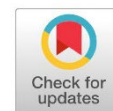


Research Article

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Identification of Insect Pests in Stored Pulses within Tripoli, Libya

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Abstract: This study investigated the presence of insect pests in five stored pulses which are chickpeas, beans, white pea beans, peas, and red lentils collected from Tripoli city markets. The results revealed that one or more beetle species infested 39.05% of the samples. The percentages of samples infested were as follows: beans 52.38%, peas 42.86%, red lentils 38.11%, white pea beans 33.33%, and chickpeas 28.57%. The results also show that eight weevil species of insect pests were detected in the samples. These were cowpea weevil *Callosobruchus maculatus* (F.), pulse beetle *Callosobruchus chinensis* L., bean weevil *Acanthoscelides obtectus* (Say), faba bean beetle *Bruchidius incarnatus* Boheman, grain weevil *Sitophilus granarius* (L.), lesser grain borer *Rhizopertha dominica* (F.), red flour beetle *Tribolium castaneum* (Herbst) and saw-toothed grain beetle *Oryzaephilus surinamensis* (L.). The most frequently found beetle species were; cowpea weevil *C. maculatus* with 18.10 %, bean weevil *A. obtectus* 14.29 % and lesser grain borer *R. dominica* 8.57 %.

Keywords: Stored Pulses, Insect Pests, Legumes, Tripoli City.

تعريف الآفات الحشرية بالبقوليات المخزونة في مدينة طرابلس، ليبيا

الباحث الأول*: قسم وقاية النباتات،
كلية الزراعة، جامعة طرابلس، ليبيا.

المستخلص أجريت هذه الدراسة للبحث في أنواع الآفات الحشرية المتواجدة بخمسة أنواع من الحبوب البقولية وهي: الحمص، الفول، الفاصوليا البيضاء، البازلاء والعدس الأحمر. تم الحصول على عينات هذه البقوليات عشوائياً من أسواق محلية مختلفة بمدينة طرابلس كما يلي: سوق الجمعة، تاجوراء، عين زارة، طرابلس المركز، أبو سليم، حي الأندلس وجنزور. أظهرت النتائج أن 39.05 % من العينات كانت مصابة بنوع أو أكثر من الحشرات. من خلال النتائج المتحصل عليها كانت النسب المئوية للعينات المصابة كالتالي: الفول 52.38 %، البازلاء 42.86 %، العدس الأحمر 38.11 %، الفاصوليا البيضاء 33.33 % والحمص 28.57 %. بينت النتائج أيضاً وجود ثماني أنواع من الآفات الحشرية في العينات المدروسة. وهي: سوسة اللوبيا *Callosobruchus maculatus* (F.)، خنفساء الفول الصينية *Callosobruchus chinensis* L.، خنفساء الفاصوليا *Acanthoscelides obtectus* (Say)، خنفساء الفول الصغيرة *Bruchidius incarnatus* Boheman، سوسة الحبوب *Sitophilus granarius* (L.)، ثاقبة الحبوب الصغرى *Rhizopertha dominica* (F.)، خنفساء الدقيق الحمراء *Tribolium castaneum* (Herbst) و خنفساء الحبوب المنشارية *Oryzaephilus surinamensis* (L.). من خلال النتائج المتحصل عليها كانت أكثر أنواع الخنافس وجوداً هي سوسة اللوبيا *C. maculatus* بنسبة مئوية 18.10 %، خنفساء الفاصوليا *A. obtectus* 14.29 % وثاقبة الحبوب الصغرى *R. dominica* بنسبة مئوية بلغت 8.57 %.

الكلمات المفتاحية: البقوليات المخزونة؛ الآفات الحشرية؛ البقوليات؛ مدينة طرابلس.



INTRODUCTION

Pulses are mostly referred to as grain legumes including all forms of peas and beans (Osman et al., 2015). Grain legumes such as chickpeas, pigeon peas, cowpeas, field peas, lentils, and beans are an excellent supply of protein for vegetarian people, and are an integral part of daily food in many forms worldwide (Akter et al., 2019; Mutungi et al., 2022; Norton et al., 1985). In addition, grains and pulses have remarkable nutritional value in developing countries (Arthur & Throne, 2003; Babu et al., 2003).

In general, pulses are subjected to storage for a long time (Tiwari et al., 2011), which means conditions, such as time, temperature and moisture content lead to physicochemical and biological changes resulting in a serious effect on the nutritional composition, germination and longevity (Akter et al., 2019; Hentges et al., 1991; Menkov, 2000; Stathers et al., 2020). According to (Sharma et al., 2016) major problem in the production of pulses is the infestation of insect pests, which cause serious losses both in the field and storage. However, Infestation begins in the field, but most of the harm is done during storage and may cause total loss within three months (Swella & Mushobozy, 2007).

Previous studies reported that infestation in pulses occurred due to bruchids, which cause *huge* damage in pulses during storage, by eating the whole kernel and only leaving the pericarp, which makes the grain inedible and unfeasible (Gangrade, 1974). Among these species of the genus *Callosobruchus*, *C. maculatus* and *C. chinensis* are some of the most devastating insects during the storage of cowpeas, chickpeas, mung beans, black grams, lentils, and peas (Banga et al., 2018).

According to the literature, in tropical areas, insects may lead to 100 % detrimental effects in stored pulses (Egwuatu, 1987). However, in India, it was found that chickpeas and lentils had suffered about 30 % and 15 % storage losses, respectively (Haile, 2006). Furthermore, a study by (Gujar & Yadav, 1978) found about 55-69 % pulse weight loss and 45.60-66.30 % loss in protein content of chickpeas by the pulse beetle *C. chinensis*.

To effectively control insect pests and reduce the damage caused by insects in storage, it is important to know the kind of insect species occurring in particular pulses. However, in Libya, studies on stored pulses pests are not available. Therefore, this study was conducted to identify insect pests associated with some types of stored pulses in Tripoli, Libya.

MATERIALS AND METHODS

The research was carried out in the Plant Protection Department, Faculty of Agriculture, Tripoli University, Tripoli/ Libya from May to September 2023.

Pulses types and study areas

The pulse seeds for the study were: Chickpeas *Cicer arietinum*, beans *Vicia faba*, White pea beans *Phaseolus vulgaris*, peas *Pisum sativum*, and red lentils *Lens culinaris*, and were purchased from random markets in different areas in Tripoli city as following: Soug al Jum'aa, Tajoura, Ain zara, Centre of Tripoli, Abu Salim, Hay al anddalus and Janzur.

Sample collection methods

A random sampling method was used for the selection of pulses. From each market 250 g of each type of pulse were taken from a total of 21 local markets and the total numbers of samples were 105 (five types of pulses × 7 different areas × 3 markets in each area = 105 samples total), collected in plastic bags, labelled with important information and brought back to the laboratory.

Sieves of different sizes (mm) were used to separate the adult insects from the sample pulses. Live and dead insects from samples were collected and immediately preserved in glass jars (100 ml) and kept for further identification. Then, samples were kept in glass jars (1000 ml) covered with nylon gauze and rubber bands and incubated at $25^{\circ}\text{C} \pm 2^{\circ}$ for 4 weeks of observation to detect beetles from internal infestation.

Identification and counting of insect pests

The identification of pest species was conducted by observing the external morphology of the pest insects using a dissecting microscope. Finally, the insect species were identified using taxonomic keys of the books related to stored product insect pests by different authors (Hagstrum, 2013; Hagstrum & Subramanyam, 2006, 2009).

RESULTS

Overall, 39.05 % of pulses samples were infested by one or more beetle species. The percentages of samples infested were as follows: beans 52.38%, peas 42.86%, red lentils 38.11%, white pea beans 33.33% and chickpeas 28.57%. The results in Table 1 show that eight weevil species of insect pests were detected in the samples and all of them were under the order Coleoptera. These were cowpea weevil *Callosobruchus maculatus* (F.), pulse beetle *Callosobruchus chinensis* L., bean weevil *Acanthoscelides obtectus* (Say), faba bean beetle *Bruchidius incarnatus* Boheman, grain weevil *Sitophilus granarius* (L.), lesser grain borer *Rhizopertha dominica* (F.), red flour beetle *Tribolium castaneum* (Herbst) and saw-toothed grain beetle *Oryzaephilus surinamensis* (L.). The most frequently found beetle species were; cowpea weevil *C. maculatus* with 18.10 %, bean weevil *A. obtectus* 14.29 % and lesser grain borer *R. dominica* 8.57 % (Table 1).

However, saw-toothed grain beetle *O. surinamensis* was found to be present only in one sample and red flour beetle *T. castaneum* was present only in two samples and was absent in the other samples.

Table (1). Beetle species found in stored pulses samples from different areas in Tripoli city, Libya

Species	Common name	Samples infested	Percentage infested (n= 105)
<i>Callosobruchus maculatus</i> (F.)	Cowpea weevil	19	18.10 %
<i>Acanthoscelides obtectus</i> (Say)	Bean weevil	15	14.29 %
<i>Rhizopertha dominica</i> (F.)	Lesser grain borer	9	8.57 %
<i>Callosobruchus chinensis</i> L.	Pulse beetle	4	3.81 %
<i>Bruchidius incarnatus</i> Boheman	Faba bean beetle	4	3.81 %
<i>Sitophilus granarius</i> (L.)	Grain weevil	3	2.86 %
<i>Tribolium castaneum</i> (Herbst)	Red flour beetle	2	1.90 %
<i>Oryzaephilus surinamensis</i> (L.)	Saw-toothed grain beetle	1	0.95 %

Table 2 shows that four insect species were found in the chickpeas samples. Cowpea weevil *C. maculatus* was found in Soug al Jum'aa and Tajoura areas. Also, pulse beetle *C. chinensis* was found in Soug al Jum'aa and the Centre of Tripoli. While, faba bean beetle *B. incarnatus* was found Centre of Tripoli and Abu Salim areas and not found in the other chickpeas samples. In addition, grain weevil *S. granarius* was found in one chickpea sample in the Tajoura area.

Table (2). Total insect distribution of each species in chickpeas from different areas in Tripoli city, Libya

Study area	Total insect distribution of each species			
	<i>C. maculatus</i>	<i>C. chinensis</i>	<i>B. incarnatus</i>	<i>S. granarius</i>
Soug al Jum'aa	17	9	0	0
Tajoura	54	0	0	6
Ain Zara	0	0	0	0
Centre of Tripoli	0	22	35	0
Abu Salim	0	0	35	0
Hay al anddalus	0	0	0	0
Janzur	0	0	0	0

In addition, five insect species were found in the bean samples. These species were cowpea weevil *C. maculatus*, pulse beetle *C. chinensis*, bean weevil *A. obtectus*, faba bean beetle *B. Incarnates* and lesser grain borer *R. dominica*. Cowpea weevil *C. maculatus* was present in five of the study areas and bean weevil *A. obtectus* was found in six areas. Whereas, lesser grain borer *R. dominica* was present in Soug al Jum'aa and Centre of the Tripoli area. On the other hand, pulse beetle *C. chinensis* was found only Tajoura area while faba bean beetle *B. incarnatus* was present only in Centre of the Tripoli area (see Table 3).

Table (3). Total insects distribution of each species in beans from different areas in Tripoli city, Libya

Study area	Total insect distribution of each species				
	<i>C. maculatus</i>	<i>C. chinensis</i>	<i>A. obtectus</i>	<i>B. incarnatus</i>	<i>R. dominica</i>
Soug al Jum'aa	16	0	5	0	163
Tajoura	3	2	11	0	0
Ain Zara	0	0	5	0	0
Centre of Tripoli	78	0	37	93	89
Abu Salim	3	0	0	0	0
Hay al anddalus	32	0	3	0	0
Janzur	0	0	78	0	0

Table 4 shows that three insect species were found in white pea bean samples, which were cowpea weevil *C. maculatus*, bean weevil *A. obtectus* and faba bean beetle *B. incarnates*. However, faba bean beetle *B. incarnates* was present in only in the Centre of Tripoli.

Table (4). Total insect distribution of each species in white pea beans from different areas in Tripoli city, Libya

Study area	Total insect distribution of each species		
	<i>C. maculatus</i>	<i>A. obtectus</i>	<i>B. incarnatus</i>
Soug al Jum'aa	0	37	0
Tajoura	23	11	0
Ain Zara	0	0	0
Centre of Tripoli	3	17	5
Abu Salim	14	76	0
Hay al anddalus	19	0	0
Janzur	0	0	0

The results in Table 5 show that three species of insects were found in peas samples. These were cowpea weevil *C. maculatus*, pulse beetle *C. chinensis*, and bean weevil *A. obtectus*. However, pulse beetle *C. chinensis* was present only in the Tajoura area.

Table (5). Total insect distribution of each species in peas from different areas in Tripoli city, Libya

Study area	Total insect distribution of each species		
	<i>C. maculatus</i>	<i>C. chinensis</i>	<i>A. obtectus</i>
Soug al Jum'aa	24	0	0
Tajoura	11	7	0
Ain Zara	0	0	5
Centre of Tripoli	1	0	19
Abu Salim	5	0	12
Hay al anddalus	21	0	0
Janzur	0	0	11

As can be seen from Table 6, four species of insects were found in the red lentils samples. These were grain weevil *S. granarius*, lesser grain borer *R. dominica*, red flour beetle *T. castaneum*, and saw-toothed grain beetle *O. surinamensis*. Lesser grain borer *R. dominica* was found in all areas of the study except in Tajoura area. Also, saw-toothed grain beetle *O. surinamensis* was found in Soug al Jum'aa area and it was absent from the other samples in the other areas.

Table (6). Total insect distribution of each species in red lentils from different areas in Tripoli city, Libya.

Study area	Total insect distribution of each species			
	<i>S. granarius</i>	<i>R. dominica</i>	<i>T. castaneum</i>	<i>O. surinamensis</i>
Soug al Jum'aa	0	408	0	78
Tajoura	23	0	0	0
Ain Zara	0	3	19	0
Centre of Tripoli	0	93	2	0
Abu Salim	0	78	0	0
Hay al anddalus	2	5	0	0
Janzur	0	36	0	0

DISCUSSION

As mentioned before in the results all species found and recorded in the present study were from the order of Coleoptera, this finding suggests the importance of beetles in stored grain pulses. Some studies have reported that infestation in pulses occurred due to bruchids, which causes major losses in pulses during storage (Gangrade, 1974; Mookherjee et al., 1970). Among these pests, the pulse beetle *Callosobruchus* sp. (Coleoptera: Bruchidae), is a serious pest of stored grain of pulses such as cowpeas, chickpeas, garden peas, and lentil and black gram (Yusuf et al., 2019). According to some studies they are important beetles of pulse crops in Asia and Africa under storage conditions (Menkov, 2000; Msolla & Misangu, 2002). *Callosobruchus* has been found to cause weight loss, decreased germination potential, and a reduction in the commercial value of the grains (Murithi et al., 2019). *Callosobruchus* is a major pest of legume seeds and prefers warmer, humid conditions (Rees, 2004). Additionally, the pulse beetle *C. maculatus* can cause a potential loss in legume ranged from 12-30 % (Proctor, 1994), 55-69 % loss in seed weight and 45.6-66.3 % loss in protein contents of chickpea (Endshaw et al., 2020; Gujar & Yadav, 1978) and even up to 100 % loss in grain legumes (Kulkarni et al., 1985; Magagula & Maina, 2012). Also, losses in stored pulses by *C. chinensis* infestation have been reported from the Philippines, Japan, Indonesia, Sri Lanka, Burma, India, and Bangladesh (Mahdi & Rahman, 2008).

According to the findings of the current study, bean weevil *A. obtectus* was also shown to be a pest of stored pulses, this result is corroborated by (Njoroge et al., 2017; Vera-Graziano & Cruz-Izquierdo, 2016; Vuts et al., 2018), who reported a similar observation. However, its populations are commonly detected in legume storages because their life cycle is well adapted for reproduction in a closed environment (do Nascimento et al., 2020). *A. obtectus* larvae feed inside kernels and cause losses often higher than 30 % (Pemonge et al., 1997). *A. obtectus* females oviposit a bunch of eggs into the same pod. Only a few pods are likely infested, but due to the weevil's high intrinsic

rate of increase under storage conditions, this initial infestation is sufficient to cause a fast destruction of stored beans by the next weevil generation (Schmale et al., 2002). Several studies reported that severe damage causes by *A. obtectus* on both French bean *Phaseolus vulgaris* L. and lima beans *Phaseolus lunatus* L. in Africa (Elhefny & Abdelfattah, 2022; Msolla & Misangu, 2002; Paul et al., 2009), Europe (Alvarez et al., 2005; Schmale et al., 2002), Australia (Bailey, 2007), America (Kingsolver, 2004; Romero-Nápoles, 2010), the Mediterranean region (Ayvaz et al., 2010; Regnault-Roger et al., 2004).

The results obtained show that the presence of the faba bean beetle *B. incarnates* in chickpeas, beans, and white pea beans samples. A previous study reported that faba bean beetle *B. incarnates* is an important pest that attacks the stored bean and causes heavy losses in quantity, quality, and germination rate of infested faba bean seeds (Sabbour & Abd El Aziz, 2010). Also, the results showed the presence of the grain weevil *S. granarius* in chickpeas and red lentils samples. The grain weevil *S. granarius* is an important primary pest of stored products (Rees, 2004). It is distributed worldwide but particularly in cooler regions and can infest sound grain including wheat, barley maize, and grain products (Rees, 2004). According to (Hagstrum & Subramanyam, 2009), the grain weevil is reported to attack around 53 different commodities.

As shown in Tables 3 and 6 the lesser grain borer *R. dominica* was found in the beans and red lentils samples. According to the literature, the lesser grain borer *R. dominica* is a serious pest of stored wheat (Jaipal et al., 1984), and is distributed in all the countries of the world (Hill, 1990). Also, infest various other commodities including rice, sorghum, rye, barley, maize, pulses, dried vegetables, and fruits, both adults and larvae that feed on cereal grain cause extensive damage (Hagstrum, 2013; Perišić et al., 2021; Phillips & Throne, 2010).

Furthermore, red flour beetle *T. castaneum* and saw-toothed grain beetle *O. surinamensis* were found in the red lentils samples. Presence of major stored pests like grain weevil *S. granarius* and lesser grain borer *R. dominica* can attracts more insect pests and broken grains and pulses consistently favour the development of secondary storage pests during grain storage such as *T. castaneum* and *O. surinamensis*.

CONCLUSION

Insect infestation in stored pulses causes a huge loss by contaminating it or by eating it. Therefore, it is necessary to understand the behavior, type of insects, and their life cycle to reduce post-harvest damage. The focus of this research was to identify insect species in stored pulses. From this study, it can be concluded that eight weevil species of insect pests were collected from the infested pulse samples. These were cowpea weevil *C. maculatus*, pulse beetle *C. chinensis*, bean weevil *A. obtectus*, faba bean beetle *B. incarnatus*, grain weevil *S. granarius*, lesser grain borer *R. dominica*, red flour beetle *T. castaneum* and saw-toothed grain beetle *O. surinamensis*.

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