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Progeny Production by *Stegobium paniceum* (L.) (Coleoptera: Anobiidae) (Drugstore Beetle) in Different Spices

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ABSTRACT

Spices are indispensable ingredients in culinary and medical fields. Despite numerous reports on the presence of *Stegobium paniceum,* the drugstore beetle in certain spices, information on its infestation in locally-available spices is scarce. Therefore, the objective of this study was to ascertain the degree of infestation of *S. paniceum* in ten different food commodities generally used as spices and indigenous medicine. Twenty, one-month-old adults of *S. paniceum* were introduced into 12 g of a particular food commodity and removed after two weeks. Four replicates from each treatment were maintained at 30 °C and 65% relative humidity. The progeny adults emerged in each medium were recorded at 4-week intervals for 12 weeks. The maximum progeny was recorded in coriander followed by fennel seeds and cumin seeds. The progeny adult emergence was minimum in cinnamon, clove, dill seeds, cardamom, chilli, pepper corn and turmeric powder. This study concludes that *S. paniceum* infests broad range of food commodities used as spices and medicinal materials. The findings highlight the importance of protecting the spices from the infestation of *S. paniceum*. Furthermore, the spices having high infestation rate would serve as potential rearing media for maintaining *S. paniceum* cultures for experimentation.

1. Introduction

Losses occurred due to stored-product insects are about 10% in temperate regions and 50% in tropical areas [1]. Approximately 80% of the storage grain losses in Sri Lanka is due to insects [2]. Stored-product insects are most widely distributed in warehouses, processing plants, flour mills, retail stores [3]. Packaged food products, grain, plant and animal-derived products are seriously damaged by stored product insects [4].

The drugstore beetle, *Stegobium paniceum* is considered as one of the most damaging stored-product insects [4,5]. It has a worldwide distribution and mostly abundant in temperate regions [4]. It is a small insect, 2-3.5 mm long, oval-shaped and light brown to red brown. Adult female lays approximately 75 eggs. The larval period ranges from 4-20 weeks and pupation takes 12-18 days. Normally the entire life cycle is less than two months but it can exceed up to seven months under low temperature [6]. Optimum development of *S. paniceum* occurs at 30 °C and 60-90% relative humidity [4].

Sri Lankan spices have occupied a high demand in the world market since ancient times. Other than main agricultural products exported from Sri Lanka, 56% consist of spices and allied products. In 2016 export earnings from spices declined by 16% mainly due to adverse weather conditions and damage from pests [7]. Despite many studies on insects infesting grains and other processed products [3], such studies on infestation of spices frequently used in Sri Lanka by *S. paniceum* are limited [8]. Therefore, the objective of this study was to find out the infestation levels of *S. paniceum* in ten different food ingredients locally available and frequently used as spices and indigenous medicine.

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2. Material and Methods

2.1 Insect cultures

Cultures of *S. paniceum* were originally collected from Kurunegala, Sri Lanka and maintained in coriander medium inside the incubator (FH-1200 LED T8, HiPoint Laboratory, Taiwan) at 30±1°C and 65±1% relative humidity were used in the experiments. *S. paniceum* 200 adults were introduced to 200 g of coriander seeds in plastic bottles with vent-holes at the lid. After two weeks, the adults were sifted out and newly immerged insects were taken to the experiment after one month.

2.2 Experimental procedure

Ten locally-available spices coriander, cardamom, pepper corn, cumin seeds, dill seeds, clove, fennel seeds, chilli, cinnamon and turmeric powder were used for this experiment. Before used in the experiment, all the spices were washed well and oven dried at 40±1ºC inside the oven (UN260, Memmert GmbH, Germany). Twelve grams from each of those spices coriander, cardamom, pepper corn, cumin seeds, dill seeds, clove, fennel seeds, chilli, cinnamon and turmeric powder were used as commodities. One-month-old adults of *S. paniceum* (20) were introduced into a vial (3.6 cm diameter and 6.2 cm height) containing 12 g of a particular food medium. The lids of those vials had small openings for aeration. The vials with the insects introduced were maintained for two weeks inside the incubator (FH-1200 LED T8, HiPoint Laboratory, Taiwan) and the parent adults were sifted out. Four replicates from each treatment were maintained inside the incubator (30±1°C and 65±1% relative humidity). The progeny adults emerged in each medium were counted at one month intervals for three months using a vacuum pump (Rocker 300, Rocker Scientific Co. Ltd, New Taipei City). The weight of progeny adults was also taken using analytical balance (Mixee-N, India).

2.3 Statistical analysis

The progeny count and weight in three different months were separately analyzed using ANOVA procedures of Statistical Analysis System (SAS) [9]. Mean separation was done by Turkey's test with significance of P=0.05.

3. Results and Discussion

3.1 Progeny adults emerged in different spices one month following initial infestation

The highest progeny was recorded in coriander (*F*=474.55; *df*=9; *P*<0.0001). Fennel seeds and cumin seeds had lower progeny production than coriander. All the other spices recorded the lowest progeny. Of them, cinnamon, clove and dill seeds recorded very low progeny (less than 10 individuals) whereas cardamom, pepper, chilli and turmeric powder had virtually no progeny (Figure 1).

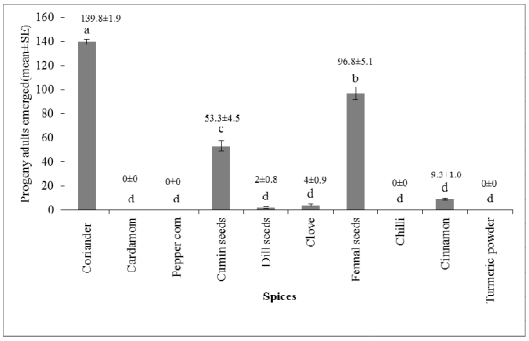

Figure 1: Progeny adults emerged (mean±SE) in different spices one month following initial infestation.
*Mean progeny produced in spices followed by the same letter are not significantly different according to Tukey's test.

3.2 Progeny adults emerged in different spices two months following initial infestation.

The highest progeny was recorded in coriander, cumin seeds and fennel seeds(*F*=70.61; *df*=9; *P*<0.0001). Furthermore, no differences were observed among these three commodities. Chilli recorded progeny less than above three spices. The lowest progeny was recorded in cinnamon, cardamom, pepper, dill seeds, clove and turmeric powder (Figure 2).

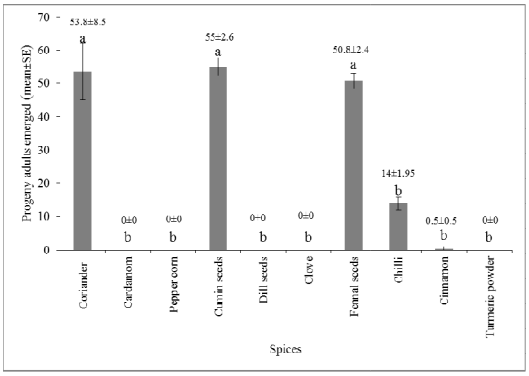

Figure 2. Progeny adults emerged (mean±SE) in different spices two months following initial infestation.
*Mean progeny produced in spices followed by the same letter are not significantly different according to Tukey's test.

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3.3 Progeny adults emerged in different spices three months following initial infestation.

The highest progeny was recorded in coriander followed by fennel seeds and cumin seeds had lower progeny production than coriander. All the other spices had significantly lower progeny. Of them, except chilli, no progeny was produced in other spices (F=1069.29; df=9; P<0.0001) (Figure 3).

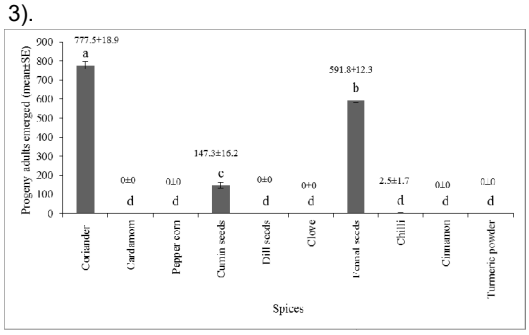

Figure 3. Progeny adults emerged (mean±SE) in different spices three months following initial infestation.

*Progeny produced in spices followed by the same letter are not significantly different according to Tukey's test.

3.4 Weight of progeny adults emerged in different spices two months following initial infestation.

The highest progeny weight was recorded in cumin seeds, coriander and fennel seeds, and there were no differences among them (F=27.45; df=9; P<0.0001). Progeny weight of chilli was lower than cumin seeds and coriander but similar to fennel seeds. All the other spices recorded the lowest progeny weight where except cinnamon, the progeny weight was virtually zero in the other spices (Figure 4).

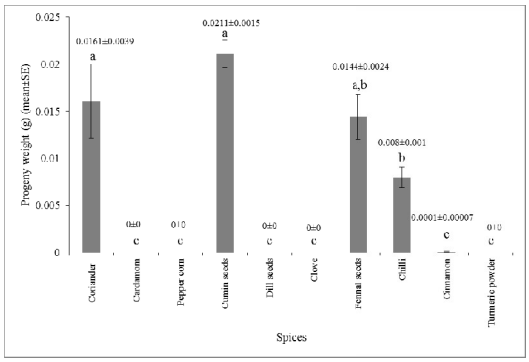

Figure 4. Weight of progeny adults emerged (mean±SE) in different spices two months following initial infestation.

*Progeny weight in spices followed by the same letter are not significantly different according to Tukey's test.

3.5 Weight of the progeny adults emerged in different spices three months following initial infestation.

The highest progeny weight was recorded in coriander followed by Fennel seeds and cumin seeds(F=518.49; df=9; P<0.0001). The progeny weight of all the other spices except chilli was zero, and was the lowest progeny category(F=518.49; df=9; P<0.0001) (Figure 5).

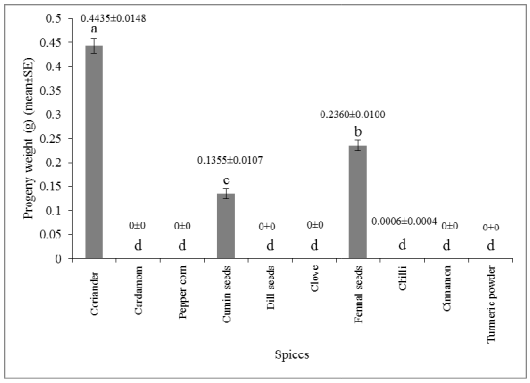

Figure 5. Progeny weight of adults emerged (mean±SE) in different spices three months following initial infestation.

*Progeny weight in spices followed by the same letter are not significantly different according to Tukey's test.

Various studies have been done for different stored-product insects to find out their progeny production in different stored food items [10,11]. But the studies related to *S. paniceum* and *Lasioderma serricorne* which are the major pest of stored spices and spice products, are limited [8]. *Stegobium paniceum*, the drugstore beetle has been detected in certain spices but no specific information is available regarding its infestation in some locally available spices. This research mainly focused to find out infestation levels of *S. paniceum* in some locally available spices. According to the results, during three consecutive months the highest significant infestation recorded in coriander, fennel seeds and cumin seeds. Chilli recorded very low progeny production during 2nd and 3rd months. Cinnamon, clove and dill seeds recorded very low progeny production during first month. No any progeny production recorded in cardamom, pepper corn and turmeric powder.

Temperature and humidity combination have a significant effect for the different life cycle stages of *S. panecium* [12]. Maximum number of eggs per *S.*

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paniceum female was obtained in the region of 20-25ºC and 60-80% RH [12]. In this research also temperature and humidity maintained constant as 30±1ºC and 60±1% RH. But fluctuation in progeny production recorded during three consecutive months. During 2nd month reduction of the progeny production occurred in coriander and fennel seeds, but cumin seeds continued to maintain the progeny similar to the first month. Further studies need to find out the reason for this difference. After three months from initial infestation, coriander seeds, fennel seeds and cumin seeds had 7-, 6- and 3-times higher progeny production, respectively than 1st month.

Differences in the progeny weight found in the current research are not proportional to that of the progeny adults produced in the second month. However, the third month observations demonstrate a close association between the said parameters. While the composition of different spices in terms of nutrients, growth promoters/inhibitors may affect these differences. It will be important to test this in future studies.

The results obtained in this study show the relative susceptibility of different spices to infestation by *S. paniceum.* While this information will be important for taking necessary steps to protect the said spices from insect infestation, those commodities are potential food media for the maintenance of laboratory colonies of *S. paniceum*. Various studies previously have been done to find out different control methods for *S. paniceum.* These include exposure to temperature [13,14], carbon dioxide [15] and essential oils from plants [16]. The essential oil from *Z. bungeanum* on the control of drug store beetle have been studied and found that effective contact and fumigant insecticidal actions of this oil may help to control expansion of *S. paniceum* populations and adult beetles were more susceptible than larvae to fumigant action of the oil [17]. Above control methods can be effectively used to control *S. paniceum* for the spices which had a high infestation of this species.

For the protection of stored food from insect infestation, use of biorational methods are emphasized more at present [18]. Recent developments of such attempts include exposure to altered environmental conditions [19], use of aggregation pheromones [20], kairomones [21], insect growth regulator methoprene [22] and the bacterial formulation spinosad [23] and controlled/ modified atmosphere or fumigation [2]. Identification of the degree of damage by *S. paniceum* to different commodities during storage would help to design and develop appropriate methods to reduce such damage using the above convincing control methods which address the environment and consumer safety. Further, the spice commodities having high infestation can be used as rearing media for *S. paniceum* to be used in experiments.

4. Conclusion

This study reveals that infestation of *S. paniceum* differs with the commodity. High infestation of *S. paniceum* occurred in coriander, fennel seeds and cumin seeds. While implementation of management practices is required for those spices, those media can be used as potential rearing media for culturing *S. paniceum*. All the other seven spices recorded very low infestation. *S. paniceum* infestation is minimum in cardamom, pepper corn, dill seeds, clove, chilli, cinnamon and turmeric powder.

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