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Evaluation of insecticidal biopotency of three plant extracts on woolly-bear caterpillar, *Pericallia ricini* (F.) (Arctiidae: Lepidoptera) on castor been, *Ricinus communis* Fabr. Field conditions

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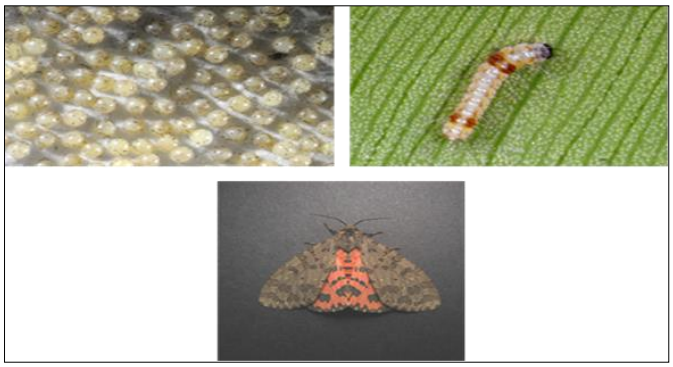
Abstract
An experiment was conducted to test three plant products under laboratory conditions against woolly-bear caterpillar, *Pericallia ricini* (F.) (Arctidae: Lepidoptera). The Sweet flag, *Acorus calamus* Linn. (Rhizomes), *Cinnamonum aromaticum* Nees. (Seeds) and nirgundi, *Vitex negundo* Linn. (Leaves) petroleum ether extract were tested on castor-bean, *Ricinus communis.* Chemical control of woolly-bear caterpillar, *Pericallia ricini* using insecticides of common use has done in many time leave residues that may remain viable for noticeable periods and uneconomical, hence studies have been made at the Department of Zoology, Dayanad Brijendra Swaroop Collage, C.S.J.M. University, Kanpur, Uttar Pradesh, India Concentrations 0.5,1.0 and 2.0 per cent formulations of above mentioned plant extracts. *Acorus calamus* Linn. Rhizomes extract showed 73.33, 83.33 and 100.00 per cent, *Vitex negundo* leaves extract 73.33, 76.66 and 93.33 per cent whereas *Cinnamonum aromaticum* gave only 16.66, 23.33 and 33.33 per cent mortality of woolly bear caterpillars of *Pericallia ricini* were observed after 72 hours in field trials. All the extracts were considerably superior over control.

Keywords: Wooly-bear, *Pericallia ricini*, *Vitex negundo*, *Acorus calamus* and *Ricinus communis*

Introduction
Castor, *Ricinus communis* L. is a non-edible oil seed crop mostly grown as intercrop in groundnut under rainfed condition. In traditional medicine, there are many natural crude drugs that have the potential to treat many disease and disorders one of them is *Ricinus communis* (Euphorbiaceae) popularly known as 'castor plant' and commonly known as Endi or Errandi. The *Ricinus communis* is widespread throughout tropical regions as ornamental plants.
Castor oil extracted from the seeds of *Ricinus communis* (castor) is used as lubricant, vegetable oil and purgative. The *Ricinus communis* or castor plant has high traditional and medicinal value for maintain the disease free healthy life. Traditionally the plant is used as laxative, purgative, fertilizer, insecticides and fungicide etc. whereas the plant possess beneficial effects such as anti-oxidant, anti-histamic, Anti-nociceptive, anti-asthmatic, antiulcer, immune-modulatory, Anti-diabetic, hepato-protective, Antifertility, anti inflammatory, anti-microbial, central nervous system stimulant, lipolytic, wound healing, insecticidal and larvicidal and many other medicinal properties. This activity of the plant possess due to the important phytochemical constituents like flavonoids, saponins, glycosides, alkaloids and steroids etc [1]. Jitendra Jena and Ashish Kumar Gupta The aim of this paper is to explain the details of phyto-protective, larvicidal, ecofriendly, biodegradable and insecticidal properties of *Ricinus communis* for the future research work.
The woolly-bear caterpillar, *Pericallia ricini* (F.) is is one of the important defoliating major pest of solanecious vegetables. The damage is caused by caterpillar. It feeds on leaves resulting in defoliation. The larva is robust, greyish black or blackish brown with red head and thick tuft of hairs arising from the body. The adult is greyish brown or black with black spots on wings. Hind wings are pink or red colour with black spots.
Biorational IPM is an approach that considers the farm as part of an agro ecosystem and field observation based solutions to pest problems. Biorational Integrated pest management is “a systems approach for management of crop pests based on source of pest problems, and then relies on preventive tactics and herbal insecticidal control to keep pest population within acceptable limits (Gurr *et al.*, 2004) [2].

The emphasis of naturally occurring integrated pest management is on proactive measures to redesign the agricultural ecosystem to the disadvantage of a pest and to the advantage of its parasite and predators. (Dufour, 2001) [3]. Plant origin insecticides generally do not pose toxic hazards environmental pollution, residual toxicity, safe to hum International Journal of Pharmacy and Pharmaceutical Sciences an and domestic stock. This communicate on includes some observations on the effect of certain plant extractives against wooly-bear caterpillar, *Pericallia ricini*. This paper high light the ecofriendly use of three indigenous plant extractives as alternatives of synthetic hazardous insecticides.



Material and Methods

Rearing of Woolly-Bear, *Pericallia ricini*

The eggs of *P. ricini* were collected from the castor plant, *Ricinus communis* and kept in sterilized glass beakers at 26}2 °C, 70}5% relative humidity (RH) in a BOD incubator. The first instars larvae were transferred to glass troughs and fed fresh, soft and sterilized castor leaves. The fresh castor leaves were supplied daily to developing larvae which were shifted to sterilized glass troughs to prevent overcrowding and infection from excrement. The last instars larvae were transferred to sterilized glass troughs containing sawdust for pupation. The last instars larvae moulted into pupae inside the cocoons and after a pupation period of 10–12 days adult moths emerged from the cocoons. Moths were kept in acrylic net cages measuring about 30 × 30 × 30 cm and provided with 10% honey solution for feeding and fresh castor leaves for oviposition.

Plant material

Rhizomes of sweetflag, *Acorus calamus* Linn. and seeds of *Cinnamonum aromaticum* Nees. and leaves of *Vitex negundo* Linn. Were collected from vicinity of Kanpur Nagar from agricultural field of farmers and near the pond. The rhizomes, seeds and leaves were washed thoroughly with distilled water and dried in sunshade for a week and separately ground with the help of grinder and make them powder form.

Extraction of plant extracts

Acorus calamus Linn. rhizomes, *Cinnamonum aromaticum* Nees. Seeds and *Vitex negundo* Linn. Leaves were collected in the vicinity of Kanpur Nagar dried in shade and make them powder farm and extracted them with the help of soxhlet apparatus using petrilium ether (PE) as solvent. The concentration of 0.5, 0.1 and 2.0 per cent of *Acorus calamus*, *Cinnamonum aromaticum* Nees. and *Vitex negundo* Linn. were prepared in water using triton x-100 at the rate of 0.5 percent as emulsifier and benzene at the rate of 5.0 percent as solvent. To test the insecticidal properties, the field trials were performed during March and April 2020 in experimental field at Fattepur village affiliated to department of Zoology, D.B.S. College, C.S.J.M. University, Kanpur, Uttar Pradesh, India.

Experimental Procedure

The plant extracts were tested by dry film technique in the field conditions. For any extract three concentration and two controls, one with emulsifier and second without spraying were sprayed on used. Paired petri-dish were selected for this work. For preparing a film 1.0 ml. of the okra leaves insecticidal preparation was pured into a petri-dish and it was gently shaken till the liquid phase evaporated leaving behind on the petri-dish covered muslin cloth a uniform dry film of plant extracts. Ten red cotton bugs, *D. koengii* were introduced into one such petri-dish covered muslin cloth. The bugs were given a continuous exposure to the insecticidal films for two hours. After the treatment the bugs from each paired petri-dish covered muslin cloth were transferred to a separate clean petri-dish covered muslin cloth containing fresh okra leaves as food. Mouth of polythene bags covered leaves was kept kept in position with rubber band around it. Observations on mortality of bugs were recorded after 6, 12 and 24 hours of their release.

Table 1: Details of different botanicals against caterpillars of *Pericallia ricini*

Treatment	Treatment detail	Vernacular Name	Natural Faimly	Natural order	Paet Used
T1	*Acorus calamus* Linn	Sweet flag	Acoraceae -	Acorales	Rhizomes
T2	*Cinnamonum aromaticum* Nees	Cassia	Luraceae	Leirales	Seeds
T3	*Vitex negundo*	Legundi	Lamiaceae	Lamialels	Leaves
T4	Water +Emulsified water	-	-	=	-
T5	Untreated Control	-	-	=	-

Table 2: Preparation of different botanicals formulations against *Pericallia ricini*

S. No.	Concentration (%)	Amount of tock Solution (ml)	Amount of Benzene (ml)	Amount of Emulsifiable Water (ml)	Total Amount (ml)
1	0.50	5.00	20.00	475.00	500.00
2	1.00	10.00	15.00	475.00	500.00
3	2.0-	20.00	5.00	475.00	500.00

Extraction of Plant Material

Shade dried powder of *Acorus calamus* Linn. rhizome, *Cinnamonum aromaticum* Nees. seeds and *Vitex negundo* Linn. leaves were dissolved separately in 250 ml of acetone (boiling point 40–60 °C) and heated at 50 °C for two days by using a Soxhlet apparatus and filtered through Whatmann no.

1 filter paper. The filtrate was condensed in a rotatory evaporator under reduced pressure of 22–26 mm Hg at 45°C to allow complete evaporation of acetone. A dark brown, sticky, thick paste of crude extract was obtained separately. The 0.5, 1.0 and 2.0 per-cent concentrations were obtained and kept in a refrigerator at 4 °C. To test the insecticidal properties field trials were performed during March and April 2020 in the laboratory Department of Zoology, D.B.S. College, Kanpur.

3: Experimental Procedure

Freshly moulted 3rd instar larvae of *P. ricini* were selected from the stock batch of the homogenous culture of a single laying of egg mass and divided into batches of 10 larvae each. Each larva of the experimental group was administered topically with the three concentrations ie 0. 5, 1.0, and 2.0 per-cent of each extract with the help of a micro-applicator. The controls were either untreated or treated with emusifiable water. After topical administration, both treated and control larvae were transferred to sterilized glass troughs and provided with fresh okra leaves for feeding and sand dust for pupation. All the three treatments were replicated thrice. Observations were recorded at regular intervals, beginning 24 h post treatment till emergence of larvae and adults.

The plant extracts were tested by dry film technique. For any insecticide three concentration and two controls, one with emulsifier and second without spraying were used. Paired petri-dished (10 cm. Diameter) were selected for this work. For preparing a film 1.0 ml. of the insecticidal preparation was purred into a petri-dishes half and it was gently shaken under an electric fan till the liquid phase evaporated leaving behind on the glass surface a uniform dry film of plant extracts. Ten red cotton bugs were introduced into one such paired petri-dish. The larvae were given a continuous exposure to the insecticidal films for two hours. After larval treatment from each paired petri-dish were transferred to a separate clean glass jar (2.3 cm. X5.0 cm.) containing fresh castor bean leaves as food. Mouth of jar was kept covered by a piece of muslin cloth kept in position with rubber band around it. Observations on mortality of larvae were recorded after 24, 48 and 72 hours of their release.

Table 1: Mean larval mortality % of Woolly-Bear caterpillar, *Pericallia ricini* (F.)

Treatments	Conc.	Mortality percentage after		
Extract		6hrs	12hrs	24hrs
Acorus calamus	0.5	30.00	50.00	86.66
Acorus calamus	1.0	43.33	80.00	96.66
Acorus calamus	2.0	63.33	90.00	100.00
Grand Total		45.55	73.33	94.44
Control (Water+E.water)	-	00.00	00.00	00.00
Control (Untreated)	-	00.00	00.00	00.00
Standard Error (SE)	-	4.47	4.47	3.86
Critical Difference (CD) at 5.0%	-	7,14	17.77	14.85

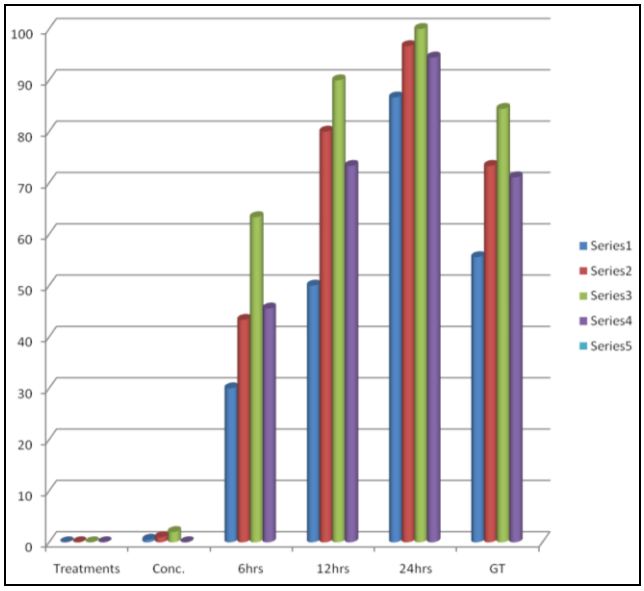


Fig 1: Mean larval mortality percentage of *Pericallia ricini* (F.) using *A. calamus* extract under laboratory trials

Table 2: Mean mortality percentage reduction of *Pericallia ricini* Fabr. with *C. aromaticum* extract under laboratory trials.

Treatments	Conc.	Mortality percentage after		
Extract		6hrs	12hrs	24hrs
Cinnamonum aromaticum	0.5	00.00	10.00	26.66
Cinnamonum aromaticum	1.0	00.00	23.33	33.33
Cinnamonum aromaticum	2.0	00.00	26.66	33.33
Grand Total		00.00	23.33	31.10
Control(Water+E.water)	-	00.00	00.00	00.00
Control (Untreated)	-	00.00	00.00	00.00
Standard Error (SE)	-	00.00	04.94	03.29
Critical Difference (CD) at 5.0%	-	99.00	18.94	12.67

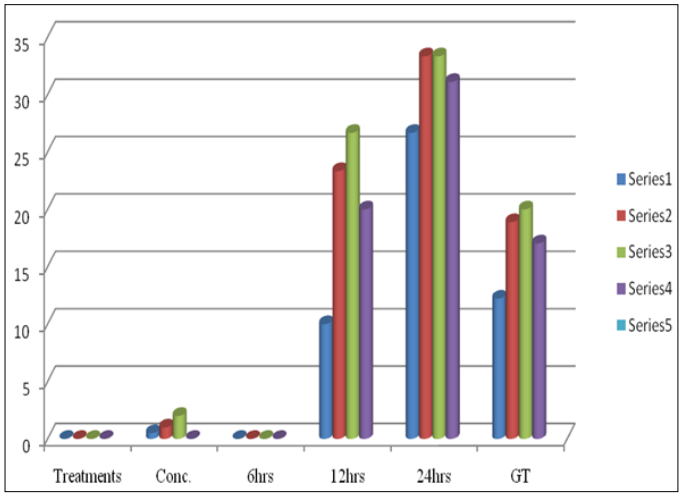


Fig 2: Mean larval mortality percentage of Woolly-Bear, *Pericallia ricini* (F.) with *C. aromaticum* extract under laboratory trials.

Table 3: Mean larval mortality percentage of *Pericallia ricini* (F.) with *Vitex negundo* extract under laboratory trials.

Treatments	Conc.	Mortality percentage after		
Extract		6hrs	12hrs	24hrs
Vitex negundo	0.5	17.33	19.00	80.00
Vitex negundo	1.0	40.00	63.33	86.66
Vitex negundo	2.0	50.00	80.00	96.00
Grand Total	-	35.77	54.11	87.55
Control (Water+E.water)	-	00.00	00.00	00.00
Control (Untreated)	-	00.00	00.00	00.00
Standard Error (SE)	-	00.00	4.94	3.29

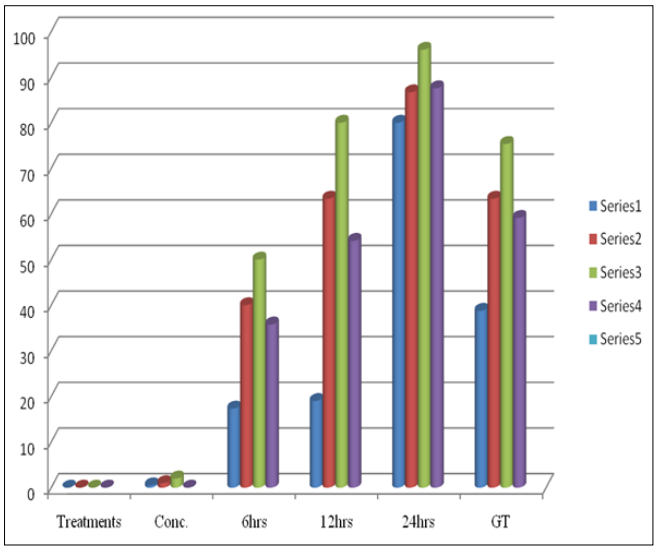


Fig 3: Mean larval mortality percentage of *Pericallia ricini* (F.) with *V. negundo* extract under laboratory trials

Table 4: Mean larval mortality percentage of *Pericallia ricini* (F.) with three botanical extract under laboratory trials

Treatments	Mean mortality per centage after			
Treatments	6hrs	12hrs	24hrs	GT
Acorus calamus Linn.	45.55	73.33	94.44	71.10
Cinnamonum aromaticum Nees	00.00	19.99	31.10	17.03
Vitex negundo Linn.	35.77	54.11	87.55	59.14
Mean mortality per centage	27.10	49.14	71.03	49.09

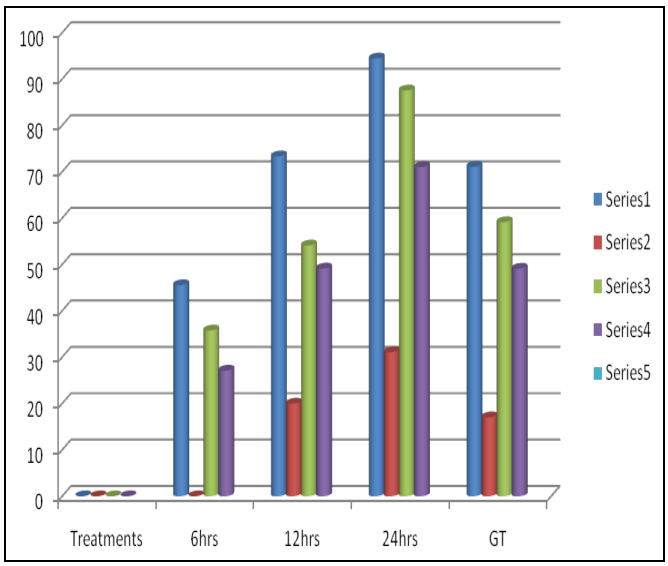


Fig 4: Mean larval mortality percentage of *Pericallia ricini* (F.) using three botanical extract under laboratory trials

Statistical Analysis

All the data regarding larval mortality after 6, 12 and 24 hours of their release were subjected to ANOVA to determine significant differences between mean larval duration of the treated and control groups.

Results and Discussion

The data, on the mortality percentage from the laboratory experiments are given in table 1, 2 and 3. From summary data on the mortality of larvae presented in table 4, it is evident that in all the sets of experiment spraying *of Acorus calamus*, *Cinnamonum aromaticum* and *Vitex negundo* emulsion and in dry film resulted in killing of larvae.

Data depicted from table that *Acorus calamus* Linn. 0.5, 1.0 and 2.0 percent gave 71.00 percent after 6 hours, 19.00, 63.33 and 80.00 per cent after 12 hrs and and 86.66, 96.66 and 100.00 per cent mean larvae mortality after 24 hours spraying (table 1). Similarly, table 3 indicated that *Vitex negundo* 0.5, 1.0 and 2.0 percent gave 17.33, 40.00 and 50.00 percent after 6 hours, 19.00, 63.33 and 80.00 per cent after 12 hrs and 80.00, 86.66 and 96.00 per cent larvae mortality after 24 hours spraying (table 3), where as in cash of *Cinnamonum aromaticum* concentrations of 0.5, 1.0 and 2.0 percent gave negligible mortality after 6 hours, 10.00, 23.33 and 26.66 per cent after 12 hrs and 26.66, 33.33 and 33.33 per cent mean larvae mortality after 24 hours spraying (table 2). Overall, data depicted from table 4 that *A. calamus* Linn. Was proved most potent gave significant mortality (71.10 per cent) followed by *V. negundo* (59.12 per cent) whereas *C. aromaticum* (17.03 per cent) and taken as unit (Table 4).

In conformity of above findings the essential oil of *A. calamus* has been demonstrated to possess anti active-insect activity against the maize weevil, *S. zeamais* [4] and insecticidal activity against many species of insects, e.g., the larger grain borer, *Prostephanus truncates*, [5] the tobacco armyworm, *Spodoptera litura* [6] and the booklouse, *Liposcelis bostrychophila* [7]. However, a literature survey has shown that there is no report on contact of *A. calamus* essential oil against the *Pericallia ricini*, thus we decided to investigate the insecticidal bio-potential activity of the essential oil of *A. calamus* against for the first time management of *Pericallia ricini* from its extractives.

On one hand significant insecticidal bioefficacy of sweet flag, rhizomes of *Acorus calamus* was reported by Dixit *et al.* 1956, (household pest), Khan 1986 (*Callosobruchus chinensis*), Pierce and Schmidt 1993 (*Prostephanus truncates*), Schmidt GH, Streloke 1994 (*Prostephanus truncatus*), Chandel *et al.* 2001 (*Tribolium castenium*) and Rao *et al.* (2002) studied the joint action potential of neem (*Azadirachta indica*) in combination with sweet flag (*Acorus calamus*) (S) and pungam (*Pongamia glabra* [*P. pinnata*]) (P) at 1:1:1 (NSP I), 2:1:1 (NSP II) and 3:1:1 (NSP III) ratios (v/v) for antifeedent and growth inhibitory effects on *E. vittella* and reported reduction in food intake by *E. vittella* in all the treatments compared to the control. NSP I (60 EC) at 0.3% have gave 80 per cent feeding protection over control against third instar larvae of *E. vittella* while Rao *et al.* (2003) studied the potential of neem extract (*Azadirachta indica*) (N) with extracts of sweet-flag (*Acorus calamus*) (S) and Pungam (*Pongamia glabra* [*P. pinnata*]) (P) at 1:1:1 (NSP I), 2:1:1 (NSP II) and 3:1:1 (NSP III) (v/v) ratios for the control of *E. vittella* in the laboratory. The mixtures were more effective than individual treatments. The mortality of shoot and fruit

borer was maximum (93.33%) in NSP (I) compared to neem alone.

It was found that the essential oil of *Acorus calamus* rhizomes showed insecticidal activity were reported time to time by various entomologist like Dubey *et al.* 2004 (*Spilarctia obliqua*) [16], Chandel *et al.* 2005 (*C. chinensis*) [17], Chandel *et al.* 2005 (*Dysdercus koenigii*) [18], Sharma *et al.* 2008 (*Spodoptera litura*) [19], Yao *et al.* 2004 [20] reported the effect of (Z)-asarone isolated from *A.calamus* possess strong insecticidal activity.

Similarly on the other hand extractives of *Vitex negundo* also possess protective power towards infestation of *Percallia recini* on castor, *Ricinus communis* reported by Adiroubane and Letchoumanane, 1998) conducted a field experiment to evaluate efficacy of 3 plant extracts, sacred basil (*Ocimumsanctum*), Malabar nut (*Adhatoda vesica*), Chinese chaste tree (*Vitex negundo*) and synthetic insecticides (endosulfan and carbaryl) and their combination products in controlling *Okra* jassids, *Amrasca biguttula biguttula* and fruit-borers, *Earias* spp. by spraying them at 10, 25 and 40 days after sowing. All the treatments suppressed both the jassid population and fruit borer incidence.

The infestation of *Percallia recini* on castor, *Ricinus communis* also reported by Hebbalkar *et al.* 1992 on (mosquito) [21], Adiroubane and Letchoumanane 1998 (*Okra* jassids, *Amrasca biguttula biguttula* and *Earias* spp) [22], Raja *et al.* 2000 (*Callosobruchus maculatus*) [23], Yuan *et al.* 2006 (*Plutella xylostella*) [24], Kannathasan *et al.* 2007(*Culex quinquefasciatus*) [25], Kannathasan *et al* .2008(*Culex quinquefasciatus*) [26], Karunamoorthi *et al.* 2008 (*Culex tritaeniorhynchus*) [27], En-shun *et al.* 2009 (aphids) [28] and Kim *et al.* 2010 (*Tribolium castaneum*) [29], respectively and reported significant mortality to their test insect.

The above discussions suggest that the essential oil and its four compounds show the potential to be developed as natural insecticides against stored-products insects. However, for the practical application of the of three extractives as novel insecticides, further studies on the safety of the extractives toward human beings and on the development of formulations are necessary to improve the efficacy and stability, and to reduce cost.

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