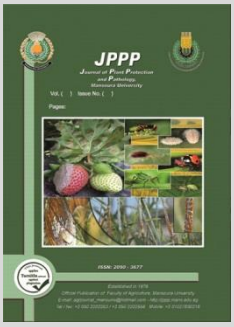
Journal of Plant Protection and Pathology

Journal homepage & Available online at: www.jppp.journals.ekb.eg

Influence of Dried Fruits and Nuts on Development and Survival of The Sawtoothed Grain Beetle, *Oryzaephilus surinamensis* (L.)

Awadalla, S. S.[1*]; T. E. Ata[2] and Doaa M. Ismael[1]

[1]Economic Entomology Department, Faculty of Agriculture, Mansoura University, Mansoura, Egypt.
[2]Plant Protection Department, Faculty of Agriculture, Damietta University, Damietta, Egypt.



ABSTRACT

The present experiments were carried out in the laboratory belonging to the Economic Entomology Department at Faculty of Agriculture, Mansoura University Egypt. To obtain the insect; samples of the infested stored rice with different stages of *Oryzaephilus surinamensis* were transferred to the laboratory and kept under laboratory conditions until adults emergence. The total development of immature stages in relation to the different food types were recorded. The shortest developmental time was on dry dates and the longest time was on semi-dry palm (32.6±1.04 and 36.9±0.96 days, respectively) with highly significantly differences in development times of the insect among food types in non-choice test. The highest survival rates of the larval and pupal stages of the insect was when the larvae fed on dry dates (87.0 and 96.6%, respectively). The highest number of the adults emerged and the highest weight loss were obtained when larvae fed on dry dates in non-choice test. The highest average number of the attracted adults, female egg-laying and F1 progeny were obtained on dry dates in free-choice test. In free-choice test, the highest immature survival rateand the largest weight loss were obtained on dry dates.

***Keywords*:** Dried fruits, Nut fruits, Food preference, Survival rates, *Oryzaephilus surinamensis*.

INTODUCTION

The dried fruits dates as well as the nut fruits including dates, hazel nut and almond are rich-nutrient food. The food includs vitamins E and K, protein, insoluble and soluble fibers, thiamine, folic acid and polyunsaturated or monounsaturated fatty acid, minerals (such as potassium, copper and magnesium), and antioxidants and phytosterol compounds (Souza *et al.* 2015;Cardoso *et al.* 2017 and Tas and Gökmen 2017).

The sow-toothed grain beetle, *Oryzaephilus surinamensis* (L.) is a secondary insect pest with their larvae and adults feed on the stored materials. Cereals like barley, corn, rice, and wheat as well as chocolate, nuts, peas and yeast considered a preferred host plants for *O. surinamensis* (Trematerra *et al*., 2000 and 2016). Also, these insect feed on the frass which produced by the damaged kernels (Throne *et al*., 2003 and Hotling *et al*., 2014). The insect adults are relatively feed on creaked grains, the nut fruits in shells, chocolate and biscuits in commercial and residential settings and due to small size and flattened shape(Rees, 1996 and 2004).

The developmental stages and the survival rates affected with the different stored materials such as dry fruits, nut fruits, oil seeds and leguminous seeds where the larval duration was the longest and the survival rates and the emergence of the adults were the highest on the dried fruits and nut fruits (Awadalla *et al*., 2021). Furthermore, some biological aspects of the insect varied in relation to different commodities such as dates, rice and sesame and different temperatures(20, 25, 30 and 35°C and 65% RH). The highest and lowest infestations by the insect were on rice and dry dates, respectively (Hashem *et al*. 2021).

Thus, the present work aims to study the influence of the dried fruits and nut fruits on the developmental stages and survival rate of the saw-toothed grain beetle, *O. surinamensis* (L.) under laboratory conditions.

MATERIALS AND METHODS

The present experiments were carried out in the laboratory of the Economic Entomology Department at the Faculty of Agriculture, Mansoura University, Egypt. The insect pest was obtained from infested stored rice samples with the saw-toothed grain beetle, *O. surinamensis* ,transferred to the laboratory, and then kept at conditions of 30± 1°C, 60± 5% RH, and complete darkness until adult emergence. An insect culture was started by introducing five batches, each one consisted of 150 adult females and males, on 120 grams of creaked rice in glass jars. Each glass jar was covered with muslin and rubber bands, permitted until egg-laying for ten days, and then removed. The new generation of the emerged adults transferred to other glass jars with new creaked rice grains to produce a new generation of the insect under the laboratory conditions.

Non-choice tests:

The dried fruits used were the dry and the semi- dry dates, while the nuts were the hazelnut and almond. The dried fruits and nuts were sterilized with freezing at - 15°C for 48 hours to kill any hidden stages of any insect special living inside these fruits and nuts (El-Sabaay, 1988). All the tested materials were creaked to small parts and maintained in an incubator under the same described physical conditions above for two weeks to obtain equilibrium moisture content with the obtained relative humidity (Ezz, 1976). Enough numbers of the produced eggs were maintained in the incubator until egg hatching. Ten petri-dishes (10 cm diameter) were used for each food material and each one considered as a replicate. Each petri-dish contained 10 grams of creaked fruits or nuts. Ten young larvae (newly hatched) were produced for each petri-dish and transferred to the incubator (30°C ±1°C, 60 ±5% R.H. and darkness) until emergence of the adults. The larval stage, the pupal stage and the total developmental time

* **Corresponding author.**
E-mail address: awadalla28@mans.edu.eg
DOI: 10.21608/jppp.2024.261429.1209

were estimated on each food type. Also, larval and pupal survival percentages were estimated on each food material. Moreover, adult emergence and grain weight loss in each treatment was calculated.

Free-choice tests:

In the present study, five glass jars accommodated were used and considered as replicates. Each accommodation was contained four petri-dishes which contained five grams of the creaked tested dried fruits and nuts. twenty pairs of the emerged insect adults aged between 10 and 12 days were maintained in the center of each accommodate to allow for the insect adults to preferred the dried fruits or nuts species as free choice tests and allow adult females to computing and the females egg-laying on the preferred any tested species. The females are allowed to egg-laying for ten days and then removed after this time. The attracted individuals' numbers for the males and females on each dried fruits or nuts were recorded. Moreover, the number of egg-laying and the number of the emerged individuals for the first generation after four weeks were recorded and calculated. Also, the weight loss for each tested material was recorded.

Data analysis:

Data were analyzed by using one-way ANOVA and means separated using Duncan's Multiple Range Test (CoStat Software, 1989).

RESULTS AND DISCUSSION

Non-choice tests:

The present data arranged in Table (1) showed the influence of the tested dried fruits and nuts on the immature stages of the saw-toothed beetle *O. surinamensis* under laboratory conditions of 30±1°c and 60 ± 5% relative humidity. The incubation periods were the same valves in all types and presented by 6.3 ± 0.57 days without significant difference. Meanwhile, the larval stage durated the shortest time when the larvae feed on dry dates followed by hazel nut and almond and presented by 17.4±0.89, 18.5 ± 0.76 and 18.8±0.83 days, respectively. The longest time for the larval stage was recorded on semi-dry dates with value of 20.7 ± 0.93 days. Statical analysis revealed that a highly significantly difference was obtained when the larvae feed on different dry fruits and nuts. The pupal stage according to the different dry fruits and nuts ranged between 8.9 ± 0.64 days on dry dates and 9.9 ± 0.66 days on semi-dry dates without significant differences.

Table 1. Influence of the tested dried fruits and nuts on the immature stages of the saw-toothed grain beetle, *O. surinamensis* under laboratory conditions.

The biological aspects	dried fruits and nuts			
	Dry dates	Semi-dry dates	Hazel nut	Almond
Incubation period	6.3±0.57 a	6.3±0.57 a	6.3±0.57a	6.3±0.57 a
Larval stage duration	17.4±0.89 c	20.7±0.93 a	18.5±0.76 b	18.8±0.8 b
Pupal stage duration	8.9±0.64 a	9.95±0.66 a	9.4±0.82 a	9.7±0.9 a
Total immature stage	32.6±1.04 c	36.9±0.96 a	34.2±1.07 b	34.8±0.92 b

The average followed by the same letters in rows is not significantly differentiated at 5% of probability levels (CoStat Software, 1989).

As a conclusion, data illustrated in Table (1) recorded the total immature stages according to the different tested food types where the insect larvae when feed on the dry dates, the total immature stage recorded the shortest time and presented by 32.6 ± 1.04 days. While, the longest time was on semi-dry dates and presented by 36.9 ±0.96 days with highly significantly differences under non-choice tests.

Data illustrated in Fig. (1) showed the rate of the survival for the insect larvae and pupae according to the different food types under non-choice test. The highest rates of the survival for the insect larval and pupal stages under non-choice tests when the larvae feed on dry dates and presented by 87.0 and 96.6%, respectively

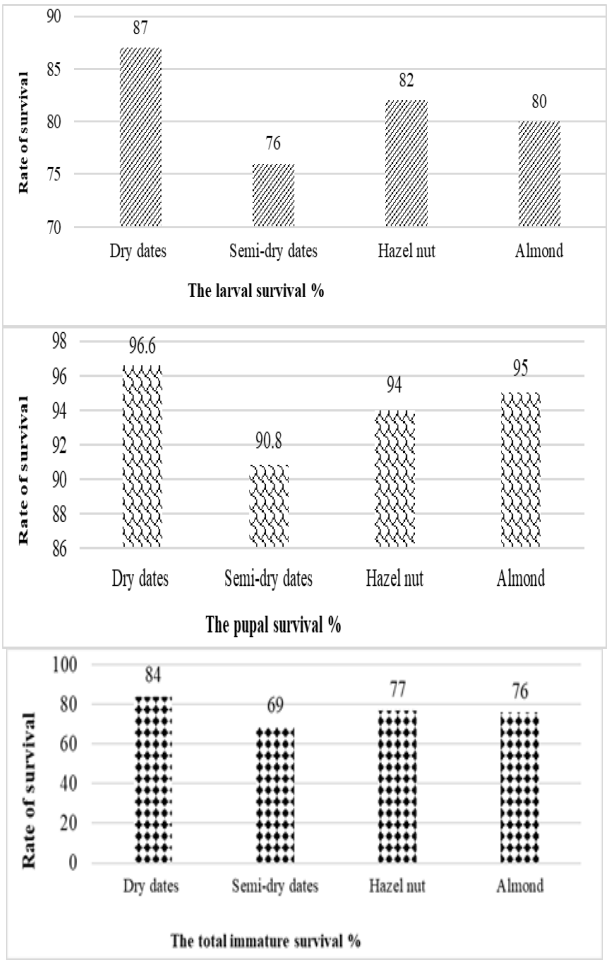


Figure 1. The rate of survival for the larvae and pupae of saw-toothed grain beetle, *O. surinamensis* according to the different dried fruits and nuts under non-choice test.

In respect to the average number of the emerged adults according to the different food types Fig. (2) under non-choice test. The highest average number of the emerged adults recorded when the larvae feed on dry dates and presented by 8.4 ± 0.73 individuals.

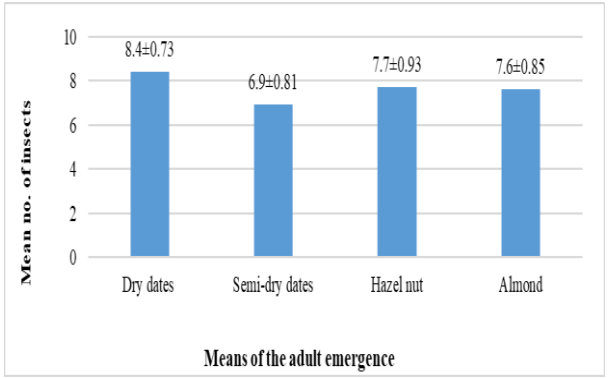


Figure 2. The mean number of the insect adult emergence according to the different dried fruits and nuts under non-choice test.

According to the weight loss in different dried fruits and nuts after feeding the insect larvae (Fig. 3). The weight loss percentage ranged between 20.3% on semi-dry dates and 24.5% on dry dates under non-choice test.

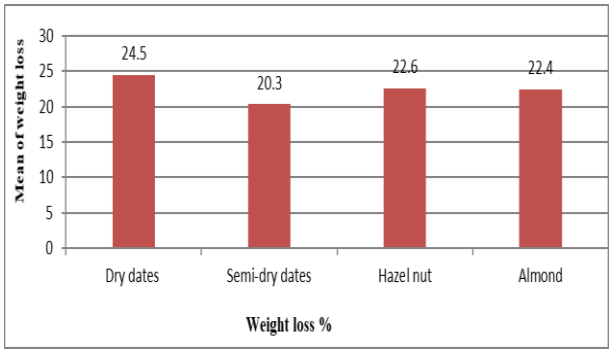


Figure 3. The weight loss in different dried fruits after feeding the larvae of the insect under non-choice test.

Free-choice tests:

The obtained results arranged in Table (2) showed the influence of the dried fruits and nuts on attractive the insect adults, female egg-laying and the number of the emerged individuals for the first generation (F1) under the free-choice tests. The highest average number of the attracted adults and the average number of the deposited eggs were obtained on dry dates (13.2 ± 0.63 individual and 86.8 ±1.93 eggs) while, the lowest average number were obtained on almond (7.4±0.58 indiv. and 49.8 ±1.34 eggs) with highly significant difference, respectively.

On the other hand, the average number of the emerged individuals or the first generation (F1 progeny) were the highest on dry dates followed by hazel nut and presented by 79.6±0.87 and 55.6 ±0.67 individuals while the lowest recorded on semi-dry dates and almond which presented by 32.2 ± 0.51 and 36.2 ± 0.57 individuals with a highly significant differences, respectively.

Table 2. influence of the dried fruits and nuts on the attracted insect adults, egg-laying and the number of the emerged individuals for the first generation F1 under non- choice tests.

The biological aspects	Dried fruits and nuts			
	Dry dates	Semi-dry dates	Hazel nut	Almond
Number of the attracted insect adults	13.2±0.63 a	8.6±0.75 bc	10.8±0.51 b	7.4 ±0.58 c
Number of the deposited eggs	86.8±1.93 a	51.4±1.85 c	69.2±1.78 b	49.8± 1.34 c
Number of the emerged individuals (Progeny F1)	79.6±0.87 a	32.2±0.51 c	55.6±0.67 b	36.2±0.57 c

The average followed by the same letters in rows is not significantly differentiated at 5% of Probability levels (CoStat Software, 1989).

The obtained data in Fig. (4) showed the rate of the survival for the immature stages of the insect on different dry fruits and nuts under free choice test. The rate of the survival ranged between 62.6 % on semi-dry dates and 91.7% on dry dates under free choice test.

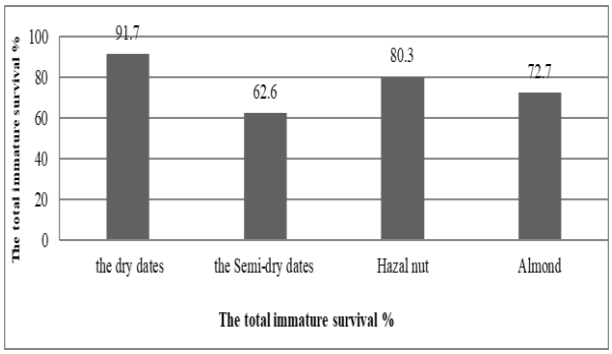


Figure 4. The rate of survival for the immature stages of the insect pest on different dry fruits and nuts under non-choice test.

According to the weight loss percentage, data in Fig. (5) showed that, the highly average percentage of the weight loss recorded on dry dates followed by hazel nut and almond and represented by 36.2, 19.4 and 17.8%, respectively.

These findings are in agreement with those of (Latifin *et al*. 2020; Tazbian 2016 and Mallah *et al*. 2016) found that, the dry dates was the most substrate for the larval survival and insect performance. The hast plant and the insect interaction are dynamic systems and selection of the host by the insect as food, place for reproduction and shelter depending on physical and chemical aspects of the host plant (Cox and Collins 2002; Mahroof, Hagstrum 2012 and Moawad and El-Ghamdi 2013). Firstly, physical aspects which included shape, surface texture and size determined the host suitability for the target species of the insects (Cope and Fox 2003 and de Sa *et al*. 2014). Moreover, the food dryness affected the movement and the survival of the insect pest larvae and the adults (Latifian *et al.* 2020). Another studier based on the moisture content, the food substrates including dried fruits and fruit nuts were tested for the saw-toothed grain beetle (Babikir 2005 & Nurul and Noor 2019).

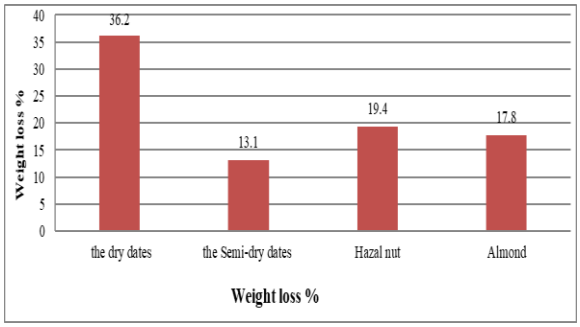


Figure 5. The weight loss of the insect pest on different dry fruits and nuts under free choice test.

While, the chemical aspects of the host substrates such as protein, amylose and starch content effected on the adult longevity, mortality and the developmental of the immature stages (Aldosari *et al.* 2002; Chuck-Hernandez *et al.* 2013; Sahito *et al*. 2017; Seifi *et al.* 2016 and Kavallieratos *et al.* 2019). The feeding on diets with low quality lead to delayed the growth and reduces the development as well as fecundity, fertility and rate of the survival (Borzoui *et al*. 2015; Latifian and Rad 2015 and Borzoui *et al.* 2017). The present study indicated that, the shortest immature stages and the highest rates of the survival when the larvae of the insect pest feeding on dry dates (Lalitha *et al*. 2005; Borzoui *et al.* 2015 and Awadalla *et al.* 2021).

REFERENCE

Aldosari, S. A., Al-Suhaibani, A. M., & Ali, A. G. (2002). usceptibility of some dry date palm varieties to infestation by *Oryzaephilus surinamensis* L., Coleoptera: Silvanidae in relation to their chemical composition. *Assiut Journal of Agricultural Sciences (Egypt).*

Awadalla, H. S.; Guedes, R. N. C. and Hashem, A. S. (2021). Feeding and egg-laying preferences of the sawtoothed grain beetle Oryzaephilus surinamensis: Beyond cereals and cereal products. *Journal of Stored Products Research, 93, 101841.*

Babikir, E. E. B. (2005). The Susceptibility of Some Date Cultivars to the Infestation by the Saw-Toothed Grain Beetle, *Oryzaephilus surinamensis* L. (Coleoptera-Silvanidae) (Doctoral dissertation, Sudan University of Science and Technology).

Borzoui, E., Naseri, B., & Namin, F. R. (2015). Different diets affecting biology and digestive physiology of the Khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae). *Journal of Stored Products Research, 62, 1-7.*

Borzoui, E., Naseri, B., & Nouri-Ganbalani, G. (2017). Effects of food quality on biology and physiological traits of *Sitotroga cerealella* (Lepidoptera: Gelechiidae). *Journal of Economic Entomology, 110(1), 266-273.*

Cardoso, B. R.; Duarte, G. B. S.; Reis, B. Z. and Cozzolino, S. M. (2017). Brazil nuts: Nutritional composition, health benefits and safety aspects. *Food research international (Ottawa, Ont.), 100(2), pp 9-18.*

Chuck-Hernández, C., Serna-Saldívar, S. O., & García-Lara, S. (2013). Susceptibility of different types of sorghums during storage to *Sitophilus zeamais* Motschulsky. *Journal of stored products research, 54, 34-40.*

Cope, J. M., & Fox, C. W. (2003). Oviposition decisions in the seed beetle, Callosobruchus *maculatus* (Coleoptera: Bruchidae): effects of seed size on superparasitism. *Journal of Stored Products Research, 39(4), 355-365.*

CoStat-Statutical Software. California: CoHort Software (1989), pp. 302

Cox, P. D., & Collins, L. E. (2002). Factors affecting the behaviour of beetle pests in stored grain, with particular reference to the development of lures. *Journal of Stored Products Research, 38(2), 95-115.*

de Sá, L. F. R., Wermelinger, T. T., da Silva Ribeiro, E., de Amaral Gravina, G., Fernandes, K. V. S., Xavier-Filho, J., ... & Oliveira, A. E. A. (2014). Effects of *Phaseolus vulgaris* (Fabaceae) seed coat on the embryonic and larval development of the cowpea weevil *Callosobruchus maculatus* (Coleoptera: Bruchidae). *Journal of Insect Physiology, 60, 50-57.*

El-Sabaay, T. (1998). The effectiveness of certain vegetable oils as wheat grain protectants against the granary weevil, *Sitophilus granaries* (L.) and the lesser grain borer, *Rhyzopertha dominica* (F.). *PhD. Thesis, Cairo Univ. 103pp.*

Ezz, E. (1976). Studies of damage in some stored grains due to infestation with certain insects. *PhD. Thesis, Cairo Univ.*

Hashem, A. S.; Guedes, R. N. C. and Awadalla, H. S. (2021). Feeding substrate and temperature interplay determining infestations and losses by the sawtoothed grain beetle (*Oryzaephilus surinamensis*). *Journal of Stored Products Research, 94, 101887.*

Hotling, S.; Haberlag, B.; Tamm, M.; Collatz, T.; Mack, P.; Steidle, J. L. M.; Vences, M. and Schulz, S. (2014). Identifiation and synthesis of macrolide pheromones of the grain beetle *Oryzaephilus surinamensis* and the frog *Spinomantis aglavei*. *Chem. Eur J. 20, 3183–3191.*

Kavallieratos, N. G.; Athanassiou, C. G.; Boukouvala, M. C. and Tsekos, G. T. (2019). Inflence of different non-grain commodities on the population growth of Trogoderma granarium Everts (Coleoptera: Dermestidae). J. *Stored Prod. Res. 81, 31–39.*

Lalitha, S., Shade, R. E., Murdock, L. L., Bressan, R. A., Hasegawa, P. M., & Nielsen, S. S. (2005). Effectiveness of recombinant soybean cysteine proteinase inhibitors against selected crop pests. Comparative Biochemistry and Physiology Part *C: Toxicology & Pharmacology, 140(2), 227-235.*

Latifian, M., & Rad, B. (2015). Determination of the population densities of different development stags of Sawtoothed beetle *Oryzaephilus surinamensis* L. in Date fruit) Sayer cultivar (bausing spectrophotometry method. *IAU Entomological Research Journal, 6(4), 353-365.*

Latifian, M.; Jalili Moghadam, M. and Ramzi Jahromi, S. (2020). The survival and biological characteristics of *Oryzaephilus surinamensis* L. (Coleoptera: Silvanidae) in the feeding conditions on three date palm cultivars. Arch. Phytopathol. *Plant Protect. 53 (15–16), 698–714.*

Mahroof, R. M. and Hagstrum, D. W. (2012). Biology, behavior, and ecology of insects in processed commodities. In: Hagstrum, D. W.; Phillips, T. W. and Cuperus, G. (Eds.), Stored Product Protection. Kansas State University, Manhattan, KS, pp. 33–44.

Mallah, N. A.; Sahito, H. A.; Kousar, T.; Kubar, W. A.; Jatoi, F. A. and Shah, Z. H. (2016). Susceptibility of different varieties of stored date palm fruits infested by saw tooth grain beetle, *Oryzaephilus surinamensis* (L., 1758) under laboratory conditions. *Journal of Entomology and Zoology Studies, 4(6), 438-443.*

Moawad, S. S. and Al-Ghamdi, F. F. (2013). Susceptibility of some dry date cultivars to infestation by *Oryzaephilus surinamensis* (L.) (Coleoptera: Silvanidae). *American Journal of Experimental Agriculture, 3(3), 651-663.*

Nurul, A. H., & Noor, M. A. (2019). Food Preference of (Coleoptera:) to Different Types of Plant Products. *Malaysian Journal of Halal Research, 2(2), 53-57.*

Rees D. P. (1996). Coleoptera, pp. 1-39. In: Integrated management of insects in stored products (Subramanyaam B. and, Hagstrum, D. W., Eds). Marcel Dekker inc., New York, USA.

Rees, D. P. (2004). Insects of Stored Products. *CSIRO Publising, Collinwood.*

Sahito, H. A.; Mallah, N. A.; Kousar, T.; Kubar; W. A.; Shah, Z. H.; Jatoi, F. A. and Mangrio, W. M. (2017). Life

table parameters of saw toothed grain beetle, *Oryzaephilus surinamensis* (L., 1758) on different varieties of stored date palm fruits infested under laboratory conditions. *Journal of Entomology and Zoology Studies, 5(1), 95-99.*

Seifi, S., Naseri, B., & Razmjou, J. (2016). Nutritional physiology of the Khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae) fed on various barley cultivars. *Journal of economic entomology, 109(1), 472-477.*

Souza, R. G.; Gomes, A. C.; Naves, M. M. and Mota, J. F. (2015). Nuts and legume seeds for cardiovascular risk reduction: scientific evidence and mechanisms of action. Nutrition reviews, 73(6), pp 335-347.

Taş, N. G. and Gökmen, V. (2017). Phenolic compounds in natural and roasted nuts and their skins: a brief review. Current Opinion in Food *Science, 14, pp 103-109.*

Tazbian, F. (2016). Survey, damage assessment and biology study of saw-toothed grain beetle, Oryzaephilus surinamensis (doctoral dissertation, department of entomology, sher-e-bangla agricultural university, dhaka.).

Throne, J. E.; Doehlertb, D. C. and McMullen, M. S. (2003). Susceptibility of commercial oat cultivars to *Cryptolestes pusillus* and *Oryzaephilus surinamensis*. *J. Stored Prod. Res. 39, 213–223.*

Trematerra, P.; Kavallieratos, N. G. and Athanassiou, C. G. (2016). Laboratory tests on the ability of *Oryzaephilus surinamensis* adults to locate different types of chocolate varying in quantity of cocoa. *Bulletin of Insectology, 69(1), 21-24.*

Trematerra, P.; Sciarreta, A. and Tamasi, E. (2000). Behavioural responses of *Oryzaephilus surinamensis*, *Tribolium castaneum* and *Tribolium confusum* to naturally and artificially damaged durum wheat kernels. *Entomologia Experimentalis et Applicata, 94(2), 195-200.*

تأثير أنواع من الفواكهه المجففة والنقل على الأطوار غير الكاملة ومعدل البقاء الحشرة خنفساء سورينام

سمير صالح عوض الله ، طارق السيد عطا[2] و دعاء ميزاراسماعيل[1]

[1]قسم الحشرات الاقتصادية - كلية الزراعة - جامعة المنصورة
[2]قسم وقاية النبات – كلية الزراعة– جامعة دمياط

الملخص

أجريت التجارب الحالية بالمعمل التابع لقسم الحشرات الإقتصادية بكلية الزراعة جامعة المنصورة. للحصول على الحشرة تم نقل عينة من الأرز المخزن المصاب بأطوار مختلفة من الحشرة إلى المعمل ووضعها تحت الظروف المعمل حتى ظهور الحشرة البالغة. تم تسجيل جميع الأطوار غير اليافعة وفقاً لأنواع الأغذية المختلفة التي تم إختبارها، أقصر مدة سجلت على التمور الجافة وأطولها كانت على التمور شبه الجافة وقدمت بـ 32.6±0.96 يوم مع وجود إختلافات عالية المعنوية تحت إختبار عدم الإختيارية على التوالي. أعلى معدلات البقاء لمرحلتي يرقات الحشرة والعذارى تحت إختبار عدم الإختيارية عندما تتغذى اليرقات على التمر الجاف وبلغت 87.0% لليرقات و96.6% للعذارى. كما تم الحصول على متوسط عدد البالغات الناشئة عن طريق تغذية يرقات التمر الجاف وتم تسجيل نسبة النقص في وزن التمر الجاف تحت اختبار عدم الاختيارية. تم الحصول على أعلى متوسط لعدد البالغات المنجذبة وإناث الواضعة للبيض وذرية الجيل الاول تحت اختبار الاختيار الحر في التمور الجافة، كما أن معدل البقاء على قيد الحياة للاطوار غير اليافعة وفقدان الوزن كان الأعلى للتمر الجاف.