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Effect Of *Mesembryanthemum* sp. On The Date Pest *Oryzaephilus surinamensis* (Saw Toothed Grain Beetle)

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The saw toothed grain beetle, *Oryzaephilus surinamensis*, is a destructive stored product pest which diminishes the yield, quantity, and quality of many stored products. This study was designed to investigate effect of the wild plant, *Mesembryanthemum* sp. Powder on the adult *O. surinamensis*. Beetles were collected from infested dates in Sakaka, Saudi Arabia, and identified, morphologically. Beetles were exposed to the *Mesembryanthemum* powder for varying times. Results demonstrated that the daily mortality of adult *O. surinamensis* was significantly increased (*P> 0.05*) when compared to the control, throughout the experimental period. Additionally, the median mortality time (IT_{50}) of *Mesembryanthemum* on adult *O. surinamensis* was 3.7 days. These findings suggested that the usage of *Mesembryanthemum* powder in fighting stored product insects is a promising eco-friendly approach for managing these pests. Incorporating this natural powder into date storage practices could empower farmers and businesses to minimize losses inflicted by *O. surinamensis*. Further research is crucial to optimize the application methodology and to confirm long-term efficacy and safety.

Keywords: *Oryzaephilus surinamensis, Mesembryanthemum* sp., Mortality, Bio-pesticides, Eco-friendly.

INTRODUCTION

Dates are highly nutritious and include a lot of carbohydrates, minerals, and proteins, according to a literature review conducted recently (Ayad et al. 2020). A little more than half of all products and dates that were kept were lost in storage. Millions of Euros were predicted to be lost annually by the damages of stored products on a global scale (Fornal et al. 2007).

Date palm fruits that have been stored dry or semi-dry are severely vulnerable to insect infestation, primarily from the saw toothed grain beetle (*O. surinamensis* (L., 1758)) (Coleoptera: Silvandae). The quality and quantity of dates are decreased as a result of infestation with this pest (Aldryhim and Adam, 1998). Additionally, it can cause severe damage, including loss of weight, contamination, fragmented endosperm, shattered germs, and fractured seed surfaces (Busvine, 1980; Robinson, 2005; Beckel et al. 2007; Leelaja et al. 2007). Adult *O. surinamensis* are external feeders on already-infested kernels, and their body parts, frass, and secretions contribute to the substrate's contamination (Throne et al. 2003; Hötling et al. 2014). But it also infests the germ of broken grains (Arthur, 2000). *O. surinamensis* destructive potential extends to a broad host range of food items, such as grains, seeds, oilseeds, legume seeds, dried fruit, date palms, nuts, and cereals (Athanassiou et al. 2007; Latifian et al. 2020; Nika et al. 2020). This insect species has a range of preferred dwelling surfaces, all of which are vulnerable to different degrees of damage (Nika et al. 2020). Compared to synthetic chemical pesticides, botanical insecticides are thought to be safer and more eco-friendly option. Furthermore, human and environmental toxicity of botanical insecticides is minimal (Benner, 1993; Isman, 2005). Some botanical compounds, like pyrethrum, rotenone, neem, and essential oils are still traditionally used on a modest scale for pest control. Unfortunately, only a few number of these compounds are being utilized commercially (Isman, 1997; 2005). The lack of natural sources, standardization, quality control, and registration are some of the obstacles preventing these chemicals from being commercialized (Isman, 1997). Furthermore, a large number of other pesticidal plants and their active components still need to be identified and investigated (Cloyd et al. 2009). Farmers in underdeveloped nations typically employ unrefined plant

extracts, which might have negative effects like overdose and food poisoning (Shaalan et al. 2005). To guarantee correct formulation and application to pests on the appropriate crop, traditional knowledge about their application is essential (Isman, 2008). Sustainable agriculture relies heavily on indigenous knowledge, although it is poorly documented and owned by a small number of elderly individuals. Therefore, concerted efforts between scientists and traditional farmers/ healers are necessary to share ideas and develop well-researched user packages (Gradé, 2008).

A wild plant called *Mesembryanthemum forsskalii* grows wildly in the deserts of Saudi Arabia, Egypt, and many other countries. It is utilized as a source of edible leaves and seeds and is locally called "Samh" (Bilel et al. 2020; Awabdeh et al. 2022). This plant is grown in Aljouf region of Saudi Arabia (Abdel-Hamid et al. 2021). it has been researched for its chemical composition, antifungal capabilities, and antioxidant activity (Bilel et al. 2020). Despite being a distinct species with a different morphology and physiology, it is in the same genus as *Mesembryanthemum crystallinum* (Abdel-Hamid et al. 2021).

The current project attempts to detect date pests in Sakaka supermarkets, and investigate the potential biocidal properties of *Mesembryanthemum* sp. on the identified date pests.

MATERIALS AND METHODS

Gathering samples and identifying insects:

Adult insects were taken from infested dates at stores which sold cereal, dates, and preserved goods at Sakaka, Saudi Arabia. The insects were housed in plastic jars with sterile food media (date) and kept at room temperature, 25 °C ± 2 and 70% ± 5 RH. The jars were sealed with gauze and fastened with rubber bands. For the purpose of identifying stored product beetles, insects were recognized using Halstead keys (1986).

Mesembryanthemum sp. biocidal action on the saw toothed grain beetle, *O. surinamensis*:

Two groups of newly emerged *O. surinamensis* adults (1-4 day old) were put in plastic sacks 5 cm× 19 cm, punctured with a needle for ventilation. One group was administered clean date food, and the other was administered date food containing one gram of *Mesembryanthemum* powder. Each group has five replicates, and each replicate contains 10 insects. Insects were considered dead if they don't move when shaking or stimulating them by brush. The mortality were recorded daily for seven days, and the experiment was repeated at three different times.

Statistical analyses:

Data was statistically analyzed using one-way ANOVA and post-hoc tests. In addition correlation between percentage mortality and time of exposure was measured. Finally, the median mortal time (IT_{50}) of the *Mesembryanthemum* on adult *O. surinamensis* was estimated. All data was manipulated using SPSS computer software, ver. 25.

RESULTS

insect identification:

The primary goals of the current study were to detect date pests in Sakaka stores and look into *Mesembryanthemum* sp. ability to fight mature *O. surinamensis*.

According to Halstead (1986), date samples were taken from ten stores which sell preserved food items, and they were then analyzed to determine which pests were causing the infestation. For every sample that was gathered, *O. surinamensis* was found to be the dominant pest species.

Mesembryanthemum sp. impact on the adult *O. surinamensis*:

From the first to the 7th day, the insecticidal impact was noted. The death rate was 16.4% on the first day and reached 25.71%, 46.43%, 60.71%, 73.57%, 90%, and 100% on the 2nd to the 7th day, respectively (Table 1). On the first and second days, the control group's proportion of mortality was 0%. On the other hand, it reached 4.3%, 5.7%, 7.9%, 12.9%, and 12.9% on the 3rd to the 7th day, respectively (Table 1). When compared to the control group, treatment with *Mesembryanthemum* powder significantly increased the proportion of daily mortality (*P> 0.05*) in all experimental days.

Table 1: The effect of *Mesembryanthemum* on daily *O. surinamensis* mortality

	Days	Mortality	Min-max	Std. Error
Control	1	0	0	0%
	2	0	0	0%
	3	4.3%	0-10%	1.30%
	4	5.7%	0-20%	1.70%
	5	7.9%	0-20%	1.60%
	6	12.90%	0-20%	2.10%
	7	12.90%	0-20%	2.10%
Treated	1	16.40%	0-60%	0%
	2	25.71%	10%-100%	6.40%
	3	46.43%	20%-100%	6.20%
	4	60.71%	30%-100%	6.10%
	5	73.57%	50%-100%	4.90%
	6	90%	70%-100%	2.50%
	7	100%	100%	0%
LSD test at 0.05		***P= 0.02***		

The post-hoc analyses between paired day-period revealed that the difference in daily mortality between

the treated and control groups was statistically significant in all comparison cases (Fig. 1).

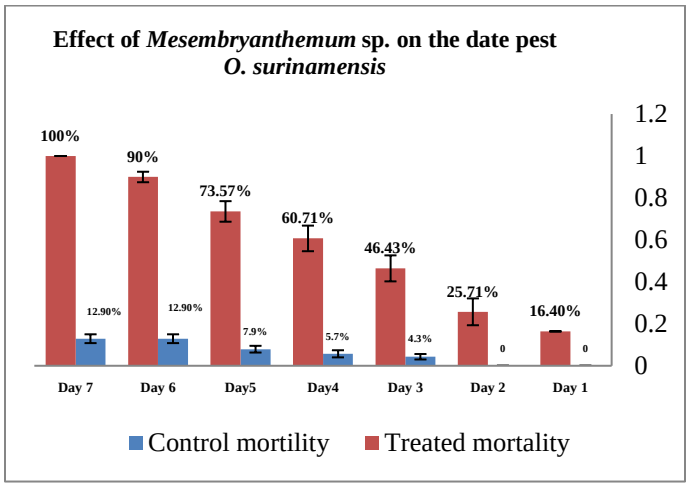

Figure 1: Effect of *Mesembryanthemum* on adult *O. surinamensis.*

Accumulated daily mortality of both control and treated groups was correlated to the time interval of the exposure period to the powder.

Results indicated that the percentage mortality was strongly correlated to time of exposure (r^2= *0.9*) in the case of treated group. Whilst the percentage mortality was not correlated to the time (r^2= *-3.48*) in the case of control group (Fig. 2).

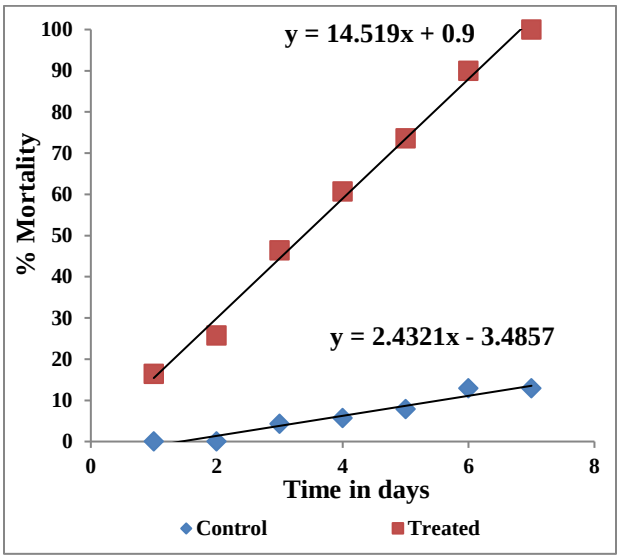

Figure 2: Regression correlation analysis of adult *O. surinamensis* mortality and time of exposure to *Mesembryanthemum* powder.

Finally the median mortality time (IT_{50}) of the *Mesembryanthemum* on adult *O. surinamensis* was estimated as 3.7 days (Fig. 3).

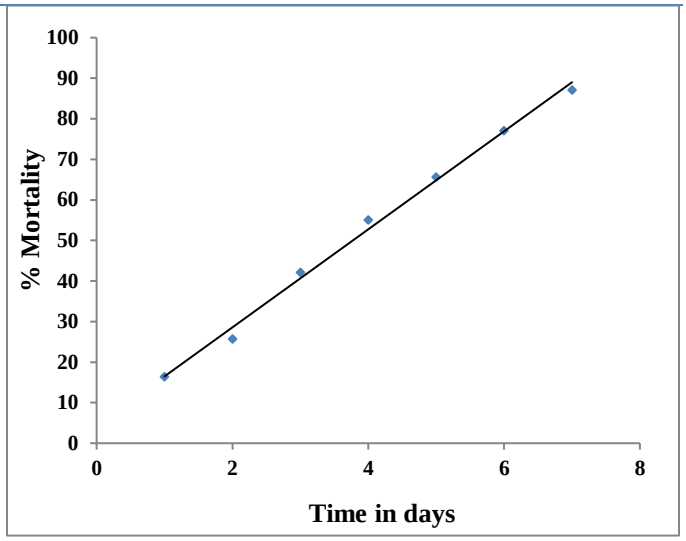

Figure 3: Estimation of the median mortality time (IT_{50}) of *Mesembryanthemum* powder on adult *O. surinamensis*.

DISCUSSION

O. surinamensis (L.) (Coleoptera: Silvanidae), is a major pest of cereals and allied amylaceous products. Additionally, a large range of goods are susceptible to infestation, such as oilseeds, nuts, yeast, sugar, tobacco, seeds, and dried fruit (Mahroof et al. 2012). It is smaller than most species of stored product insects, and was the most active and mobile one.

Environmental elements such humidity, sugar content, temperature, and length of storage have also been found to impact *O. surinamensis* survival and mortality (Hashem et al. 2012; Hashem et al. 2021). According to Khan et al. (2019), at the maximum concentration of 8%, the death rate of beetles increased with the increase of *M. crystallinum* powder concentration. After being exposed for 24 hours, all beetles were dead. On the other hand, not a single beetle in the control group perished in the same time frame. The insecticidal impact of *C. dioscoridis, C. nardusspreng,* and *M. oliefera* leaf powder on the adult mortality of *O. surinamensis* was reported by Omran et al. (2018). The outcomes showed that the various powders differed significantly from one another. *M. oliefera* powder ranked best with 78.89% mortality, followed by *C. nardusspreng* powder with 60% mortality and *C. dioscoridis* powder with 35.18% mortality. The IT_{50} (3.7 d) is a very promising time in respect to safety and economically efficacy of using *Mesembryanthemum* sp. powder as a strategy of combating stored product insect. By integration of all investigation, our results presented a cheap, safe, eco-friendly, and promising approach to combat adult *O. surinamensis*. Addition of the *Mesembryanthemum* sp. powder is also expected to reduce the damage of reduced date pests. .

CONCLUSIONS

Mesembryanthemum sp. powder, an environmentally safe and biodegradable substance, could offer a promising management strategy of *O. surinamensis* on dates with an acceptable IT_{50} of 3.7 days. Also it can reduce the need for chemical control of stored product insects. This will reduce the hazardous effects of the chemical insecticides on human and environmental health.

Supplementary materials

Not applicable. All of the data is included in the article.

Author contributions

All authors were equally contributed in this work. All authors read and approved the final version.

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Institutional Review Board Statement

No endangered species are included in this study. Thus there is no need to Bioethical Committee's approval.

Informed Consent Statement

Not applicable.

Data Availability Statement

All of the data is included in the article.

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Conflict of interest

The authors declared that present study was performed in absence of any conflict of interest.

REFERENCES

Abdel-Hamid AM, Ibrahim M, Alnusairi GS. (2021). Comparison of Egyptian and Saudi *Mesembryanthemum forskalii* Hochst. ex Boiss. as an unconventional alternative protein of wheat and barley. Indian Journal of Experimental Biology (IJEB), 59(03):194-201.

Aldryhim YN, Adam EE. (1998). Use of Radiation and disinfestations in the control of *Oryzaephilus surinamensis* (L.), A pest of stored dates. Saudi J. Biological Sci. 5(2).

Arthur HF. (2000). Immediate and delayed mortality of *Oryzaephilus surinamensis* (L.) exposed on wheat treated with diatomaceous earth: effects of temperature, relative humidity, and exposure interval, J Stored Prod Res., (37), 13-21, doi: 10.1016/s0022-474x(99)00058-2.

Athanassiou GC, Nickolas GK, Maria CB, Beckel HS, Lorin I, Lazzari SMN. (2007). Rearing method of *Oryzaephilus surinamensis* (L.) (Coleoptera: Silvanidae) on various wheat grain granulometry. Rev. Bras. Entomol., 51(5):501-505.

Awabdeh S, Asoufi H, Tawarah K, Abulaila K, Al-Nsour S. (2022). Chemical Profiling Analysis of *Mesembryanthemum (opophytum) forsskalii* Hochst. ex Boiss. Advances in Environmental Biology, 16:1-4. 10.22587/aeb.2022.16.12.1.

Ayad AA, Williams LL, Gad El-Rab DA, Ayivi R, Colleran H, Aljaloud S, Ibrahim SA, Yildiz F. (2020). A review of the chemical composition, nutritional and health benefits of dates for their potential use in energy nutrition bars for athletes. Cogent Food & Agriculture, 6(1): 1809309. doi:10.1080/23311932.2020.1809309

Beckel HDS, Lorini I, Lazzari S. (2007). Rearing method of *Oryzaephilus surinamensis* (L.)(Coleoptera, Silvanidae) on various wheat grain granulometry. Revista Brasileira de Entomologia, 51:501-505.

Benner JP. (1993). Pesticidal compounds from higher plants. Pesticide Science, 39(2):95-102.

Bilel H, Elsherif MA, Moustafa SMN. (2020). Seeds oil extract of *Mesembryanthemum forsskalii* from Aljouf, Saudi Arabia: Chemical composition, DPPH radical scavenging and antifungal activities. OCL-

J, 27:10.
Busvine JR. (1980). Insects and Hygiene: The Biology and control of insect pests of medical and domestic importance, 3rd Ed. Springer Sci. Business Media, BV, Germany, 568.
Cloyd RA, Galle CL, Keith SR, Kalscheur NA, Kemp KE. (2009). Effect of Commercially Available Plant-Derived Essential Oil Products on Arthropod Pests. J. Econ. Entomol. 102(4):1567-1579. doi:10.1603/029.102.0422
Fornal JT, Jelinski J, Sadowska S, Grunda J, Nawrot A Ni, Warchalenski JR, Blaszczak W. (2007). Detection of granary weevil *Sitophilus granarius* (L.) eggs and internal stage analysis. J. Stored Prod. Res., 43:142-148.
Gradé JT. (2008). Indigenous knowledge in agriculture: a case study of traditional practices in crop management in Ghana. International Journal of Agricultural Sustainability, 6(1):41-54.
Halstead DGH. (1986). Keys for the identification of beetles associated with stored products. I—Introduction and key to families. Journal of J Stored Prod Res., 22(4):163-203. doi:10.1016/0022-474x(86)90011-1.
Hashem MY, Ahmed SS, El-Mohandes MA, Gharib MA. (2012). Susceptibility of different life stages of sawtoothed grain beetle *Oryzaephilus surinamensis* (L.) (Coleoptera: Silvanidae) to modified atmospheres enriched with carbon dioxide. J Stored Prod Res., 48:46-51. https://doi.org/10.1016/j. jspr.2011.09.002
Hashem AS, Guedes RNC, Awadalla HS. (2021). Feeding substrate and temperature interplay determining infestations and losses by the sawtoothed grain beetle (*Oryzaephilus surinamensis*). Journal of Stored Products Research, 94:101887.
Hötling S, Haberlag B, Tamm M, Collatz J, Mack P, Steidle JL, Schulz S. (2014). Identification and synthesis of macrolide pheromones of the grain beetle *Oryzaephilus surinamensis* and the frog *Spinomantis aglavei*. Chemistry-A European Journal, 20(11):3183-3191.
Isman MB. (2005). Botanical insecticides: for richer, for poorer. Pest Management Science, 61(7):658-665.
Isman MB. (2008). Botanical insecticides: a global perspective. In Biopesticides: Use and Delivery (pp. 33-63). Humana Press.
Isman MB. (1997). Neem and other botanical insecticides: barriers to commercialization. Phytoparasitica, 25(4):339-344.
Khan MA, Khan SA, Khan IA. (2019). Efficacy of botanicals against the red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). Pure and Applied Biology, 8(2):1427-1434.
Latifian M, Jalili MM, Ramzi JS. (2020). The survival and biological characteristics of *Oryzaephilus surinamensis* L.(Coleoptera: Silvanidae) in the feeding conditions on three date palm cultivars. Archives of Phytopathology and Plant Protection, 53(15-16):698-714.
Leelaja BC, Rajashekar Y, Rajendran S. (2007). Detection of eggs of stored-product insects in flour with staining techniques. J. Stored Prod. Res., 43(3):206-207.
Mahroof RM, Hagstrum DW, Phillips T, Cuperus GW. (2012). Biology, behavior, and ecology of insects in processed commodities. Stored product protection, 23:33-44.
Nika P, Kavallieratos G, Nikos E. (2020). Developmental and reproductive biology of *Oryzaephilus surinamensis* (L.) (Coleoptera: Silvanidae) on seven commodities J. Stored Prod. Res., 87. https://doi.org/10.1016/j.jspr.2020.101612
Omran IM, Hassan KS, Almansour N. (2018). Effect of some plants powder and insecticides admiral and runner against saw-toothed grain beetle *Oryzaephilus surinamensis* L. (Silvanidae: Coleoptera). Journal of Entomology and Zoology Studies, 6(3):189-194.
Robinson WH. (2005). Handbook of Urban Insects and Arachnids. Camb. Univ. Press, Camb., 490 pp.
Shaalan EA, Canyon D, Younes MW, Abdel-Wahab H, Mansour AH. (2005). A review of botanical phytochemicals with mosquitocidal potential. Environment International, 31(8):1149-1166.
Throne JE, Hallman GJ, Johnson JA, Follett PA. (2003). Post-harvest entomology research in the United States Department of Agriculture–Agricultural Research Service. Pest Management Science: formerly Pesticide Science, 59(6-7):619-628.