



# Assessing the Molluscicidal Potential of Ethanolic Extract of *Zingiber officinale* on *Bulinus wrighti*, a Carrier of Bilharzia

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## ABSTRACT

This study assess the molluscicidal potential of various preparations of *Zingiber officinale* (ginger) against *Bulinus wrighti*, a freshwater snail vector for schistosomiasis. Snails were exposed to different concentrations of *Z. officinale* extracts, with mortality recorded at intervals of 24, 48, 72, and 96 hours. To assess environmental safety, *Oreochromis niloticus* (tilapia) fish were also exposed to the 24-hour LC90 concentration of the molluscicidal formulations over a 96-hour period to observe potential toxicity to non-target species. Results indicate that molluscicidal efficacy of the plant-derived formulations, particularly those using ethanolic extraction, is both time- and concentration-dependent. The ethanolic extract of *Z. officinale* oleoresin showed a significant decrease in LC50 from 176.10 mg/L at 24 hours to 38.65 mg/L at 96 hours, highlighting its increased potency with prolonged exposure. These findings confirmed that ethanol-based plant extracts of *Z. officinale*, showed promising molluscicidal activity against *B. wrighti*. The absence of observed toxicity in tilapia suggests this extract may offer an environmentally friendly option for controlling schistosomiasis vectors in aquatic environments, supporting their potential use in integrated pest management strategies.

## INTRODUCTION

Schistosomiasis is one of the most widespread parasitic diseases affecting humans, second only to malaria in its socio-economic and public health importance, significance in tropical and subtropical regions. It is the most common of the waterborne diseases and poses one of the greatest health risks in rural areas of developing countries (John, 2004). The disease is particularly prevalent in tropical and subtropical regions, especially among impoverished communities that lack access to safe drinking water and adequate sanitation. It is estimated that at least 90% of patients requiring treatment for schistosomiasis reside in Africa (John, 2004).

Nanvya *et al.* (2011) reported a schistosomiasis infection prevalence of 55.7% in the Ndinjor district of Langtang North Local Government Area in Plateau State, Nigeria. Among those infected, 41.3% had urinary schistosomiasis (*S. haematobium*), while 14.4% were infected with intestinal schistosomiasis (*S. mansoni*). Similarly, Abdullahi *et al.* (2011) examined 6,600 urine samples for *S. haematobium* infection across 44 Local Government Areas in Kano State, Nigeria, finding a 42.7% infection rate, with the highest prevalence of 64.0% in Kura Local Government Area. One effective strategy to combat schistosomiasis is to eliminate the carrier strains and sever the critical link in the parasite's life cycle (Singh and Singh, 2000), which can be achieved using compounds known as molluscicides.

Of 106 plant species utilized in Nigerian herbal medicine, 23 methanolic extracts (12.7%) demonstrated 100% effectiveness against *Bulinus globosus* (Adewunmi and Sofowora, 1980). Many plant species have undergone extensive field evaluations in other endemic areas of Africa (John, 2004). However, there has been limited research on the molluscicidal efficacy of *Allium sativum*, against *Bulinus wrighti*, which is abundant in local water bodies and acts as the intermediate host for *Schistosoma haematobium* in this region.

Studies have shown that school-aged children in various parts of the country, from both rural and urban environments, are particularly affected by *S. haematobium*, with prevalence rates ranging from 20% to 70% in certain communities (Nanvya *et al.*, 2011). Environmental changes, such as the construction of artificial dams, lakes, and quarries, have created additional breeding sites for intermediate hosts and new transmission foci due to poor sanitation practices.

Synthetic molluscicides pose health risks to humans and livestock and should only be used if they are safe for humans and non-target animals. In contrast, plant-based molluscicides are receiving increased attention for their environmentally friendly, biodegradable, and less persistent nature, making them less hazardous to non-target species.

The primary aim of "Assessing the Molluscicidal Potential of Ethanolic Extracts of *Zingiber officinale* on

*Bulinus wrighti*, a Carrier of Bilharzia" is to evaluate the effectiveness of ethanolic extracts from ginger (*Zingiber officinale*) in killing or inhibiting the growth of *Bulinus wrighti*, a freshwater snail species that transmits bilharzia (schistosomiasis). This research aims to determine whether these natural extracts can serve as an environmentally friendly alternative to chemical molluscicides, thereby contributing to the control of bilharzia transmission in affected regions.

## MATERIALS AND METHOD

### Study Area

This study was carried out in Parasitology laboratory of Biological Sciences, Usmanu Danfodiyo University Sokoto, Sokoto state. Sokoto is the capital city of Sokoto State, lies between latitude 13° 3' 490N, longitude 5°14' 890E and at an altitude of 272m the sea level above. It is located in the extreme North Western part of Sokoto North and South local government areas and also some parts of Kware LGA from the North, Dange Shuni LGA from South and Wamakko LGA to the West. Sokoto metropolis is estimated to have a population of 427,760 people (NPC/FRN,2007) and by the virtue of its origin, the state comprises mostly Hausa/Fulani and other groups such as Gobirawa, Zabarmawa, Kabawa, Adarawa, Arawa, Nupes, Yorubas, Ibos and others. Occupation of city inhabitants include trading, commerce, with a reasonable proportion of the population working in private and public sectors (MOI, 2008). The Sokoto township is in dry Sahel surrounded by sandy terrain and isolated hills. Rainfall starts late that is in June and ends early, in September but may sometimes extend into october. The average annual rainfall is 550 mm with peak in the month August. The highest temperatures of 45°C during the hot season are experienced in the months of March and April. Harmattan, a dry cold and dusty condition is experienced between the months of November and February (Abdullahi *et al.*, 2009). Modern Sokoto city is a major commerce centre in leather crafts and agricultural products (MOI, 2008).

### Collection of Snails

Adult *Bulinus wrighti* were collected from their natural habitat from kwalkwalawa local fresh water river in sokoto metropolis. The snails were identified by Head of Zoological Museum of Natural History, Biological Science Department, A. B. U. Zaria, Nigeria. Size of the shell was  $\pm 2.00$ cm. pH of the dechlorinated tap water was 7.2 and the temperature was 32.2° C. Snails were acclimatized in the laboratory conditions for 72 hours in the Plastic aquaria containing dechlorinated tap water before being used for molluscicidal tests. Dead animals were removed quickly to avoid contamination of aquarium water.

## Plant Materials Used in the Research

Plant was identified and confirmed by a senior plant taxonomist from Biological Sciences Department, Usmanu Danfodiyo University Sokoto. Rhizome of *Zingiber officinale* were purchased from market during the period of March to July.

## Preparation of Plant Extracts

Ginger Powder- Oleoresin was obtained by extraction of dried *Zingiber officinale* (ginger) powder with alcohol. Fresh ginger rhizome was purchased peeled and cut into small pieces and air dried and pulverized by mortar and pestle, powder was sieved and stored at low temperature in fridge.

## Ethanolic Extraction

Five hundred grams (500g) of air-dried *Z. officinale* (rhizome), was extracted with 1.5 litres of ethanol. Each extraction was kept in orbital shaker for 30 mins. All the extracts were filtered, using muslin cloth and concentrated to dry under reduced pressure in a rotary evaporator at 40°C which yield ethanolic extract of the *Z. officinale*. The extract were kept in fridge in Laboratory for further use.

## Study of Toxicity of Different Preparation of Plant Derived Molluscicide

Toxicity experiments were performed by the method of Singh and Singh (1997). Ten experimental animals were kept in each aquarium containing 3 litres of dechlorinated tap water, and exposed continuously for 96h to different concentrations of plant materials and preparations. Control animals were kept in similar conditions without treatment. During experimental period snails were kept in starved condition. As it was periodic sampling the mortality was recorded after every 24 hours interval up to 96 hours during exposure of the snails. Each experiment was replicated six times.

The toxic effect of the molluscicides was also studied against fish *Oreochromis niloticus* (Tilapia). In

these experiments a group of 10 Tilapia were exposed in 6 litres of dechlorinated tap water. The fishes were exposed to 24 hours LC<sub>90</sub> (of snail) to 96 hours.

No response to a needle probe in case of snails, and no response against touch in case of fish (Tilapia) were taken as evidence of death. Dead animals were removed on each observation during exposure period to avoid any contamination of the aquarium water Singh and Singh 1997

## Statistical Analysis

Lethal concentration (LC<sub>50</sub>) value, lower (LCL) and upper (UCL) confidence limits, and slope value were calculated according to the method of POLO (probit or logit) computer programme of Russell *et al.*, (1977).

## RESULTS

This part of the result deals with study of molluscicidal properties of different preparation of *Z. officinale* against *B. wrighti*. The Snails were exposed to different concentrations of preparations (Table-1). Mortality was recorded after 24h, 48h, 72h, and 96h during the exposure period. *Tilapia* Fish were exposed to (24h LC<sub>90</sub> against *B. wrighti*) of molluscicidal formulation for 96h to observe any toxic effect against non target animals in aquatic environment. Toxicity evaluation of the plant derived formulation showed that the molluscicidal activity of the preparations against *B. wrighti* was time and dose dependent.

Table 2, shows toxicity of Oleoresin against *B. wrighti*. This result showed that the LC<sub>50</sub> decreased from 176.10mg/l (24h) to 38.65mg/l (96h).

**Table 1:** Doses of Plant extracts Tested on *B. wrighti* for Toxicity.

| Name of Treatment                            | Concentration (mg/L) |
|----------------------------------------------|----------------------|
| Ethanolic extraction of <i>Z. officinale</i> | 20, 30, 60, 80       |

**Table 2:** Toxicity of Ethanolic Extraction of Oleoresin (ginger) against *B. wrighti*

| Exposure Time | LC <sub>50</sub> (mg/l) | LCL    | UCL    | Slope Value | t-ratio | g-Value | Heterogeneity |
|---------------|-------------------------|--------|--------|-------------|---------|---------|---------------|
| 24hr.         | 176.10                  | 107.85 | 761.07 | 1.72± 0.46  | 3.72    | 0.27    | 0.43          |
| 48hr.         | 86.63                   | 69.44  | 127.95 | 2.32±0.42   | 5.50    | 0.12    | 0.47          |
| 72hr.         | 61.99                   | 53.85  | 74.32  | 3.45±0.44   | 7.69    | 0.08    | 1.12          |
| 96hr.         | 38.65                   | 33.22  | 44.79  | 3.40±0.40   | 8.44    | 0.07    | 1.26          |

Batches of ten snails were exposed to different concentrations of ethanolic extract of ginger (*Oleoresin*) powder. Mortality was recorded at every 24hr. Each set of experiment was replicated six times. Concentrations given are the final concentration (w/v) in the aquarium water.

A value of t-ratio greater than 1.96 indicates that regression is significant. Value of heterogeneity factor was less than 1.0 denotes that in the replication test of random samples, the concentration response line would fall within 95% confidence limits and thus the model fits the data adequately.

The indexes of significance of potency estimation 'g value' indicate that the value of mean was within the limits at all probability levels (90, 95, 99) as it was less than 0.5.

## DISCUSSION

This study reveals that the ethanolic extract of *Zingiber officinale* exhibits molluscicidal properties against *Bulinus wrighti*, with its effects being both time- and concentration-dependent.

The primary active compound in *Z. officinale* is gingerol, known for its molluscicidal effect against other snail species such as *Lymnae acuminata* (Singh & Singh, 2000). The dry rhizome of *Z. officinale* contains 1-4% volatile oils, contributing to its characteristic aroma and taste (Zafar *et al.*, 2001), and its molluscicidal activity may be partly attributed to saponins (Label *et al.*, 2012). Previous studies by Label *et al.* (2012) indicated molluscicidal effects of methanolic extracts of *Z. officinale* against *Bulinus globosus*, with an LC50 of 214.72 mg/L at 24 hours. In contrast, the ethanolic extract used in this study yielded an LC50 of 176.10 mg/L at 24 hours and 38.65 mg/L at 96 hours for *B. wrighti*, suggesting that ethanolic extracts have enhanced molluscicidal efficacy potentially due to differences in extract penetration or the metabolic pathways of the two snail species.

Our findings confirmed that ethanolic extracts of *Z. officinale* is effective against *B. wrighti*. This supports observations. No mortality was observed in *Oreochromis niloticus* (tilapia) even at 24-hour LC90 of the molluscicides investigated in this study which indicated that the use of these molluscicides is safe to non target Animals such as fish. This suggests that tilapia can rapidly detoxify the active compounds, or that they have a metabolic pathway distinct from snails.

The steep slope values across toxicity studies indicate that small increases in molluscicide concentration result in significantly higher snail mortality. A t-ratio above 1.96 signifies significant regression, while a heterogeneity factor below 1.0 indicates that concentration-response data align with the 95% confidence limits, confirming that the model accurately represents the data. Additionally, the potency estimation

index (g-value) supports consistency in response across probability levels (90, 95, 99), as all values were below 0.5.

## CONCLUSION

The findings of this research demonstrate that ethanolic extracts of *Zingiber officinale* (ginger) possess significant molluscicidal properties against *Bulinus wrighti*, a key vector for schistosomiasis. The effectiveness of this extracts is shown to be both time- and concentration-dependent, with extract displaying high molluscicidal activity tested, the superior efficacy of ethanol as a solvent for extracting active phytochemical highlights the importance of using appropriate extraction methods to maximize potency, as ethanol-based extracts consistently outperformed their aqueous counterparts as reported by other researchers elsewhere.

Moreover, the safety evaluation showed no adverse effects on non-target *Oreochromis niloticus* (tilapia) fish, even at high concentrations, suggesting that these plant-derived molluscicides may offer an environmentally safe alternative to synthetic chemical agents. These findings suggest that the use of natural molluscicides, particularly ethanol-extracted formulations from ginger could be a viable, eco-friendly solution for schistosomiasis vector control in endemic regions. This study supports further research into field applications and the possible integration of these plant-based molluscicides into existing pest management frameworks to effectively and sustainably reduce snail populations and schistosomiasis transmission.

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