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ORIGINAL ARTICLE

Progeny emergence of *Lasioderma serricorne* (F.) (Coleoptera: Anobiidae) in different spices

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Abstract

Spices claim uniqueness as flavoring and coloring agents in culinary industry, and accompany medical properties. Previous studies have uncovered infestation of these important commodities by certain insect species but such studies on *Lasioderma serricorne*, the cigarette beetle, are scarce. The objective of current study was to determine the ability of *L. serricorne* to develop population in selected locally-available spices. Four replicates of each spice type were infested with one-month-old, twenty adults of *L. serricorne*. The infested samples were maintained in the incubator at 30±1°C and 65±1% relative humidity. These parent adults were removed in two weeks. The emergence of progeny life stages was determined at 1-month intervals for 3 months. In the first month, only larvae and pupae were available but adults were not developed; the maximum larvae and pupae emerged in fenugreek. In the second month, all the life stages were present in spices; the maximum progeny was in fenugreek. In the third month, larvae and adults were available but not the pupae; the maximum adults emerged in curry leaves while many larvae were found in fenugreek. This study reveals the successful invasion and reproduction of broad range of spices by *L. serricorne* adults. The findings are important in the protection of spices concerned from insect infestations during the storage. By contrast, the spices with high infestation level would be useful rearing media for developing *L. serricorne* population as required for experiments.

Keywords*: Cigarette beetle, Commodities, Infestation level, Life cycle, Reproduction*

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1. Introduction

The cigarette beetle, *Lasioderma serricorne*, is distributed worldwide and has been reported to feed on many food materials over decades. It has a wide range of hosts representing raw cereals, pulses, oil seeds (Hagstrum et al. 2012) as well as tobacco seed, starch, dried fish, cotton seed, dog food, almond, dried roots, dried dates, beans, tea, many other plant/animal specimens (Runner 1919; Howe 1957; Singh et al. 1977; Arbogast et al. 2002; Blanc et al. 2006). It is also reported in feed mills and flour mills (Hagstrum et al. 2012). The adult beetle is light to dark brown, 2-4 mm long, globular in shape and occasionally feeds while the larva acquires scarabaeiform shape during rest, and actively feeds (Coffelt and Vick 1973; Borror et al. 1992; Hagstrum et al. 2012). Despite the existing knowledge on the hosts of *L. serricorne*, the information on feeding/infestation by *L. serricorne* on many food commodities including those used in culinary purposes still remains unknown.

There is a high demand for Sri Lankan spices throughout the world. Approximately 56% of agricultural products exported from Sri Lanka include spices and spice-based products (Weerasinghe and Jayasundara 2021). However, profit gained from the spices exported from Sri Lanka has declined in the recent years, and pest damages are identified as a cause for the same (Hussain and Abid 2011). *Callosobruchus maculatus*, *Tribolium castaneum* (Tripathi et al. 2009), *Stegobium paniceum* (Sajeewani et al. 2020), *Sitophilus zeamais* (Udo 2005), *Lasioderma serricorne* (Kant et al. 2022) have been identified as common pests of gains and spices in different parts of the world (Hagstrum and Subramanyam 2006). Similar studies have been conducted in Sri Lanka as well (Wijayaratne et al. 2009; Wijayaratne et al. 2019; Dissanayaka and Wijayaratne 2020a,b; Kumari et al. 2020a,b; Premathilaka et al. 2023; Wijayaratne 2023). But the reports on the damage caused by *L. serricorne* on different spices used in Sri Lanka are very limited (Gunasekaran and Rajendran 2005). Therefore, objective of the current study was to determine the infestation and progeny emergence by *Lasioderma serricorne* in ten spices commonly found in Sri Lanka.

2. Materials and Methods

2.1 Insect cultures

Lasioderma serricorne adults were collected from Anuradhapura, Sri Lanka and reared in flour medium inside the incubator (FH-1200 LED T8, Hipoint Laboratory, Taiwan) at 30±1°C and 65±1% relative humidity (r.h.). The flour medium was prepared using whole meal wheat flour (7-Star whole meal flour, Serendib Flour Mills Pvt. Ltd., Orugodawatte, Sri Lanka) and 5% of red rice flour (Ruhunu Foods, Pallekale, Kandy, Sri Lanka). *Lasioderma serricorne* 200 adults were introduced to 200 g of flour medium each placed in plastic containers with vent-holes on the lid. The adults were sifted out after two weeks. The adults of the progeny emerged were taken for the experiment at one month following eclosion (Sajeewani et al. 2020).

2.2 Experimental procedure

Ten, locally-available spices were used for this experiment. Those were coriander, pepper, cumin, clove, chilli, cinnamon, local turmeric, Indian turmeric, curry leaves and fenugreek. The spices were cleaned and washed well. Next, those commodities were dried under sunlight for five days in morning hours. After drying, the spices were ground into fine powder using the grinder (Mixee-N, Singer India Ltd., New Delhi). Twelve grams of each spice powder were weighed (AS 220.R2 PLUS, RADWAG Wagi Elektroniczne, Radom, Poland) and placed in separate 60 mL plastic vials. Twenty adults of *L. serricorne* aged one month were introduced into these vials containing a particular type of spice powder. Four replicates of each spice were tested in the study. The opening of each vial was covered using lids having small holes made using a pin for aeration. The vials having spices and insects were placed inside incubator (FH-1200 LED T8, HiPoint Laboratory, Taiwan) and maintained for two weeks (Wijerathne et al. 2020). After two weeks, the parent adults were sifted out manually using an artist brush. The spice samples were put back into the vials and maintained inside the incubator at 30±1°C, 65±1% r.h. The progeny larvae, pupae and adults emerged in each replicate sample were counted every month. Following the counting of progeny at the end of each month, all those live and dead larvae, pupae and adults were removed from the respective samples leaving only the eggs. These spice samples in vials were returned to the incubator. The progeny emerged in each replicate spice sample (from the eggs) was determined in the subsequent month for three months following the same procedure.

2.3 Statistical analysis

The different life stages of *L. serricorne* emerged in individual replicate spice samples monthly were used to calculate mean and standard error of replicates of a spice sample. These were then analyzed using the ANOVA mixed procedure of the Statistical Analysis System (SAS). Mean separation was done using Least Squares Means (LS Means). The significance was tested at P=0.05 (Karunarathne et al. 2020; Sajeewani et al. 2020; Sammani et al. 2020; Premathilaka et al. 2023).

3. Results and Discussion

3.1 Progeny emerged in different spices after one month of initial infestation

In general, more larvae were observed than pupae and adults at one month following initial infestation. The maximum number of larvae emerged in fenugreek ($F_{9,27}$=2885.26, p<0.0001) after one month. The lowest larval progeny was recorded in coriander, red chilli powder, cinnamon, black pepper and clove. Of them, red chilli powder, cinnamon and clove had virtually no progeny larvae. Cumin, local turmeric, Indian turmeric, curry leaves, coriander and black pepper had progeny larvae emerged lower than fenugreek (Table 1).

The availability of pupae was highest in fenugreek after one month. Next highest progeny production occurred in curry leaves followed by cumin. All the other spices recorded very low pupae

as progeny (<5 individuals). Of them, red chilli powder, cinnamon, pepper and clove had virtually no progeny pupae ($F_{9,27}$=39.64, p<0.0001). No adults were observed in any of the spices after one month of initial infestation.

3.2 Progeny emerged in different spices after two months of initial infestation

In contrast to the first month observations, progeny adults were observed in certain spices at two months following initial infestation. Further, on the whole, the adults were more abundant than larvae and pupae. The highest number of adults were counted in fenugreek ($F_{9,27}$=1436.02, p<0.0001) and next high progeny was occurred in cumin, Indian turmeric and curry leaves. Other spices had very low adult production; except coriander and black pepper, rest of the spices got zero adults emerged at two months (Table 2). The highest progeny of larvae was recorded in fenugreek ($F_{9,27}$=69.79, p<0.0001). Then curry leaves had the second highest record of progeny followed by coriander, cumin, Indian turmeric and local turmeric where the mean progeny was less than 3. Furthermore, there was no progeny larvae occurred in red chilli powder, black pepper, cinnamon and clove. The highest number of pupae were emerged in fenugreek followed by those developed in curry leaves and Indian turmeric. All the other spices had zero pupae emerged ($F_{9,27}$=46.90, p<0.0001).

3.3 Progeny emerged in different spices after three months of initial infestation

In general, there were no progeny pupae emerged. Overall, low amount of progeny life stages emerged in all spices except fenugreek at three months following initial infestation. The larvae were recorded only in fenugreek and coriander; fenugreek had the higher number of larvae ($F_{9,27}$=8.49, p<0.0001). All the other spices had no larvae (Table 3). The number of adults emerged was also low after 3 months. Considerable progeny adults were observed only in curry leaves ($F_{9,27}$=3.99, p<0.0025). Clove and fenugreek had very low development of adults. Local turmeric, Indian turmeric had even fewer adults. Coriander, red chilli powder, black pepper and cumin produced no adults.

Table 1: Progeny *Lasioderma serricorne* emerged (mean±SE) in different spices at one month following initial infestation (n=4).

Spice	Scientific name	Progeny emerged (mean±SE)*		
		Larvae	**Pupae**	**Adults**
Indian turmeric	*Curcuma longa*	25.50±0.33de	1.25±0.25d	0
Local turmeric	*Curcuma longa*	34.25±0.33c	0.50±0.25ef	0
Coriander	*Coriandrum sativum*	0.75±0.33fg	0.25±0.25ef	0
Red chilli powder	*Capsicum annuum*	0h	0g	0
Black Pepper	*Piper nigrum*	0.50±0.33fg	0g	0
Curry leaves	*Bergera koenigii*	22.25±0.33de	4.25±0.25b	0
Cinnamon	*Cinnamomum verum*	0h	0g	0
Clove	*Syzygium aromaticum*	0h	0g	0
Fenugreek	*Trigonella foenum-graecum*	194.50±0.33a	23.25±0.25a	0
Cumin	*Cuminum cyminum*	49.25±0.33b	2.50±0.25c	0

*For a given life stage in a column (either larvae or pupae), means followed by the same letter are not significantly different according to LS Mean separation following ANOVA.

Table 2: Progeny *Lasioderma serricorne* emerged (mean±SE) in different spices at two months following initial infestation (n=4).

Spice	Scientific name	Progeny emerged (mean±SE)*		
		Larvae	**Pupae**	**Adults**
Indian turmeric	*Curcuma longa*	0.75±0.23ef	0.50±0.43c	6.25±0.42bc
Local turmeric	*Curcuma longa*	0.50±0.23ef	0d	0f
Coriander	*Coriandrum sativum*	2.75±0.23c	0d	0.75±0.42e
Red chilli powder	*Capsicum annuum*	0g	0d	0f
Black Pepper	*Piper nigrum*	0g	0d	0.50±0.42e
Curry leaves	*Bergera koenigii*	5.50±0.23b	4.75±0.43b	3.25±0.42d
Cinnamon	*Cinnamomum verum*	0g	0d	0f
Clove	*Syzygium aromaticum*	0g	0d	0f
Fenugreek	*Trigonella foenum-graecum*	35.0±0.23a	22.5±0.43a	143.75±0.42a
Cumin	*Cuminum cyminum*	2.0±0.23d	0d	7.25±0.42bc

*For a given life stage in a column (either larvae, pupae or adults), means followed by the same letter are not significantly different according to LS Mean separation following ANOVA.

Table 3: Progeny *Lasioderma serricorne* emerged (mean±SE) in different spices at three months following initial infestation (n=4).

Spice	Scientific name	Progeny emerged (mean±SE)*		
		Larvae	**Pupae**	**Adults**
Indian turmeric	*Curcuma longa*	0c	0	1.0±0.15d
Local turmeric	*Curcuma longa*	0c	0	0.75±0.15e
Coriander	*Coriandrum sativum*	13.75±11.69b	0	0f
Red chilli powder	*Capsicum annuum*	0c	0	0f
Black Pepper	*Piper nigrum*	0c	0	0f
Curry leaves	*Bergera koenigii*	0c	0	20.50±0.15a
Cinnamon	*Cinnamomum verum*	0c	0	0f
Clove	*Syzygium aromaticum*	0c	0	3.5±0.15bc
Fenugreek	*Trigonella foenum-graecum*	342.50±11.69a	0	3±0.15bc
Cumin	*Cuminum cyminum*	0c	0	0f

*For a given life stage in a column (either larvae, pupae or adults), means followed by the same letter are not significantly different according to LS Mean separation following ANOVA.

In summary, fenugreek had the highest larvae, pupae and adults emerged throughout the storage period. Red chilli powder, black pepper, cinnamon and clove media did not favor the development of *L. serricorne.* Cumin, curry leaves and coriander had variable effects on the development of this insect species.

Insect infestation in stored food commodities has been reported over centuries (Cotton 1963; Athanassiou et al. 2011; Hagstrum and Flinn 2014). As reported in the other countries in throughout the world, the insect damage grains (Edde 2012); flour (Athanassiou et al. 2021); oil seeds (Sinha and Waters,1985; Hagstrum and Subramanyam 2006); dried fruits, nuts and seeds (Cox 1975; Sinha and Waters 1985; Hill 1990; Burks and Kuenen 2012); animal feed (Kavallieratos et al. 2019). There has been considerable amount of such damage is reported from Sri Lanka as well on the above commodities (Palipane 2001; Wijayaratne et al. 2009; Wijayaratne et al. 2019; Dissanayaka and Wijayaratne 2020a,b; Kumari et al. 2020a,b; Premathilaka et al. 2023). However, the studies on insect infestation in spices is limited. Sajeewani et al. (2020) reported coriander, fennel seeds and cumin are highly susceptible to *Stegobium paniceum*. The current study found that both coriander and cumin are highly infested by *L. serricorne* as well. Further, chilli, cinnamon and pepper are less prone to *S. paniceum* according to that previous study. The current study found that those spices had minimum infestation by *L. serricorne*. Premathilaka et al. (2023) reported that the infestation by *Tribolium*

castaneum varies with the seed type. This is in line with the current findings as the infestation by *L. serricorne* varied with the type of spice.

As insect growth and development is directly influenced by the temperature and relative humidity (Hagstrum and Subramanyam 2006; Hagstrum et al. 2012). The optimum ecological conditions for the development of *L. serricorne* are 32.5°C and 70-80% (Allotey and Unanawo 1993; Yu 2008). However, the current study was conducted at 30±1°C and 65±1% r.h. Considering the geographical variation across the globe, it would be worthwhile to test how the progeny development in these spices varies in different temperature and r.h. profiles. Further, as these spices are maintained in retailers in packaged form, testing their progeny emergence under such circumstances would also be important. Further, as Sajeewani et al. (2020) found that these spices are susceptible to *S. paniceum*, the ability of *L. serricorne* to infest the said spices when pre-infested by *S. paniceum* deem worthy of investigation. Therefore, future research needs to focus on the above avenues.

The current study reveals relative susceptibility in different spice commodities to infestation by *L. serricorne.* As the direct impact, this research projects the spices need attention for protection from insect damage during storage. On the contrary, the same information on high infestation in those commodities make them promising media for rearing these insects as required in developing the population for experimental purposes. As the alternative, those media in which *L. serricorne* population emerged low may probably be used as sources for the management of this species. All these attempts ensure the protection of spices during storage to meet the consumer demand and thus paves the way for food security which is a burning issue in the world at present.

4. Conclusions

This study comprehends that the progeny development of *L. serricorne* varies with the type of spice. High infestation of *L. serricorne* occurs in fenugreek. Further, cumin, curry leaves and turmeric also serve as potential hosts for the development of this insect species. The susceptibility of these spices for progeny development by *L. serricorne* during storage needs attention to ensure the protection of these spices. By contrast, *L. serricorne* development was minimum in red chilli powder, black pepper, cinnamon and clove media. Further, the current knowledge on high infestation of *L. serricorne* in the identified spices would offer useful insights for using them as rearing media for this insect species for increasing its population during experiments.

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