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Comparison of the reproduction and mortality of the *Oryzaephilus surinamensis* on three date cultivars (Khadrawy, Barhee, Bream) and testing the effectiveness of *Cinnamomum cassia* and *Foeniculum vulgare* as a bio-insecticide

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Abstract:

Oryzaephilus Surinamensis is an important insect pest that infects many grains and dry fruits. Khadrawy, Bream, and Barhee are among the best Iraqi dates. The growth and reproduction of the *Oryzaephilus Surinamensis* differ according to the date type. *Cinnamon* and *Foeniculum vulgare* play an important role in the biological control of stored insects, as the powders of these plants contain various safe and effective ingredients. The present study was conducted to determine the growth density of the *Oryzaephilus Surinamensis* on three varieties of dates: Khadrawy, Bream, and Barhee, and to control this insect biologically using two types of spices: cinnamon and *Foeniculum vulgare*. The results of the study showed that the highest growth rate of the insect was on the Khadrawy (24.3), followed by Bream 19.9 and Barhee 6.9. *Cinnamon cassia* and *Foeniculum vulgare* powder recorded different mortality rates, *Foeniculum vulgare* powder was superior in being an insect killer at a concentration of 1, 3 and 6 gm with a mortality rate of 100% on Khadrawy and Barhee while 60, 70 and 90% on Bream at a concentration of 1, 3 and 6, While *Cinnamon cassia* powder at a concentration of 1,3 and 6 gm recorded a mortality rate of 100% on Barhee and 80, 90 and 90 on Khadrawy and 50, 60,70 on the Bream. The study recommended the need to experiment with other plant powders in the future to expand the scope of biological control that kills insects with safe and environmentally friendly alternatives.

Keywords: *Oryzaephilus surinamensis; Reproduction; Mortality; Date cultivar; Bio-insecticide.*

Introduction:

Dates are considered one of the most important types of fruits because of their nutritional value and medical benefits that exceed all other types of fruits that humans eat (1). Phytochemicals provide dates with their nutritional and sensory qualities in addition to their pharmacological ones (2). Many insect pests have the potential to infest date fruits (3). Around the world, the sawtoothed grain beetle, Oryzaephilus surinamensis (L.) (Coleoptera: Silvanidae), is a significant pest of a variety of stored goods such as dates (4). The factors that helped the insect spread globally and infect a wide range of grains and stored materials are its small size, high speed of movement, ability to feed, and flat body shape. What increased the danger of the insect is its ability to break the grains and make tunnels inside them, increasing their moisture and clumping, in addition to the remains of larvae and adults, which lead to poor taste and spoilage of the

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grains. The use of chemical pesticides led to the emergence of resistant strains of pests, killing non-target organisms, and poisoning cases among workers in the grain field (5-7). Plant extracts and derivatives have been investigated in several studies as chemical alternatives that can be used in insect pest control (8). Cinnamon is the powder of the outer shells (bark) of the trunks of perennial trees that grow to about seven meters in height and belong to the botanical genus Cassia and are scientifically known as Cassia cinnamomum. The powder resulting from grinding these shells is known as Cinnamon (9). The compounds found in cinnamon bark are biopesticides, that is, substances of natural origin that are characterized by their low toxicity to non-target species and their easy availability (10). Anethum graveolens L. is an annual herbaceous plant belonging to the Umbelliferae family (11, 12). It is an aromatic plant, due to its nutritional, economic, and medical importance, its cultivation has spread (13). The powdered F. vulgare may be useful for handling stored (14,15). The study aims to determine the ability of the *Oryzaephilus Surinamensis* to grow and reproduce on the three varieties of dates: Khadrawy, Barhee, and Bream, as well as to determine the toxicity of some plant powders, such as cinnamon and anise, in eliminating the *Oryzaephilus Surinamensis* that infects various dates.

Materials and Methods:

Insect collection, growth, and reproduction:

Date palm fruits infested with the *Oryzaephilus surinamensis* were collected from local markets. The insects were isolated and transferred to uninfested fruits such as Halawi date, placed in plastic containers measuring 25*25*30 cm, covered with a muslin cloth, tightened with a rubber and kept in the laboratory. We are isolating and separating males of the Oryzaephilus surinamensis from females. The adult male can be distinguished from the female by the presence of a visible sex part protruding from the upper part of the legs on the inner side of the thigh of the third pair, also by colour and size. After separating the males from the females, the insects are placed in plastic boxes measuring 4.4*1,10 cm. The containers are then closed with tight lids to prevent the insects from escaping. After that, these containers were transferred and kept in the laboratory at room temperature for 60 days.

Five grams of each type of date (Bream, Barhee, and Khadrawy) were weighed using a sensitive balance and placed in plastic boxes. Three replicates were made for each type of date, and 10 insects of the Oryzaephilus surinamensis were placed in each box, 5 males and 5 females. After that, these boxes were tightly closed to prevent the insects from escaping from the boxes. These boxes were transferred to be stored in the laboratory at room temperature and monitored for 60 days as a control group.

Bio-insecticide:

Plant powders used:

Cinnamomum cassia sticks and *Foeniculum vulgare* seeds were brought from the market and then ground into a fine powder using an electric grinder and stored in a glass container for the purpose of using these powders to combat Oryzaephilus surinamensis.

Weighing 1 gm, 3 gm, and 6 gm of each of cinnamon powder and *Foeniculum vulgare* seed powder, each weight was placed in a plastic box measuring 4.4*1*10 cm containing 5 gm of each of the three types of dates (Khadrawy, Barhee, and Bream). *Oryzaephilus surinamensis*, 5 males and 5 females, were placed at each weight, i.e., three different weights for each type of dates. The boxes were closed and kept in the laboratory at room temperature and were monitored for 30 days. The results were corrected according to the 1925 Abbott equation (16).

$$\text{Corrected killing rate\%} = \frac{\text{\% to die in treatment - \% to die in control}}{\text{100 \% to die in treatment}} * 100$$

Result and Discussion:

Our results showed that the reproduction rate of *Oryzaephilus surinamensis* is high when they grow in Khadrawy dates 24.3, followed by Bream dates 19.9, and then Barhee dates 6.9, as shown in Table 1.

The reason may be that this type of date is less soft than other types, which allows the *Oryzaephilus surinamensis* the ability to grow and move freely, as this insect was found in the inner cavity of the date, in addition to the presence of many larvae inside the dates. Abrasim (17) mentioned that some physical, chemical, and anatomical characteristics, fruit maturity rate, and tree yield were studied. The characteristics of weight and size of the fresh Khadrawy fruit and sucrose concentration increased continuously to record the highest values at the Khalal stage, then there was a gradual decrease in these characteristics during the Rutab and Tamr stages. As for the concentration of total soluble solids, reducing and total sugars, the increase was gradual and reached their highest values at the Tamr stage. Unlike Barhi dates, the presence of a sugary liquid known as molasses did not help the *Oryzaephilus surinamensis*, as these insects stuck to the liquid and could not move well, which led to their not reproducing well. Al-Redhaiman. 2004. (18), wrote that the total sugar content of Barhee dates was reported to be 75.29% on a dry weight basis. A slight increase in the total sugar content of the fruits was observed in all treatments under study, but at different rates; the highest rate of increase in total sugar occurred during the storage period. In addition, the temperature, which is room temperature ranging between 29 and 30 degrees Celsius, helped increase the rate of insect reproduction in the Bream and Khadrawy dates, as insects are active at moderate temperatures. Therefore, it is preferable to store dates at low temperatures, as the rate of activity of these insects decreases, thus preventing their reproduction in date stores. Al-Deeb. (19), mentioned that the temperatures are fast, non-chemical alternatives for disinfection and chemical control of sawflies in stored products such as dates, as sawflies are killed by exposure to low temperatures of -22 °C and high temperatures of 55 and 50 at different times. Our results showed that the powder of the *Foeniculum vulgare* gave the highest result in killing adult insects, reaching 100% on the Barhee variety and for all concentrations, and similar results were shown on the Khadrawy variety and for all concentrations. As for the cinnamon powder, it recorded a high percentage of insect death on the Barhee variety by 100%, followed by the Khadrawy variety by 80% and 90% at a concentration of 1 and 3 g, respectively, as shown in Table 2.

Table (1): The number of growth stages on different dates (calculated after 60 days)

Date cultivar / Phase	Khadrawy	Barhee	Bream
Larva	2	1.6	1.6
Pupa	/	/	/
Adult	22.3	5.3	18.3
Total	24.3	6.9	19.9

Table 2: Percentage of adult mortality by plant powders

Type of plant powder	Concentration (gm)	mortality rate Khadrawy(%)	mortality rate Barhee (%)	mortality rate Bream (%)
Cinnamon cassia	1	80	100	50
	3	90	100	60
	6	90	100	70
Foeniculum vulgare	1	100	100	60
	3	100	100	70
	6	100	100	90
Control	0	0	0	0

Based on our results, *Foeniculum vulgare* and *Cinnamon* powder can be used as bio-insecticides for stored date pests .Our results are consistent with Guesmi *et al*. (20), which documented that the *Foeniculum vulgare* seeds are promising bioactive plant compounds for botanical insecticides against stored product insects. *Cinnamon* powder and extract can be used as an insecticide against stored grain pests in an easy and human-safe way (21). Our results showed a difference in insect mortality rates between the two plant powders above, this difference in the toxic effect of plant powders is attributed to the difference in the quality and quantity of active compounds contained in plants, and thus the difference in the rates of mortality according to the active ingredient in the plant powder. Ukoroije et al. (22) mentioned that the effectiveness of insect repellents depends on multiple factors, including the type of insect repellent (active ingredients), formulation, and method of application. The mode of action of biopesticides on insects includes repellent action, antifeeding activity, oviposition deterrent properties, growth and development inhibition, toxicity, attractants, sterility, and mortality. This aligns with what Mohammed et al. (23) mentioned, as they stated some plant powders are used as insect killers and pesticides. Therefore, biopesticides can be included in integrated pest management programs to protect crops and control insect pests.

Conclusions:

This study showed that the reproduction rate of *Oryzaephilus surinamensis* varied according to the date cultivar, being the highest in Khadrawy, followed by Bream and then Barhee. This study

also showed that the powder of *Foeniculum vulgare* and *cinnamon* can be considered as potential products that can be developed as potential pesticides against adults. In addition, *Foeniculum vulgare* and *Cinnamon* powder are potential candidate insecticides against larvae. These plant powders can be used to develop effective, safe, biodegradable, and cheap plant insecticides to control date pests in storage, which eliminates the risk of resistance in the target insects. Therefore, further recommendations on studying the active ingredients in plant powders, their mechanism of action, and the effect of powders on insect reproduction on other date cultivars, and testing other plant powders as insecticides for insects that attack stored dates are necessary in the future.

Authors' Contributions:

Z.J.M: Methodology, Project administration, Data curation, Data validation. Z.Z.G: Reviews, Writing, Editing. All writers read and approved the final manuscript.

Conflict of Interest:

The authors reveal no conflicts of interest.

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