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Usage of some botanical oils to control the land snail *Monacha* sp. (Gastropoda : Helicidae)

Amal, H.E. Abdel-Rahman
Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

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Abstract:

The land snail *Monacha* sp. (Müller) (Gastropoda : Helicidae) is a serious pest of a wide range of field and vegetable crops. Nowadays using natural molluscicides for snail control is considered to be the most pragmatic approach. The aim of this study was to assess the molluscicidal potential of three essential botanical natural oils, clove oil, *Syzygium aromaticum* (*S. aromaticum*); black cumin oil or black seed oil, *Nigella sativa* L(*N. sativa*) and mustard oil, *Brassica alba* (*B. alba*) comparing with non-specific molluscicide (neomyl) as a standard chemical pesticide against *Monacha* snail. The tested oils as well as neomly were applied as sprays to *Monacha* adults under laboratory and field conditions. All tested compounds gave satisfactory control against *Monacha* snail . Neomly excreted highest molluscicidal potential followed by *S. aromaticum* oil, *N. sativa* oil and *B. alba* oil under laboratory conditions where the mean value of mortality percentage reached 90, 79, 66 and 60 respectively after 21 days of treatment. The tested compounds revealed the same trend of action against the target snail under field conditions i.e., the reduction % of population after 21 days of treatment was 93.28%, 76.76%, 64.16% and 50.75% for neomyl, *S. aromaticum*, *N. sativa and B. alba* respectively with high significant difference in between (L.S.D0.05 = 2.89). Bioassay toxicity test showed that *S. aromaticum* oil was the most effective and *B. alba* was the least effective after all time intervales i.e., value of LC_{50} was 4.17%, 9.29% and 15.29% after 24hrs; were 3.24%, 7.86% and 12.42% after 48 hrs; were 2.90%, 7.31% and 11.73% after 72 hrs and were 2.81%, 7.31% and 11.73% after 96 hrs for *S. aromaticum*, *N. sativa* and *B. alba* respectively. Toxicity index proved that *S. aromaticum* oil was the superior one gave the arbitrary index value 100 unites. and Relative potency established that *B. alba* excerted the least toxic effect (1fold) against *Monacha* snail. In the light of these results, clove oil, black cumin oil and mustard oil as botanical natural oils safe on the environment, can be used to control this pest as an attempt to dispense the usage of chemical pesticides.

Introduction

Land snails are considered one of the most serious pests of many crops and vegetables causing heavy economic damages as a result of feeding the plant's leaves , roots, and fruits (Hussein and Sabry, 2019) and contamination agricultural products with their bodies, feces or slime, leading to deterioration of their qualities and financial loss (Ali, 2017). The glassy clover snail, *Monacha* sp. (Müller)
(Gastropoda : Helicidae) is considered the most predominant land snail in all localities at Sharkia Governorate attacking all plants (Mahrous *et al*., 2002).

Nonspecific molluscicides have been described over a century (Parvate and Thayil (2017) and still one of the most effective methods (Radwan *et al.*, 2008) must be used only in integrated pest management for controlling pests when their numbers cannot be reduced by employing non-chemical methods (Edyta *et al.*, 2018). Now, the use of these chemicals is not being encouraged due to about 25 million of agricultural workers in developing countries are poisoned every year by pesticides (Farag, 2017). They cause disruption of natural biological control systems, undesirable effects on non-target organisms, harmful for most of the living organisms, and development pests' resistance to synthetic insecticides which are applied to reduce their populations (Ismail *et al*. , 2015). So, scientists attention has been directed toward monitoring the molluscicidal activity of different plants (Abdel-Rahman, 2017; Mortada *et al*., 2012 and Mourad, 2014). The natural plant derivatives known as botanical pesticides constitute an alternative way of reducing chemical insecticide usage and could extend the list of friendly agents applied in pest control (Edyta *et al.* , 2018) particularly essential oils (Eos). Eos are excellent natural botanical products due to their high bioactive potential constituting a rich source of bioactive compounds that are biodegradable into nontoxic products, easy availability , economic viability (Lahlou, 2004). They potentially suitable for use in integrated management programs, may be applied to food crops shortly before harvest without leaving excessive residues, environmentally safe, with low cost, can be used by individuals and communities in specific situations (Redwane *et al*., 2002). Also, they have repellent, antifeedant and insecticidal effects (Khater, 2012), can be inhaled, ingested or skin absorbed by insects (Edyta *et al*, , 2018).

For these reasons, much effort has been focused on plant Eos and their constituents as potential sources of pest control agents (Bakkali *et al.*, 2008; Minjas and Sarda, 1986; WHO, 2005 and Koul *et al*., 2008). Of these oils, clove oil, *Syzygium aromaticum* (*S. aromaticum*); black cumin oil or black seed oil, *Nigella sativa* L (*N. sativa*) and mustard oil, *Brassica alba* (*B. alba*). Clove oil has exhibited biological activity on a wide range of organisms ranging from microorganisms to humans (Kumar *et al.,* 2011). A finding by Ismail and Abd El-Kader (2011) evaluated the potential of the flower-bud powder and commercially available eugenol of clove; *Syzygium aromaticum* against juveniles and adults of *M. cartusiana* using baiting technique. Hollingsworth *et al*. (2012) revealed potent ovicidal activity of clove oil against the eggs of *Cantareus apersus* and *Succines* sp. Parvate and Thayil (2017) assessed the molluscicidal activity of clove oil against the adult snails of *A. fulica* and evaluate its toxic effect on various tissues of the snail.

Black cumin oil has antihistaminic, anti-inflammatory, antidiabetic, antimicrobial, antitumor, antihypertensive and insect repellant effects (Gulçin and Zehra, 2018). Ismail *et al.* (2015) evaluated the relative efficacy of the essential oil black cumin (*Nigella sativa* L.) against *Ceroplastes rusci* L. and *Asterolcanium pustolans* Cock. on fig trees. No data are available about the toxicity of black cumin oil for land snails using spray application.

Mustard oil is a natural preparation, active against insects (Edyta *et al.,* 2018), causing growth inhibition effects via topical application to the dorsum of *Trichoplusia ni* (Akhar *et al*., 2014). The effect of mustard oil applied in the diet of insects has been evaluated against *Bradysia impatiens* from the order Diptera (Main *et al*., 2014) and *Bruchidius incarnatus* from the order Coleoptera (Sabbour and E-Abd-El-Aziz 2010). Ismail *et al.* (2015) evaluated the relative efficacy of the essential mustard oil (*Brassica nigra* Koch.) There are no available data on the toxicity of this plant product applied on the land snails. Lot of natural compounds have been explored and found to be effective in snails like *Lymnaea acuminata*(Chauhan *et al.,*2011), *Subulina octona* (Silva *et al*., 2012), *Indoplanorbis exustus* (Pandey and Singh,2009), *Eobania vermiculata*, *Monacha cartusiana* (Aal and Hamed, 2010 and Abdel-Rahman, 2017).

The aim of this study was to estimate the potential usefulness of clove, black cumin and mustard oils in plant protection from *Monacha* snail. The present research provides new results concerning the molluscicidal activity of the tested oils as specific natural plant alternatives applied to the target snail *Monacha* sp. via spray application of the oils.

Materials and methods

1. Tested animal:

Adults of *Monacha* sp. were collected from infested Egyptian clover (*Trifolium alexandrium*) field at Soofea village, Awlad-Sakr district, Sharkia Governorate and transferred to the laboratory in porious plastic bag. In the laboratory the snails were kept in ventilated glass jar under laboratory conditions and were fed a diet of fresh clover plant for acclimatization one week before bioassay.Dead snails were removed immediately (Eshra, 2014).

2.Tested materials:

2.1. Nonspecific molluscicide:

Neomyl (Lannate ® 90% SP):

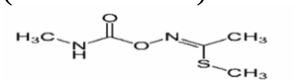
Trade name: Neomyl 90% WP

Common name: methomyl

Chemical group: Carbamates

Chemical name: S-methyl N (methylcarbamoyloxy) thioacetimidate.

The chemical structure: (C5H10N2O2S).



2.2. Specific molluscicides: Botanical essential oils (ESO):

2.2.1. Clove oil:

Scientific name: Clove

Biological name: *Syzygium aromaticum / Caryophyllus aromaticus / Eugenia caryophyllata*.

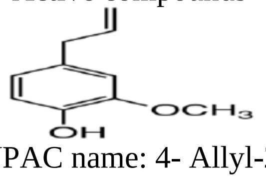
Other names: Clove, clovos, caryophyllus.

Family*: Myrtaceae*.

Active compounds: The major compounds are eugenol (88, 58%), which is a member of the phenyl propanoids class of chemicals compounds (Chaieb *et al.*, 2007a).

chemical structure: (C10H12O2).

Active compounds



IUPAC name: 4- Allyl-2-mthoxyphenol

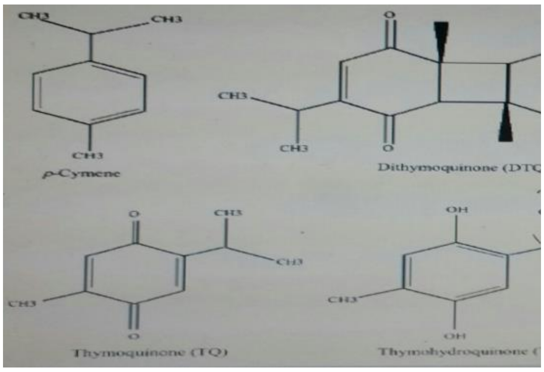
2.2.2. Black seed oil:

Scientific name: Black cumin

Biological name: *Nigella sativa* L.

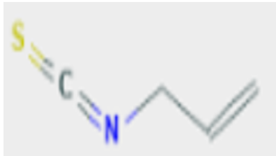
Other names: In different languages the plant is known by various names, e.g., black cumin, black seed, black

caraway (English), Habbah Al-Sauda, seed of blessing (Arabic), chernushka (Russian), çörek out (Turkish), and Cyah-daneh in Persian.
Family*:* Ranunculaceae
Active compounds: Thymoquinone, α-thujene and p-cymene are the major ones, especially thymoquinone. The chemical structure of main ingredients of *N. sativa* oil including thymoquinone, dithymquinone, thymohydroquinone, pcymene, and thymol (Amin and Hosseinzadeh, 2015).
Chemical structure of the active ingredients of *N. sativa L.* seeds.



2.2.3. Mustard oil:
Scientific name: mustard
Biological name: *Brassica alba* /*Brassica nigra* Koch. /*Brassica juncea* (L.) Coss. /*Brassica carinata.*
Other names: white mustard /black mustard /brown or Indian mustard/ Ethiopian mustard.
Family: Cruciferae
Active compounds: Allyl isothiocyanate in *Brassica juncea* (L.) Coss (Jimmy *et al.*, 2003). Butyl isothiocyanate in *Brassica alba* (Edyta *et al*., 2018).

Clove oil, black cumin oil and mustard oil as pure oils (100%) were obtained by El-Captain Company for extracting natural oils and were procured from perfumery and Tween 80 from pharmacy. 1% tween 80 solution was used as a vehicle for oils (Klopell *et al.*, 2007). The required concentrations of oils dissolved in 1% tween 80 solution (v/v) were always prepared fresh before use.
Chemical structure: C_4H_5NS or $CH_2=CHCH_2N=C=S$



3. Laboratory evaluation:

Laboratory experiments were performed according to the method of Parvate and Thayil (2017). In order to determine the LC50 values of the tested materials, the acclimatized animals were divided into three groups viz., control, vehicle treated group and tested oils treated group in plastic cups. Tested oils' treated animals were sprayed with varying concentrations (2%, 5%, 8%, 14%, 20% and 26%) of each oil that were prepared in 1% tween 80 solution (V/V). Neomyl concentrations (0.125%, 0.25%, 0.5%, and 1%) were prepared in tap water (W/V).The tested oils, the vehicle and neomyl were applied as sprays to the animals. Each concentration was replicated three times with ten healthy adults of each replicate in plastic cup. Cups were covered with muslin clothes and secured with rubber band to prevent snails from escaping (Hilmy and Hegab, 2010). The mortality of animals was observed at a regular interval of 24 hrs. of treatment as per the WHO (1965) by touching it with a stainless-steel needle. Loss of response was considered as death of animal. The dead snails were counted and immediately removed. Mortality percentages were recorded after 1,2,3,4,7,15 and 21 days of treatment. Values of LC50 after 24, 48, 72 and 96 hrs. of treatment were computed using costat statistical software, Costat (2005) Version 6.311. The relative efficiency as Toxicity index (T.I) and Relative potency (R.P.)

(Fold) were determined by using Sun's equation (1950) as follows:

$$\text{Toxicity index} = \frac{\text{LC50 or of LC90 of the highest efficient compound}}{\text{LC50 or of LC90 of the other compound}} \times 100$$

Relative potency (R.P.) values were measured according to the method described by Zidan and Abdel-Maged (1988).

$$\text{Relative potency (Fold)} = \frac{\text{LC50 or of LC90 of the lowest efficient compound}}{\text{LC50 or of LC90 of the other compound}}$$

Analysis of variances was conducted to test significance between treatments at different compounds using F. test and L.S.D0.05 values according to Snedecor (1957).

4. Field evaluation:

Field experiment was carried out in Egyptian clover (*Trifolium alexandrium*) field infested with land snail *Monacha* sp. at Soofea village, Awlad-Sakr district, Sharkiah Governorate. (1% tween 80) solution was prepared by incorporating the calculated volume with water (v/v). The tested oils were applied as solution sprays concentration (30%) that was prepared freshly in (1% tween 80) solution (v/v). Neomyl solution concentration (2%) was prepared by incorporating the calculated weight with water (w/v). Each treatment had three replicates as plots. Each plot 3x3.5m= 10.5m². All spray applications were made once on March, 2020 using knapsack sprayer. Alive snails inside each plot were counted before just treatment and after 1, 3,7,15 and 21 days of spray application. Reduction percentages were statistically calculated according to the formula of Henderson and Tillton (1955) as mentioned by Abdel-Rahman *et al*. (2019). Analysis of variances in field trials were compared by F. test and L.S.D0.05 according to Little and Hills (1978). Statistical analyses were designed using Costat (2005) Version 6.311.

Results and discussion

1. Laboratory results:

Table (1) illustrated that the tested plant oils excerted consederable toxic effect comparing with neomyl against *Monacha* adults. Neomyl was the most toxic compound followed by *S. aromaticum* oil, *N. sativa* oil and *B.alba* oil where the general mean value of mortality percentage was 87.5, 64.8 , 50 and 40 ; was 88.3, 69, 55 and 48 ; was 89, 73, 60 and 50 ; was 90, 76, 64 and 54 and was 90, 79, 66 and 60 after 1,3,7,15 and 21 days consecutively. Analysis of variances revealed significant differences between these values at different tested compounds where L.S.D $_{0.05}$ values were 32.56, 28.41, 29.45, 29.84 and 29.89 after 1,3,7,15 and 21 days respectively. Results in Table (2) showed the potency of the tested botanical ESO against *Monacha* adults as LC50, toxicity index and Relative potency after 24, 48, 72 and 96 hrs of treatment under laboratory conditions. Considering the LC50 value, *S. aromaticum* oil revealed the most toxic potency recording the lowest values of LC50 whereas that of *B.alba* oil was the least in this concern, recording the highest LC50 and *N. sativa* oil located in between i.e., values of LC50 were 4.17, 9.29 and 15.29 after 24 hrs.; were 3.24, 7.86 and 12.42 after 48hrs ; were 2.90, 7.31 and 11.73 after 72hrs and were 2.81, 7.31 and 11.73 after 96hrs of treatment with *S. aromaticum* oil, *N. sativa* oil and *B.alba* oil, respectively. Toxicity of the three tested oils was found to be time and concentration dependent up to three days of exposure period. LC 50 values (%) decreased from 4.17, 9.29 and 15.29 (24 hrs) to 3.24, 7.86 and 12.42 (48 hrs) to 2.90, 7.31 and 11.73 (72 hrs) and remained nearly the same i.e., 2.81, 7.31, and 11.73 (96hrs.) as that of the third day.

As seen in Table (2), Toxicity index proved that *S. aromaticum* oil was taken as the standard molluscicide and gave the arbitrary index value 100 unites. Toxicity index was 100, 44.88 and 27.27; was 100, 41.22and 26.08; was 100, 39.67 and 24.72 and was 100, 38.44 and 23.95 for *S. aromaticum*, *N. sativa* oil and *B.alba* oil after 24 hrs, 48hrs, 72 hrs and 96 hrs successively against *Monacha* snails. The corresponding values of the relative potency were (3.67, 1.60 and 1); (3.83, 1.60 and 1); (4.04, 1.60 and 1) and (4.17, 1.60 and 1). Respecting the relative potency, *S. aromaticum* oil was the standard, recording the highest toxic potency (3.67, 3.83, 4.04 and 4.17) after 24, 48, 72 and 96 hrs. respectively, followed by *N. sativa* oil (1.60, 1.60 and 1.60) and *B.alba* oil was the lowest (1, 1, 1 and 1) after the same time intervals. An excessive mucous secretion and complete withdrawal of the whole body inside the shell was observed due to direct effect of the tested oils's sprays on the epithellial cells of *Monacha* snail's foot.

Table (1): The general means of mortality percentages of *Monacha* snails treated with different concentratios of the tested compounds as sprays under laboratory conditions for 21 days.

Toxicant	**Conc. (%)**	**Mortality % after indicated time (Days)**						
		1	**2**	**3**	**4**	**7**	**15**	**21**
Neomyl	1	١٠٠	100	100	100	100	100	100
	0.5	١٠٠	100	100	100	100	100	100
	0.25	١٠٠	100	100	100	100	100	100
	0.125	٥٠	52	53	55	55	60	60
	Mean	**87.5a**	**88a**	**88.3a**	**89a**	**89a**	**90a**	**90a**
***Syzygium aromaticum* oil**	26	90	90	90	90	90	100	100
	20	80	80	80	80	90	90	100
	14	70	70	76	80	80	86	92
	8	60	60	68	70	70	70	70
	5	49	50	50	50	60	60	60
	2	40	50	50	50	50	50	50
	Mean	**64.8ab**	**66.7ab**	**69ab**	**70ab**	**73ab**	**76ab**	**79ab**
***Nigella sativa* oil**	26	80	80	80	80	90	90	90
	20	70	70	70	80	80	90	90
	14	60	60	70	70	70	70	70
	8	40	40	40	44	46	50	55
	5	30	38	38	40	40	44	46
	2	20	30	34	34	34	40	45
	Mean	**50b**	**53b**	**55b**	**58b**	**60b**	**64ab**	**66b**
***Brassica alba* oil**	26	70	70	70	70	70	80	90
	20	60	60	67	67	70	70	70
	14	40	50	50	50	55	55	60
	8	30	40	40	40	40	45	50
	5	20	30	30	30	35	44	50
	2	20	30	30	30	30	30	40
	Mean	**40b**	**47b**	**48b**	**48b**	**50b**	**54b**	**60b**
F.test		0.0198*	0.0168*	0.0221*	0.0242*	0.0365*	0.0618*	0.1254*
L.S.D 0.05		32.56	27.98	28.41	28.63	29.45	29.84	29.89

Table (2): Comparative toxicity of the tested essential oils (%) to *Monacha* snails.

Toxicant	LC_{50} % after				*Toxicity index after				**Relative potency after			
	24 hrs.	**48 hrs.**	**72 hrs.**	**96 hrs.**	**24 hrs.**	**48 hrs.**	**72 hrs.**	**96 hrs.**	**24 hrs.**	**48 hrs.**	**72 hrs.**	**96 hrs.**
***Syzygium aromaticum* Oil**	4.17	3.24	2.90	2.81	100	100	100	100	3.67	3.83	4.04	4.17
***Nigella sativa* oil**	9.29	7.86	7.31	7.31	44.88	41.22	39.67	38.44	1.60	1.60	1.60	1.60
***Brassica alba* oil**	15.29	12.42	11.73	11.73	27.27	26.08	24.72	23.95	1	1	1	1

***= Toxicity index compared with *S. aromaticum* oil.**
****= Relative potency compared with Mustard oil.**

Data presented in Table (3) indicated the mean numbers of alive *Monacha* snails that were counted in treated plots under field conditions. The applied concentration was 2% neomyl, 30% S. *aromaticum* oil, 30% *N. sativa* oil and 30% *B.alba* oil sprays. A significant negative correlation was observed between the toxic efficiency of the tested compound and the mean number of alive *monacha* adults in treated plots i.e., neomyl had highest toxic efficiency exhibited (48d) followed by *S. aromaticum* oil (166c) *N. sativa* oil (256b) and *B.alba* oil (339a) after 21 days of treatment. A converse relationship between mean number of alive snail and time of treatment where mean values were (90, 76, 69, 62 and 48) for neomyl; were (256, 228,214, 180 and 166) for *S. aromaticum* oil; were (360, 339, 311, 270 and 256) for *N. sativa* oil and were (450, 436, 415, 367 and 339) for *B.alba* oil after 1, 3, 5, 7, 15 and 21 days respectively

Table (4) revealed the general means of reduction percentages of *Monacha* snails after treatment with one concentration of the tested compounds as sprays under field conditions. *Monacha* snails revealed the same trend of reaction against the tested compounds under laboratory conditions i.e., neomyl exhibited highest reduction percentages over 21 days of treatment followed by *S. aromaticum* oil , *N. sativa* oil and *B.alba* oil where the corresponding values were 87.41, 64.16, 49.60 and 37.00 ; were 89.33, 68.08, 52.54 and 38.96 ; were 90.33, 70.23, 56.41 and 41.9 ; were 91.32, 74.80, 62.20 and 48.62 and were 93.28, 76.76, , 64.16 and 50.75 after 1,3,7,15 and 21 days respectively. F. test showed significant differences between values of the reduction percentages at the four tested compounds.

Table (3): The mean numbers of alive *Monacha* snails after treatment with the tested compounds as sprays under field conditions.

Toxicant	The mean numbes of alive snails in replicates after treatment under field conditions					
	Replicate	**1 day**	**3 days**	**7 days**	**15 days**	**21 days**
Neomyl 2%	r 1	85	74	71	59	47
	r2	93	78	68	63	49
	r3	92	76	68	64	48
	Mean	**90 d**	**76 d**	**69 d**	**62 d**	**48 d**
***Syzygium aromaticum* oil**	r 1	258	230	210	180	163
	r2	250	224	214	183	169
	r3	260	230	218	177	166
	Mean	**256c**	**228c**	**214c**	**180c**	**166c**
***Nigella sativa* oil**	r 1	365	336	310	264	252
	r2	355	339	311	270	260
	r3	360	342	313	276	256
	Mean	**360b**	**339b**	**311b**	**270b**	**256b**
***Brassica alba* oil**	r 1	443	431	411	362	338
	r2	451	433	413	370	337
	r3	456	444	421	369	342
	Mean	**450a**	**436a**	**415a**	**367a**	**339a**
F. test		**0.00 *****	**0.00 *****	**0.00 *****	**0.00 *****	**0.00 *****
L.S.D $_{0.05}$		**10.09**	**8.09**	**6.61**	**7.93**	**5.41**

Table (4): The general mean values of population reduction percentages of *Monacha snails* treated with one concentration of the tested compounds as sprays under field conditions.

Toxicant	The general means of population reduction percentages of snails after indicated days				
	1 day	**3 days**	**7 days**	**15 days**	**21 days**
Neomyl	87.41a	89.33a	90.33a	91.32a	93.28a
***Syzygium aromaticum* Oil**	64.16b	68.08b	70.23b	74.8b	76.76b
***Nigella sativa* oil**	49.60c	52.54c	56.41c	62.2c	64.16c
***Brassica alba* oil**	37.00d	38.96d	41.9d	48.62d	50.75d
F. test	0.000 ***	0.000 ***	0.000 **	0.000 ***	0.000 **
L.S.D $_{0.05}$	1.41	1.13	0.97	1.11	2.89

In the present work , the results cleared that the tested oils *S. aromaticum, N. saliva* and *B. alba* as well as neomyl have substantial molluscicidal effective against adults of *Monacha* sp. with concentration and time dependent. Neomyl excerted the highest toxicity agree with the finding of Hussein *et al.*, 1999; Abdel-Rahman, 2010 and Abdel-Rahman *et al*., 2019 who revealed that neomyl excreted highly toxic effect against *Monacha* snail but Ali *et. al.*, 2012; Salama *et al.*, 2005 and Abdelgaleil, 2005 found that methomyl was moderately toxic and was the least effective test material against land snails. Hussein *et al.* (1999) attributed its highly toxic effect to the use of commercial methomyl (Lannate 90%) with its additives and/or the higher sensitivity of the tested population.

The present results concerned with clove oil, *S. aromaticum* are in agreement with Parvate&Thayil, 2017 who indicated that clove oil is highly effective against land snail *A. fulica* and can be used to control its population. They found that the LD 50 values (%) by applying topical administration to the snails decreased from 7.965 (24 hrs.) to 5.157 (48 hrs.) to 3.916 at (72 hrs.) and remained the same i.e. 3.916 at (96 hrs.) thus, its toxicity was found to be time and concentration dependent up to three days of exposure exhibiting a significant negative correlation. Hollingsworth *et al.* (2012) revealed that clove oil exhibited ovicidal properties against eggs of several varieties of snails including *A. fulica* and said that clove oil being eco-friendly and also being exempted from pesticide registration requirement and pesticide residue tolerance requirements. Ismail *et al.* (2015) found that the reduction of infestation values under the effect of clove oil, varied greatly with the time elapsed after spraying and according to the nature of each tested compound. Ismail and Abdel Kader (2011) revealed that the reduction percentages for *M. cartusiana* adult snails were 39.6, 57.2 and 62.4 % for (1, 2 and 4 %) concentrations of essential oil *S. aromaticum*, using baiting technique under field conditions after 21 days and elucidated that the eugenol compound is responsible for most of the characteristic aroma of cloves and indicated that the flower bud powder and the clove oil eugenol of *S. aromaticum* are important sources of botanical molluscicides. The molluscicidal activity of *S. aromaticum* may be attributed to the presence of several constituents, mainly eugenol (Kumar and Singh, 2006), eugenol acetate beta-caryophyllene, 2-heptanone (Chaieb *et al.*, 2007 b). Acetyl- eugenol, alpha-humulene, methyl salicylate, iso-eugenol, methyl-eugenol (Yang *et al.*, 2003), phenylpropanoides, dehydrodieugenol, trans-confireryl aldehyde, biflorin, kaempferol, rhamnocitrin, myricetin, gallic acid, ellagic acid and oleanolic acid (Cai and Wu 1996). Rani *et al*., 2012 indicated that 60% - 90% of clove oil is constituted by eugenol which is regarded to be the source of its antifungal, anaesthetic and antiseptic properties. Bauer *et al.* (2001) revealed that eugenol is the major compound in the essential oil extracted from *S. aromaticum*, comprising 75 to 85% of the total. Eugenol consists of a member of the phenyl-propanoides class of chemical compounds (Chaieb *et al.* 2007a). Juven *et al*. (1994), indicated that the toxicity of clove oil (Eugenol) was primarily due to phenolic compounds, because these compounds sensitize the phospholipid bilayer of the microbial cytoplasm membrane causing increase permeability, unavailability of vital intracellular constituents and/ or impairment of bacterial enzymes systems (Farag *et al*., 1989).

The results respect to mustard oil *Brassica alba* agree with Edyta *et al*. (2018) who said that the mustard oil had a strong insecticidal activity against lepidopteran pests and it seems to be a promising candidate for protecting crops from insect infestation. He showed that, the application of 2% of the oil caused 100% mortality of *C. pomonella* and *D. pini*. Ismail *et al.* (2015) cleared that black mustard oil (*Brassica nigra*) treatment caused higher pronounced toxic effect than black cumin oil (*Nigella sativa*) against

Ceroplastes rusci L. and *Asterolecanium pustolans* Cock. infesting fig trees where the number of insects *Ceroplastes rusci* L. dropped from 26.9 to 17.3 and from 28 to 22.1 for *Brassica nigra and Nigella sativa* respectively after the first post – treatment count. The same trend was observed against *Asterolecanium pustolans* Cock where the number dropped from 52.3 to 41.3 and from 42.3 to 34.3 for *Brassica nigra and Nigella sativa* respectively. They also showed that *Brassica nigra* oil among other essential oils, presented moderate activity; giving an average of 56.4% reduction followed by *Nigella sativa* oil 51.3 % reduction , throughout the whole experimental interval and decided that black mustard oil could be used successfully for controlling *Ceroplastes rusci L.* and *Asterolcanium pustolans Cock* on fig trees. Edyta *et al.* (2018), concluded that, mustard oil (*B. alba*) exhibited high insecticidal activity against pests from the order Lepidoptera and seems to be an effective biopesticide. Amin and Hosseinzadeh (2015) reported that *N. sativa* seeds contain a complex of more than 100 compounds, some of which have not yet been studied or even identified. Unsaturated fatty acids in fixed oil and essential oil components, especially thymoquinone, dithymoquinone, thymohydroquinone, thymol, alkaloids, saponins, and vitamins as well as trace elements. They have shown the antinociceptive and anti-inflammatory potential of *N. sativa* seeds active ingredients, in particular, thymoquinone, the main active constituent. (Isman, 1999) reported that plant essential oils are potential candidates for snail control, due to their selective action, and little or no harmful effects on the non target organisms and the environment.

The attempt was made to test the potential of the plant oils, *S. aromaticum, N. sativa* and *B. alba* against the adult stage of *Monacha* snail. It can be concluded from the result of our study that the potential of *S. aromaticum, B. alba* and *N.sativa* oils may be used as a potent molluscicides for controlling *Monacha* snail. However, further studies are necessary to elucidate the mechanism of action in snail body.

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