

Food preference, repellent and attractive effects of 14-kinds of spices to the rust red flour beetle *Tribolium castaneum* Herbst

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Abstract

This study aim to determine the food and oviposition preference for rust red flour beetle to the different types of spices, also the attractive and repellent effects of the spices to the adults and larvae of the beetle.

Results showed that adults and larvae of the insect preferred ginger spice than the others, with a percentage of 32 and 16%, respectively, when given a free choice for feeding. On the other hand adult beetle preferred ginger for egg laying which and gave the highest number (9.66) after 10 days exposure in the free choice. All spices showed attractive effect to adults except cardamom and roselle while only roselle showed repellent effect to larvae.

Key words: Rust red flour beetle - Spices - *Tribolium castaneum*

Introduction

The rust red flour beetle *Tribolium castaneum* Herbst, is of Indo- Australian origin and now occurs worldwide in the warmer climates [1]. It is one of the more successful and cosmopolitan pest species[2], a serious pest of stored food in the houses and grocery stores. This beetle feed on a wide range of foods but it is the most important pest of flour and cereal products. It is also a pest of other stored products such as peas, beans, nutmeats, dried fruits, dried milk, cake mixes, spices, drugs, chocolate, cacao, oil seeds, dried flowers, herbarium, animal specimens and hides [3, 4,5,6].

The aim of the present investigation is to study the food and egg laying preference of rust red flour beetle to 14 kinds of spices, also the attractive and repellent effects of the spices to the adults and larvae of the beetle.

Materials and methods

The spices were obtained from the local market. In order to get rid of any probable insect infestation, specimens of all spices were maintained under freezing temperature for about 24 hours [7]. The spices used common name, scientific name, order,

family and the part used are illustrated in the table (1). Spices identification is confirmed in Herbarium of Biology Department, College of Science, Mosul University.

Food preference of adult rust red flour beetle to the spices

The preference of adult rust red flour beetle for feeding to the spices conducted in this study was evaluated according to the free-choice of feeding test [8]. For this test, rounded metal tray 40 cm diameter and 3 cm depth were used. The tray classified in to 14 equal parts, each of them for one type of spices. And a center part represented the control.

Hundred adults (one day old) of rust red flour beetle taken from the laboratory cultures were released in the tray center. The tray was covered with muslin cloth tightened with rubber band then placed in incubator at 33±1°C and 60±5% relative humidity. The number of adults presented with each specimen of spice in each part of tray was recorded 24 hours after the onset the experiment. The tests repeated three times, with newly adults from the laboratory cultures at a time.

Table (1): Spices used in the investigation

Spices common Name	Scientific Name	Order	Family	Part used
Cardamom	<i>Elettaria Cardamomum</i> L.	Zingiberales	Zingiberaceae	Seeds
Red Pepper	<i>Capsicum frutescens</i> L.	Solanales	Solanaceae	Dried fruits
Black Pepper	<i>Piper nigrum</i> L.	Piperales	Piperaceae	Dried fruits
Coriander	<i>Coriandrum sativum</i> L.	Apiales	Apiaceae	Dried fruits
Cumin	<i>Cuminum cyminum</i> L.	Apiales	Apiaceae	Dried fruits
Cubeb	<i>Piper cubeba</i> L.	Piperales	Piperaceae	Dried fruits
Ginger	<i>Zingiber officinale</i> Rosc.	Zingiberales	Zingiberaceae	Rhizomes
Roselle	<i>Hibiscus sabdariffa</i> L.	Malvales	Malvaceae	Red calyces
Cinnamon	<i>Cinnamomum verum</i> L.	Laurales	Lauraceae	Bark
Anise	<i>Pimpinella anisum</i> L.	Apiales	Apiaceae	Dried fruits
Thyme	<i>Thymus serpyllum</i> L.	Lamiales	Lamiaceae	Leaves
Mint	<i>Mentha piperita</i> L.	Lamiales	Lamiaceae	Leaves
Clove	<i>Syzygium aromaticum</i> L.	Myrtales	Myrtaceae	Flowers
Bay Leaf	<i>Laurus nobilis</i> L.	Laurales	Lauraceae	Leaves

Food preference of rust red flour beetle larvae to the spices

Similar experiments as indicated later were conducted but in this case 100 of 4th instar larvae (after one day

starvation) were released in the tray center instead of adult beetles.

Egg laying preference of adults rust red flour beetle to the spices

The same experiment of the adult preference to the spices for feeding was used for preference of egg laying except in this case 10 pairs (male and female) of 15 days old adults (because this species begin to lay their eggs after this period of time, [9] were placed in the tray center. The numbers of eggs laid by the adults on each spice specimen were recorded after 10 days of the beginning of experiment. Three replicates were used for each treatment.

Attractive and repellent effects of spices used to adult and larvae rust red flour beetle

The repellent and attractive effect of the different spices to both adults and larvae of were done using of

$$\text{Attractive percentage} = \frac{\text{Number of insects move towards the spice more than 25 cm away from the center}}{\text{Total insect number}} \times 100$$

$$\text{Repellent percentage} = \frac{\text{Number of insects move opposite the spice more than 25 cm away from center}}{\text{Total insect number}} \times 100$$

$$\text{Balancing percentage} = \text{Attractive percentage} - \text{Repellent percentage} = \pm \text{Attractant Repellent}$$

A completely randomized design was used and the data were subject to analysis of variance (ANOVA) and mean values were compared by Duncan's multiple range test to determine the significant difference between varieties [12].

Results and discussion

Food preference of adult rust red flour beetle to the spices

Results in table (2) revealed that adult of rust red flour beetle showed variation in their attractants to the specimens of the spices when exposure to its in the tray of the free choice test. The highest percentage number of adults (32%) was found on the ginger specimens, which is highly significant difference from that percentages of the other spices. The statistical analysis show no significant difference in the values of percentage number attracted to the most spices cardamon, red pepper, coriander, cumin, cubeb, roselle, cinnamon, anise, mint, clove and bay leaf and these values ranging between 2% and 8.66%. The Black pepper showed the lowest number 1.33% of adults attracted to its.

Food preference of rust red flour beetle larvae to the spices

Result in table (3) indicated that ginger was the more preferable spice than others to which 16.00% of the larvae attracted. Bay leaf and cinnamon was the following spices in preference by the larvae of rust red flour beetle, which the value attracted was 14.00 and 11.00% respectively. The lower percentage number of larvae attracted to cubeb and coriander, 1.66 and 2.00% respectively and there was no significant difference between them. The other spices showed various levels of attraction to specimens of spices ranging between 4.00 and 7.00% which were

chemotropometer apparatus [10] with some modification. The apparatus consist of a wood made box (48 cm length, 20 cm in width and 20 cm highness) having a mobile cover. Through the two opposite far sides of the box pass graduated glass tube (100 cm length and 3 cm diameter) with a hole in the middle to insert the tested insects from. The tube is open in both ends to insert the food in one side and food mixed with spice in the other side after wards the two ends of tube closed up with cotton. 100 individuals of the tested insect were entered to the tube throughout the hole and the repellent, attractive and balancing percentage were calculated after 15 minutes from the begging of the test using for the following equations [11]. Each test were replicated three times.

no significant difference between them. [13] Recorded that *Tribolium castaneum*, *Oryzaephilus surinamensis* and *Rhizopertha dominica* as aserious pests of dry rhizome of stored ginger in India and Bangladesh. [14] Found that *Coriandrum sativum* L. showed repellent activity against adult beetle of *Tribolium castaneum*.

Egg laying preference of adult rust red flour beetle to the spices

The data in table (4) revealed the number of eggs laid by adult females of rust red flour beetle on different type of spices when giving a free choice. Results stated that females laid the highest number of eggs on ginger spice which was 9.66 eggs whereas laid the lowest number of eggs in the black pepper which was 1.00 egg. The statistical analysis showed variation in the number of laid due to the spices. Duncan's test showed no significant difference in the number of eggs laid by females between the following spices: cumin, roselle, cinnamon, anise, mint, clove and bay leaf. Also there was no significant difference between cardamon, red pepper, black pepper, coriander, cubeb, ginger and thyme. The statistical analysis indicated positive correlation between food preference and eggs laid preference for the rust red flour beetle.

Table (2): Percentage number of adult rust red flour beetle found on the spices after 24 hrs. of exposure in the free choice test.

spices	% number of adult	
	Range	Means $\pm$ S.D
Cardamon	8 – 10	8.66 $\pm$ 1.15 b
Red pepper	4 – 5	4.66 $\pm$ 0.57 bcd
Black pepper	1 – 2	1.33 $\pm$ 0.57 d
Coriander	4 – 7	5.33 $\pm$ 1.52 bcd
Cumin	3 – 10	6.33 $\pm$ 3.51 bcd
Cubeb	2 – 5	3.66 $\pm$ 1.52 bcd
Ginger	25 – 38	32.00 $\pm$ 6.55 a
Roselle	1 – 5	3.66 $\pm$ 2.30 bcd
Cinnamon	5 – 8	6.66 $\pm$ 1.52 bcd
Anise	1 – 12	5.66 $\pm$ 5.68 bcd
Thyme	1 – 4	3.00 $\pm$ 1.73 cd
Mint	2 – 4	3.33 $\pm$ 1.15 bcd
Clove	1 – 3	2.00 $\pm$ 1.00 d
Bay leaf	5 – 7	5.66 $\pm$ 1.15 bcd
Control	6 – 11	7.66 $\pm$ 1.82 bc

Different letters vertically means significant difference at $P \leq 0.05$.

Table (3): Percentage number of larvae rust red flour beetle found on the spices after 24 hrs. of exposure in the free choice test.

spices	% number of adult	
	Range	Means $\pm$ S.D
Cardamon	4 – 6	5.00 $\pm$ 1.00 cde
Red pepper	4 – 6	4.66 $\pm$ 1.15 de
Black pepper	3 – 5	4.00 $\pm$ 1.00 de
Coriander	2 – 2	2.00 $\pm$ 0.00 e
Cumin	4 – 9	6.66 $\pm$ 2.51 cde
Cubeb	1 – 2	1.66 $\pm$ 0.57 e
Ginger	10 – 27	16.00 $\pm$ 2.51 a
Roselle	5 – 9	7.00 $\pm$ 2.00 cde
Cinnamon	7 – 17	11.00 $\pm$ 5.29 abcd
Anise	2 – 6	3.66 $\pm$ 2.08 de
Thyme	5 – 9	6.66 $\pm$ 2.08 cde
Mint	3 – 5	4.00 $\pm$ 1.00 de
Clove	3 – 5	4.00 $\pm$ 1.00 de
Bay leaf	11 – 19	14.00 $\pm$ 4.35 ab
Control	9 – 10	9.66 $\pm$ 0.81 bcd

Different letters vertically means significant difference at $P \leq 0.05$.

Attractive and repellent effects of spices to adults rust red flour beetle

Results in table (5) indicated that all spices tested have an attractive property to the adult rust red flour beetle excepting cardamon and roselle which appeared repellent property. The attraction percentage ranging between 1.00% in case of roselle and 19.00% in case of mint.

Results in table (6) showed that all spices used appeared attraction effect to the larvae of rust red flour beetle except roselle which displayed a repellent effect. Ginger was the preferable for the larvae than the other spices which have 27.30% attraction percentage followed by cardamom.

Table (4): Number of eggs laid by adult female rust red flour beetle on different types of spices after 10 days of exposure in the free choice test.

spices	% number of adult	
	Range	Means $\pm$ S.D
Cardamon	2 – 7	4.66 $\pm$ 2.51bcd
Red pepper	0 – 3	1.33 $\pm$ 1.52 e
Black pepper	0 – 2	1.00 $\pm$ 1.00e
Coriander	2 – 5	3.33 $\pm$ 1.52cde
Cumin	5 – 10	7.66 $\pm$ 2.51abc
Cubeb	1 – 3	2.00 $\pm$ 1.00de
Ginger	6 – 13	9.66 $\pm$ 2.34a
Roselle	5 – 12	9.33 $\pm$ 3.51a
Cinnamon	6 – 9	7.66 $\pm$ 1.51abc
Anise	4 – 10	6.66 $\pm$ 2.51b
Thyme	3 – 8	4.33 $\pm$ 3.05cde
Mint	5 – 8	6.33 $\pm$ 1.52bcd
Clove	2 – 6	4.66 $\pm$ 3.78bcd
Bay leaf	8 – 9	8.33 $\pm$ 0.57ab

Different letters vertically means significant difference at $P \leq 0.05$.

Table (5): The attractive and repellent effects of different types of spices to the adult rust red flour beetle.

spices	Attraction %	Repellent %	% Balasnce + Attraction - Repellent
Cardamon	1.33	6.66	- 5.33
Red pepper	3.00	2.66	+ 0.34
Black pepper	9.66	6.66	+ 3.00
Coriander	6.66	5.66	+ 1.00
Cumin	6.00	4.66	+ 1.34
Cubeb	9.66	6.66	+ 3.00
Ginger	6.00	3.00	+ 3.00
Roselle	1.00	9.00	- 8.00
Cinnamon	10.66	6.66	+ 6.33
Anise	13.66	4.00	+ 9.66
Thyme	6.66	4.66	+ 2.00
Mint	19.00	7.00	+12.00
Clove	6.00	4.66	+ 1.34
Bay leaf	12.66	8.00	+ 4.66

(22.60%), mint (19.60%), clove (19.00%) and bay leaf (18.60) while black pepper and coriander have the less attraction percentage (7.00%).

Reviewing the obtained results indicated that all spices which having attractive effect to adult and larvae of this insect seemed to be have low attraction percentage, not in excess of 27.30% in any case. The variation found in the attraction and repellent percentage may be attributed to the variation in chemical component of these spices. Therefore, these spices may influence in the insect refractionable behavior nutrition like insect direction therefore it may be act as active food deterrents or food stimulants and sometime the insect attractive to the unfavorable substance to it because the affective substance within the food composition may be not comprehend

Table (6): The attractive and repellent effects of different types of spices to the larvae rust red flour beetle

spices	Attraction %	Repellent %	% Balasnce + Attraction - Repellent
Cardamon	22.60	8.60	+ 14.00
Red pepper	15.00	10.00	+5.00
Black pepper	7.00	3.00	+ 4.00
Coriander	7.00	2.00	+ 5.00
Cumin	8.00	2.60	+ 5.40
Cubeb	10.00	2.00	+ 8.00
Ginger	27.30	0.60	+ 26.70
Roselle	3.00	17.30	- 14.30
Cinnamon	10.00	5.00	+5.00
Anise	17.30	5.00	+ 12.30
Thyme	7.60	2.00	+ 5.60
Mint	19.60	0.00	+ 19.60
Clove	19.00	1.00	+ 18.00
Bay leaf	18.60	2.30	+ 16.30

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التفضيل الغذائي والتأثير الطارد والجاذب لأربعة عشر نوعاً من التوابل

الطحين الحمراء الصدئية لخنفساء Tribolium castaneum Herbs

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الملخص

أجري البحث لتحديد تفضيل خنفساء الطحين الحمراء الصدئية لأنواع مختلفة من التوابل للتغذية ولوضع البيض إضافة إلى معرفة التأثير الجاذب والطارد للتوابل لكل من اليرقات والحشرات الكاملة. أظهرت النتائج أن اليرقات والحشرات الكاملة فضلت التغذية على الزنجبيل عن بقية التوابل الأخرى ونسبة 32 و 16% على التوالي عند إعطاءها الاختيار الحر للتغذية. من ناحية أخرى، فإن إناث الحشرة فضلت الزنجبيل أيضا لوضع البيض ونسبة 9.66 % مقارنة مع بقية التوابل. أظهرت جميع التوابل تأثيرا جاذبا للحشرات الكاملة باستثناء الهيل والكوجرات بينما أظهر الكوجرات فقط تأثيرا طاردا لليرقات.