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Nisar Ahmed Mallah
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Hakim Ali Sahito
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Tasneem Kousar
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Waheed Ali Kubar
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Faheem Ahmed Jatoi
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Zafar Hussain Shah
Department of Zoology, Faculty
of Natural Sciences, Shah Abdul
Latif University, Khairpur,
Sindh - Pakistan

Correspondence

Hakim Ali Sahito
Department of Zoology,
Faculty of Natural Sciences,
Shah Abdul Latif University,
Khairpur, Sindh - Pakistan
Email: hakim.sahito@salu.edu.pk
Ph.#. 0301-3515723

Susceptibility of different varieties of stored date palm fruits infested by saw tooth grain beetle, *Oryzaephilus surinamensis* (L., 1758) under laboratory conditions

Nisar Ahmed Mallah, Hakim Ali Sahito, Tasneem Kousar, Waheed Ali Kubar, Faheem Ahmed Jatoi and Zafar Hussain Shah

Abstract

The date palm fruit is a very important source of nutrients and cash crop of Sindh, Pakistan because of ideal climatic conditions for cultivation. The commercially important varieties are grown namely; Kupro, Karbalian, Aseel, Fasly and Dadhi and research study was carried out under laboratory conditions from August, 2015 to April, 2016 in relation to sugar, moisture and ash contents. The highest sugar content and moisture observed in Kupro was 85.90% and 23% whereas; lowest was 65.50% and 10% in Aseel and Dadhi dry varieties. During storage process these varieties were infested by Saw tooth grain beetle, *Oryzaephilus surinamensis* (L.). The maximum mean infestation was recorded 40.42% on Kupro and minimum 22.85% on Aseel and Dadhi (dry dates). The mean infestation is positively correlated with sugar and moisture content. The study revealed that Kupro and Karbalian semi-dry varieties were more attractive to pest as compared to Aseel and Dadhi dry, the reason might be because of attraction toward high sugar and moisture contents.

Keywords: Nutritional value, moisture, ash, sugar, saw tooth grain beetle and *P. dactylifera*

1. Introduction

Date palm, *Phoenix dactylifera* (L.) is a heavenly fruit, its properties have been described in most of the religious books and the most ancient tree cultivated since, 4000 B.C. Pakistan is the 6th largest producer of the dates after Egypt, Saudi Arabia, Iran, Algeria and Iraq with a production of 557279 tons per year [1]. The area under cultivation of dates in Pakistan and Sindh was 84,700 and 29,300 hectares respectively and its total production were 426,300 and 201,100 tons, respectively [2]. There are about more than 300 varieties of date-palm cultivated in Pakistan. Sindh is also known as the biodiversity centre of dates. Several varieties are similar to those cultivated in Iraq, Iran and the Gulf countries like Hillawi, Zahidi, Shakeri, Basri etc. About 85% of date-palm crop is cultivated in district Khairpur Mir's Sindh [3, 4]. Aseel variety of date palm of Khairpur is the queen of all varieties grown in Pakistan. It is also considered as a commercial variety in Pakistan. It is an excellent in semi-dry variety as well as good in dry variety with appropriate fruit size 4.3 cm in length and 2.5 cm in diameter [5, 6]. The date markets of Khairpur and Sukkur export about 80 to 90% dried dates (Chuhara) to India, where being used in religious activities. In the major producing countries date palm has regarded as more important crop than others. The growth of date palm has been gradually decreased due to infestation of pest and disease problems [7].

The stored dry and semi-dry (fresh) fruits of date palm face a critical problem of insects infestation mostly from saw toothed grain beetle, *Oryzaephilus surinamensis* (L., 1758) (Coleoptera: Silvanidae) reducing the dates quality as well as quantity and weight loss [8]. The strong chewing mouth parts of *O. surinamensis* allow them to access food which is stored inside boxes. They try to enter inside the material as they are attracted to stored material due to its smell and odor. Therefore, they will make every attempt to find their way inside. Like other fruits, date palm have got some production problems and its fruits are attacked by a number of pests such as; black palm beetle, *Oryctes rhinoceros* Linnaeus, greater date moth, *Arenipses sabella* Hampson, red palm weevil, *Rhynchophorus ferrugineus* Olf., lesser date moth, *Batrachedra amydraula* Meyrick, scales and mites as well [9]. Saw toothed grain beetle is one of the most common grain stored product insect pest worldwide [10] which does not grow

well in whole grain however, it grows faster on broken and milled grain and increases the population rapidly [11]. Adults and larvae both attack on flours, cereals, nuts, fresh dates / fruits and dried fruits because of their ability as cosmopolitan invaders of packaged food [12]. It is very small insect which has the ability to hide in many places in stored facilities, make it difficult to be controlled by insecticides and it has built up resistant to several insecticides as well [13,14]. It prefers cereal food than oil seeds to feed [15,17] and tried to grow on oil seeds [18] that requires good balance of carbohydrates in diet.

The insects attacking on date palm trees and dates fruit in Sultanate of Oman. Stored dates in Oman face a serious problem of infestation by saw toothed grain beetle and reduce the quality of dates fruit day by day [19, 20] dates fruit being a sweet and nutritious 2500-3000 calories/kg supplying food. It is used as a staple food because the ripped dates content about 80% sugar. In Sindh two research institutes are working on the date palm, one is Kot Diji date palm research institute and other is date palm research institute Shah Abdul Latif University Khairpur, both are located in district Khairpur Mir's. In these institutes some researchers worked on the nutritional value of date fruits and tissue culture of date palm but very little work has been done on the damage caused by saw tooth grain beetle to the different stored dates varieties of Sindh in relation to their nutritional value.

2. Materials and Methods

2.1 Collection of insects

The dates contaminated by pest, *Oryzaephilus surinamensis* were collected from the stores, shops, homes, Khajoor Mandy of Khairpur and Chuhara Mandy of district Sukkur. After collection those infected dates were brought under laboratory conditions for the culture maintenance. The observations were made on weekly basis.

2.2 Artificial infestation by Saw tooth grain beetle, *O. surinamensis*

Saw tooth grain beetle, *Oryzaephilus surinamensis* reared on different semi-dry and dry varieties of stored date palm fruit viz; Kupro, Karbalian, Aseel, Fasli (semi-dry dates) and Aseel and Dadhi (dry dates) under room temperature in the Entomology laboratory, Department of Zoology, Shah Abdul Latif University Khairpur during the August, 2015 to April 2016. The plastic jars of about 1.5 kg capacity were used in the research study. Dates of different varieties were infested by 10 pairs of adults saw tooth grain beetle. The examination leads to determination of infestation ratio in different varieties to observe varietal susceptibility of dates against saw tooth grain beetle through the under given formula:

$$\text{Rate of infestation} = \frac{\text{No. of infected dates}}{\text{Total no. of dates}} \times 100$$

2.3 Feeding behavior of *O. surinamensis*

For observing the feeding behavior first of all, 50 grams of each variety which were free from insect infestation, were weighed by electronic balance machine and kept in small plastic boxes along with 10 pairs of pest, *O. surinamensis* individually put in to each box. This whole process was continued for three successive generations and then data was recorded and analyzed to observe the percentage of damage and monitor the varietal susceptibility of different stored date palm varieties against saw tooth grain beetle. The boxes were covered tightly to prevent movement of beetles from inside to outside and then kept at room temperature. After every generation the weight of date fruit of each box was calculated and growth ratio of beetles was determined. Like this, the weight of infested date fruit was observed after every one generation according to the under given formula:

$$\text{Damaged weight ratio} = \frac{\text{Damaged weight}}{\text{Total weight}} \times 100$$

3. Results

3.1 Infestation of different date fruit varieties by saw tooth grain beetle

Having identified male and female through the help of microscope, the main difference was found, a tooth like structure was present on the hind leg of the male along the femur, which was not present on female of saw tooth grain beetle, *O. surinamensis*. The examination leads to determination of infestation percentage in different date fruit varieties and to observe varietal susceptibility of dates against saw tooth grain beetle. The present study revealed that the maximum infestation percentage was observed on semi-dry dates Kupro and Karbalian 80% and 70% during the month of April while, the minimum infestation percentage on dry dates Aseel and Dadhi 15% during the months of December, January and February but during the months of October and November moderate infestation was recorded. The fruit dates of every variety were highly infested in month of April because during this month there was a favorable temperature for the growth. However, in every month it was observed that Kupro and Karbalian date fruits were more infested while the Aseel and Dadhi dry dates were less infested (Table- 1).

It was observed the maximum infestation on semi-dry dates Kupro, (40.42±19.09) and Karbalian, (34.28±17.44) due to high concentration of moisture 23, 20% and sugar 85.9, 80.55%, while the Fasli semi-dry dates were moderately infested (27.14±14.09). However, the minimum infestation was recorded on dry dates Aseel and Dadhi, (22.85±11.12) due to less content moisture, 10% and sugar, 65.50%. Great effect of moisture and total sugar content on infestation of dates by saw tooth grain beetle was observed during the present study. The total ash from different varieties ranged between 1.35 to 1.95%, respectively in all grams (Table- 2).

Table 1: Month wise infestation (%) of different date varieties by saw tooth grain beetle

Months	Kupro, semi-dry	Karbalian, semi-dry	Aseel, semi-dry	Fasli, semi-dry	Aseel, dry	Dadhi, dry
October	40	33	30	25	20	20
November	35	29	25	20	15	15
December	24	18	15	15	15	15
January	24	20	15	15	15	15
February	35	30	30	25	20	20
March	45	40	40	35	30	30
April	80	70	60	55	45	45
Mean±SD	40.42±19.09	34.28±17.44	30.71±15.66	27.14±14.09	22.85±11.12	22.85±11.12

Table 2: Overall mean infestation on different date varieties by saw tooth grain beetle in relation to moisture, ash and total sugar

Date variety	Mean Infestation + SD	Moisture %	Ash %	Total Sugar %
Kupro (semi-dry)	40.42±19.08	23	1.35	85.90
Karbalian (semi-dry)	34.28±17.44	20	1.80	80.55
Aseel (semi-dry)	30.71±15.66	15	1.95	73.50
Fasli (semi-dry)	27.14±14.09	14	1.40	70.80
Aseel (dry)	22.85±11.12	10	1.70	65.50
Dadhi (dry)	22.85±11.12	10	1.65	65.50

3.2 Feeding behavior of saw tooth grain beetle on different semi-dry and dry date fruit varieties

The feeding performance of saw tooth grain beetle on different semi-dry and dry fruit of date palm was observed on Kupro, Karbalian, Aseel, Fasli (semi-dry dates) and Aseel, Dadhi (dry dates) as to observe the susceptibility of these varieties of date palm against saw tooth grain beetle. The feeding behavior was observed month wise (October to April) and also result recorded the how much damage (percentage in

grams) of each date fruit variety and which month is the most injurious to check the accuracy of results with rearing of three successive generations under the laboratory conditions on different semi-dry and dry date fruit varieties, commonly grown in Sindh. The maximum damage 50% was recorded in the month of April in semi-dry Kupro date fruit but the lowest damage 7% was recorded in the months of December and January in dry dates Aseel and Dadhi. The main reason of high damage was in April and low in December and January, the favorable environmental conditions particularly (Temp. and RH %) (Table- 3).

The feeding behavior of saw tooth grain beetle was observed on different semi-dry and dry date palm fruit varieties for three successive generations. The maximum feeding of pest was recorded on semi-dry date palm fruit varieties; Kupro, (12.80±2.78)% and Karbalian, (11.64±1.84)%, while the lowest feeding on dry date palm fruit varieties; Aseel, (5.37±1.16)% and Dadhi, (5.22±1.01)%. The feeding ratio increased generation wise (in grams) while the maximum feeding was recorded in 3rd generation damage (Table- 4).

Table 3: Month wise damaged percentage in grams of different date fruit varieties by saw tooth grain beetle

Months	Kupro semi-dry	Karbalian semi-dry	Aseel semi-dry	Fasli semi-dry	Aseel Dry	Dadhi dry
October	25	16	16	14	12	12
November	20	14	14	12	10	10
December	16	10	10	9	7	7
January	15	9	10	7	7	7
February	20	15	15	13	10	10
March	30	25	25	20	15	15
April	50	40	40	30	20	20
Mean+SD	25.14±12.11	18.42±10.84	18.57±10.70	15.00±7.78	11.57±4.64	11.57±4.64

Table 4: The feeding behavior of Saw tooth grain beetle on different date varieties

Date varieties	Generation-1	Generation-2	Generation-3	Mean+SD
Kupro (semi-dry)	10.15	12.55	15.70	12.80±2.78
Karbalian (semi-dry)	10.05	11.23	13.66	11.64±1.84
Aseel (semi-dry)	7.48	8.69	9.75	8.64±1.13
Fasli (semi-dry)	7.08	8.15	9.25	8.16±1.08
Aseel (dry)	4.23	5.34	6.55	5.37±1.16
Dadhi (dry)	4.11	5.45	6.11	5.22±1.01





Dates before infestation

Dates after infestation

4. Discussion

Saw tooth grain beetle, *Oryzaephilus surinamensis* (L.) is a serious pest; it feeds on almost all stored food products including date palm fruits particularly in upper Sindh. It is causing severe infestation to the stored dates, so the date fruit made spoilage, damaged and unable for human consumption, therefore it affected the dates quality and market value. During present study we have tried to do some work on stored date fruit, its occurrence, mode of damage and feeding behavior of *O. surinamensis* (L.). For this study we reared saw tooth grain beetle on main varieties of semi-dry dates such as Kupro, Karbalian, Aseel and Fasli and dry dates Aseel and Dadhi. Present study was based on to observe

susceptibility of different varieties of stored date palm fruits infested by Saw tooth grain beetle *Oryzaephilus surinamensis*, as to get knowledge that which variety is more susceptible/ vulnerable. Aseel is one of the main of the varieties, which is cultivated in upper areas of Sindh, Pakistan. It is being a good, has also been exported to Asian countries. This variety is stored in two forms one is semi-dry form (Khajoor) and other is dry form (Chuhara) that is why, this variety is also called as the queen of all varieties [5, 21]. Reported that many farmers reap and collect Aseel variety during before maturing stage (Khalal) and boil its fruit to make dry dates called “Chuhara” otherwise; about half of the fruits will be destroyed and spoiled, if there is monsoon rain [22].

This same Aseel variety was harvested at ripening tamar stage to make semi-dry date "Khajoor". Both forms of this variety are exported but about 80% of dry dates of Aseel variety was exported to India, where being used in religious activities. The advanced countries reject our dates fruit because of infestation by pest and presence of pesticides. The present study revealed that the maximum average mean infestation of Saw tooth grain beetle was observed on semi-dry dates Kupro and Karbalian, due to high percent of moisture and total sugar, while the Fasli semi-dry dates moderate infected by saw tooth grain beetle. However, the minimum infestation was recorded on dry dates Aseel and Dadhi, due to less content of moisture and total sugar. The infestation percentage in all varieties was high in the month of April, during this month semi-dry date Kupro and dry dates Aseel and Dadhi were infested. While during the months of December, January and February the fruit of date varieties were less infested. It was observed that the high infestation in dates was by Saw tooth grain beetle, and this was due to high moisture, total sugar, and also favorable temperature, while there was no significant difference on infestation due to ash (1.35 to 1.95%). These results agreed with other researchers like [23, 24] all these reported that 40-75% infestation rate in date varieties, and also observed that the 27-35 °C temperature was a favorable for the growth of Saw tooth grain beetle.

The results showed significant differences between semi-dry and dry dates with the rate of development, mortality and survival rate of *O. surinamensis*. The results indicate that the maximum population of *O. surinamensis* was observed on semi-dry date varieties Kupro and Karbalian, while on dry date varieties the population was minimum. On Kupro 440 mature stage adults and on Karbalian 400 mature adults, while on Aseel 210 and on Dadhi 200 mature adults were counted. The maximum survival percentage was found on Kupro and Karbalian, while the minimum was observed on Aseel and Dadhi. The total average mortality percentage maximum was showed on Dadhi (53.48%), while the minimum was showed on Kupro (12%). The above results indicate that the high population of *O. surinamensis* corresponded with the highest percent of moisture and total sugar as well as favorable temperature (27-35 °C). These results agreed with [23, 24] who reported that the growth rate of *O. surinamensis* was positive with correlation with increased level of total sugar. He also reported that 180-250 adults were found on dry dates after two months. Due to long length of storage period in stores, markets and homes, damage caused by stored-products pests to semi-dry and dry stored date palm fruit is considerable. Also, long storing periods increased the rate of decay/damage dates because of the increasing in *O. surinamensis* growth and activity. Almost stores of date palm in Sindh are located in regions where climatic conditions (temperature and humidity) are suitable for the development of stored-products pest [25]. also reported that *O. surinamensis* damages the stored date fruits and it is distributed in Middle Eastern countries such as Iran, Iraq, Saudi Arabia, Bahrain, Yemen, Egypt, Tunisia and Libya [26].

Significant differences were also recorded month wise infestation rate and damage on semi-dry and dry date varieties. Results showed that maximum rate of infected and damage dates observed during the month of April, because in this month temperature increased, while the minimum rate of infected and damage dates observed in December and January months, because during these months temperature decreased. In this concern, many researchers such as [27-30] agreed and

indicated that the *O. surinamensis* beetles are generally active in the range of 25-35 °C temperature, and rate of infected date fruits and growth rate of beetles decrease in degrees of temperature that are higher or lower than that range. The information provided by this study could support us in developing IPM programming for the pests of stored date palm fruits. So the results of this study may help in programming measured control such as control of storage pests, improved fruit storage methods, and reducing the damage of stored date fruits by *O. surinamensis*. Radiation Technique offers an alternative method for the pest control because it requires less time, leaves no residue and can be as effective as fumigants. Present study revealed that due to usage of pesticides and insecticides, we could not export our date fruits to advanced countries mostly Europe and America. Therefore, we should introduce eco-friendly control techniques like sex pheromones and biological control of *O. surinamensis*, which will not only save our date palm fruits from infestation but also save the quantity and quality of date fruits as well as save our environment from pollution.

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