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Fumigant Toxicity of Essential Oils Against *Corcyra cephalonica* and *Sitotroga cerealella*

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Abstract The laboratory experiments carried out to find the fumigant toxicity of 17 essential oils from locally available herbs, weeds and west materials against *Corcyra cephalonica* (Lepidoptera : Galleriinae) and *Sitotroga cerealella* (Lepidoptera : Gelechiidae) in wheat. The essential oils from *Chenopodium botrys*, *Piper nigrum*, *Cuminum cyminum*, *Callistemon citrinus*, *Cinnamomum tamala*, *Artemisia annua*, *Cinnamomum zeylanicum*, *Murraya koenigii*, *Citrus reticulata*, *A. sativum*, *Pinus roxburghii*, *F. vulgare* was found highly effective against both insects at 0.2 and 0.4%. The essential oil of lantana Camera and Curcuma longa were found highly effective against *Corcyra cephalonica* and *Sitotroga cerealella* at 0.4% concentration. This is an important finding to explore the several types of herbs weeds and west material for sustainable management of *Corcyra cephalonica* and *Sitotroga cerealella* in short as well as long term storage of wheat and gram at very low concentrations.

Keywords Fumigant toxicity, Essential oils, *Corcyra cephalonica*, *Sitotroga cerealella*.

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Introduction

Fumigation is one of the major chemical methods to control the stored grain pests worldwide. Currently only two phosphine and methyl bromide are available in our country for this purpose, but most of the stored grain insects have developed resistance to these chemicals which also adversely affect the non target organism. Also they are not very suitable to uses by farmers who neither possess technical knowledge or infrastructure for its uses. Thus it is necessary to develop certain new alternatives that must be ecologically sound with no residual activity and adverse effect on other non target organism. In this regards many essential oils of plant origin have already been evaluated against stored grain insect pests [1, 2]. Essential oil from more than seventy five plant species belonging to different families, such as Anacardiaceae, Apiaceae (Umbeliferae), Araceae, Asteraceae (Compositae), Brassicaceae (Cruciferae) Chenopodiaceae, Cupressaceae, Graminaceae, Lamiaceae (Labiatae), Lauraceae, Liliaceae, Myrtaceae, Pinaceae, Rutaceae and Zingiberaceae have been studied for fumigant toxicity against insect pests of storage grain [3]. In the present study, attempt has been made to study the fumigant toxicity of some essential oils against *Corcyra cephalonica* (Lepidoptera : Galleriinae) and *Sitotroga cerealella* (Lepidoptera : Gelechiidae) in wheat, because both

Table 1. Scientific name and family of the essential oils of which was used to study the fumigant toxicity against *C. cephalonica* and *S. cerealella*.

Sl. No.	Scientific name	Family	Conc % (v/w)
1	*Allium sativum* L.	Lilliaceae	0.2, 0.4
2	*Artemisia annua* L.	Asteraceae	0.2, 0.4
3	*Callistemon citrinus* L.	Myrtaceae	0.2, 0.4
4	*Chenopodium botrys* L.	Chinopodiaceae	0.2, 0.4
5	*Cinnamomum tamala* L.	Lauraceae	0.2, 0.4
6	*Cinnamomum zeylanicum* L.	Lauraceae	0.2, 0.4
7	*Citrus reticulata* L.	Rutaceae	0.2, 0.4
8	*Cuminum cyminum* L.	Umbelliferae	0.2, 0.4
9	*Curcuma longa* L.	Zingiberaceae	0.2, 0.4
10	*Foeniculum vulgare* L.	Umbelliferae	0.2, 0.4
11	*Jatropha curcas* L.	Euphorbiaceae	0.2, 0.4
12	*Lantana camara* L.	Verbenaceae	0.2, 0.4
13	*Murraya koenigii* L.	Rutaceae	0.2, 0.4
14	*Myristica fragrans* H	Myrtaceae	0.2, 0.4
15	*Pinus roxburghii* R	Pinaceae	0.2, 0.4
16	*Piper nigram* L.	Piperaceae	0.2, 0.4
17	*Syzygium aromaticum* L.	Myrtaceae	0.2, 0.4
18	Untreated control		

are serious insects under Indian condition.

Materials and Methods

The laboratory experiments were conducted in Post Harvest Entomology Laboratory of Department of Entomology, G. B. Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand during 2009–2010. Pure culture of test insects were developed in the control room maintained at 27°C ± 1 temperature and 70±5% relative humidity. Rice moth *Corcyra cephalonica* reared on broken grain of maize and sorghum. Sterilized broken grain @ 2.5 kg along with 100g of groundnut powder and 5g yeast are taken in a wooden box (45 cm × 30 cm × 10 cm). Streptomycin 0.05% added to prevent bacterial infection, *Corcyra* eggs @ 0.5 cc (8000–9000 eggs)/box are uniformly mixed in broken grain. After 35—40 days emerged *Corcyra* adults will collected every morning and transferred to specially designed matting chamber and provide honey solution as food than used for experiment purposes. Plastic jars of about 1.0 kg capacity were used for rearing purpose of *Sitotroga cerealella*. At the center of the lid a hole of 1.8 cm diameter was made and covered with 30 mesh copper wire net to facilitate aeration in the jar. The adults of *Sitotroga cerealella* reared on the broken maize grain with 5% yeast powder. After disinfestation the moisture content of the grain was measured and raised to 13.5% by mixing water in the grain. Oils selected for the study were extracted from the locally available plants by steam distillation at Medicinal and Aromatic Plants Research and Development Center, Pantnagar and by Clevenger Apparatus in Post Harvest Entomology Laboratory Pantnagar.

The experiment was conducted on *Corcyra cephalonica* and *Sitotroga cerealella* to confirm the efficacy of essential oils mentioned in Table 1. The experiment was conducted under controlled conditions at 27 ± 1°C temperature and 70 ± 5% relative humidity. Hundred gram wheat grains of variety PBW–343 (moisture content 13.5%) was filled in each plastic vial. Each treatment was replicated 3 times. Untreated grain was used as control. Different set was prepared for each insect. Ten adults of *Corcyra cephalonia* and *Sitotroga cerealella* (0–3 days old) were released in each vial. After releasing the insects measured quantity of oil was poured on the absorbing mat, which was then placed inside the vial in the center. Screw cap of vials was then tightly closed. Insects were then allowed to feed and breed for one month. The insects emerging in the F_1 generation were counted till the emergence of the last insect or until the grain was spoiled. Data was analyzed in com-

Table 2. Number of adults of *C. cephalonica* emerged and percent inhibition in grain treated with different essential oils in preliminary and confirmatory tests. Data in parenthesis indicate log (X + 1) transformed values.

Essential oils	Conc % (v/w)	Preliminary test: No. of adults emerged	Preliminary test: % Inhibition	Confirmatory test: No. of adults emerged	Confirmatory test: % Inhibition
Allium sativum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Allium sativum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Artemisia annua	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Artemisia annua	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Callistemon citrinus	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Callistemon citrinus	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum tamala	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum tamala	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum zeylanicum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum zeylanicum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cuminum cyminum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cuminum cyminum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Curcuma longa	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Curcuma longa	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Foeniculum vulgare	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Foeniculum vulgare	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Jatropha curcas	0.2	40.0 (3.7)	29.03	44.3 (3.8)	33.49
Jatropha curcas	0.4	20.0 (3.0)	35.48	25.7 (3.2)	61.50
Lantana camara	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Murraya koenigii	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Murraya koenigii	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Myristica fragrans	0.2	42.0 (3.7)	35.48	44.0 (3.8)	33.99
Myristica fragrans	0.4	15.3 (2.7)	50.54	20.3 (3.0)	69.50
Pinus roxburghii	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pinus roxburghii	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pipper nigram	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pipper nigram	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Syzygium aromaticum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Syzygium aromaticum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Untreated control		31.0 (3.4)	0.0	66.7 (4.2)	0.0
SEm±		(0.38)		(0.44)	
CD at 5%		(0.1)		(0.12)	

pletely randomized design after suitable transformation with log (X +1).

Results and Discussion

The fumigant toxicity of seventeen essential oils was evaluated against two major stored grain insects, *Corcyra cephalonica* (Table 2) and *Sitotroga cerealella* (Table 3). The experiment was conducted twice to confirm the efficacy of the essential oils.

The study revealed that most of the essential oils inhibited the feeding and breeding of the test insects. However, the level of inhibition was highly correlated with the dose at which essential oils were used for treatments. The efficacy of essential oils was classified in different categories on the basis of F_1 progeny production. In majority storage system only a few individuals begin the infestation and the final losses greatly depends on the rate of their multiplication. Therefore, more weightage was given to sup-

Table 3. Number of adults of *S. cerealella* emerged and percent inhibition in grain treated with different essential oils in preliminary and confirmatory tests. Data in parenthesis indicate log (X + 1) transformed values.

Essential oils	Conc % (v/w)	Preliminary test: No. of adults emerged	Preliminary test: % Inhibition	Confirmatory test: No. of adults emerged	Confirmatory test: % Inhibition
Allium sativum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Allium sativum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Artemisia annua	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Artemisia annua	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Callistemon citrinus	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Callistemon citrinus	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Chenopodium botrys	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum tamala	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum tamala	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum zeylanicum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cinnamomum zeylanicum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Citrus reticulata	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cuminum cyminum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Cuminum cyminum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Curcuma longa	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Curcuma longa	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Foeniculum vulgare	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Foeniculum vulgare	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Jatropha curcas	0.2	21.7 (3.1)	49.22	33.3 (3.5)	26.47
Jatropha curcas	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Lantana camara	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Murraya koenigii	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Murraya koenigii	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Myristica fragrans	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Myristica fragrans	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pinus roxburghii	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pinus roxburghii	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pipper nigram	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Pipper nigram	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Syzygium aromaticum	0.2	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Syzygium aromaticum	0.4	0.0 (0.0)	100.00	0.0 (0.0)	100.00
Untreated control		42.7 (3.6)	0.0	45.3 (3.8)	0.0
SEm±		(0.57)		(0.24)	
CD at 5%		(0.36)		(0.7)	

pression of F_1 progeny. With this assumption, products inhibiting more than 90% F_1 progeny were classified as highly effective while inhibition of 80 to 89 and 70 to 79% were ranked as moderately and less effective, respectively. The products showing less than 70% F_1 progeny suppression were ranked as least effective for the control of the insect pest of stored grain.

Fumigant toxicity of essential oils against *C. cephalonica*

The fumigant toxicity of essential oils against *C. cephalonica* is presented in Table 2 which indicates that all essential oils except *M. fragrans* and *J. curcas* completely suppressed the progeny of *C. cephalonica* at 0.2 and 0.4% concentration as not any adult emerged from treated grains in both preliminary and confirmatory test. The essential oils of *M. fragrans* and *J. curcas* were least effective against *C. cephalonica*. Efficacy of leaf oil of Dalchini, *Cinnamomum zeylanicum* (Lauraceae) against the eggs of *C. cephalonica* was studied at 0.00, 0.10, 0.20, 0.50, 1.00 and 2.00% concentration. The oil resulted in inhibition of egg hatching which increased with the increase in the concentration of the oil. The minimum LC_{50} value for cinnamon leaf oil recorded was (0.3773±0.0368). Toxicity of *Citrus clean* (composed of citronella oil, pine oil and natural oils from lemongrass and marigold) against *C. cephalonica*.

Fumigant toxicity of essential oils against *S. cerealella*

The fumigant toxicity of different essential oils against *S. cerealella* is presented in Table 3 which indicates that all oils except *J. curcas* oil were highly effective against *S. cerealella* at 0.2 and 0.4% concentration as not any adults emerged from treated grain in both preliminary and confirmatory study. The oil of *J. curcas* was least effective against *S. cerealella* at 0.2% concentration as only 49.22 and 26.47% inhibition was observed in preliminary and confirmatory test, respectively. Paranagama et al. [4] tested this oil on stored rice in wooden boxes lined with aluminium foil against *S. cerealella* and found that the population of test insect was significantly lower in oil treated rice and the milling quality of rice was not affected but it enhanced flavor and stickiness of cooked rice.

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