh. lindoensis* deaths. There was positive correlation between wood vinegar concentration and average mortalities of snails (R = 0.8906) (Figure 1).

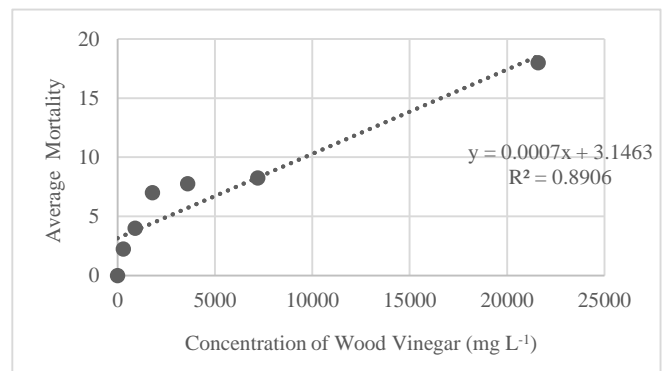


Fig 1. *Oh. lindoensis* mortality in response to various concentrations of wood vinegar

The results of the probit analysis of the wood vinegar test against *Oh. lindoensis* shows the number of snail deaths by 50% (LC₅₀) and the number of snail deaths by 90% (LC₉₀) as presented in Table 2.

TABLE II. LC₅₀ AND LC₉₀ VALUES OF *OH. LINDOENSIS* MORTALITY AFTER 24 HOURS ROOM TEMPERATURE

	Wood vinegar	
	LC ₅₀ (mg L ⁻¹)	LC ₉₀ (mg L ⁻¹)
Estimate	9696.2	210087.4
Lower bound	5473.8	57564.4
Upper bound	26699	4282719

In the treatment of wood vinegar, it can be estimated that LC₅₀ value of 9696.2 mg L⁻¹ and LC₉₀ value of 210087.4 mg L⁻¹. Therefore, vinegar has the ability to kill 50% of snails starting at a concentration of 5473.8 mg L⁻¹ to 26699 mg L⁻¹, and can kill 90% of snails starting at a concentration of 57564.4 mg L⁻¹ to 4282719 mg L⁻¹.

IV. DISCUSSION

Based on the results of the wood vinegar test against *Oh. Lindoensis*, wood vinegar had a potential as a molluscicide. Giving wood vinegar showed an increase in *Oh. lindoensis* mortality along with the increasing concentration of wood vinegar. Wood vinegar had the ability to kill 50% of the population of *Oh. lindoensis* snails (LC₅₀) at a concentration of 9696.2 mg L⁻¹, and kills 90% of the *Oh. lindoensis* snails population (LC₉₀) at a concentration of 210087.4 mg L⁻¹.

Wood vinegar is usually used in agriculture to kill insects and plant pests [13][14][15][16]. In addition to these benefits, based on the results of this study wood vinegar could also be used as a molluscicides for *Oh. lindoensis* snails. The results of this study showed that the concentration of wood vinegar needed to kill 50% of snails was much higher than in some previous studies using several types of molluscicides derived from plants such as methanol extract from *Jatropha curcas* L (LC₅₀ = 16.9032 mg L⁻¹), methanol extract from *Ricinus communis* (LC₅₀ = 20.6267 mg L⁻¹), methanol extract of *Jatropha gossypifolia* (LC₅₀ = 10.4157 mg L⁻¹), [17] methanol and rough extracts from *Jatropha curcas* L (LC₅₀ = 5 mg L⁻¹) and (LC₅₀ = 50 mg L⁻¹) against *Biomphalaria glabarata*; [18] extract *Eucalyptus globulus* (LC₅₀ = 55 mg L⁻¹) against *Schistosoma mansoni* worms and their host intermediaries; [19] and ethanol extract from *Solanum nigrum* (LC₅₀ = 2.96 mg L⁻¹) *Solanum villosum* (LC₅₀ = 4.88 mg L⁻¹) *Solanum sinaicum* (LC₅₀ = 3.19 mg L⁻¹) against *Biomphalaria glabarata*. [20] Other studies had also been carried out using *Eupatorium adenophorum* against *Oh. lindoensis* snails which results obtained were as follows: the concentration of *Eupatorium adenophorum* leaf extract 0.27% was able to kill *Oh. lindoensis* snail at the 58th hour. [21]

Wood vinegar contains phenols, aldehydes, ketones, organic acids, alcohols and esters which can be used to fertilize plants in around the habitat of *Oh. lindoensis* snails. The concentration of wood vinegar needed to kill 50% of the

snail population is quite high, which is 9696.4 mg L⁻¹ so it is estimated that the amount of coconut shells needed is also large enough to make such amount of wood vinegar. Als considering the extent of the focus of schistosomiasis snails which are the habitat of *Oh. Lindoensis*, it will certainly require a greater amount of wood vinegar. Therefore, it is necessary to do further research on the application of wood vinegar to *Oh lindoensis* in their habitat (field tests).

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