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A laboratory study on the suitability of some foodstuffs and the food preference behavior of the sawtooth beetle *Oryzaephilus surinamensis* L.

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Abstract

The experiment was conducted in the laboratories of the Department of Plant Protection, College of Agriculture, University of Karbala, for the academic year 2024-2025, to study the effect of the loss rate of different food types and the feeding behavior of the Sawtooth Beetle, *Oryzaephilus surinamensis*, (Coleoptera: Silvanidae). The results showed that the design of the feeding dish) affected the insects feeding behavior of the Sawtooth, as the insect preferred the food it was intended to eat, as indicated in the results. However, the rearing (Feeding) period had no clear effect on its behaviour in terms of food preference, the insect consistently selected and fed on its preferred food insect. The results of the statistical analysis indicated a direct relationship between the length of the storage period and the high percentage of food loss, as the values gradually increased in all food items studied over time. The Flour food item recorded the highest percentage of food loss after 70 days of treatment, reaching 10.07%, followed by Oats at 5.52%. Regarding the Rice and Mung Beans food items, the analysis revealed average loss rates of 4.56% and 3.2%, respectively, after 70 days of treatment. The results also showed a clear preference for the food items presented to the insect over the seven days. It was observed that some food items were more attractive to the insect than others, reflecting selective feeding behavior linked to the nature of the chemical components or nutritional value of those items.

Keywords: Food preference, Sawtooth grain beetle Oryzaephilus surinamensis, Feeding Dish type.

Introduction

Stored foodstuffs, especially grains are of great economic importance to the world's populations. These populations maintain strategic reserves sufficient to cope with severe production shortages and natural disasters for several months [1]. One of the most major Stored foodstuffs, especially grains are challenges is preserving the quality of grains and their products during storage from various warehouse pests. Grains and stored foodstuffs are exposed to significant losses during storage due to infestation by various types of insects, rodents, and other pests. This causes the infested foodstuffs to acquire a pungent odor due to gaseous secretions (volatile substances

[2].Foodstuffs are exposed to various forms of damage for a variety of reasons, including contamination by insect feces. Insect infestations cause substantial damage which reduces their commercial value and, in turn, lowers consumer demand. This occurs in several ways, the most important of which is the mixing of whole insect bodies, parts thereof, or various stages of insects, such as eggs, larvae, and pupae, with grains, their products, or moulted skins. This also occurs when their waste mixes with food, accompanied by unpleasant odours. This results in structural changes in stored products, which have a significant impact on human health. It is essential to emphasize that understanding the impact of insect infestations on stored agricultural products and food quality is crucial for achieving the desired level of food security in the future [3]. The Sawtooth beetle O. surinamensis, a member of the family Silvanidae and the order Coleoptera, is a significant insect pest in major stored-product worldwide due to its ability to cause damage to various types of grains, including wheat, as it infects many stored products globally [4]. Damage to stored grains and their products due to exposure to multiple insect pests has caused significant economic losses, estimated at approximately 10-40% of the world's stock [5].

Materials and Methods

Collection and Rearing of the Sawtooth Beetle Oryzaephilus surinamensis.Individuals of the beetle were collected from infested local dates in storage and from infested local amber Rice seeds from local markets in Karbala city, starting September 1, 2024. Identification was performed by Assistant Professor Sienaa Al-Zurfi of the University of Kerbala, College of Agriculture, Department of Plant Protection, using standard taxonomic keys from ‘Basics of Insect Taxonomy for the Silvanidae family. The insects were placed in 700 ml glass bottles, each containing 150 g of grain. The bottles were covered with ventilated muslin cloth and tied with rubber bands. The insects were placed in an incubator at 25 ± 1 °C and 70 ± 5% relative to permit reproduction and egg laying for two weeks. Adults were removed o obtain first-generation individuals. The insect colony was continuously replenished to obtain immature stages for laboratory experiments. To remove molted skins, new colonies were designated after isolating newly emerged adults from old colonies and adding them to healthy seeds [6]. A study on the food preferences of the Sawtooth Beetle, O. surinamensis. Samples of local foodstuffs (Rice, Lentils, Mung Beans, Oats, Flour, Coconut, Sesame, and Gluten) were collected from local stores and various locations in Karbala Governorate. These foodstuffs were stored in a freezer at -20°C for 24 hours to eliminate any other insect infestations that may be present on or within the foodstuffs [7].

A study on the food preference of the Sawtooth Beetle, O. surinamensis, on different nutritional media.

The food preference study was conducted of two experiments, based on the length of the generation and the number of insects on the preferred food.

Experiment 1: This experiment was conducted on 10/2/2024 to determine the amount of weight loss in the insect's food for a period of 30, 40, and 70 days and for two generations of the insect. This experiment was also conducted to test the insect's viability on seven plates of different food materialsSesame, and, start with small letter each separately and simultaneously. Each type of food was considered a treatment with three replicates to calculate the amount of loss in the food medium after insect infestation. Fifty grams of each food material, free of any insect infestations, were taken [8]. Each plate was placed separately, with three replicates, in a sterilized glass container measuring 5 x 100 cm. Five pairs of Sawtooth Grain Beetle adults were added to it. The, Each container was covered with felt cloth to allow ventilation and the seal was tightened with a rubber band. The glass containers were placed in an incubator at 25°C [9]. to calculate the percentage of weight loss in each food type and to assess the effect of nutrition on the generation duration of the Sawtooth Beetle.

Calculating the loss rates in the food media of the Sawtooth Beetle, *O. surinamensis.*

Seven food types were used simultaneously in an incubator at 25°C and 60-70% humidity. Three replicates of each food were used to calculate the weight loss rate for each food separately after one generation of the insect. Samples were monitored for two generations of the insect on the same food, with weight calculated after 30, 40, and 70 days. The weight of the food was measured before and after the adult insects were placed on it, allowing for comparisons to determine which food achieved the highest weight loss rate, considered the ideal and preferred food for the insect. Weight loss is calculated using the equation for calculating the percentage loss of food weight:

Insect Behavior in Their Preferred Food

The experiment was repeated to determine the food preferences of the Sawtooth Beetle and the number of insects it preferred in each dish. This was done using a Petri dish divided into eight sections using cardboard partitions. These partitions were not connected in the center of the dish, creating a gap open to all parts of the dish. This gap allowed the insects to move easily within the dish. Seven types of food were placed (Rice, Lentils, Mung Beans, Oats, Flour, Coconut, Sesame, and Gluten). 3 grams of each food item were placed in one section of the dish, while 50 Sawtooth Beetle adults were placed in the eighth section of the dish. The experiment was conducted with three replicates, i.e., 150 insects. The insect numbers were counted daily for a week in each section of the dish containing the grains [10].

Results and Discussion

Loss rates in the food media of the Sawtooth Beetle, O. surinamensis

Statistical analysis (Table 1) showed that the food type, the time period, and their interaction had a significant effect. The amount of food lost during each generation for each type of food provided to the Sawtooth Beetle adults was highest in flour reaching 6.92% meanwhile, it reached 3.11% for both Rice and Oats, compared to start with small letter , with loss rates of 1.64, 1.11, 1.82, and 1.63, respectively. After two generations, food loss reached 7.80, 3.85, and 3.47% for Start with small letterwere 1.53, 1.88, 1.86, and 2.24, respectively.

Table (1): Loss rates in food media for the Sawtooth Beetle, O. surinamensis.

Foodstuff	Loss rates over time period/day			Nutrient rate
	30	40	70	
Rice	2.74	3.11	4.56	3.47
Lentils	1.02	1.11	2.47	1.53
Flour	6.41	6.92	10.07	7.80
Sesame	1.49	1.64	2.53	1.88
Oats	2.91	3.11	5.52	3.85
Coconut	1.35	1.63	2.60	1.86
Gluten	1.70	1.82	3.20	2.24
Period rate	2.52	2.76	4.42	
L.S.D 0.05	**Foodstuff**	**Time period**	**Food substance * Time period**	
	0.8143	0.5331	1.4104	

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

The results of this study were similar to findings by [11], who investigated which nutritional media yielded the highest weight loss when rearing the date moth E. cautella on rice , raisins , figs , and barley grits The loss percentages reached 14.15, 22.2, 31.5, and 20.03/100 g, respectively. The results of the study showed that figs and dates significantly outperformed barley grits, in addition to a higher growth rate in the insect population, as well as a shorter generation period, a higher number of eggs laid, and higher hatching percentages, which were lowest in individuals fed barley grits. Food loss increased with time, reaching 4.42% after 70 days Regarding the interaction between them, the nutrient (Flour) was the most significant among the nutritional media, with a loss percentage of 10.07 after 70 days. The differences in the growth rate of the insect population and the duration of the generation depend primarily on the natural components of each medium and the extent to which the contents of each food affect the insect's lifespan. This has a positive or negative impact on the insect, causing it to grow and increase in numbers within a short period compared to other media, which may not contain the ideal growth requirements the insect needs. From here, the concept of food preference emerges, which can be utilized in control programs by using these foods as traps to attract or repel the insect and control its population [9].

Percentage of Nutrient Loss During Storage Periods

The results of the statistical analysis also indicate a clear direct relationship between the length of the storage period and the increased percentage of food loss, as values gradually increased for all food items studied over time. It is note worthy that Flour recorded the highest percentage of food loss after 70 days (10.07%), followed by oats (5.52%), indicating their high susceptibility to deterioration during long-term storage. Rice and mung beans showed moderate loss rates of 4.56% and 3.2%, respectively, after 70 days. Statistical analysis results showed that the lowest loss rate recorded was for Lentils, which did not exceed 2.47% even after 70 days, indicating their relative stability during storage. Sesame and Coconut also showed moderate loss rates, reaching maximums of 2.53% and 2.6%, respectively, at the end of the studied period. These results reflect the impact of storage factors on food quality. The differences in loss rates are likely due to variations in the physical and chemical properties of each material, such as moisture and fat content, as well as the sensitivity of some materials to oxidation or microbial spoilage [12].

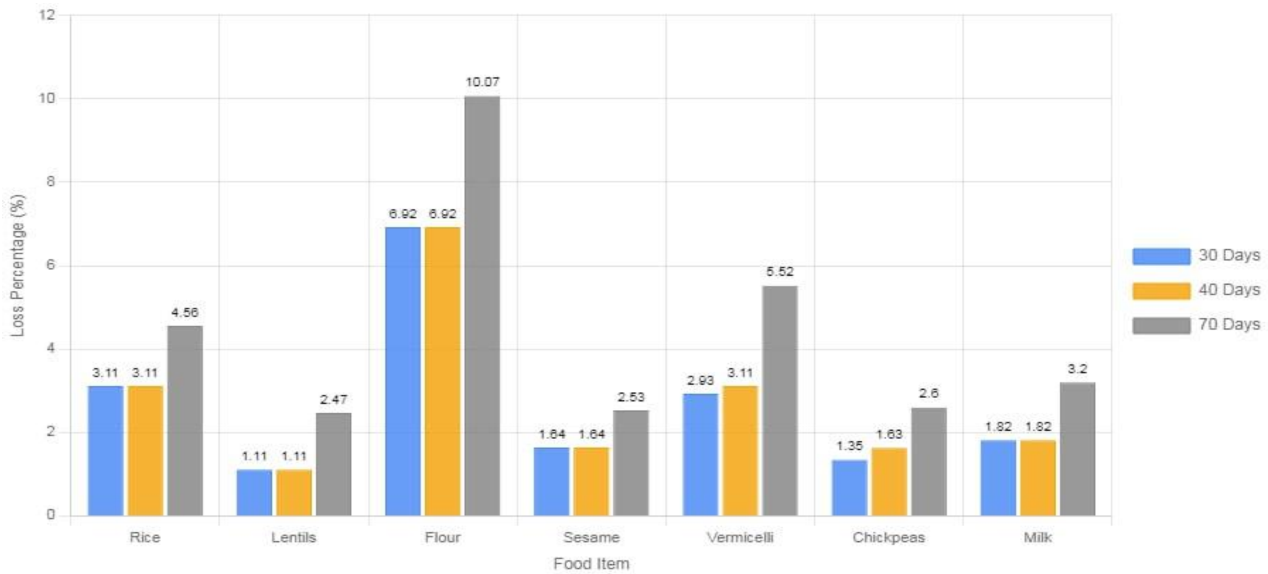

Figure (1): Change in the Percentage of Nutrient loss over three different time periods (30, 40, and 70 days)

The results of Table 2 (shown in Figure 2) indicate that the Sawtooth beetle continued to search for its preferred food item on the first day of the experiment. It was observed that its highest preference was for the oat food item, with an average presence of 14.33/insect, with no significant differences between the Flour and Lentil food items (4.33 and 4.00)/insect, respectively. No significant differences were also observed for both Sesame and Mung Beans, with an average presence of (5.44 and 5.66)/insect, respectively. There were significant differences observed between rice (13.00)/insect and flour lentils, sesame, Mung Beans, and Coconut, with an average presence of (4.33, 4.00, 5.66, and 3.00)/insect, respectively. On the second day, the highest percentage of insect preference was for Rice, with significant differences observed among the various food materials. On the third day, flour was superior with a percentage of (14.33)/insect, with significant differences between the different food materials. On the fourth day, Rice, Flour, and Oats were superior with an average of (13.00, 13.33, and 12.33)/insect, respectively. On the fifth day, Rice, Flour, and Oats were superior with significant differences between the different food materials, with a percentage of (12.00, 13.00, and 12.00)/insect, respectively. On the sixth and seventh days, the highest food intake was Rice, at 13.23/insect, with significant differences between the other food sources. The reason for the insect settling on Rice may be due to the fragility of its seeds, which makes it easier for the insect to burrow into the seed. The insect's lack of preference for other food sources may be due to the hardness of the seeds or their size. The moisture content of the seeds may also affect the insect's attractiveness [13].

Table (2): Food preference behavior of the Sawtooth Beetle,O. surinamensis.

Foodstuff	Loss rates over time period/day							Nutrient rate
	1	2	3	4	5	6	7	
Rice	13.00	15.00	11.66	13.00	12.00	13.66	14.33	13.23
Lentils	4.00	2.33	2.00	1.33	2.33	1.33	1.33	2.09
Flour	4.33	9.00	14.33	13.33	13.00	14.66	14.66	11.90
Sesame	5.66	4.33	5.00	5.66	4.33	5.00	4.66	4.95
Oats	14.33	13.33	11.33	12.33	12.00	10.00	10.00	11.90
Coconut	3.00	4.66	5.66	5.33	5.00	4.00	4.00	4.52
Gluten	5.66	4.00	3.33	1.66	1.33	1.00	1.00	2.57
Period rate	7.14	7.52	7.61	7.52	7.14	7.09	7.14	

L.S.D 0.05	Foodstuff	Time period	Food substance * Time period
	1.1329	1.329	2.9973

Means with a different small letter in the same column are significantly different (P<0.05)
Means with a different capital letter in the same row are significantly different (P<0.05)

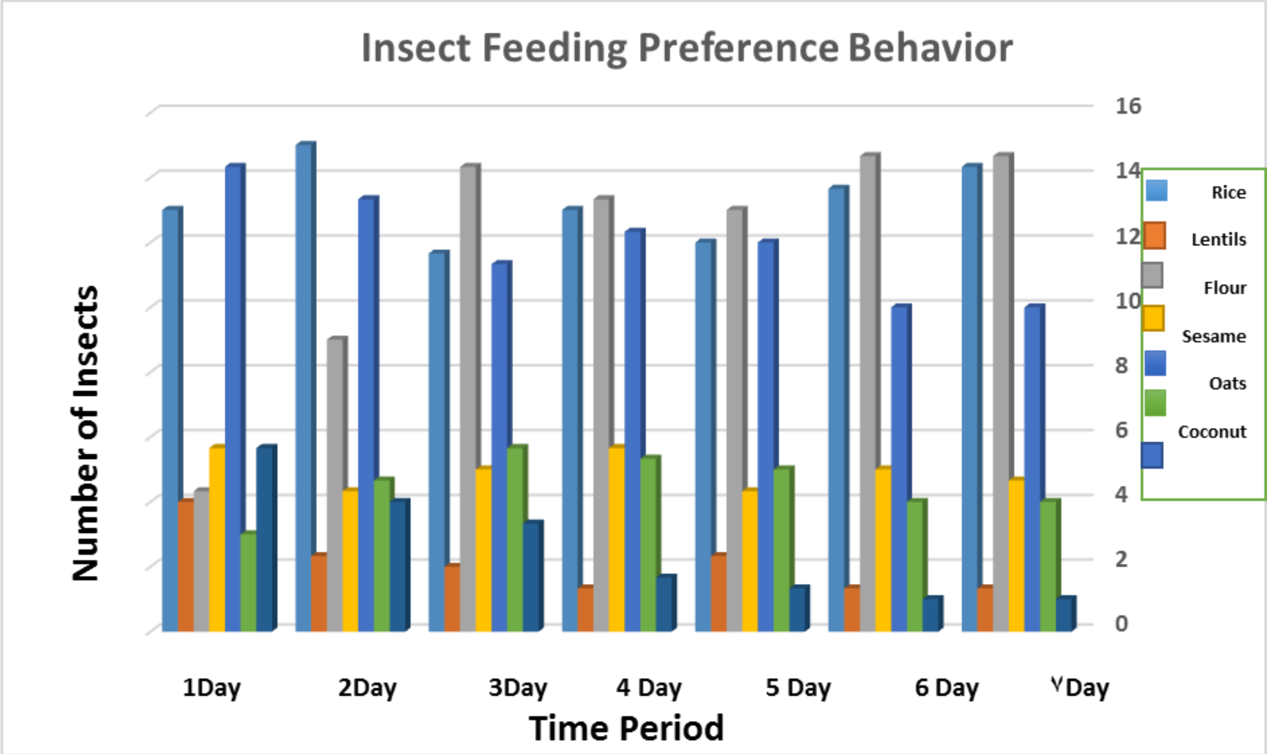

Figure (2): Food Preference of O. surinamensis during different time periods (days) 1 days 2 days 3 days 4 days 5 days 6 days 7 days

Food preference behavior of the Sawtooth Beetle, O. *surinamensis*

The results in Table 2 show a clear difference in the insect's preference for the food items presented to it over the seven days. The results indicated that some food items were more attractive to the insect than others, reflecting selective feeding behavior related to the chemical components or nutritional value of those items. Rice recorded the highest food preference rate, at 13.23 insects, followed by Flour and Oats, with 11.90 insects each. This indicates that these items were among the most attractive foods for the insect during the experimental period. This is likely due to their high content of easily digestible fats or sugars, which increases the insect's appetite. In contrast, the results for Sesame and Coconut showed average food preference rates of 4.95 and 4.52 insects, respectively. This indicates that insects may be less attracted to feeding on them compared to the first three materials. This may be due to their composition, which may not be sufficiently attractive due to the secondary compounds they contain, which limit their palatability. Lentils and Mung Beans were the least attractive materials for insects, recording low preference rates of 2.09 and 2.57 insects, respectively, with relatively stable values across days. This indicates a weak feeding response to these materials, possibly due to their low content of attractants or the presence of repellents or anti-feeding compounds.

The average daily food preference also showed a gradual increase, peaking on day 7 (7.14 insects). This may reflect the insect's adaptation to environmental conditions or its increased nutritional needs over time. Statistically, the least significant difference

(LSD) test at the 0.05 probability level (P = 1.1329) revealed that there were truly significant differences between the various food items, with the differences between the highest and lowest preference items far exceeding this statistical threshold, thereby enhancing the reliability of the results. Rice, Flour, and oats were found to be the most preferred food items by the insect. They can therefore be considered highly attractive food sources for use in behavioral control experiments or as attractant baits. Meanwhile, Lentils and Mung Beans were less preferred and could be used as Non-attractive components in selective bait systems.

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