



Comparative Evaluation of Extermination Efficiency and Histological Changes Induced by the Alcoholic Extract of *Lawsonia inermis* and Molluscicide Metaldehyde in Ground Snail *Monacha cartusiana*

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Abstract

Background: Wild snails, particularly *Monacha cartusiana*, are among the most damaging mollusc pests to crops. Given the environmental damage caused by the continued use of conventional chemical pesticides. **Objectives:** This study aimed to evaluate the effectiveness of an alcoholic extract of (*Lawsonia inermis* L.) against adult *Monacha cartusiana*. **Methodology:** An experimental study was conducted in the Department of Biology, College of Education for Pure Sciences, University of Kerbala, Karbala, Iraq, from November 2025 to March. The immersion test was used in two experiments, each involving four groups (control, 100, 150, and 200 mg/ml), each containing ten adult snails. Histopathological examination of the digestive gland and foot tissues was performed after fixation with formalin, drying with ethanol, and staining with hematoxylin and eosin. **Results:** The henna extract at a concentration of 200 mg/ml exhibited the strongest toxic effect, causing progressive, time-dependent mortality that continued until the seventh or eighth day. The effect of metaldehyde at the same concentration was more rapid. The extract's potency was approximately 70.0% that of metaldehyde. Histological examination revealed fibrosis and cellular degeneration in the digestive gland, and damage to muscle cells and fibers with ruptures in the foot tissues, compared to control specimens. **Conclusion:** The alcoholic extract of *L. inermis* produces significant toxic and histopathological effects on *Monacha cartusiana*, supporting its potential as an environmentally friendly option in integrated management of wild snails. [Bangladesh Journal of Infectious Diseases, June 2026;13(1):166-170]

Keywords: *Monacha cartusiana*; *Lawsonia*; histopathology; land snail; metaldehyde

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Introduction

The land snail *Monacha cartusiana* belongs to the class Gastropoda within the phylum Mollusca. This species is characterized by its small size, light-colored shell, and high adaptability to environmental conditions, which facilitates its rapid spread within fields. It is considered an important agricultural pest because it feeds on leaves and

tender plant tissues, leading to losses in crops and field plants.

Current studies have shown high densities of this snail in crops such as alfalfa, cabbage, lettuce, and wheat, with an increase in its numbers during the spring and wet seasons. Furthermore, this species is receiving increasing research attention in the field of pest control, as it has been used as a model for

evaluating the effectiveness of chemical pesticides, natural extracts, and bio-alternatives^{1,2}. Land snails belonging to the class Gastropoda are associated with many microorganisms and pathogens. They act as intermediate hosts or carriers for some parasites, bacteria, and fungi, contributing to their transmission and spread in the agricultural environment. The mucous secretions produced by the snails also help protect some microorganisms and increase their ability to survive and spread under different environmental³. Gastropoda are home to a diverse range of intestinal microbes, and studies have revealed that the gut bacteria in gastropods are involved in various biological aspects, such as growth, immunity, and host-parasite interactions^{4,5}. As a result of the economic damage caused by these snails, controlling their spread has become one of the biggest challenges facing agricultural production, given their status as significant agricultural pests and disease vectors. While synthetic pesticides remain the primary method of pest control, the increasing resistance to pesticides and their harmful effects on non-target species highlight the urgent need for safer alternatives⁴.

Control methods have diversified, including mechanical and chemical approaches. For example, metaldehyde is used to control this type of snail. However, the excessive use of these chemical pesticides leads to significant environmental and health problems that affect other members of the ecosystem, with direct, indirect, and cumulative damage⁶⁻⁷. Typically, pest control programs rely primarily on traditional pesticides, despite the problems they cause. However, it is essential to research more effective and resistant compounds for use in controlling these pests. The overuse of traditional molluscicides such as methomyl and metaldehyde has raised serious concerns due to the development of resistance, environmental pollution, and risks to non-target organisms⁸⁻⁹. Our study aimed to evaluate the effectiveness of an alcoholic extract of the henna plant (*Lawsonia inermis* L.) as a molluscicide against adult *Monaca cartosiana* snails, and to compare it with the effectiveness of the pesticide metaldehyde.

Methodology

Study Design: An experimental study was conducted in the Department of Biology at the College of Education for Pure Sciences, University of Kerbala, Karbala, Iraq, from November 2025 to March 2026. Adult *Monaca cartosiana* were manually collected from farms in the Al-Jadwal

Al-Gharbi and Al-Kamaliyah areas of the Karbala Governorate in the mornings, on several occasions. Plastic bottles were used for collecting the snails under study, and all information about the snails, including the location and date of collection, was recorded. As for the *Lawsonia inermis* plant, it was purchased from the markets in the form of fresh leaves

Plant Material and Preparation of the Alcoholic Extract:

The ethanol extraction method was adopted for the preparation of the henna leaf extract due to its high efficiency in extracting phenolic compounds and tannins. The leaves were washed, dried, and crushed. 500 g of the powder was then soaked in 5000 mL of 70.0% ethanol (1:10 w/v) for 48 to 72 hours with periodic stirring. The mixture was filtered and dried in a hot air oven at a temperature below 500 C. The resulting extract was stored in a refrigerator at 40 C until use¹⁰.

Experimental Design: Two independent biological experiments were carried out under similar laboratory conditions, each involving four groups of ten healthy adult snails (n = 10 per group) (Table 1).

Table 1: Design of the Two Experiments

Group	Treatment	Concentration (mg/mL)	n
A0 (Control)	Distilled water only	—	10
A1	<i>L. inermis</i> alcoholic extract	100	10
A2	<i>L. inermis</i> alcoholic extract	150	10
A3	<i>L. inermis</i> alcoholic extract	200	10
B0 (Control)	Distilled water only	—	10
B1	Metaldehyde	100	10
B2	Metaldehyde	150	10
B3	Metaldehyde	200	10

Histopathological preparation: Snails from the group exposed to the highest effective concentration 200 mg/ml were dissected, along with samples from the control group, to obtain the digestive gland and foot. The tissues were fixed in 10.0% formalin solution, then histological sections were performed according to the¹¹ method, and the slides were stained with (H&E) and examined under a light microscope to detect pathological histological changes, with a direct comparison between the treated slides and normal control slides for each organ.

Statistical Analysis: Descriptive statistics (mean, standard deviation, percentages) were performed

along with cumulative mortality analysis, time-response mortality analysis, and LD₅₀ estimation, at a significance level of $P < 0.05$ ¹².

Ethical Consideration: Ethical Clearance: Ethical approval was obtained from the relevant Institutional Ethics Committee before the study commenced. Written informed consent was obtained from all participants. All procedures were conducted in accordance with the Declaration of Helsinki.

Results

Molluscicidal activity: Among the three concentrations of the alcoholic henna extract tested (100, 150, and 200 mg/mL), the highest concentration (200 mg/mL) exerted the most pronounced and direct toxic action against adult *M. cartusiana*, inducing a gradual, time-dependent mortality pattern that continued progressively until day 7 to 8 of exposure. The lower concentrations (100 and 150 mg/mL) produced comparatively reduced toxic effects. In the parallel bioassay, metaldehyde at 200 mg/mL produced a markedly faster onset of toxicity, with the first mortalities recorded at approximately 36 hours (i.e., from day 3) post-exposure, consistent with the rapid mucus-depleting and dehydrating mode of action characteristic of this molluscicide. When efficacy was compared at the equivalent 200 mg/mL concentration and observation endpoint, the alcoholic henna extract achieved approximately 70.0% of the molluscicidal efficacy recorded for metaldehyde, calculated using the direct percentage-mortality method described in Section 2.5.

Histopathological Alterations: Microscopic image of the intestine of a control group snail. A and B: Normal intestinal histological structure was observed. The intestinal wall consists of a mucous layer (black arrow) lined with simple columnar epithelial cells resting on a basement membrane (yellow arrow) supported by connective tissue. The apical surfaces of the epithelial cells show distinct cilia (blue arrow) projecting into the intestinal lumen (red arrow). No pathological histological changes were detected (Figure I).

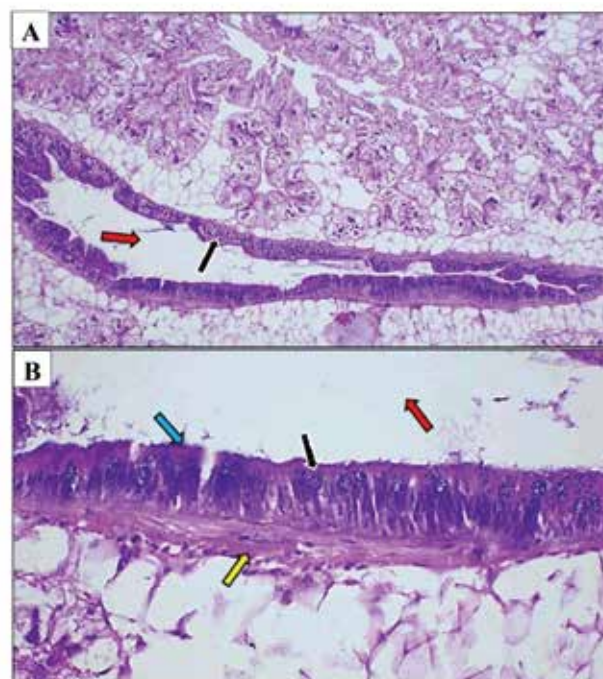


Figure I: Microscopic Image of The Intestine of a Control Group Snail H&E A: 100x, B: 400x

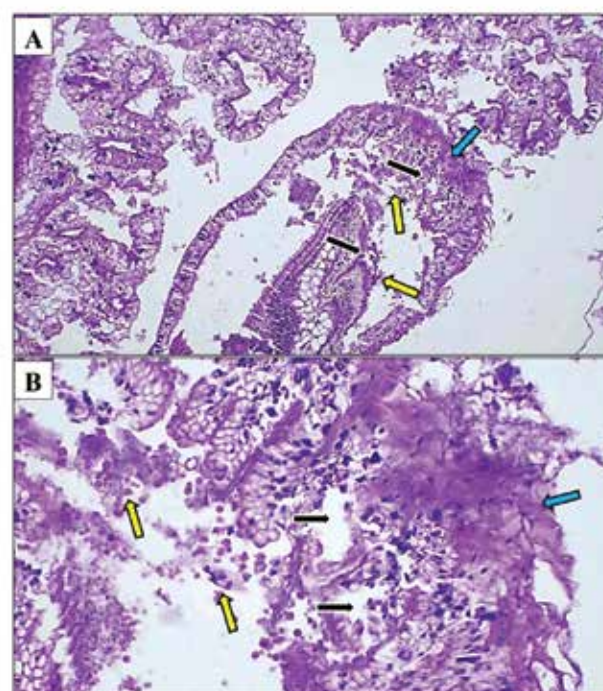


Figure II: Photomicrography of intestine of metaldehyde-treated group snail (H&E A: 100x, B: 400x)

Table 2. Mortality Outcomes at the Most Effective Concentration (200 mg/mL)

Treatment (200 mg/mL)	Onset of mortality	Mortality pattern	Relative efficacy
Alcoholic henna extract	Gradual onset*	Progressive, time-dependent mortality continuing to day 7–8	≈70% of metaldehyde
Metaldehyde	≈56 h (day 3)	Rapid onset and progression to high overall mortality	Reference standard (100%)

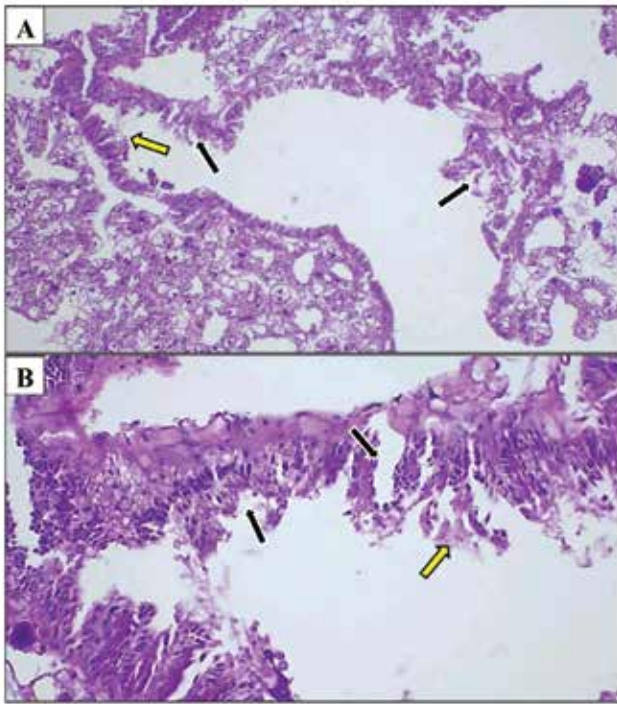


Figure III: Photomicrography of intestine of henna extract-treated group snail (H&E. A: 100x and B: 400x)

Discussion

The present findings demonstrate that the alcoholic extract of *Lawsonia inermis* possesses considerable molluscicidal activity against the land snail *Monacha cartusiana*, with the highest tested concentration (200 mg/mL) producing a progressive mortality pattern that reached approximately 70.0% of the efficacy achieved by the synthetic standard, metaldehyde, under identical exposure conditions. This level of relative efficacy is broadly consistent with previous reports describing plant-derived molluscicides as generally effective, though typically somewhat less potent than established synthetic standards such as metaldehyde, methomyl, or oxamyl, when compared directly^{1,4}.

The markedly faster onset of mortality observed with metaldehyde within approximately 36 hours relative to the slower, progressive action of the henna extract continuing to day 7 to 8 is consistent with the well-documented mode of action of metaldehyde, which irreversibly damages mucus-secreting cells of the integument and digestive epithelium, triggering excessive mucus discharge, rapid dehydration, and death within a comparatively short period^{7,13}. In contrast, the slower action of the henna extract may reflect a more gradual cytotoxic or oxidative mechanism, potentially mediated by lawsone and related phenolic constituents known to exert

antioxidant, cytotoxic, and membrane-disruptive activities in other biological systems¹⁴⁻¹⁵.

The observed histological changes such as fibrosis and degeneration of the digestive gland are consistent with previous findings for other chemical and herbal molluscicides. The digestive gland is the primary site of toxin accumulation and metabolism, in addition to the direct lethal effect. The rupture and destruction of muscle fibers in the foot are expected to impair locomotion, feeding, and surface attachment, even in snails that do not die during the observation period, thus enhancing the overall effect of the treatment. Practically, this supports the potential use of the *L. inermis* extract as an environmentally friendly molluscicide, given its relative environmental and animal safety compared to metaldehyde. However, its lower potency and slower onset of action make it more suitable as a supplementary component within an integrated pest management program alternating or combining it with low doses of conventional pesticides rather than as a direct replacement¹⁶⁻¹⁸.

Conclusion

The current study demonstrated that the alcoholic extract of *Lawsonia inermis* (henna) exhibited significant concentration-dependent efficacy in controlling *Monacha cartusiana*. A concentration of 200 mg/ml showed approximately 70.0% efficacy compared to the chemical molluscicide metaldehyde under the same exposure conditions and method. Histopathological examination confirmed that the molluscicide caused damage and fibrosis to the digestive gland, foot, and gonad tissues of the snails, while the damage was less severe than in the snails exposed to the alcoholic extract of the henna. These results support the potential use of henna as an environmentally friendly alternative in the integrated management of wild snails.

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Conflict of interest:

The Author has declared no conflict of interest in this work.

Financial Disclosure

No funding is received for this work.

Authors' contributions

The whole work was done by Enas Adel Giyad under the supervision of Dr. Israa Naser Ghulam. Both authors approved the final manuscript.

Data Availability

Any questions regarding the availability of the study's supporting data should be addressed to the corresponding author, who can provide it upon justifiable request.

Ethics Approval and Consent to Participate

All experimental procedures for animals were conducted in accordance with approved ethical controls and after obtaining approval from the Institutional Animal Care and Use Committee (IACUC) at the University of Karbala - College of Veterinary Medicine, under approval number: UOK.VET.BI.2026.177, in full compliance with the animal welfare standards applicable in experimental studies.

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