Population density of khapra beetle on 14 –kinds of stored spices under natural storage conditions

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Abstract

This study was conducted to determine the population density of khapra beetle *Trogoderma granarium* Everts when reread on fourteen kinds of the common used spices (Cardamon, Red pepper, black pepper, Coriander, Cumin, Cubeb, Ginger, Roselle, Cinnamon, Anise, Thyme, Mint, Clove, and Bay Leaf) under natural storage conditions for 2 and 4 month storage in addition to evaluate the loss caused due to the infestation.

Results revealed that the population density of the insect varied significantly according to the spices used. The highest mean population density was 390.83 in anise while black pepper showed the lowest population density (19.33). On the other hands, results illustrated that the highest mean weight loss was 9.77% on anise followed by 8.16 on clove while the lowest was o.68% found in black pepper followed by 1.25% on red pepper.

Key Words: Khapra beetle – spices – *Trogoderma granarium*

Introduction

Khapra beetle is one of the world's most feared stored product pests. Its infests a wide varieties of dried plant and animal materials especially seeds of most plant family. In addition to seeds, khapra beetle also infest spices, dried gums, dried fruits, dried milk, dried blood, dried meat and fishes and many other materials [1].

Population of khapra beetle build up rapidly in a short time under hot, dry conditions, predictably in areas which for at least 4 monts of years have a mean temperature greater than 20°C and relative humidity below 50% [2]. Iraqi is one of the countries considered to contain endemic population of khapra beetle [3].

Spices and herbs, as dried seed, fruit, root, bark or vegetative, are used in food to impart flavor, pungency and color. They also have antioxidant, antimicrobial, pharmaceutical and nutritional properties [4,5,6].

The aim of this study is to determinate the population density of khapra beetle reared on the fourteen kinds of spices in addition to evaluate the loss due to artificial infestation with two pairs of insects for 2 and 4 month of storage under natural storage conditions.

Materials ant methods

Population density and damaged caused due to artificial infestation of khapra beetle *Trogoderma granarium* Everts on fourteen kinds of spices were studied under natural storage conditions. The study included two storage periods, 2 and 4 months beginning from June till October, 2008.

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.

For each spice 25 gm were taken and placed in glass container of 50 ml capacity then transferred to it two pairs (male and female) of newly emerged adults (some hours old). The adults needed for this purpose were obtained by isolating many male and female pupae, separately from the laboratory cultures, in a glass Petri-dish and maintained in incubator till adult emergence. The mouth of containers were covered with muslin cloth tied with rubber band then placed these container in the laboratory under natural conditions. Three replicates were used for each spice, and for the both duration storage.

Materials ant methods

At the end of each storage period, the number of all insect stages (larvae, pupae and adults) was calculated. In order to estimate the loss in weight of the spices due to insect infestation, for the two storage periods the specimens residue (after the removal of all insect stages and refuses) were weighted and the loss in weight caused by insect feeding was estimated.

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 [8].

Table (1): Spices used in the investigation

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

Results and discussion

The results in table (2) indicated that the number of larvae, pupae and adults, also the total number of all developmental stages of khapra beetle differed according to the kinds of spices used and the long of storage period. It was found that the number of the larvae ranged between 1.00 on the red pepper to 118.67 on the anise after 2 months of storage, however, the number increased with the increasing of storage period to reach values ranged between 18.33 larvae on black pepper and 536.33 larvae on anise after 4 months of starting the storage.

Table (2): population density of khapra beetle on different types of spices at two storage periods under natural conditions.

spices	Storage period (month)	No. of larvae	No. of pupae	No. of adults	Total No. of all stage
Cardamon	2	45.33 fg	4.33 de	39.33 e-i	89.00 e-j
	4	162.67 e	0.00 e	37.33 e-i	200.00 e
	Mean	**104.00 e**	**2.16 cd**	**38.33 b**	**144.50 d**
Red pepper	2	1.0 g	1.66 e	9.00 k-l	20.67 i-j
	4	40.0 fg	0.00 e	14.00 j-l	54.00 g-j
	Mean	**20.50 fg**	**0.83 d**	**11.50 cd**	**37.33 e**
Black pepper	2	6.67 g	0.66 e	6.00 l	13.33 j
	4	18.33 g	0.00 e	7.00 l	25.33 h-j
	Mean	**12.50 g**	**0.33 d**	**6.50 d**	**19.33 e**
Coriander	2	92.0 eg	13.00 cd	43.00 c-h	148.00 e-g
	4	327.0 cd	0.00 c	79.00 a	406.00 cd
	Mean	**209.50 d**	**6.50 b-d**	**61.00 a**	**277.00 bc**
Cumin	2	96.67 e-g	10.33 c-e	51.00 b-g	158.67 e-g
	4	383.33 bc	0.00 e	73.67 ab	457.00 bc
	Mean	**240.00 b-d**	**5.16 cd**	62.33 a	307.83 b
Cubeb	2	24.0 g	10.00 c-e	13.67 j-i	47.67 g-j
	4	86.67 e-g	0.00 e	31.33 g-k	118.00 e-j
	Mean	**55.33 e-g**	**5.00 cd**	**22.50 c**	**82.83 de**
Ginger	2	3.67 fg	6.33 de	15.00 j-i	56.33 g-j
	4	127.33 ef	0.00 e	67.67 a-c	195.00 e
	Mean	**65.50 ef**	**3.16 cd**	**41.33 b**	**125.67 d**
Roselle	2	84.0 eg	9.66 c-e	36.33 f-j	130.00 e-i
	4	276.33 d	0.00 e	51.00 b-g	327.33 d
	Mean	**180.17 d**	**4.83 cd**	**43.76 b**	**228.67 c**
Cinnamon	2	35.67 fg	17.00 bc	27.33 g-i	79.33 f-j
	4	149.67 e	0.00 e	48.33 c-h	198.00 e
	Mean	**92.67 e**	**8.66 a-c**	**37.83 b**	**138.67 d**
Anise	2	118.67 ef	26.33 ab	35.00 f-j	180.00 ef
	4	536.33 a	0.00 e	63.33 a-d	601.67 a
	Mean	**327.50 a**	**13.16 ab**	**49.16 ab**	**390.83 a**
Thyme	2	78.33 e-g	16.66 c	41.33 d-h	136.33 e-h
	4	391.0 bc	0.00 e	47.00 c-h	437.00 b-c
	Mean	**234.67 b-d**	**8.33 a-c**	**43.67 b**	**286.67 bc**
Mint	2	77.67 e-g	14.00 cd	44.00 c-h	135.67 e-h
	4	364.0 c	0.00 e	65.00 a-d	429.00 bc
	Mean	**220.83 cd**	**7.00 b-d**	**54.50 ab**	**282.33 bc**
Clove	2	96.33 e-g	28.66 a	33.67 f-j	158.67 e-g
	4	448.67 bc	0.00 e	61.33 a-e	513.33 ab
	Mean	**272.50 bc**	**14.33 a**	**47.50 ab**	**336.00 ab**
Bay leaf	2	100.0 e-g	18.33 bc	25.67 h-l	144.00 e-g
	4	466.67 ab	0.00 e	57.67 a-f	457.67 bc
	Mean	**283.33 ab**	**9.16 a-c**	**41.67 b**	**300.83 bc**

Different letters vertically means significant difference at $p \leq 0.05$

According to the mean number of larvae on different spices, results indicated that kind of spices play an important role on the population density of the larvae presented on its. The superior number of the larvae was 327.50 observed on the anise followed by 283.33 larvae on bay leaf which was no significant difference between them. On the other hands the lowest number of the larvae was 12.50 seemed on black pepper followed by 20.50 larvae on red pepper and 55.33 larvae on cubeb where there was no significant difference between them. These three spices contain a chemical group of alkaloid compounds responsible for its pungency property that may be toxic and antifeedant to the insects.

The number of pupae found on different spices at the end of two months storage period was low and ranged between the lowest value of 0.66 pupae on black pepper and highest value of 28.66 on clove while there was any pupa found on all kinds of spices at the end of four months storage period because of at this time (the beginning of October) the temperature decreased and the insect inter hibernation in the larval stage.

With regard to the effect of spices types on the mean population density of the pupae, results in table (2) proved that clove have the highest number of pupae on it which was 14.33 while black pepper has the lowest number of pupae on it which was 0.33 pupae. The statistical analysis of the data indicated that the spices type have significant effect on the number of pupae found on its.

The number of the adults presented in the different spices varied with the storage period. After 2 months of storage, the highest number of adults was 51.00 found on cumin whereas the lowest number was 6.00 adults presented on black pepper. After 4 months of storage the number of adults increased to reach its higher 79.00 adults on coriander followed by 73.67, 67.67, 65.00 adults on cumin, ginger and mint, respectively which the statistical analysis showed insignificantly difference between them. Moreover, the lowest number of adult presented was 7.00 adults on the black pepper. This results in corresponding of [9] which reported that black pepper could inhibit the development of F1, progenies of *Callosobruchus chinensis*.

Regardless of the storage period, the mean number of adults presented on the spices showed a clear significant difference and the highest number was 62.33 adults found on cumin followed by 61.00, 54.50, 49.16, 47.50 adults on coriander, mint, anise and clove respectively, which there was no significant difference between them. Moreover, the lowest number was 6.50 adults which found on black pepper.

The total number of all stages was obviously low after 2 months of storage on all spices in comparison with that found after 4 months and the variability in the numbers was huge. After 2 months of storage, the number presented on the spices swinging between the low value of 13.33 individuals on black pepper and the high value of 185.00 individuals on Anise. While after 4 months of storage the number presented Waverly between the low value of 25.33 individuals on black pepper and the high value of 601.67 individuals on anise.

Irrespective of the storage period, spices have a great effect on the biology of khapra beetle and then to the population density of the mean total number of all stage presenting. Results in table (2) elucidated that anise gave the highest mean total number of all stage (390.83) while black pepper gave the lowest mean total number of all stage (19.33). These results illustrated that anise was the preferable spice for the growth and development of khapra beetle than the other spices used, in converse to the black pepper. The chemical and physical properties of the spices play an important role in these differences.

Reviewing the obtained results, the suitability of the used spices to the growth and development of khapra beetle in accordance with population density of the total number of all stages could be arranged in the following descending order : anise > clove > cumin > bay leaf > thyme > mint > coriander > rosselle > cardamon > cinnamon > ginger > cubeb > red pepper > black pepper.

[10] said that admixture of 7.5% (w/w) of dry powder red pepper *Capsicum frutescens* with cowpea caused 30.00% mortality in adult *Callosobruchus maculates* and reduced F1 production of 60.00%. [11] found that 3% (w/w) of ginger powdered rhizome admixed with wheat caused 56.00% mortality in adult *Sitophilus oryzae* in 30 days, compared with 29.00% in the untreated controls. The emergence of F1 adults was reduced by 60.00% compared to the control. [12] admixed the green gram with 3.00% (w/w) ginger powdered rhizome and caused 58.08% adult mortality in *Callosobruchus chinensis* after 15 days exposure compared to the control 12.05%. On the other hand, [13] found that 10% (w/w) admixed of mint *Menta spicata* with green gram prevent oviposition in adult *Callosobruchus analis* and the production of F1 ofter an exposure period of 60 days. [14] mentioned that 6% ground powdered black pepper *Piper nigrum* applied to maize caused 100% mortality in adult *Sitophilus zeamais* within 6 days. The toxicity of black pepper was attributable to the presence of piperine.

Results in table (3) showed that weight loss caused by khapra beetle infestation to the various spices used was compatible with the population density of the total number of all stages presented. The percentage loss in weight increased with the increasing of storage period. After 2 months of storage, the lowest value of this percentage loss was 0.49% on black pepper while rises to the highest value of 5.50% on anise. After 4 months of storage this percentage ranged between the lowest value of 0.87%. on black pepper and the highest value of 14.05% on anise.

The mean weight loss percentage resulted from injury by the infestation depending on the type of spice. The

highest mean weight loss percentage noticed was 9.77% on anise followed by 8.16% on clove, and 7.93% on cumin, which the statistical analysis llowed by 1.25% on red pepper. showed insignificant differences between them. On the other hand, the lowest mean weight loss percentage was 0.68% found on black pepper, fo

Table (3): Weight loss percentage of spices due to infestation with khapra beetle for 2 and 4 months periods.

spices	Weight loss percentage after		Mean
	2 months	4 months	
Cardamon	2.98 g-l	5.75 ef	4.36 ef
Red pepper	0.98 kl	1.52 i-l	1.25 gh
Black pepper	0.49 l	0.87 l	0.68 h
Coriander	4.00 f-j	9.87 b-d	6.93 b-d
Cumin	4.52 fg	11.35 bc	7.93 ab
Cubeb	1.44 j-l	3.87 f-j	2.65 fg
Ginger	1.70 h-l	5.06 fg	3.38 f
Roselle	3.56 f-k	7.61 de	5.58 de
Cinnamon	1.72 h-l	4.90 fg	3.31 f
Anise	5.50 e-g	14.05 a	9.77 a
Thyme	4.12 f-I	10.12 bc	7.12 b-d
Mint	3.63 f-j	8.98 cd	6.30 cd
Clove	4.51 fg	11.82 ab	8.61 a
Bay leaf	4.30 f-h	10.53 bc	7.41 bc

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

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الكثافة العددية لخنفساء الخابرا في أربعة عشر نوعاً من التوابل تحت الظروف الطبيعية للخزن

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الخلاصة

أجريت هذه الدراسة لتقييم الكثافة العددية لخنفساء الخابرا Trogoderma granarium Everts عند تربيتها على أربعة عشر نوعا من التوابل الشائعة الاستعمال (الهيل، الفلفل الأحمر، الفلفل الأسود، الكزبرة، الكمون، الكبابة، الزنجبيل، الكوجرات، الدارسين، الينسون، الزعتر، النعناع، القرنفل، ورق الغار) تحت ظروف الخزن الطبيعية ولفترة 2 و4 أشهر من التخزين إضافة إلى تقدير الفقد في الوزن المتسبب عن الإصابة.

أظهرت النتائج أن الكثافة العددية للحشرة تباينت معنويا تبعا لنوع التوابل المستخدمة وأعطت الحشرة أعلى متوسط للكثافة العددية عند تربيتها على الينسون بلغ 390.83 في حين ظهرت أقل كثافة عددية على الفلفل الأسود وبلغت 19.33. من ناحية أخرى لوحظ أعلى متوسط للفقد في الوزن وبلغ 9.77% في حالة الينسون تلاه في ذلك القرنفل 8.16% في حين كان أقل متوسط للفقد في الوزن على الفلفل الأسود وبلغ 0.68 تلاه في ذلك الفلفل الأحمر 1.25%.