



ABILITY OF WAREHOUSE INSECTS TO TRANSMIT FUNGI ON STORED NUTS

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Article history:	Abstract:
<p>Received: 24th August 2023</p> <p>Accepted: 24th September 2023</p> <p>Published: 28th October 2023</p>	<p>Given the importance of fruit and nut aggregates that can be stored and the many and varied insect pests they are exposed to, and the other damage that accompanies these insects, as they are considered one of the most important biological factors responsible for the infection and spread of fungi in warehouses, and the rot and damage caused by fungi to raw food materials, the study aimed to isolate fungi from nuts and demonstrate the ability of insects to transmit fungi to stored nuts. The results of isolation of fungi from damaged nuts were shown after growing them on potato dextrose medium at a temperature</p> <p>25c the presence of An, Af, Fusarium fungi Penicillium, Rhizocotania and Rhizopus fungus. The results showed the dominance of Rhizopus fungus over the rest of the species.</p> <p>The fungi were isolated from insects, as the diagnostic results showed the presence of four types of fungi accompanying the insects officinalis, represented by Penicilliu , An, Af and Rizopus , and Penicillium fungi were dominant at 40% of the total fungi isolated.</p> <p>When testing the ability of insects to transmit fungi, the results showed the ability of storage insects to transmit three fungi, including An, Af , and Penicillium fungi.</p>

Keywords:

INTRODUCTION:

Nuts are a group of dry fruits that can be stored, and their cultivation is widespread in different places in the world. This fruit is characterized by its high oil content, crude proteins, carbohydrates, and phosphorus. It is of high health and economic importance, as it contains unsaturated fats, which help in lowering cholesterol in the blood. It also contains a group of vitamins B6, B2, and B1. As for the economic aspect , it It is important in the production of oils, cosmetics, and natural treatments, and some types of it are included in the European diet, especially France. Nut groups include many types belonging to several genera, including walnuts, almonds, pistachios, cashews, pecans, beans, and other types. (Aeguieb and Messal 2018).

There are more than a thousand registered species of insects that infect stored materials in various countries of the world, some of which belong to the order Coleoptera and Lepidoptera, which constitute 60% and 9-8%, respectively. These pests can cause health damage such as allergy, irritation, or Skin ulcers or damage to the respiratory system through pest residues, as some species of bird beetles secrete quinine , which has been observed to cause cancer in some experimental animals (Ismail, 2014). The importance of stored material pests in relation to public health comes from contamination or pollutants from insects. Stored materials, which are much more valuable than the food consumed by these insects, also cause a loss in the quantity of food and a change in its quality, as mentioned in 2003). (Throne *et al* . stated that losses resulting from pests that infect stored materials may reach one billion dollars/year in the United States of America, while Muhammad et al. 1994) stated that global losses resulting from pests attacking stored grains and their products are estimated at 36 million tons annually, i.e. The equivalent of one billion Iraqi dinars in value of agricultural products, which is estimated at 25 billion dollars. According to the Food and Agriculture Organization, the rate of loss in grain weight reaches 10% in Brazil and reaches 20% in grains stored in poor countries . *et a l* ., 2002), and in extreme cases, the percentage of grain weight loss reached 73%.

Fungi are considered one of the most important problems that exist at the present time due to their wide spread in nature, and they are considered one of the most important main causes that cause bacterial spoilage of foodstuffs, as they can grow in a wide and different group in human foods, including raw materials. (Gizachew et al . , 2014) It causes a threat to human health by consuming toxins produced by some fungi throughout the food chain in developed and developing countries. Hymery (*Garnier et al* ., 2016). It is mainly responsible for visible and invisible changes,

such as unpleasant odors and unpalatable flavors, which lead to food spoilage and significant economic losses. (Garnier *et al.*,

. (2017) The group of fungi of the genus *Aspergillus* is considered one of the most widespread species in most environments and is one of the most important producers of aflatoxins. (Balina *et al.*, 2018).

Contamination of feed, grains, and most foodstuffs with fungi and their toxins is one of the most threatening problems in countries, especially those that lack ideal storage conditions. It is considered a source that causes health concern, which has called on these countries to provide safe, healthy, and pollution-free food sources to achieve food security, and as a result, humans or animals are not exposed to these toxins. (Makun *et al.* . 2010).

METHODS:

First: Isolating the fungi associated with the nuts

The fungi contaminating the nuts that were used in the research were isolated. The samples were surface sterilized using sodium hypochlorate at a concentration of 1% or ethyl alcohol at a concentration of 70% for 3 minutes, then washed with water for 3 minutes as well. After that, the samples were taken with tweezers and placed on filter paper and then transferred to Petri dishes containing the PDA culture medium, then cultured with 5 replicates of nuts, after which the dishes were incubated in the incubator at a temperature of 25°C for five days, and during this period the growth of the fungi was monitored (Kazim, 2017).

Second: Testing the ability of warehouse insects to transmit fungi to stored nuts

1 - Seed safety test

Intact nuts were collected from the markets (almonds, walnuts, pistachios, macadamia) weighing 1 kg for each type and placed in polyethylene bags and transported to the laboratory and placed in the refrigerator at a temperature of 5°C for 72 hours for the purpose of protecting them from infestation by insects and fungi (Kazim, (2017).

2- Treating samples with insects to test their ability to transmit fungi

The nuts were planted in plastic containers sterilized with 70% ethyl alcohol. The size of the container was 10 The samples were preserved for 15 days under laboratory conditions, after which the fungi were isolated from nuts treated with insects, as previously mentioned.

RESULTS AND DISCUSSION :

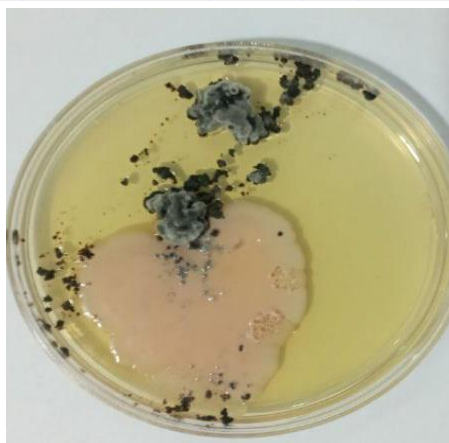
The results showed 300 isolates of fungi belonging to different genera and species. The isolates were diagnosed based on the phenotypic characteristics of the fungus in comparison with those known species, based on the foundations of diagnosis, such as the color and shape of the fungal colony, the appearance of the spores, the shape of the reproductive body, as well as the characteristics of the mycelium. The diagnostic results showed the presence of the fungus *Rhizopus spp* in all Types of nuts (walnuts, almonds, pistachios, corn, pumpkin seeds, macadamia, sunflowers, peanuts) at a rate of 40%, as shown in Table No. (1), which is the highest percentage of occurrence, at 120 isolates, because the fungus is fast-growing and prefers the use and decomposition of stored foods. And agricultural products, and thus it is the most widespread species (Harles , 2021). And *the Aspergillus niger fungus* appeared At a rate of 26.66%, with a rate of 80 isolates, it is the most common after the *Rhizopus spp* fungus due to its ability to grow on foodstuffs with low water content. This is similar to what was found by (Kazim, 2017), as he isolated it from walnut samples at a rate of 50%, and the *Aspergillus Flavus* fungus recorded a rate of 13.33%, which is 40 isolates out of the total isolates, and the presence of the *Penicillium fungus* appeared at a rate of 11.66% (35 isolates), and the *Fusarium fungus* was diagnosed from nuts, especially pistachios, as it appeared at a rate of 0.6% (2 isolates). As for the rest of the fungi, *A.versicolor* *Alternaria alternata* and *Aspergillus _ paraciticus* And *Rizocotania* appeared as a result of one isolate of each fungus.

The presence of the above-mentioned fungal species in stored nuts may be due to the characteristics that these fruits possess in terms of nutritional content, such as carbohydrates, fats, proteins, and starches, which are important for the growth of fungi, especially the fungus *Aspergillus flavus*, as the formation of mold is linked to the quality of the organic materials on which it feeds (Shaker *et al.*, 2012).

The reason for the appearance of all types of *Aspergillus* fungi is due to the species of this genus having the ability to secrete a large number of enzymes that decompose food materials, as well as their wide spread, especially since some types of *Aspergillus* can grow in low moisture content, in addition to the density of the spores they produce (Eaton *et al.* , 1994).



Rizocotonia



Aspergillus versicolor



Pencillium



Fusarium



Aspergillus niger flavus



Aspergillus

Picture (1) of fungi isolated from nuts

RESULTS OF DIAGNOSED FUNGI

The test results showed that there are two genera of fungi, one of which represents Pencillum and the other represents Aspegllius flavus and niger . The Aspegllius flavus fungus showed a great possibility of being transmitted through the storage insects represented by the khapra, the rusty beetle, the predatory bug, the sawtoothorax, and the Indian flour moth. The transmission of the Aspegllius flavus fungus through the Indian flour moth was recorded. And the khapra, the rusty beetle, and the predatory bug. As for the pencillum , it was transmitted by two insects, the saw-thorax beetle and the rusty beetle. The isolation results showed that the control group not treated with insects was free of the appearance of any type of fungi. This indicates the role of warehouse insects in transmitting fungi and their ability to rapidly transmit and spread fungi on nuts. It is due to the attachment of fungal spores, or the reproductive parts of the fungus, to the insect’s body appendages, which are represented by the hairs on the body and antennae. The ability of insects to transmit this group of fungi is due to the fact that these fungi do not secrete enzymes that decompose the insect’s cuticles, and they are opportunistic fungi that can harm the insect with wounds or wounds. Other pathogenic causes help the fungus penetrate the insect and destroy it (Al-Hadlak et al., 2007).

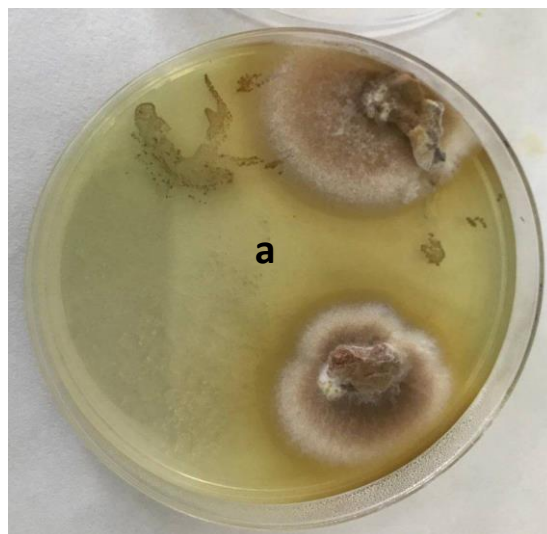
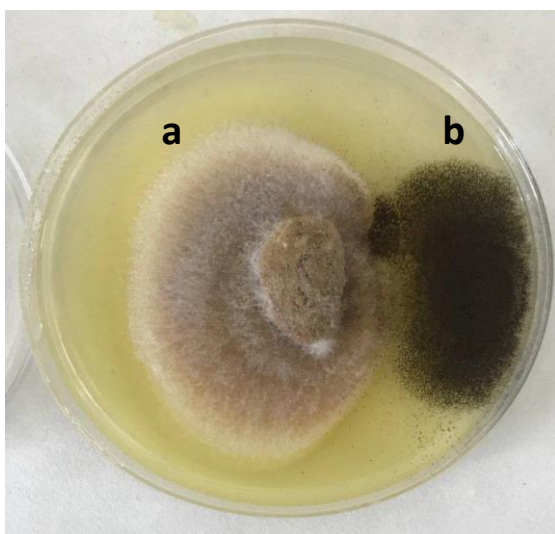
Table (1) shows the ability of insects to transmit fungi on stored nuts

The vector insect					Fungi
Xylocoris flavipes	Cadra Cautella	Tribolium castaneum	Onyzaphillus surinamensis	Trogoderma granariu	
-	-	-	-	-	A. verticolar

-	-	-	-	-	<i>Alternaria alternata</i>
+	+	+	+	+	<i>Aspergillus flavus</i>
+	+	+	-	+	<i>Aspergillus niger</i>
-	-	-	-	-	<i>Aspergillus paraciticus</i>
-	-	-	-	-	<i>Fusarium</i>
-	-	+	-	+	<i>Penicillium</i>
-	-	-	-	-	<i>Rhizopus spp</i>
-	-	-	-	-	<i>Rizocotania</i>

The sign (+) means the insect is transmitting the fungus

- The sign (-) means that the insect does not transmit the fungus



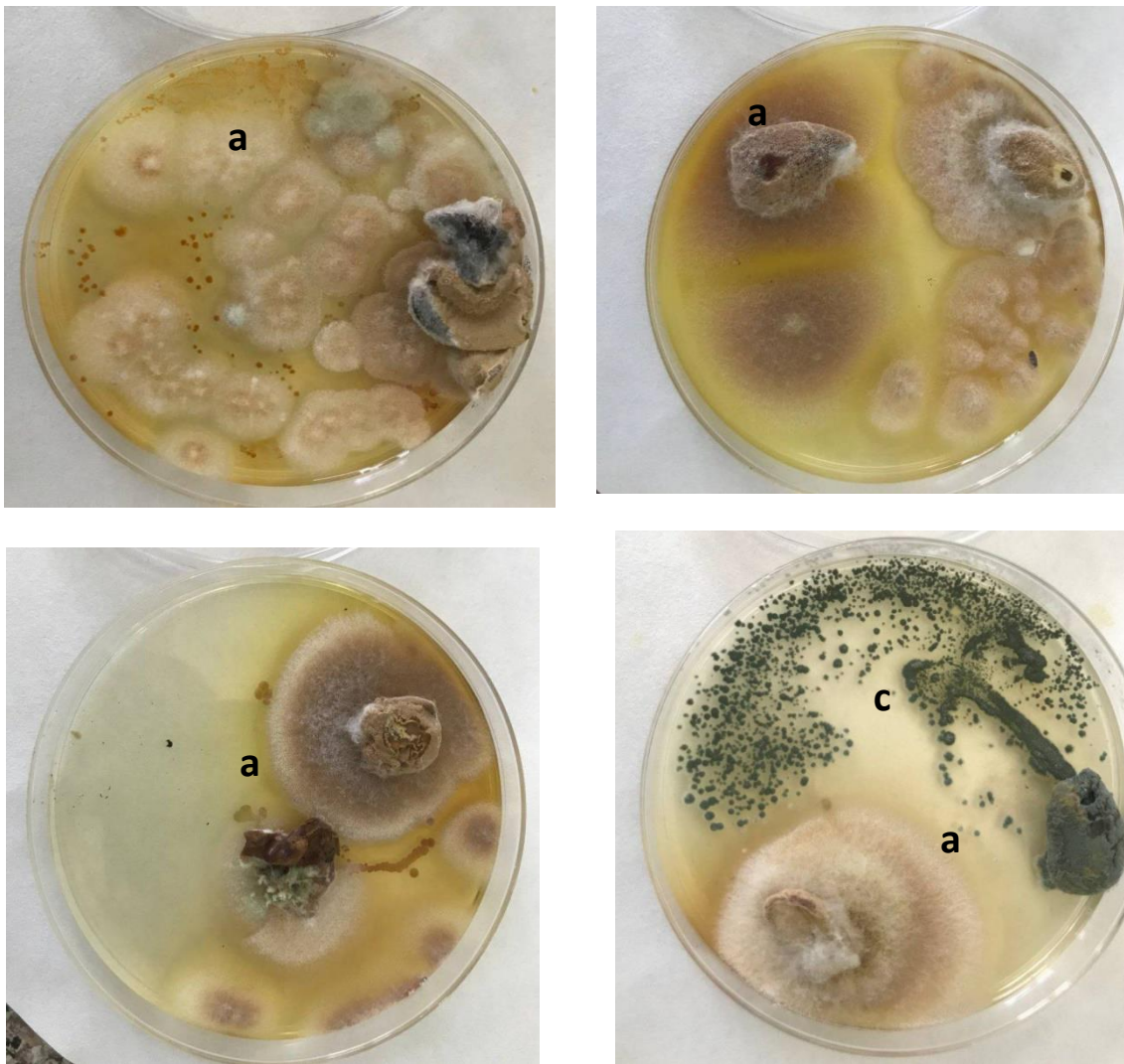


Image (2) shows isolates of fungi transmitted by insects
a- *Aspergillus flavus* b- *Aspergillus niger* c- *Penicillium*

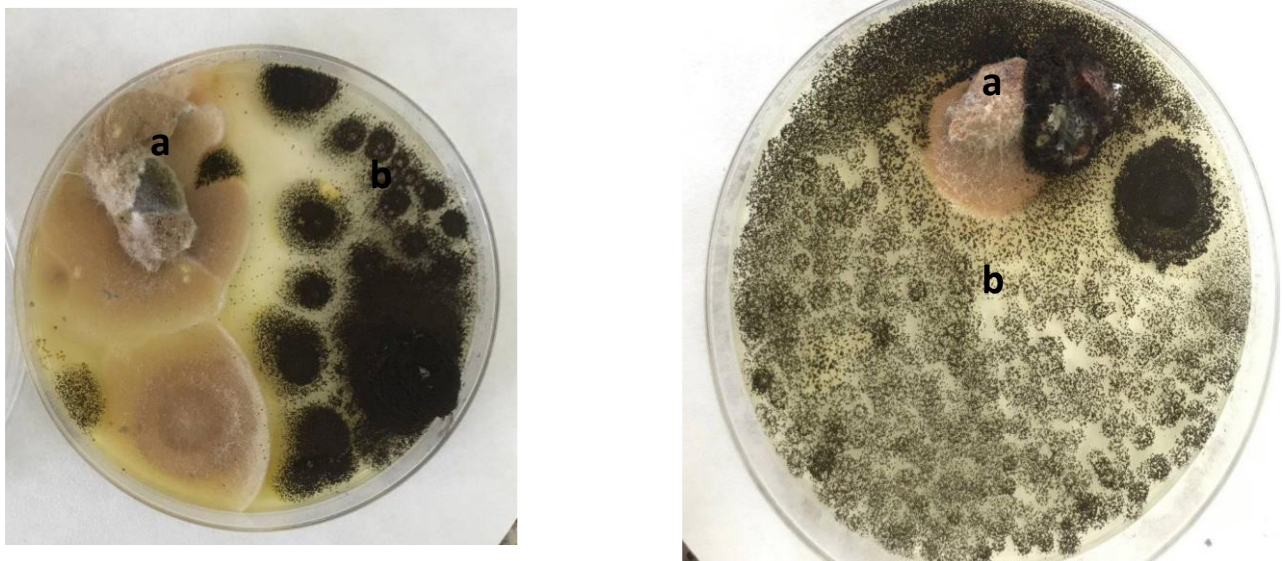


Image (3) shows fungal isolates transmitted by insects
a- *Aspergillus flavus* b- *Aspergillus niger*

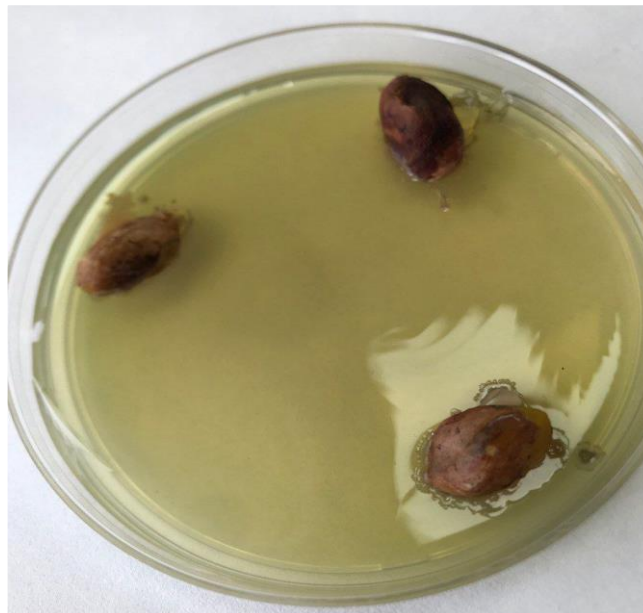


Image (4) represents the control group

CONCLUSIONS

1. Many fungal species have been isolated from nuts
2. The study showed variation in the appearance of the types of isolated fungi
3. The study proved the possibility of warehouse insects in transmitting fungi on stored nuts
4. Warehouse insects showed differences in their ability to transport nuts.

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