

Food preference, repellent and attractive effects of 14-kinds of spices to khapra beetle *Trogoderma granarium* Everts (Coleoptera; Dermestidae)



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ABSTRACT

This study aim to determine the food and oviposition preference for khapra beetle, *Trogoderma granarium* Everts, using different types of spices, also the attractive and repellent effects of the spices to the adults and larvae of the beetle. Results indicated that adults and larvae preferred cinnamon spice than the other, with a highest percent of 15.33 and 34.66%, respectively, when given a free choice for feeding. On the other hand adult beetle preferred cinnamon than other spices for eggs laying which gave the highest mean number (22.66) during its lifespan. Cinnamon showed the highest attractive effect to adult while red pepper showed the highest repellent effect.

Introduction

Although spices have been used since ancient times, they are playing anew and important role in modern foods preparation; they not only add unique flavor to our foods but contribute color and variety as well. Many of these substances are also used for other purposes, such as medicine, religious rituals, cosmetics, perfumery or eating as vegetable(1,2). Spices are subject to infestation by stored product insects especially during the hot period of the summer(3).

The great spectrum of damages to stored products including spices are caused by khapra beetle *Trogoderma granarium* Everts. Iraq is one of the countries considered to contain endemic population of khapra beetle(3,4). It is very destructive and economically important species. It is prevalent relative to other species of stored grain pests, may also be related to its greater tolerance to prolonged high temperature, can tolerate colder climates (5) and its generally greater resistance to control measure (6,7,8).

This study was conducted to determine the food and oviposition preference, repellent and attractive effects of fourteen kinds of spices to the adults and larvae of khapra beetle.

Materials and methods

Food preference of adult khapra beetle to the spices

The preference of adults for feeding to the spices conducted in this study was evaluated according to the free-choice of feeding test (9). For this test, rounded metal tray 40 cm diameter and 3 cm depth were used. The tray classified into 14 equal parts, each of them for one type of spices, and a center part represented the control.

Hundred adults (one day old) of khapra 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 $33\pm 1^\circ\text{C}$ and $60\pm 5\%$ relative humidity. The number of adults presented with each specimen of spice in each part of tray was recorded 24 hours after the onset of the experiment. The tests repeated three times, with newly adults from the same cultures at a time.

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Food preference of larvae to the spices

Similar experiments as indicated later were conducted but in this case 100 specimens of 4th instar larvae (after one day starvation) were released in the tray center instead of adult beetles.

Egg laying preference of adults to the spices

The same experiment of the adults preference to the spices for feeding was used for preference of egg laying except in this case 10 pairs (male and female) of newly emerged adults were placed in the tray center. The number of eggs laid by the adults on each spice specimen were recorded after 10 days of the beginning of experiment. Three replicates were conducted for each test.

Attractive and repellent effects of spices used to adult and larvae

The repellent and attractive effect of the different spices to both adults and larvae of this beetle were done using of chemotropometer apparatus (10). The apparatus consist of a carton 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 insects 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.

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

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

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

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 adults to the spices

Results (table 1) revealed that adults prefer some spices than another. The highest percentage number 15.33% were attracted to the cinnamon spices while the percentage number of adult attracted to the rested spices was less than that with differences between spices. The statistical analysis showed no significant differences between cardamon, coriander, cubeb, ginger, roselle and anise. On the other hand thyme and clove showed lowest preferable by the adult, the percentage of adult presented on there was 3 %.

These results are in agreement with (13), whose they estimated the olfactory response of *Lasioderma serricornis* (Fab.) and *Stegobium paniceum* L. to 27 different spices and found that turmeric gave the highest percentage of attraction to the adult followed by black pepper, cinnamon and ginger. The chemical component of spices may be play an important role in the adult choice for the spices and preference.

Food preference of larvae to the spices

Results in table (2) indicated that the percentage number of larvae found in the different types of spices when given a free choice for feeding, various greatly due to the type of spices. It was highly percentage (34.66%) on cinnamon type; followed by: ginger 13.66% and roselle 10.66%. However, the larvae displayed low preference degree to the all other spices and the value of preference ranged between 0.33 on cardamom and black pepper to 7.66% on Bay leaf. The chemical components of the food host (phenols and asters) play an important role in the insect food preference to the hosts (14).

Also the physical properties of the spices, especially the hardness have a greet effect in the color, shape, touch larval preference of the spices.

Egg laying preference of adults to the spices

Table (3) indicated the number of eggs laid by female of khapra beetle on the different types of spices when giving a free choice. It was found differences between the spices in the number of eggs laid. The female laid the highest number of eggs on the cinnamon spice which was 22.66 eggs, while laid the lowest number of eggs on the cubeb spices which was 2.00 eggs. The other spices ordered at the following succession cumin, ginger, cardamon, Roselle, anise, thyme, bay leaf, mint, clove, black pepper, red pepper and coriander. The statistical analysis of the data showed a significant difference in the number of eggs laid between cinnamon and the all other spices while showed no significant differences between them. The statistical analysis showed positive significant correlation between food preference of larvae and adults and the adult preference to lay their eggs on the spices. (15) mentioned that the preference to lay eggs by stored product pests depending, with no doubt, to the physical and chemical nature of the food attacked.

Attractive and repellent effects of spices used to adults and larvae

Results in table (4) indicated that cardamom, coriander, cumin, ginger, anise, mint, clove and bay leaf showed attractive effect by adults while red pepper, black pepper, cubeb, cinnamon and thyme showed repellent effect. The results showed that cumin was the more preferable spice for the adults than the others which gave the highest attraction percentage of 22.66% whereas black pepper and cubeb have the lowest attraction percentage 3.00%. On the other hand, red pepper have the highest repellent percentage 14.00% whereas cardamon have the lowest repellent percentage 4%. (16) indicated that cinnamon works as an effective insect repellent. Also (17) mentioned that thyme, *Thymus serpyllum* is used as mild insect repellent.

Results in table (5) revealed that all spices showed an attractive property to the larvae with the exception of cinnamon, mint and clove which appeared repellent effect to its. Red pepper showed the highest attraction percentage 17.66% while ginger and clove showed the lowest attraction percentage 4.00%. The variation found in the attraction and repellent percentage may be attributed to the variation in chemical components of these spices. The spices may influence in the insect refractive behavior therefore it may be act as

active deterrents or food stimulants and some times the insect attractive to the unfavorable substance because the effective substance within the food composition may be not comprehend by the insect due to its vapor concentration which may be not sufficient and effective to the olfactory response of the insect.

Conclusion

1. Khapra beetle prefers the cinnamon than other spices for feeding and egg laying when given free choice.
2. Adult khapra beetle showed more chemotropism to cumin than other spices while larvae showed more chemotropism to the red pepper.
3. The variation found in the attraction and repellent percentage may be attributed to the variation in chemical components of the spices.

Table (1): Number of adults khapra beetle found on the spices after 24 hrs. of exposure in the free choice test

spices	% number of adult	
	Range	Means ± S.D.
Cardamon	3 – 7	5.66 ± 2.30 cd
Red pepper	4 – 4	4.00 ± 0.00 de
Black pepper	8 – 12	10.00 ± 2.00 bc
Coriander	2 – 7	4.00 ± 2.64 dc
Cumin	2 – 5	3.66 ± 1.52 e
Cubeb	2 – 6	4.33 ± 2.08 d
Ginger	7 – 11	8.66 ± 2.04 bcd
Roselle	3 – 5	4.44 ± 1.15 de
Cinnamon	11 – 18	15.33 ± 3.78 a
Anise	4 – 4	4.00 ± 0.00 de
Thyme	3 – 3	3.00 ± 0.00 e
Mint	9 – 14	12.00 ± 2.64 ab
Clove	1 – 5	3.00 ± 2.00 e
Bay leaf	5 – 18	10.66 ± 6.66 b
Control	6 – 8	7.33 ± 1.14 bcde

Different letters vertically means significant difference at P<0.05.

Table (2): Number of larvae khapra beetle found on the spices after 24 hrs. of exposure in the free choice test.

spices	% number of larvae	
	Range	Means ± S.D.
Cardamon	0 – 1	0.33 ± 0.57 e
Red pepper	0 – 16	6.33 ± 8.50 cde
Black pepper	0 – 1	0.33 ± 0.57 e
Coriander	0 – 6	2.00 ± 3.46 de
Cumin	0 – 4	2.00 ± 2.00 de
Cubeb	0 – 4	2.33 ± 2.08 de
Ginger	11 – 16	13.66 ± 2.51 b
Roselle	7 – 13	10.66 ± 3.21 bc
Cinnamon	29 – 40	34.66 ± 5.50 a
Anise	2 – 7	5.00 ± 2.64 cde
Thyme	4 – 6	5.00 ± 1.00 cde
Mint	1 – 4	2.33 ± 1.52 de
Clove	2 – 10	6.66 ± 4.16 cde

Bay leaf	6 – 11	7.66 ± 2.88	b
Control	1 – 1	1.00 ± 0.00	de

Bay leaf	15.60	1.00	+ 14.60
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Different letters vertically means significant difference at P< 0.05.

Table (3): Eggs laid by adult female khapra beetle on different types of spices after 10 days of exposure in the free choice test.

spices	Number of egg laid	
	Range	Means ± S.D.
Cardamon	3 – 7	5.66 ± 2.36 b
Red pepper	1 – 4	2.33 ± 1.52 b
Black pepper	2 – 5	3.66 ± 1.52 b
Coriander	0 – 4	2.33 ± 2.68 b
Cumin	8 – 20	12.66 ± 6.42 ab
Cubeb	0 – 3	2.00 ± 1.73 de
Ginger	3 – 22	10.66 ± 10.01 b
Roselle	4 – 9	5.66 ± 2.86 b
Cinnamon	2 - 36	22.66 ± 18.14 a
Anise	3 – 8	5.66 ± 2.51 b
Thyme	3 – 8	5.33 ± 2.51 b
Mint	3 – 6	5.00 ± 1.73 b
Clove	3 – 5	4.33 ± 0.62 b
Bay leaf	4 – 6	5.33 ± 1.04 b

Different letters vertically means significant difference at P< 0.05.

Table (4): The attractive and repellent effects of different types of spices to spices to the adult khapra beetle.

spices	Attraction %	Repellent %	% Balasnce + Attraction - Repellent
Cardamon	6.33	4.00	+ 2.33
Red pepper	8.00	14.00	- 6.00
Black pepper	3.00	10.00	- 7.00
Coriander	12.66	6.33	+ 6.33
Cumin	22.66	5.66	+ 17.00
Cubeb	3.00	8.33	- 5.33
Ginger	11.00	6.33	+ 4.67
Roselle	7.00	7.00	0.00
Cinnamon	4.33	11.00	- 6.67
Anise	18.66	9.33	+ 9.33
Thyme	9.33	11.66	- 2.33
Mint	10.00	6.33	+ 3.67
Clove	9.00	8.33	+ 0.77
Bay leaf	13.33	7.00	+ 8.33

Table (5): The attractive and repellent effects of different types of spices to the larvae khapra beetle.

spices	Attraction %	Repellent %	% Balasnce + Attraction - Repellent
Cardamon	5.66	2.00	+ 3.66
Red pepper	17.66	4.30	+13.36
Black pepper	6.60	3.00	+ 3.60
Coriander	10.00	2.30	+ 7.70
Cumin	6.00	3.00	+ 3.00
Cubeb	8.60	0.66	+ 7.94
Ginger	4.00	0.66	+ 3.34
Roselle	8.60	3.00	+ 5.60
Cinnamon	6.00	8.00	- 2.00
Anise	9.60	1.00	+ 8.60
Thyme	10.00	0.66	+ 9.44
Mint	6.60	8.00	- 1.40
Clove	4.00	6.60	- 2.60

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التفضيل الغذائي والتأثير الطارد والجاذب لأنواع مختلفه من التوابل *Trogoderma granarium* (Coleoptera ; Dermestidae) الخابرا لخنفساء Everts

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الخلاصة:

أجريت هذه الدراسة لمعرفة التفضيل الغذائي ووضع البيض لكاملات خنفساء الخابرا لأنواع مختلفة من التوابل بالإضافة إلى تحديد التأثير الجاذب والطارد لهذه التوابل للحشرات الكاملة واليرقات. أظهرت النتائج أن الحشرات الكاملة واليرقات فضلت الدارسين على بقية التوابل للتغذية عليها عند إعطائها الاختيار الحر للتغذية وبنسبة ١٥.٣٣% و ٣٤.٦٦% على التوالي. من ناحية أخرى فضلت الحشرات الكاملة الدارسين أيضا على بقية التوابل لأجل وضع البيض بمعدل بلغ ٢٢.٦٦ خلال دورة حياتها. اظهر الدارسين تأثيراً جاذباً أكثر بأعلى نسبة للحشرات الكاملة من بقية التوابل بينما اظهر الفلفل الأحمر تأثيراً طارداً أكثر نسبة من غيره.