Volume 11, Issue 1 (2023) pp. 1-9 DOI: 10.22034/ijabbr.2023.1974052.1422

*Original Article*

# Efficacy of *Ammi majus* (Apiaceae) and *Mentha microphylla* (Labiatae) as Protectants of Wheat Grain Against *Sitophilus oryzae* L. (Coleoptera: Curculionidae)

**Seham Mansour Ismail***

Insect Population Toxicology Department, Central Agricultural Pesticides Laboratory, Agriculture Research Center, 12618, Giza, Egypt

*Corresponding Author E-mail: Seham.Ismail@arc.sci.eg

Received: 2022-12-17, Revised: 2023-01-09, Accepted: 2023-01-29

**ABSTRACT**

**Background:** Rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae) which is one of the most common species to infect wheat during storage. Low effectiveness of the chemical control strategy against this pest has been reported. Plant extracts either essential oils or powders have been reported to be an interesting source of new botanical pesticides due to their activity against various insect pests.
**Methods:** The effect of leaf powders of Khella, *Ammi majus* (Family: Apiaceae) and Spearmint, *Mentha microphylla* (Family: Labiatae) against *S. oryzae* as well as the effect on germination was tested after six months of wheat storage compared with untreated wheat.
**Results:** The efficacy of *A. majus* and *M. microphylla* leaf powders as insecticides against rice weevil was differed depending on the type of plant, time, and dose. *A. majus* and *M. microphylla* leaf powders proved toxic to *S. oryzae* at 2.0, 5.0, and 8.0 g/10.0 g wheat grain, although they differed in their efficacy. At the end of six months of treatment, *A. majus* leaf powder at 8.0 g/10.0 g wheat grain considerably outperformed *M. microphylla* leaf powder in terms of mortality rate (80.59) and adult emergence inhibition (25.51%) of *S. oryzae*. The usage of the powders considerably reduced grain damage and rice weevil infestation after 180 days of treatment (≈six months), resulting in treated wheat grains germinating by more than 70% compared with untreated wheat grains by only 24%.
**Conclusion:** Leaf powders of *A. majus* and *M. microphylla* protecting stored wheat grains from rice weevil infestation after six months of treatment, so they can be used as a potential control in IPM programs.
**Keywords:** Khella, Plant powders, Rice weevil, Spearmint, Wheat storage

## 1. Introduction

Since bread, macaroni, and other baked items made from wheat are a staple in the diets of most Egyptians, wheat is a significant cereal crop that ranks first among food and strategic crops in Egypt. Likewise, wheat straw is used as animal feed [1]. The stored wheat grains are liable to be attacked by many insect pests which results in huge economic losses, leading to their loss in terms of quality, quantity, and eventual decline in market value [2].

Rice weevil, *Sitophilus oryzae* Linnaeus cause severe damage to cereal grains, through direct feeding on grain kernels. It originated from India, spread around the world by commerce and now has a cosmopolitan distribution [2]. In Egypt in particular and Africa in general, this pest is one of the most destructive insect pests of stored grain crops that causes 10-65% damage under moderate storage conditions, while it accounts for 80% under prolonged storage conditions [3]. This pest causes loss in grain weight, nutritional value decline, end use quality deterioration in addition to the low rate of seed germination [2]. In Egypt, large wheat losses of about 10-20% [4] were recorded due to the infection with this pest during long-term storage (≈six months) in government warehouses, which are locally called “Shona”. Therefore, the control of this pest is very important, and chemical control is the most important and most widely used, but the indiscriminate and uncontrolled use by farmers led to the development of resistance and thus its ineffectiveness [5].

Various methods have been developed and used to control stored pests, in particular, powders from plant sources, which have given promising results to control several Coleopteran stored pests, such as such as *Callosobruchus maculatus* (Fab.) [6], *S. granarius* (L.) [7], *S. zeamais* (Motsch.) [8], and *Tribolium castaneum* (Herbst) [9]. However, there is no information on the evaluation of Khella, *A. majus* (Apiaceae) and Spearmint, *M. microphylla* (Labiatae) leaf powders as an insecticide for *S. oryzae*. In light of the foregoing, the objective of this study was to assess the efficacy of powdered extracts obtained from two different species of plants: *A. majus* and *M. microphylla* in protecting stored wheat grains from rice weevil (*S. oryzae*) infestation to reduce the heavy loss of wheat grains in terms of quantity and quality deterioration during storage in “Shona” for a long period of about six months.

## 2. Materials and Methods

### 2.1. Insect culture

*Sitophilus oryzae* L. cultures were kept in a controlled temperature and humidity environment (28 ± 2 °C and 70% ± 5% RH) with 12-h cycles of light and darkness. Adults were acquired from stock cultures at the Central Agricultural Pesticides Laboratory, Agriculture Research Center, Giza, Egypt, Department of Insect Population Toxicology. The insects were given whole wheat grains as meals.

### 2.2. Collection and preparation of plant powders

In the El-Fayoum Governorate of Egypt, fresh leaves of Khella, *A. majus* (Khela, Umbelliferae, Family Apiaceae), and Spearmint, *M. microphylla* (Habq El bahr, Family Labiatae), were collected. They were then taken right away to the laboratory (Figure 1). Thereafter, they were washed with running water to clean them of dust. The leaves were harvested, dried for seven days at room temperature in a shady, well-ventilated area, and then powdered using an electric grinder. The powder was then sieved through a 0.5 mm mesh to ensure particle size consistency. The powders were kept at room temperature in airtight plastic containers before being used in the tests.


**Figure 1.** The plants used in the experiment: (A) *Ammi majus* and (B) *Mentha microphylla.*

### 2.3. Laboratory experiments

To determine the effects of *A. majus* or *M. microphylla* leaf powders on adults of *S. oryzae*, 10 g of clean, uninfested wheat grain were combined with 2.0, 5.0, or 8.0 g of each plant powder in each plastic jar (250 mL). Powder/grain admixtures were thoroughly shaken for 15 min to ensure complete mixing homogenization. Then, 5 copulating pairs (5 males: 5 females) of newly emerged adults of *S. oryzae* were introduced into each cups and covered with muslin cloths. To ensure accuracy of the data, four replicates were performed for each treatment along with the control. The jars stored in conditions similar to those of rearing chamber rearing for 30 days. To estimate mortality and adult emergence were counted at 30 days after treatment as well as the grains were segregated and weighed into undamaged and insect damaged grains, the percent weight loss of wheat grains in storage was then calculated, as follows Gwinner *et al.* [10].

$$\% \, WL = \frac{UNd - DNu}{U(Nd + Nu)} \, x \, 100,$$

Where, WL percent weight loss, U is the weight of undamaged grains, D is the weight of damaged grains, Nu is the number of undamaged grains, and Nd is the number of damaged grains.

To assess the effects of *A. majus* or *M. microphylla* leaf powders at 8.0 g on adults of *S. oryzae* for 180 days (≈six months) were mixed with 10 g clean uninfested wheat grain in each plastic jar (250 mL). Powder/grain admixtures were thoroughly shaken for 15 min to ensure complete mixing homogenization. Then, 5 copulating pairs of newly emerging *S. oryzae* adults (5 males: 5 females) were put into each cup and covered with muslin cloths. To ensure accuracy of the data, four replicates were performed for each treatment along with the control and six groups were established. The jars were kept for six months (maximum storage period in the Shona in Egypt) in surroundings akin to a rearing chamber. At 1, 2, 3, 4, 5, and 6 months after treatment, counts of adult emergence and mortality were made. In the first set, insect emergence and mortality were measured 30 days after treatment, and the grains were weighted separately for undamaged and insect-damaged grains. Next, the percent weight loss was computed according to the method described in Gwinner *et al.* [10]. Thereafter, the first set of treated and untreated wheat was removed and discarded. Other groups were opened monthly, for six months (after treatment).

For the purpose of the germination test, random seed samples from each group were individually placed in Petri dishes with wet filter paper. Grains germination percentage were computed after 7 days of planting as follows:

% Germination = (Number of seeds germinated/Total number of seeds) × 100.

### 2.4. Statistical analysis

One-way analysis of variance was used to statistically analyse the collected data (ANOVA). The Tukey multiple range test (P ≤ 0.05) was used to determine any differences between the treatments.

## 3. Results

### 3.1. Effect of *Ammi majus* and *Mentha microphylla* leaf powders on the mortality and emergence of *Sitophilus oryaze* adult

The results showed the insecticidal efficacy of *A. majus* and *M. microphylla* leaf powders at 2.0, 5.0, and 8.0 g/10.0 g wheat grains, and effects varied according to plant species and dose on *S. oryaze* (Table 1). *A. majus* leaf powder at 8.0 g/10.0 g wheat grains caused 100.0% mortality to rice weevil and complete inhibited adult emergence as well as no weight losses recorded up to 30 days after treatment followed by *M. microphylla* leaf powder, while their effect gradually decreases by reducing the dose.

Data provided in Table 2 and Figure 2 demonstrate that *A. majus* and *M. microphylla* leaf powders at 8.0g/10.0g wheat grains demonstrated a substantial difference in mortality and emergence of adult *S. oryaze* compared to compare to untreated wheat grain. From 100.0 to 62.00% of weevils' mortality, and from 36.11 to 1.23% of adults' emergence. *A. majus* leaf powder was the most potent which resulted in 80.59% death and 25.51% adult emergence at the end of the six-month therapy period, *M. microphylla* leaf powder caused 62.00 and 36.11%, respectively. The findings demonstrated that as exposure time increased, adult weevil mortality dropped. There was a significant difference (P≤ 0.05) in wheat grain treated with *A. majus* leaf powder compared with *M. microphylla* leaf powder where *A. majus* had lower infection with weevils.

**Table 1.** Effect of *Ammi majus* and *Mentha microphylla* leaf powders at different doses on mortality, emergence of adult *Sitophilus oryzae,* and weight loss of wheat grains after 30 days of storage.

| Treatment | % Adult mortality | % Adult emergence | % Weight loss |
|---|---|---|---|
| *Ammi majus* | | | |
| (2 g/10.0 g wheat grain) | 85.22 (3.88) | 9.00 (1.90) | 7.56 (0.51) |
| (5 g/10.0 g wheat grain) | 93.93 (1.19) | 5.00 (1.89) | 2.00 (0.03) |
| (8 g/10.0 g wheat grain) | 100.0 (0.00) | 00.00 (0.00) | 0.00 (0.00) |
| *Mentha microphylla* | | | |
| (2 g/10.0 g wheat grain) | 71.48 (11.23) | 15.00 (1.89) | 14.56 (2.34) |
| (5 g/10.0 g wheat grain) | 84.22 (8.75) | 7.67 (5.94) | 8.33 (1.68) |
| (8 g/10.0 g wheat grain) | 96.54 (5.04) | 3.23 (1.70) | 1.33 (0.08) |
| Control | | 52.59 (4.31) | 22.89 (6.58) |

Means standard error (±SE) followed no significant difference (P≤ 0.05) in a by the same letter within columns Tukey test.

**Table 2.** Effect of *Ammi majus* and *Mentha microphylla* leaf powders on mortality and emergence of adult *Sitophilus oryzae* during different storage months.

| Treatment (8.0 g/10.0 g wheat grain) | Storage months | % Adult mortality | % Adult emergence |
|---|---|---|---|
| *Ammi majus* | 1 | 100.0 (0.00) | 00.0 (0.00) |
| | 2 | 97.65 (1.22) | 1.23 (0.02) |
| | 3 | 93.14 (9.12) | 6.33 (2.48) |
| | 4 | 89.03 (8.22) | 14.88 (0.73) |
| | 5 | 86.22 (4.50) | 20.44 (3.03) |
| | 6 | 80.59 (2.09) | 25.51 (2.37) |
| *Mentha microphylla* | 1 | 92.79 (14.26) | 4.77 (0.04) |
| | 2 | 89.26 (6.37) | 11.61 (0.51) |
| | 3 | 84.95 (9.53) | 21.45 (1.58) |
| | 4 | 79.55 (4.56) | 27.54 (5.61) |
| | 5 | 73.00 (3.02) | 33.66 (0.10) |
| | 6 | 62.00 (3.53) | 36.11 (6.57) |
| Control | 1 | | 98.00 (0.68) |
| | 2 | | 98.21 (7.35) |
| | 3 | | 98.27 (7.27) |
| | 4 | | 98.38 (8.33) |
| | 5 | | 98.41 (8.84) |
| | 6 | | 98.59 (2.02) |

Means standard error (±SE) followed by the same letter within columns no significant difference (P≤ 0.05) in a Tukey test.

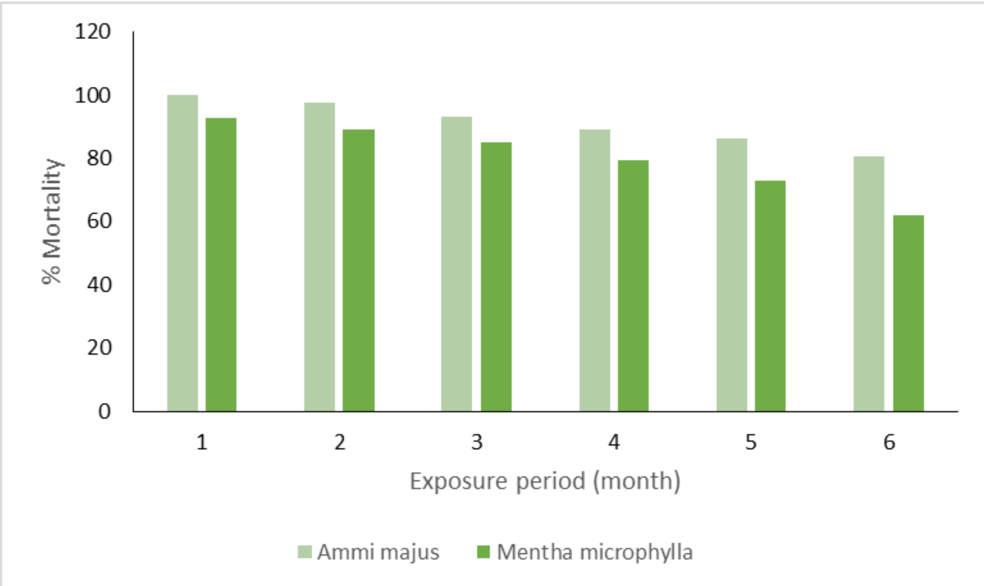


**Figure 2.** Effect of *Ammi majus* and *Mentha microphylla* leaf powders (8.0g/10.0g wheat grain) on *Sitophilus oryzae* adult mortality.

### 3.2. Effect of *Ammi majus* and *Mentha microphylla* leaf powders on grain weight loss and germination

Data indicated in Table 3 and Figure 3 show that leaf powder of *A. majus* recorded the highest germination percentage (84.09%) and the lowest weight loss (23.50%) in the treatments of wheat grain against *S. oryzae*, and the same trend was seen in wheat grain treated with *M. microphylla* leaf powder, scoring 70.04%, and 38.00%, respectively, at the end of six months of storage, while the untreated wheat grains recorded the lowest germination percentage (24.00%) with the highest weight loss (98.20%).

**Table 3.** Effect of *Ammi majus* and *Mentha microphylla* leaf powders on weight loss and germination of wheat grains during different storage months.

| Treatment (8.0 g/10.0 g wheat grain) | Storage months | % Weight loss | % Germination |
|---|---|---|---|
| *Ammi majus* | 1 | 0.00 (0.00) | 100.0 |
| | 2 | 3.34 (1.18) | 100.0 |
| | 3 | 8.29 (3.43) | 97.27 |
| | 4 | 11.21 (1.83) | 93.15 |
| | 5 | 17.04 (0.13) | 89.00 |
| | 6 | 23.50 (6.23) | 84.09 |
| *Mentha microphylla* | 1 | 4.66 (0.48) | 98.23 |
| | 2 | 14.87 (1.96) | 97.00 |
| | 3 | 20.32 (7.33) | 93.11 |
| | 4 | 26.62 (6.38) | 90.20 |
| | 5 | 33.92 (15.79) | 82.23 |
| | 6 | 38.00 (7.00) | 70.04 |
| Control | 1 | 49.39 (9.00) | 89.66 |
| | 2 | 68.88 (4.76) | 78.05 |
| | 3 | 75.56 (7.02) | 60.45 |
| | 4 | 87.11 (10.98) | 47.33 |
| | 5 | 96.44 (4.30) | 33.00 |
| | 6 | 98.20 (13.17) | 24.00 |

Means standard error (±SE) followed by the same letter within columns indicate no significant difference ($P \leq 0.05$) in a Tukey test.

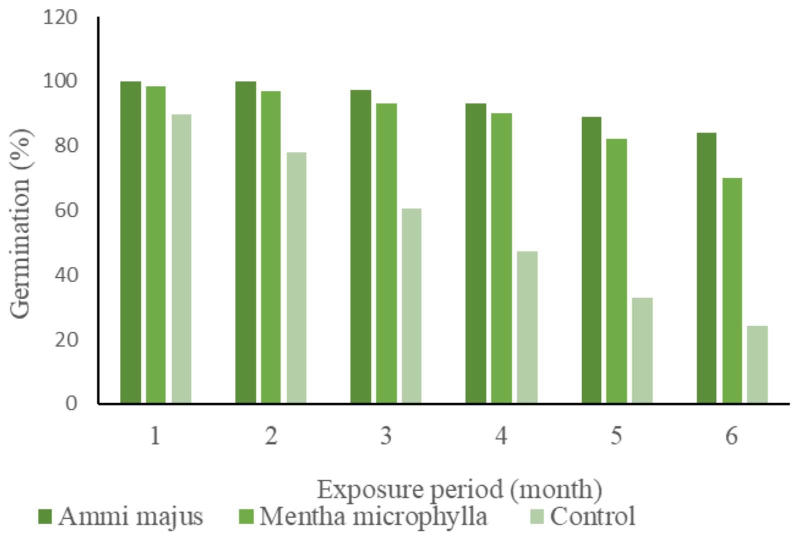


**Figure 3.** Germination percentage affected by storage periods and infection with *Sitophilus oryzae*.

## 4. Discussion

Plant extracts as powders or essential oils are potentially value in the control of storage pests [11,12,13]. In this study, the insecticidal efficacy of *A. majus* and *M. microphylla* leaf powders in protecting wheat grains during long storage (≈six months) was investigated against the rice weevil, *S. oryzae*. The results showed that *A. majus* and *M. microphylla* leaf powders had insecticidal effects on weevils. These effects varied based on the plant species, time period, and dose. In line with these findings, the earlier research on powders taken from other plant species, such as *Acorus calamus* L. and *Annona squamosal* L. [14] has shown to be effective alternatives to hazardous chemicals for suppressing *S. oryzae* [9].

Powders of *A. majus* and *M. microphylla* were effective in protecting wheat grains from infestation because they recorded the highest mortality rate and reduced the adult emergence in treated wheat grains. Present findings line with those of Devi *et al.* [15]; Govindan *et al.* [14]; Ismail and Sleem (2021) [9] reported reduced damage of grains treated with leaf powder extracts from different plant species due to their effect on mortality and adult emergence of *S. oryzae*.

Leaf powders of *A. majus* and *M. microphylla* were significantly effective in protecting wheat from weevil infestation and weight loss for up to six months of storage, which is reflected in an increased percentage of grain germination than the control group, these findings concur with Govindan *et al.* (2020); Mehta and Kumar (2020) [14,16].

## 5. Conclusion

According to the findings, *A. majus* and *M. microphylla* leaf powders exhibit a wide spectrum of negative effects on *S. oryzae*. These powders cause severe mortality, and decreased adult emergence. In addition, this study offers evidence in favour of the leaf powders of *A. majus* and *M. microphylla* as a potential source of natural insecticides, which can also be employed as a tool to control rice weevil populations for prolonged storage periods of wheat.

*Ammi majus* and *Mentha microphylla* leaf powders protecting stored wheat grains from rice weevil (*Sitophilus oryzae*) infestation after 180 days (≈six months) of treatment.

## Highlights

► The present work throw light on the influence of *A. majus* and *M. microphylla* powders in wheat grain at different storage periods against the rice weevil, *S. oryzae* L. ► Leaf powders of *A. majus* and *M. microphylla* have revealed insecticidal as well as propitious protective effect on wheat grains against weevil invasion for up to six months' storage. ► Major bioactivity against this pest is manifested by reduced the progeny and high mortality.

## List of abbreviations

Not applicable.

## Declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article. The authors declare that there is no conflict of interest.

## Authors' contributions

S.M.I. subject selection, study design, carried out the experiments, paper writing, collecting, interpretation of the data, and performing statistical analysis. The author read and approved the final manuscript.

## Consent for publications

The author agrees to have read the manuscript and authorize the publicationof the final version of the manuscript

## Conflict declaration

The authors declare that there is no conflict.

## Conflict of interest

None of the authors have any conflict of interest to declare.

## Availability of data and material

Data are available on request from the authors.


## Funding/Support

Not applicable.


## Ethics approval and consent to participate

Not applicable.


## Acknowledgements

Not applicable.



## ORCID

https://www.orcid.org/0000-0002-4885-7383


## References


1. Ministry of Agriculture & Land Reclamation (MALR). Bulletins of Food Ballance Sheet (2000–2019); Ministry of Agriculture & Land Reclamation (MALR): Cairo, Egypt, 2021. [Crossref], [Google Scholar], [Publisher]
2. FAO-Food and Agriculture Organization of the United Nations—Representation in Egypt. Food Loss and Waste in Egypt. Cairo, Egypt. 2019. Available online. (accessed on 21 August 2021). [Crossref], [Google Scholar], [Publisher]
3. Hodges R J, Benard M, Rembold F. (2014). APHLIS – Postharvest cereal losses in sub-Saharan Africa, their estimation, assessment and reduction. European Commission JRC Technical Reports, 177 pp. [Crossref], [Google Scholar], [Publisher]
4. Jha A N, Shrivastava C, Dwivedi V. (2014). Effect of infestation of rice weevil, *S. oryzae* (L.). *Indian Journal of Entomology,* 76(1): 74–86. [Crossref], [Google Scholar], [Publisher]
5. Subramanyam B, Hagstrum D. (1995). Resistance measurement and management. In: Integrated Management of Insects in Stored Products. Marcel Dekker Inc., New York. 331–398. [Crossref], [Google Scholar], [Publisher]
6. Kéita SM, Vincent C, Schmidt JP, Arnason JT, Bélanger A. (2001). Efficacy of essential oil of *Ocimum basilicum* L. and *O. gratissimum* L. applied as an insecticidal fumigant and powder to control *Callosobruchus maculatus* (Fab.) (Coleoptera: Bruchidae). *Journal of Stored Products Research*, 37(4): 339–349. [Crossref], [Google Scholar], [Publisher]
7. Tapondjou LA, Adler C, Bouda H, Fontem D A. (2002). Efficacy of powder and essential oil from *Chenopodium ambrosioides* leaves as post-harvest grain protectants against six-stored product beetles. *Journal of Stored Products Research,* 38(4): 395–402. [Crossref], [Google Scholar], [Publisher]
8. Gadewar R, Babhulkar V, Lambat P, Lambat A, Parate R, Charjan S. (2017). The influence of some botanicals against rice weevil during storage in Rabi sorghum, *International Journal of Research in Biosciences Agriculture and Technology*, V(1): 28–30. [Crossref], [Google Scholar], [Publisher]
9. Ismail S M, Sleem F M A. (2021). Toxicity and residual effect of *Annona squamosal* L. and *Piper nigrum* L. seeds

extracts against *Tribolium castaneum* and *Sitophilus oryzae*. *International Journal of Science and Research,* 10(12): 517–523. [Crossref], [Google Scholar], [Publisher]
10. Gwinner J, Harnisch R, M¨uck O. (1996). "Manual of the prevention of post-harvest grain losses," Post-Harvest Project, GTZ, D-65726, Eschborn, Germany. [Crossref], [Google Scholar], [Publisher]
11. Ismail S M. (2022). Fumigant residual impacts of *Melaleuca alternifolia* (Maid. & Betche) Cheel. (Myrtales: Myrtaceae), Terpinen-4-ol, and γ-Terpinene on *Sitophilus oryzae* L. (Coleoptera: Curculionidae) and on germination of wheat seeds. *Journal of Plant Protection Research,* 62(3): 258–264. [Crossref], [Google Scholar], [Publisher]
12. Yankanchi S R, Gadache A H. (2010). Grain protectant efficacy of certain plant extracts against rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae). *Journal of Biopesticides,* 3(2): 511–513. [Crossref], [Google Scholar], [Publisher]
13. Rajeswari R, Srinivasan M R. (2019). Efficacy of different botanicals against rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae) in stored paddy seeds. *Madras Agricultural Journal,* 106(7-9): 533–536. [Crossref], [Google Scholar], [Publisher]
14. Govindan K, Geethanjali S, Douressamy S, Pandiyan M, Brundha G. (2020). Effect of ten insecticidal plant powders on rice weevil, *Sitophilus oryzae* L. and grain weight loss in stored sorghum. *Journal of Agricultural and Biological Science*, 9(5): 2700–2709. [Crossref], [Google Scholar], [Publisher]
15. Devi B M, Devi V N, Singh N S. (2014). Effects of six botanical plant powder extracts on the control of rice weevil, *Sitophilus oryzae* L. in stored rice. *International Journal of Agriculture Innovations and Research*, 2(5): 683–686. [Crossref], [Google Scholar], [Publisher]
16. Mehta V, Kumar S. (2020). Influence of different plant powders as grain protectants on *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae) in stored wheat. *Journal of Food Protection,* 83(12): 2167–2172. [Crossref], [Google Scholar], [Publisher]

**How to cite this article**: Seham Mansour Ismail*. Efficacy of *Ammi majus* (Apiaceae) and *Mentha microphylla* (Labiatae) as Protectants of Wheat Grain Against *Sitophilus oryzae* L. (Coleoptera: Curculionidae). *International Journal of Advanced Biological and Biomedical Research,* 2023, 11(1), 1-9. Link: http://www.ijabbr.com/article_701681.html