Toxicity and Histological Effects of Clove Buds' Powder, *Syzygium aromaticum* Compared with Neomyl (Methomyl) for the Control of *Monacha cartusiana* and *Theba pisana* Snails

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Abstract

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A series of laboratory and field experiments were designed to evaluate control measures that can be utilized effectively to reduce population density and consequently the damage caused by certain land snail species *Monacha cartusiana* Müller and *Theba pisana* Müller. In addition, factors contributing towards safer control measures were investigated. When neomyl 8% and clove powder buds 40% were applied to control *M. cartusiana* and *T. pisana* under laboratory and field conditions, the toxicity effect of these applications on the tested land snail's digestive glands was investigated. The results obtained revealed that the mortality rate increased with the increase in the concentrations and exposure period. Under laboratory conditions, the mortality rate of *T. pisana* snail reached 100% when 2, 4, and 8% neomyl concentrations were utilized, whereas the mortality rate of the same snail reached 36.3% when clove powder 40% was utilized, 28 days after treatment. Under field conditions, the initial effect of the examined compounds reached 62.89% and 18.83% mortality rate when neomyl and clove treatments were applied, respectively. Furthermore, the residual effect with neomyl treatment gave a high mortality rate of 83.43%, compared to 28.88% for the clove powder treatment. Generally, it could be concluded that neomyl had the most toxic effect against *M. cartusiana* under field conditions. 8% neomyl treatment resulted in histological degeneration with alterations in the digestive cells' cytoplasm. Numerous excretory vacuoles were found in the excretory cells. Calcium cells became granulated, cytoplasm vacuoles were abundant, and bizarre nuclei ranged from pyknosis to severe karyorrhexis and complete karyolysis. The results obtained also indicated that the toxicity effects of the 40% concentration of clove buds' powder, 48 hours after treatment, were approximately the same on both treated land snail species.

Keywords: Toxicity, histology, clove, neomyl, *M. cartusiana*, *T. pisana*.

Introduction

Recently, it was observed that infestation with land gastropod species had remarkably increased and became serious pests causing damage to agricultural crops in many countries worldwide (Barker, 2002). These pests are classified under the class: Gastropoda and phylum: Mollusca. Land snail species have increased rapidly in many governorates of Egypt and caused damage to field crops, vegetables, fruit trees, and ornamental plants as reported by many authors (Arafa, 1997; Ibrahim *et al*., 2017; Ismail *et al*., 2003; Shahawy *et al*., 2008).

Previous research showed that neomyl has high toxicity and was effective for control of both land snail species, *Eobania vermiculata* and *M. cartusiana* (Helmy *et al*., 2006). On the other hand, hepatopancreas of mollusks is involved in extra- and intracellular digestion of food material, absorption of nutrients, and storage of lipids, glycogen, and minerals. It also plays a significant role in detoxification (Beeby & Richmond, 1988). The digestive gland of land snails serves as the main organ for metabolism (El-Akhrasy, 2010; Zarai *et al*., 2011) and the accumulation and biotransformation of xenobiotic and toxins due to the presence of specific binding components (Nowakowska *et al*., 2012). Clove *Syzygium aromaticum* (L.) Merr. & L.M. Perry belongs to the family Myrtaceae. The clove buds are used as a spice, medicine, and food preservative, with antiparasitical, antifungal, virucidal, antibacterial, and insecticidal activities, and in pest and pathogens control (Nurdjannah & Bermawie, 2012).

This study shed light on the control methods of these pests. In addition, histological changes were also investigated.

Materials and Methods

Laboratory and field experiments were conducted during 2021-2022 to gain principal information regarding control and histological studies of certain land snail species. Data was statistically analyzed using the F test, and the significance of the means was determined based on the calculated least significant difference between means (LSD) at the 5% probability level.

Collection of terrestrial snail species

The same size of the glassy clover snails, *M. cartusiana*, and the small garden adult snail, *T. pisana*, were collected in the early morning from infested fields at Al-Awasga location, Hehia district, Sharkia Governorate, Egypt. The collected snails were placed in plastic bags and directly transferred to

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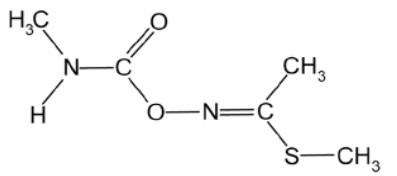
the laboratory and kept in a ventilated glass container (30 × 30 × 50 cm^3) containing moist clay soil covered with muslin cloth to prevent snails from escaping at 20±3ºC and 80±5% R.H as described by Ghamry *et al*. (1993). In order to acclimatize snail species, they were fed on fresh lettuce leaves for 14 days. Dead snails were daily removed, and only healthy ones were used in the tests.

Toxicity tests and evaluated materials

Neomyl- Methomyl 20% insecticide-KZ. The chemical formula is $C_5H_{10}N_2O_2S$, and the chemical name is Methyl N-(methylcarbamoyloxy) ethanimidothioate, and the chemical structure is as follows:



Clove buds, *Syzygium aromaticum* (L.) Merr. & L.M. Perry- The clove buds were obtained from a spice-shop. They were dried in an open area in the laboratory and ground with a blender to a fine powder. The powder was stored at 4°C in a plastic container until use. The main compound in the powder is eugenol forming at least 50%. About 10–40% is eugenol acetate, α-humulene, and β-caryophyllene. The rest, which is less than 10%, is minor components such as cadinene, diethyl phthalate, 4-(2-propenyl)-phenol, caryophyllene oxide, α-cubebin, chavicol, and α-copaene (Haro-González *et al*., 2021).

Effect of neomyl and clove buds' powder against *M. cartusiana* and *T. pisana* under laboratory conditions

Four concentrations (1, 2, 4, and 8%) of neomyl in addition to 10, 20, and 40 parts of clove powder were mixed with bran to complete 100 parts of the baits, and adequate water was added (Ismail *et al*., 2010). 25 mg of the poisonous bait was placed in each plastic box and ten healthy adult snails of *M. cartusiana* and *T. pisana* were inserted into each box. Three replicates were utilized for each treatment. The control treatment did not include any pesticide. Boxes were wrapped with muslin cloth banding with plastic rubber to prevent snails from escaping. These boxes were checked 1, 3, 7, 14, 21, and 28 days after treatment. Dead snails were counted and taken away from the boxes. Mortality rates were calculated and corrected using Abbott's formula (1925) as follows:

$$\text{Percent Control} = \frac{\text{percent living in the control - percent living in the treated plate}}{\text{percent living in the control}} \times 100$$

Effect of neomyl and clove against *M. cartusiana* under field conditions

Field experiment was conducted during March 2022 in an Egyptian clover field highly infested with the land snail, *M. cartusiana*. Poisonous baits of 8% neomyl and 40% clove powder were applied in the field at Sobaih location, Hehia district, Sharkia Governorate. 25 gm of pesticide was mixed with five parts of sugarcane syrup for attraction and integrated with wheat bran to give total amount of 100 parts of poisonous baits mixed with adequate water. Then, 100 gm of poisonous baits were placed on plastic pieces 25×25 cm^2. Each treatment was replicated three times, including the control treatment. The number of alive snails was recorded before treatment, and 1, 3, 7, 14, 21, and 28 days after treatment. Reduction rate was calculated according to the formula given by Henderson & Tilton (1955) as follows:

$$\text{Reduction rate (\%)} = \left[1 - \frac{t_2 \times r_1}{t_1 \times r_2}\right] \times 100$$

Where: r_1 is the number of alive snails before treatment in untreated plots, r_2 is the number of alive snails after treatment in untreated plots, t_1 is the number of alive snails before treatment in treated plots, t_2 is the number of alive snails after treatment in treated plots.

Histological studies of the treated snails:

The digestive glands of tested snails were treated with 8% neomyl poisonous baits and 40% of clove buds' powder for 48 hours. The snails were then dissected for histological studies. Snail organs were dehydrated through an ascending series of ethanol alcohol, cleared in xylene for 2 minutes, and immersed in three successive solutions. The first consists of a mixture of xylene and wax at 1:1 ratio; the second and the third solutions consisted of pure wax, each for half an hour in an oven at 56ºC and are then submerged in paraffin, and blocking was conducted under vacuum. Serial transverse sections of 5/6 µm were made and mounted on clean glass slides without using any adhesive material. The Ehleish's hematoxylin and eosin method was employed for general histological studies of the digestive gland (Drury & Wallington, 1980).

Results

Effect of Neomyl and Clove against *M. cartusiana* and *T. pisana* under laboratory conditions

Data in Table 1 reveal that the mortality percentages increase with the increase in concentration and exposure periods. The results indicated that all concentrations failed to exhibit any molluscicide activity against *T. pisana* after one day of treatment. Neomyl recorded the highest mortality percentages in comparison with clove after 7 days posttreatment and recorded 100% for the highest concentration at 8% while clove recorded only 23.3% for concentration of 40%. As time elapsed, mortality percentages increased by increasing concentration. Mortality percentages recorded 100% for 2, 4, and 8% of neomyl, while clove recorded 36.3% for 40% after 28 days posttreatment.

In respect with *M. cartusiana*, results in Table 1 demonstrate that after three days of treatment, the highest values of mortality recorded 36.6% for 8% neomyl and 50% for 40% clove. The mortality percentages increased as time passes, where it reached 80% for 8% neomyl and 90% for 40% clove after 7 days of treatment. Mortality percentages reached 100% for 8% neomyl and for 40% clove after 28 days posttreatment.

Effects of Neomyl and Clove powder against *M. cartusiana* under field conditions

Neomyl and clove poisonous baits were evaluated in controlling *M. cartusiana* in a highly infested field cultivated with Egyptian clover during March 2022 at Sobaih village, Hehia districts, Sharkia Governorate. Data presented in Table 2 indicate that the initial effects of the tested compounds recorded 62.89% reduction using neomyl and 18.83% reduction using clove powder. The same trend was observed also for the residual effect since neomyl had high reduction rate of 83.43%, whereas clove gave 28.88% reduction. Predominantly, it could be concluded that neomyl showed more toxicity than clove powder as poisonous bait in controlling *M. cartusiana* under field conditions.

Histological Studies

Control of the digestive gland for the tested land snail species- The digestive gland tissue consists of spherical digestive tubules separated by loose connective tissue having hemolymphatic vessels and hemocytes. Each tubule was provided externally with a circular muscle layer (Figures 1-A and 1-C). Different three cell types in both tested land snail species were observed in the epithelium lining of the lumen of the digestive gland tubules. These cells are, namely, digestive cells, calcium cells, and excretory cells.

Digestive cells- These cells are the main cellular population of the digestive tubule which are columnar with flattened or slightly rounded apical surfaces bearing well-developed brush borders. Their nuclei are often basally located and rounded or oval in outline with condensed chromatin and mostly have a single nucleolus (Figures 1-B and 1-C).

Calcium cells- These cells are lower in number than the digestive cells and occur either singly or in pairs in the angles of the tubules. They have a pyramidal shape with a narrow distal end and an obvious broad base. Calcium cells possess spherules which are round and apical secretary granules and large rounded nuclei. Nuclei are usually located near the center or in the basal half of the cell and possess a noticeable nucleolus (Figures 1-B and 1-C).

Excretory cells- These cells have a globular shape and are characterized by the presence of a single large vacuole equipped with nearly the whole volume of the cell. The excretory products are cumulative in the vacuole, and it is often in the form of a large brown body. The apical end of the cell possesses well-developed brush border. The nucleus is small and usually pressed flat against the cell base (Figures 1-B and 1-C). Generally, it could be concluded that the digestive glands of the tested land snail's species *M. cartusiana* and *T. pisana* have different three cell types in the epithelium lumen lining of the digestive gland tubules (digestive cells, calcium cells, and excretory cells).

Table 1. Efficacy of neomyl and clove poisonous baits against *T. pisana* and *M. cartusiana* snails under laboratory conditions.

Evaluated materials	Conc. (%)	Target snail	(%) Cumulative mortality rates after treatment in days						General means
			1	3	7	14	21	28	
Neomyl	1	*T. pisana*	0.0	16.66	80.00	83.33	90.00	93.33	60.55 c
		M. cartusiana	0.0	10.00	26.66	46.66	60.00	70.33	35.60 c
	2	*T. pisana*	0.0	36.66	93.33	96.66	100.00	100.00	71.10 b
		M. cartusiana	0.0	16.00	33.33	49.00	66.33	73.66	39.72 b
	4	*T. pisana*	0.0	70.00	96.66	100.00	100.00	100.00	77.77 b
		M. cartusiana	0.0	26.60	46.66	76.66	80.00	80.00	51.65 a
	8	*T. pisana*	0.0	83.30	100.00	100.00	100.00	100.00	80.55 a
		M. cartusiana	0.0	36.60	80.00	86.66	100.00	100.00	67.21 a
Clove powder	10	*T. pisana*	0.0	00.00	6.66	6.66	20.00	20.00	8.88 c
		M. cartusiana	0.0	3.33	6.66	23.33	23.33	40.00	16.10 c
	20	*T. pisana*	0.0	10.00	20.00	23.30	23.30	23.30	16.65 b
		M. cartusiana	0.0	6.66	43.33	53.33	56.66	76.66	39.44 b
	40	*T. pisana*	0.0	13.30	23.30	33.30	36.30	36.30	23.75 a
		M. cartusiana	0.0	50.00	90.00	96.66	96.66	100.00	72.22 a

Means followed by the same letters in the same column are not significantly different at P=0.05 based on Duncan's multiple range test.

Table 2. Efficacy of clove powder poisonous baits compared with neomyl against *M. cartusiana* snails under field conditions.

Tested materials	(%) Reduction percentages after indicated days							Residual effect	General means
	1	3	Initial effect	7	14	21	28		
Neomyl	56.2	69.58	62.89	74.34	84.76	91.21	-	83.43	75.22 a
Clove powder	8.53	29.14	18.83	38.65	31.41	28.23	17.24	28.88	25.53 b

Means followed by the same letters in the same column are not significantly different at P=0.05 based on Duncan's multiple range test.

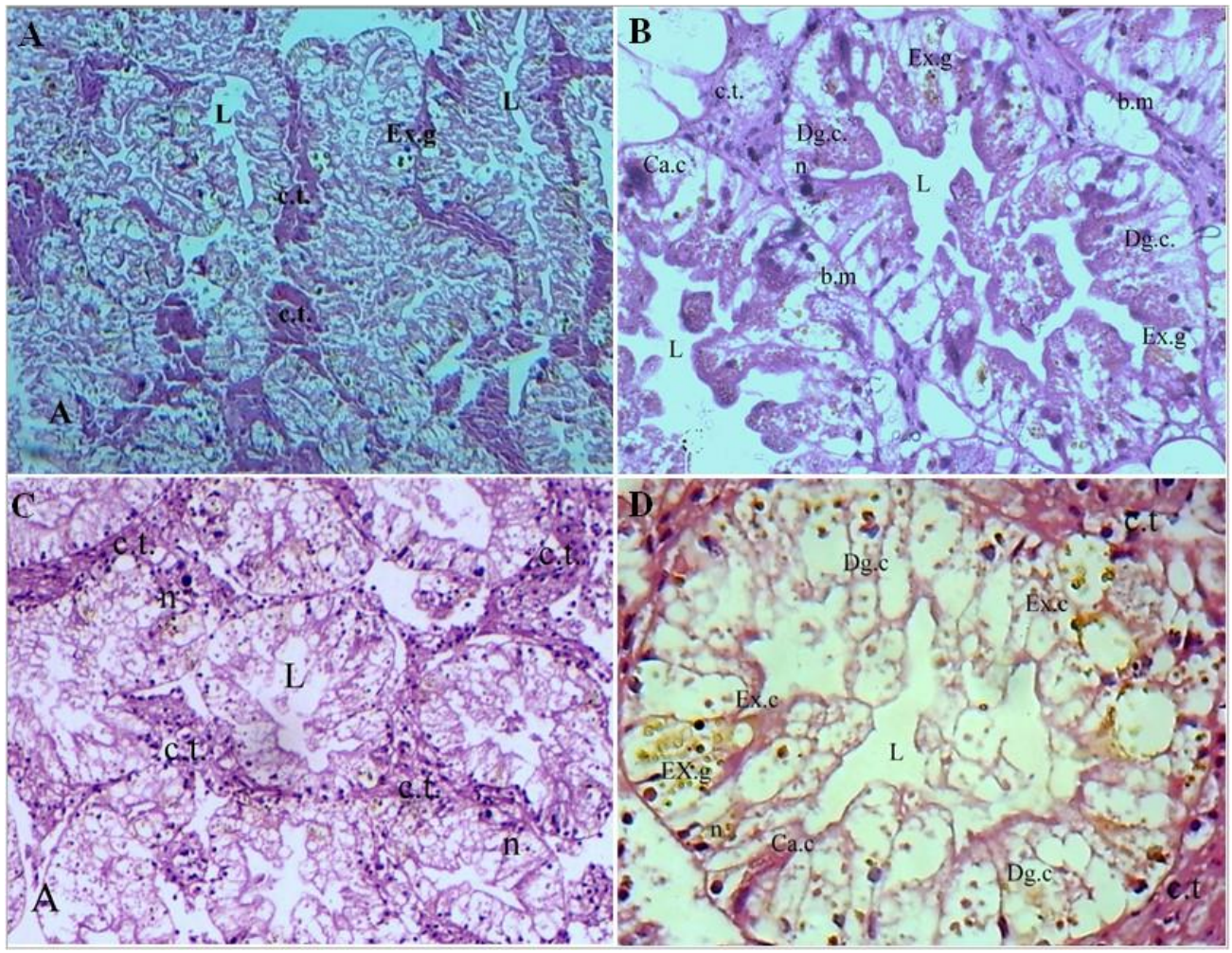


Figure 1. A= Photomicrograph of cross section passing through the digestive gland of control *M. cartusiana* snail showing (CT) connective tissue, (L) lumen, and (Ex. g.) excretory granules, X100 (HX and E); B= *M. cartusiana* snail showing (CT) connective tissue, (BM) basement membrane, (L) lumen, (n) nucleus, (Ex. g.) excretory granules, (Dg. C) digestive cell, and (Ca. c) calcium cell, X400 (HX and E); C= *T. pisana* snail showing (CT) connective tissue, (BM) basement membrane, (L) lumen, and (n) nucleus, X100 (HX and E); D= *T. pisana* snail showing (CT) connective tissue, (BM) basement membrane, (L) lumen, (n) nucleus, (Ex. g.) excretory granules, (Dg. c) digestive cell, and (Ca. c) calcium cell, X400 (HX and E).

Histopathological Alterations

Effect of 8% concentration of Neomyl 20%, 48 hours after treatment

Both tested land snail species, *M. cartusiana* and *T. pisana*, were treated with 8% of the molluscicide (20% neomyl) for 48 hours, and the treated digestive glands showed some alterations such as degeneration, rupture, and vacuolization. Furthermore, hemolytic infiltration in connective tissue was also observed (Figures 2-A and 2-C). A noteworthy degeneration and rupture were observed for digestive cells. Some excretory cells showed rupture while the cytoplasm of other excretory cells was replaced by large vacuoles (Figures 2-B and 2-D).

Degeneration was abundant, and the cytoplasm of digestive cells was altered. Numerous excretory vacuoles were seen in the excretory cells and calcium cells granulated, but vacuoles in the cytoplasm dominated and bizarre nuclei ranged from pyknosis to severe karyorrhexis and complete karyolysis (Figures 2-B and 2-C).

The toxic effect of any compound on an organism can be evaluated by observing the histopathological changes caused by the tested compound (Parvate & Thayil, 2017). The digestive glands of mollusks are the target organs that could be affected with toxicants as soon as the variations in cyto-architecture of the digestive glands of snails are used as a biomarker of induced toxicity. Thus, any structural alteration to the digestive gland affects the animals in multiple ways. In the current study, the treated land snails *M. cartusiana* and *T. pisana* with 8% of neomyl (20%) suffered from alterations such as degeneration, rupture, and vacuolization. Furthermore, hemolytic infiltration of connective tissue and a noteworthy degeneration and rupture was also manifested in digestive cells. Some excretory cells showed rupture while large vacuoles replaced the cytoplasm of other excretory cells.

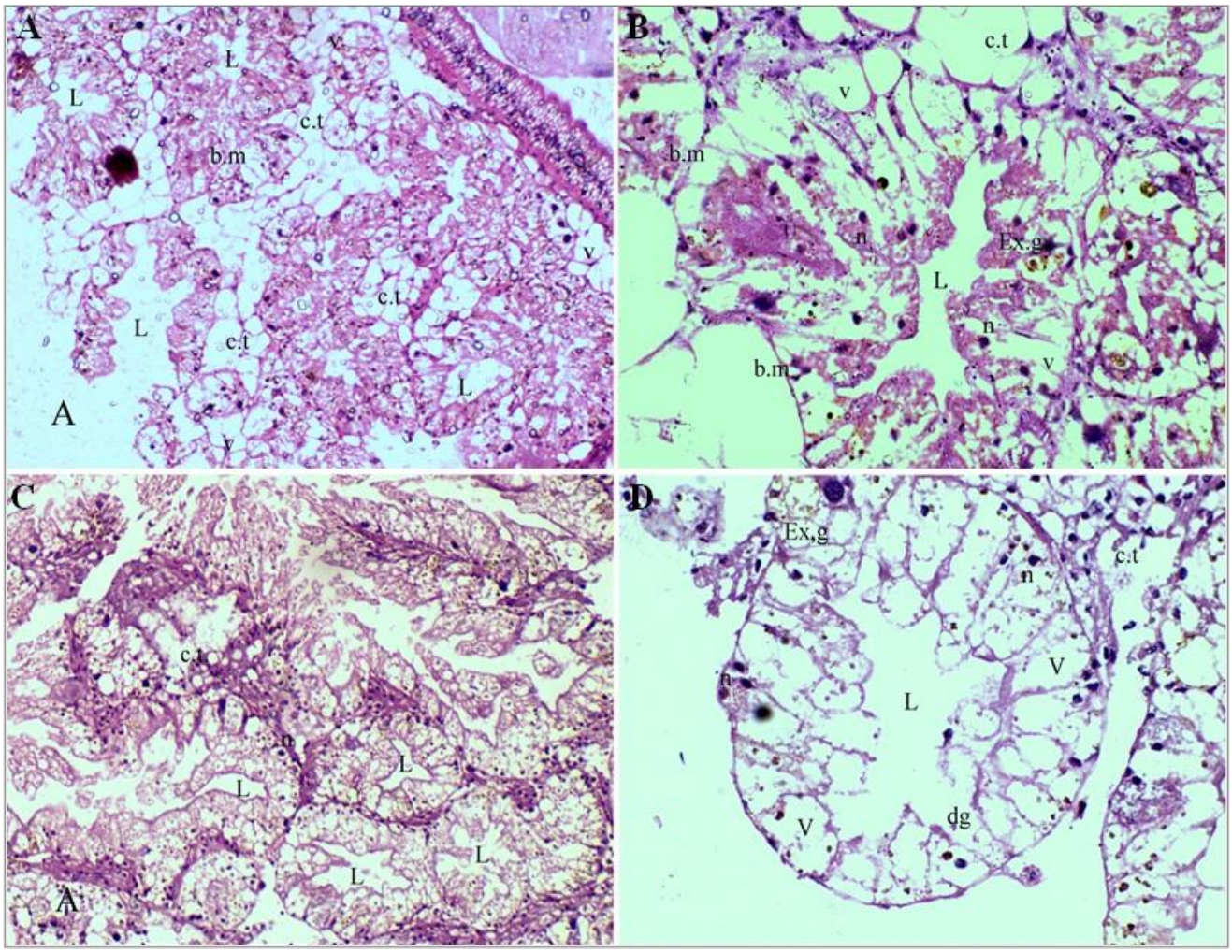


Figure 2. A= Photomicrograph of cross section passing through the digestive gland treated with 8% concentration of 20% neomyl (20%), 48 hours after treatment. *M. cartusiana* snail showing degeneration (dg), (ne) necrosis (ne) of connective tissue (CT), basement membrane (BM), lumen (L), and nucleus (n), X100 (HX and E); **B=** *M. cartusiana* snail showing degeneration (dg), vacuole (V), excretory granules (Ex. G.), connective tissue (CT), basement membrane (BM), lumen (L), and nucleus (n), X400 (HX and E); **C=** *T. pisana* showing degeneration (dg), connective tissue (CT), basement membrane (BM), lumen (L), and nucleus (n), X100 (HX and E); **D=** *T. pisana* showing degeneration (dg), connective tissue (CT), basement membrane (BM), lumen (L), and nucleus (n), X400 (HX and E).

Effect of treatment with clove buds powder (40%)

When powdered clove (40%) buds was applied for controlling the two tested land snails *M. cartusiana* and *T. pisana*, the digestive glands started with the detachment of the membrane surrounding the glands with mild degeneration. Moreover, the digestive cells were of abnormal appearance with more granulation of the cytoplasm. Excretory cells revealed that larger excretory vacuoles containing abundant excretory granules calcium cells were clearly vacuolated (Figures 3-A and 3-B).

The hepatopancreas digestive cells of snails were degenerated thinly, along with peripheral thickening of hepatic tubules and atrophy of connective tissue. The congregate of secretory material exuded from the damaged hepatocytes was also observed as excretory granules (Figures 3-A and 3-C).

The lumen after treatment lost its regular shape, and the excretory granules spread all over the gland cells because of the disintegration of a cell by rupture of the cell wall or membrane. The nucleus lost its position. In addition, degeneration was observed between the gland cells increased vacuolization (Figures 3-B and 3-D). The results obtained indicated that the toxicity effects of the powdered clove buds (40%) for 48 hours were the same on both treated land snail species, since the digestive glands started with the detachment of the membrane surrounding the glands, and the hepatopancreas digestive cells were thinly degenerated.

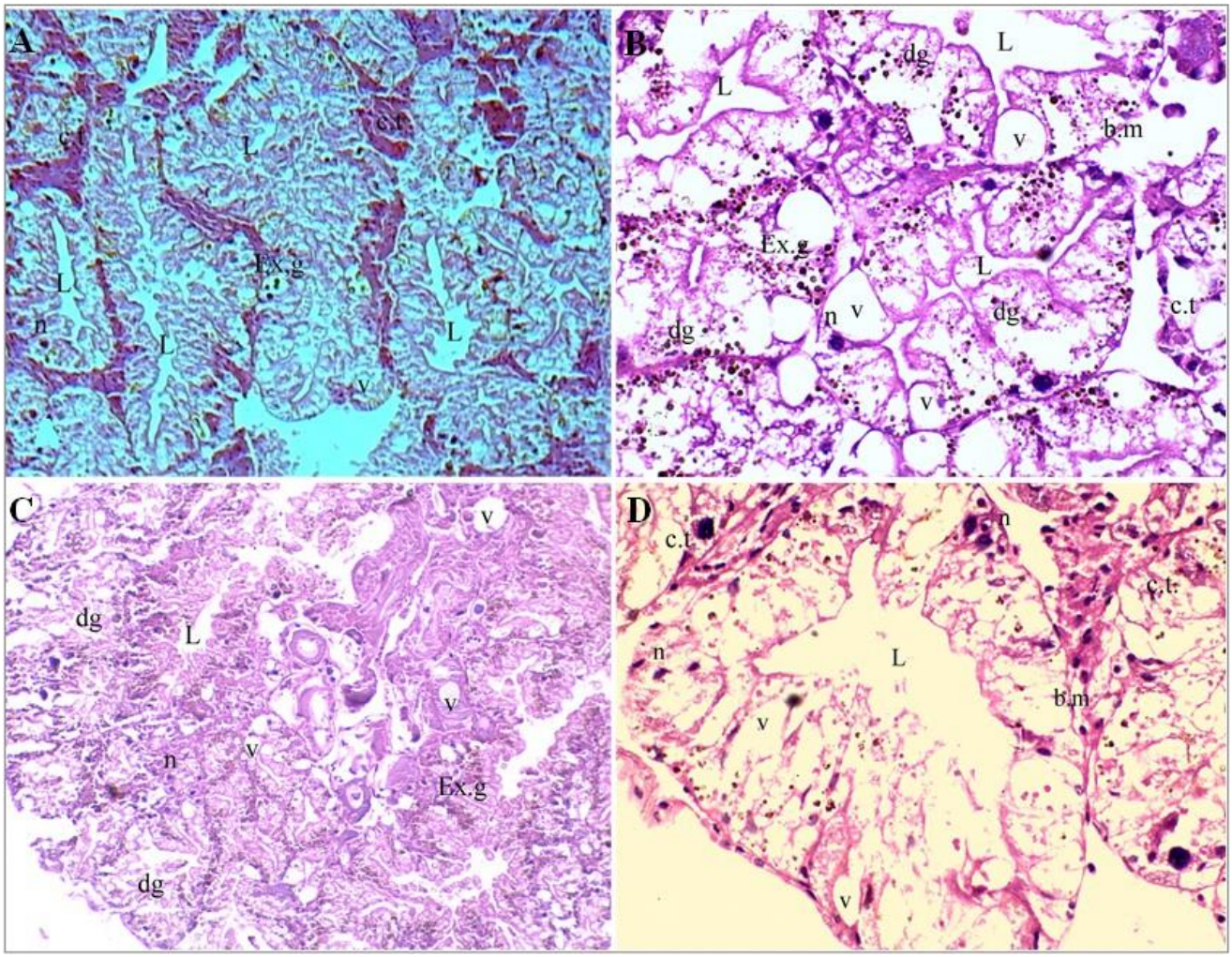


Figure 3. A= Photomicrograph of cross section passing through the digestive gland treated with powdered clove buds (40%), 48 hours after treatment. *M. cartusiana* showing degeneration (dg), connective tissue (CT), basement membrane (BM), excretory granules Ex. G.), lumen (L), and nucleus (n), X100 (HX and E); **B=** *M. cartusiana* showing (dg) degeneration (dg), connective tissue (CT), basement membrane (BM), excretory granules (Ex. G.), lumen (L), and nucleus (n), X400 (HX and E); **C=** *T. pisana* snail showing degeneration (dg), connective tissue (CT), basement membrane (BM), excretory granules (Ex. G.), lumen (L), and nucleus (n), X100 (HX and E); **D=** *T. pisana* snail showing degeneration (dg), connective tissue (CT), basement membrane (BM), excretory granules (Ex. G), digestive cell (Dg. c), calcium cell (Ca. c), lumen (L), and nucleus (n), X400 (HX and E).

Discussion

The damage caused by land snails and slugs on agricultural crops was reported by many authors in most countries worldwide (Abed, 2017; Abd El-Aal & Arafa, 2019; Abd El-haleim, 2022; Baker, 1989; Castielleio *et al*., 1996; Mahrous *et al*., 2002).

Results obtained in this study by using neomyl and clove buds' powder for the control of *M. cartusiana* and *T. pisana*, are in agreement with those reported by Daoud (2004) who showed that neomyl gave the highest toxicity against *M. cartusiana* and with Kumar & Singh (2006) who found that the toxicity of *Syzygium aromaticum* flower-bud powder was more effective against *Liminea acuminate*. Ismail & AbdEl-Kader (2011) indicated that the highest mortality rate was obtained with concentrations of 40% clove bud powder and 4% eugenol against juvenile and adult snails, 21 days after treatment. Moreover, Mobarak *et al*. (2015) reported that neomyl had the highest molluscicidal potential against *Monacha* sp., followed by *S. aromaticum* oil, *N. sativa* oil, and *B. alba* oil.

Abd El-Rahman (2020) and Abd El-Haleem (2022) demonstrated that neomyl has more toxicity than clove powder as poisonous baits in controlling *M. cartusiana*, which was also supported by Daoud (2004). Ghaly *et al*. (2009) arranged the efficacy of different pesticides in controlling snails, in a descending order, as follows: neomyl 53.59%, gastrotex 49.70%, biofly 23.03%, and flavus 17.66%. Meanwhile, Mobarak *et al*. (2015) and Abd El-Rahman (2020) indicated that the crude plant extract of *S. aromaticum*, *N. sativa*, and *B. alba* gave satisfying results compared with methomyl against *Monacha* sp. under field conditions.

Previous histological studies indicated that pesticides had an effect on the digestive glands of *M. cartusiana* and *T. pisana*, especially on the three cell types of the epithelium lining the lumen of the digestive gland tubules (Zaldibar *et*

al., 2008). Results obtained in this study are in agreement with those reported by Lopes *et al.* (2001). Furthermore, several studies have described the morphology and histology of hepatopancreas for *Monacha* sp. (Abd El-Rahman *et al*., 2012; Heiba *et al.*, 2018; Parvate & Thayil, 2017), for *H. pomatia* (Chabicovsky *et al.*, 2004), *E. vermiculata* (Abu Bakr, 2011), and *H. vestalis* (Sharaf *et al.*, 2015). In addition, several workers (Abd El-Atti *et al.*, 2020; El-Akharsy, 2010) reported that the digestive gland of untreated *M. cartusiana* consists mainly of three types of cells: digestive, excretory, and calcium cells.

The histological section of the controlled digestive gland in land snail *M. cartusiana* showed that it consists of digestive tubules lined with three different simple epithelium cells arranged on a thin basement membrane. These cells were differentiated into digestive cells, excretory cells, and calcium cells (Arrighetti *et al*., 2015; Hamed *et al.*, 2007). Zaldibar *et al.* (2007) found two cell types in the digestive gland: digestive and basophilic cells of *E. vermiculata* and *Littorina littorea.* Moreover, four cell types: digestive, calcium, excretory, and thin cells were found in *E. vermiculata* (Hamed *et al.*, 2007). The digestive gland was composed of two cell types: digestive and excretory or secretory cells of L. maximus (Abd El-Haleem, 2013).

Histological inspection of untreated digestive glands of *L. maximus* confirmed the existence of two main cell types: digestive and secretory cells. Otludil & Ayaz (2020) reported that the tubule epithelium was composed of two types of cells: digestive and basophilic cells. Moreover, histopathological alterations and toxic effect of any compound on an organism can be evaluated by observing the histopathological changes caused by the compound (Parvate & Thayil, 2017). The digestive glands of mollusks are the target organs for toxicants, and the variations in the cyto-architecture of digestive gland of snails are used as a biomarker of induced toxicity (Triebskorn & Kohler, 1996). The pathological alterations in the digestive gland of *E. vermiculata* and *M. contiana* exposed to lanate are probably due to the accumulation of insecticide in the cells of the digestive gland. This damage could be correlated with the disturbed enzyme activities in varied species. El-Akhrasy (2017) revealed that the histopathological effect of methomyl expressed as partial or complete disappearance and necrosis of mucus glandular tissue of *E. vermiculata*, and caused centric necrosis in association with degeneration of *M. obstructa*. Whereas the amalgamation of methomyl and acetylsalicylic acid improved the molluscicidal activity against both land snail species.

Ali & Said (2019) reported that the treated digestive glands showed rupture in the digestive envelope of tubules that disrupted columnar digestive cells and appeared without its content. Hemmaid *et al.* (2017) illustrated that the application of half LC_{50} of neomyl resulted in cytoplasmic degeneration in digestive cells of *E. vermiculata* and showed that digestive cells were widely degenerated. Abd El-Rahman (2020) revealed that the tissue of the hepatopancreas of *Monacha* sp. exhibited marked histological alterations, and neomyl showed necrosis, degeneration of the digestive tubule's cells, and neomyl precipitation.

The hepatopancreas digestive cells were degenerated thin, along with peripheral thickening of hepatic tubules and atrophy of connective tissue in snails. These findings are corroborated by Zheng *et al.* (1992) who reported that clove powder has medicinal properties as anti-carcinogenic, antibacterial, antiviral, and antifungal (Chaieb *et al.*, 2007), in addition to the antioxidant, anti-spasmodic, and anti-helminthic activity (Hirotaka *et al*., 2003). Lahlou (2004) indicated that clove oil has strong bioactivity. Moreover, Abd El-Rahman (2020) reported that the digestive cells of the hepatopancreas degenerated in snails exposed to both lower and higher concentrations of clove oil roughly proportional to the dose administered.

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الملخص

بيومي، شيماء محمد فتحي، نبيل عبد الله عمر، عبد الحميد حسين مهنا، شحاتة أحمد علي اسماعيل، محمد عابد، أسماء محمد السيد، محمد عبد الله عيسى، فاطمة ابراهيم الأخرسي والسيد محمد عبد العال. 2024. سمية مسحوق براعم القرنفل (*Syzygium aromaticum*) وتأثيره على الأنسجة بالمقارنة مع المبيد نيوميل (ميثوميل) لمكافحة القواقع *Monacha cartusiana* و *Theba pisana*. مجلة وقاية النبات العربية، 42(3): 318–327. https://doi.org/10.22268/AJPP-001246

تم تصميم مجموعة من التجارب المختبرية والحقلية التي يمكن استخدامها لتقليل كثافة تعداد بعض أنواع القواقع الأرضية، مثل *Monacha cartusiana* Müller و *Theba pisana* Müller، وبالتالي الحدّ من الضرر الناتج عنها. بالإضافة إلى ذلك، تمت دراسة العوامل التي تسهم في المكافحة الآمنة. تم استخدام النيوميل 8% ومسحوق براعم القرنفل 40% لمكافحة *M. cartusiana* و *T. pisana* تحت ظروف المختبر والحقل، تمت دراسة تأثير سمية هذه المعاملات على الغدد الهضمية للقواقع الأرضية المختبرة. أظهرت النتائج أن نسبة الموت قد زادت مع زيادة التركيزات ومدّة التعرض. في ظروف المختبر، بلغت نسبة الموت 100% لقواقع *T. pisana* عند استخدام التراكيز 2، 4 و 8% من النيوميل، بينما بلغت نسبة موت القوقع نفسها 36.3% عند استخدام مسحوق القرنفل 40%، بعد 28 يوماً من المعاملة. أما في ظروف الحقل، وصل التأثير الأولي للمركبات المختبرة إلى نسبة خفض قدرها 62.89 و 18.83% عند تطبيق النيوميل والقرنفل، على التوالي. علاوة على ذلك، أظهر التأثير المتبقي للنيوميل نسبة خفض مرتفعة (83.43%)، مقارنة بـ 28.88% في معاملة مسحوق القرنفل. بشكل عام، يمكن الاستنتاج أن النيوميل كان له التأثير الأكثر سمية ضد *M. cartusiana* تحت ظروف الحقل. أدت المعاملة بالنيوميل بنسبة 8% إلى حدوث تدهور نسيجي مع تغيرات في سيتوبلازما الخلايا الهضمية. تم

العثور على العديد من الفجوات في الخلايا الإخراجية. أصبحت خلايا الكالسيوم محببة، وكانت الفجوات في السيتوبلازما كثيرة العدد. وأظهرت الأنوية تغيرات من وجود تقرح إلى تفتت شديد وحتى التفتت الكامل. كما أظهرت النتائج أن تأثيرات السمية لتراكيز 40% من مسحوق براعم القرنفل، بعد 48 ساعة من المعاملة، كانت تقريباً نفسها على نوعي القواقع الأرضية المعاملة كليهما.

كلمات مفتاحية: السمية، الأنسجة، القرنفل، نيوميل، *M. cartusiana*، *T. pisana*.

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