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## EFFICACY OF SOME MEDICINAL PLANTS AGAINST RICE WEEVIL, *SITOPHILUS ORYZAE* L. AND RED FLOUR BEETLE *TRIBOLIUM CASTANEUM* (HERBST)

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### Abstract

**Objective:** Plant extracts are safe and alternate methods for the control of stored product pests. Present study was conducted to evaluate mortality and repellency effect of three medicinal plants viz. peppermint (*Mentha piperita*), sage (*Salvia officinalis*) and feverfew (*Tanacetum parthenium*) against Rice weevil, *Sitophilus oryzae* L. and Red flour beetle, *Tribolium castaneum* (Herbst).

**Methodology:** Fresh leaves of all plants were chopped into small pieces and dried in shade at room temperature. The dried leaves were minced into fine powder with an electric blender. Dry powder of each plant sample (10g) was soaked in 100 mL of methanol and placed on electric shaker for 24 hours. The extract was filtered by using filter paper and concentrated in a rotary evaporator.

**Results:** The results indicated that all of the medicinal plant extracts had repellent and fatal effects against the insect as compared to control. Among the three different plant extracts, *Mentha piperita* proved as the most effective treatment showed maximum mortality of 35.48% in *Tribolium castaneum* and 38.33% in *Sitophilus oryzae*. Present study also revealed that all the tested plant extracts significantly repelled the insects. *Tanacetum parthenium* exhibited high repellency of 4.52% and 5.95 % against *Tribolium castaneum* and *Sitophilus oryzae* respectively, while no repellency was observed in control treatment.

**Conclusion:** It is concluded that the application of these medicinal plants may be promising in protecting the stored products against insect pests without hazardous effects.

**Keywords:** Botanical insecticide, Fever few, Pest, Peppermint, Sage, *Sitophilus oryzae*, Stored grains, *Tribolium castaneum*

## INTRODUCTION

Cereal grains are staples in the diets of human beings and domestic animals. Consequently, their conservation is necessary to have this basic food available on an ongoing basis (1). Red flour beetle is a serious stored pest grain throughout the world specifically in tropical and subtropical areas (2). These pests destroy 10-20% stored pest products annually and the monetary loss can be even worse if they are not properly kept under controlled conditions in ware houses (3). The consequences of this menace, caused by these insects, impacts both quality and quantity of stored products (4) and their droppings affects the tastes and set forth a bad aroma to the attacked stock (5) because their fecal matter contains benzoquinones (6).

Such destruction may reach up to 40%, in countries where modern storing technologies have not been introduced (7). Insects are the main pests of grains and grain products during storage (8). Stored insect pests are responsible for 9% post-harvest losses in developed countries and more than 20% in developing countries (9). Rice weevil and red flour beetle are important pests of stored grains (10). These different pests are found to seriously damage both quality and quantity of stored products, thereby reducing their shelf lives (11). Both adults and larvae also feed on grain dust and broken grains, but damaged the whole grains and spend their entire life cycle outside grain kernels (12). Rice weevil, *Sitophilus*



*oryzae* L. is one of the most important pests of stored grain in the world. Larvae are legless and remain in the grain kernel for their entire life (13). Both larvae and adults can reduce wheat grain weight by 75 % (14).

Synthetic pesticides have been considered the most effective and accessible means to control insect pests of stored products (1). However, insecticides have serious drawbacks such as pest resurgence and resistance, the risk of users' contamination, food residues, lethal effects on non-target organisms, and environmental pollution (15). Plants can be a bountiful store of biochemical agents that may serve as prospective substitutes for a chemically oriented strategy (16). Botanical insecticides as compared to chemical insecticides may be safe for the environment, cheap, easily processed and used by farmers and small industries (17). So, the recent research reveals that herbal extracts can be used as potential pesticides (18). Since botanical insecticides are effective against a restricted number of organisms, are biodegradable to harmless products, are potentially fit for use in integrated pest management, and could lead to the development of new means of safe pest control agents (19). These organic extracts are ideal in contrast to man-made chemical insecticides as they are environmentally safe products (20).

Kundu *et al.* (2007) evaluated the toxicity, repellency and residual effects of bishkatali plant extracts against *Tribolium castaneum* (21). Mamun *et al.* (2009) investigated the toxicity of six plants, Bazna (*Zanthoxylum rhetsa*), Ghora-neem (*Melia sempervirens*), Hijal (*Barringtonia acutangula*), Karanja (*Pongamia pinnata*), Mahogoni (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) against red flour beetle (22). Manzoor *et al.* (2011) tested the repellent and lethal effects of five plants extracts i.e Bakain, Mint, Habulas, Lemongrass and Datura against three stored grain pests including *Tribolium castaneum* (23). Kumar *et al.* (2011) studied the adulticidal, larvicidal and growth/reproduction inhibition effects of *Mentha* species against *Tribolium castaneum* and *Sitophilus oryzae* (24). Auamcharoen *et al.* (2012) reported toxic and repellent properties of *Duabanga grandiflora* against *Sitophilus oryzae* (25). Khan (2014) investigated the repellent effect of medicinal plants against *Tribolium castaneum* Herbst (26).

The objective of the present study was to test the efficacy of three herb extracts *Mentha piperita*, *Salvia officinalis* and *Tanacetum parthenium* against two important stored pests *Tribolium castaneum* and *Sitophilus oryzae*.

## MATERIALS AND METHODS

This research was carried out at research laboratory of Zoology, SBKWU, Quetta, Pakistan

### REARING OF INSECTS

Insects were reared in Laboratory at 28 -30°C temperature and 70-75% of relative humidity. Rice and wheat flour were used as culture media for *Sitophilus oryzae* and *Tribolium castaneum* respectively. 7-14 days old adults were used for the bioassay.

### COLLECTION OF PLANTS

Fresh leaves of three plants, peppermint (*Mentha piperita*), sage (*Salvia officinalis*) and fever few (*Tanacetum parthenium*) were collected in March, 2015 from the Medicinal Garden of BARDC, Quetta.

### PREPARATION OF PLANT EXTRACT

Plant extraction method was adopted according to Khan (2014) with some modifications. Fresh leaves of all plants were chopped into small pieces and dried in shade at room temperature. The dried leaves were minced into fine powder with an electric blender. Dry powder of each plant sample (10g) was soaked in 100 mL of methanol and placed on electric shaker for 24 hours. The extract was filtered by using filter paper and concentrated in a rotary evaporator. The extract was diluted and stored in spray bottles in the refrigerator for experimental purpose. All of these extracts were used as 1ml per 50g of grains.

### APPARATUS USED FOR EXPERIMENT

For testing the plant extracts 500 ml Plastic jars were used. Before experiment all the jars were disinfected with 90% alcohol. For each replication there was one set of two jars joined by clear plastic pipe.



One jar of each set was filled with 50 g of grains, and given the name A, while the other jar was not filled with the grains and kept empty, and given the name B. (27)

## BIOASSAYS

In all replication, before filling with the grains jar A was sprayed with plant extracts, while empty jar B was not sprayed (not treated). Twenty adults of each species were collected and placed in jar A. The mouth of each jar was covered with muslin cloth to avoid escaping of adult insects. For control no extract was applied on the grains. In total there were 4 treatments including control. There were three replications for each treatment.

## TOXICITY AND REPELLENCY OBSERVATION

The mortality and repellency data i.e. dead (in jar A and B) and alive insects (in jar B) was recorded for 7 days at an interval of 24 hours. Insects found alive in the plastic pipes were considered to have been repelled.

## STATISTICAL ANALYSIS

The data for percent mortality and percent repellency was subjected to statistical analysis using RCB. The package, used for the calculations, was M-StatC. LSD test (least significant test) was used for comparing means (28) at the 5% significance level.

## RESULTS

Figure 1 demonstrates the effect of three different treatments on mortality of *Tribolium castaneum* and *Sitophilus oryzae*. Table-I presents percent mortality of *Tribolium castaneum* observed on different days (D) in the jars. The data shows that the plant extracts had significant effect on the mortality of *Tribolium castaneum*. Among all three treatments peppermint caused maximum mortality of 78.3% on D7. In this treatment the average mortality was calculated as 35.5%. In sage the mortality was seen on the 2nd day (D2) of observations which amounted to 3.33%. Furthermore it was observed that mortality increased with increasing days and reached to 71.7% on D7. The average mortality was recorded as 29.5% in sage. Percent mortality with fever few was recorded as 1.67% on D1 and reached to 73.3% on D7. The average percentage was observed as 33.1% in this treatment. In control the mortality of beetles was observed on 3rd day where it was 1.67% and slowly increased up to 20% on D7 giving the total average mortality of only 9.05%.

Table I also presents mean percent mortality data of the red flour beetles. It shows that fever few remained non-significant from peppermint and sage. Peppermint and sage significantly differ from each other. However, all of the three plant extract proved significantly better than control. It is obvious from the table-I that among three different plants, peppermint proved to be the most effective treatment followed by fever few and sage.

The percent mortality of *Sitophilus oryzae* against different plant extracts is shown in Table II. The data shows that the tested plants had significant effect on the mortality of *Sitophilus oryzae*. Highest mortality of 85.0% was found in the peppermint extracts on D7. In this treatment average mortality was found as 38.3%. The mortality in sage treatment was observed on the 1st day (D1) of observations which amounted to 3.33%. However, mortality was increased at considerable levels i.e. 78.3% on last day (D7) of observation. The average mortality was computed as 36.4% in this treatment. In fever few percent mortality was observed as 1.67% on 1<sup>st</sup> day (D1) of observation and reach to 78.3% on D7. The average percentage was found as 35.7% in fever few treatments. In control the mortality was noticed on the 4th day of observation where it was 1.67% and gradually increased up to the maximum of 16.7% on last day (D7) giving only 5.95% average mortality.

The overall mean percent mortality data in Table-II indicated that fever few peppermint and sage remained non-significant from each other. However, all of the three plant extracts are significantly differ from control.

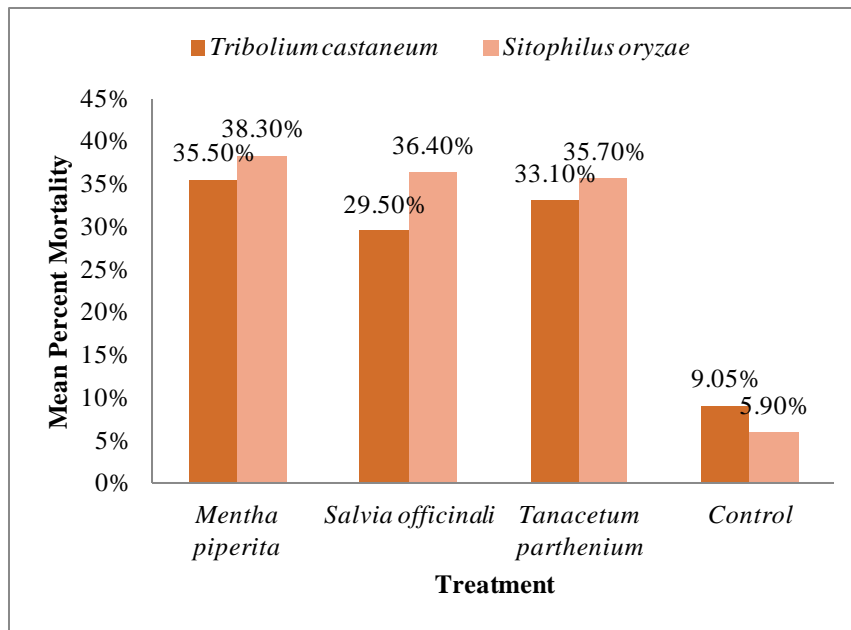


Fig. 1. Effect of treatments on Mean Percent Morality of *Tribolium castaneum* and *Sitophilus*

Table I. Mortality of red flour beetle, *Tribolium castaneum* against different treatments on different days

| S. # | Treatments  | Mortality (%) |             |             |             |             |             |             | Mean       |
|------|---|---------------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
|      |   | Day1          | Day2        | Day3        | Day4        | Day5        | Day6        | Day7        |            |
| 1    | <b>Peppermint</b><br>( <i>Mentha piperita</i> ,)    | 1.67<br>kl    | 8.33<br>i-l | 16.7<br>hi  | 36.7<br>fg  | 43.3<br>ef  | 63.3<br>bc  | 78.3<br>a   | 35.5<br>a  |
| 2    | <b>Sage</b><br>( <i>Salvia officinalis</i> )        | 0.00<br>l     | 3.33<br>jkl | 13.3<br>hij | 31.67<br>g  | 35.00<br>fg | 51.67<br>de | 71.67<br>ab | 29.5<br>b  |
| 3    | <b>Fever few</b><br>( <i>Tanacetum parthenium</i> ) | 1.67<br>kl    | 10.0<br>h-l | 10.0<br>h-l | 36.7<br>fg  | 43.3<br>ef  | 56.7<br>cd  | 73.3<br>ab  | 33.1<br>ab |
| 4    | <b>Control</b>                                      | 0.00<br>l     | 0.00<br>l   | 1.67<br>kl  | 11.7<br>h-k | 13.3<br>Hij | 16.7<br>hi  | 20.0<br>h   | 9.05<br>c  |
|      | <b>Means</b>  | 0.83<br>e     | 5.42<br>de  | 10.4<br>D   | 29.2<br>c   | 33.7<br>C   | 47.1<br>b   | 60.8<br>a   |            |

LSD value for treatments at  $\alpha$  0.05 (T) = 3.94; LSD value for days at  $\alpha$ ; 0.05 (D) = 5.21; LSD value for DxT at  $\alpha$  0.05 = 10.43; Means with different letters show significant differences (P<0.05)

Table II. Mortality of rice weevil, *Sitophilus oryzae* against different treatments on different days

| S.# | Treatments  | Mortality (%) |             |            |           |             |             |            | Mean      |
|-----|---|---------------|-------------|------------|-----------|-------------|-------------|------------|-----------|
|     |   | Day 1         | Day2        | Day3       | Day4      | Day5        | Day6        | Day7       |           |
| 1   | <b>Peppermint</b> ( <i>Mentha piperita</i> ,)       | 1.67<br>H     | 13.3<br>efg | 23.3<br>de | 33.3<br>d | 46.7<br>c   | 65.0<br>b   | 85.0<br>a  | 38.3<br>a |
| 2   | <b>Sage</b><br>( <i>Salvia officinalis</i> )        | 3.33<br>gh    | 15.0<br>ef  | 15.0<br>Ef | 30.0<br>D | 48.3<br>c   | 65.0<br>b   | 78.3<br>a  | 36.4<br>A |
| 3   | <b>Fever few</b><br>( <i>Tanacetum parthenium</i> ) | 1.67<br>h     | 10.0<br>fgh | 16.7<br>Ef | 30.0<br>D | 48.3<br>c   | 65.0<br>b   | 78.3<br>a  | 35.7<br>a |
| 4   | <b>Control</b>                                      | 0.00<br>h     | 0.00<br>h   | 0.00<br>H  | 1.67<br>H | 10.0<br>fgh | 13.3<br>efg | 16.7<br>ef | 5.9<br>B  |
|     | <b>Means</b>  | 1.67<br>f     | 9.58<br>e   | 13.7<br>E  | 23.7<br>D | 38.3<br>c   | 52.1<br>b   | 64.6<br>a  |           |

LSD value for treatment (T) at  $\alpha$  0.05 = 3.87; LSD value for days (D) at  $\alpha$  0.05 = 5.12; LSD value for DxT at  $\alpha$  0.05 = 10.25; Means with different letters show significant differences (P<0.05)

Figure 2 demonstrates the overall comparison of mean repellency values of *Tribolium castaneum* and *Sitophilus oryzae* against different treatments. The data shown in Table-III provides the mean values for the percent repellency of *Tribolium castaneum* and *Sitophilus oryzae* observed for different treatments against different plant extract. Table III shows that in case of red flour beetles plant extracts played significant role on the test insects by forcing it to transfer from treated jars (A) to untreated jars (B) through plastic pipe. However percentage repellency was not as high as percent mortality. Fever few repelled maximum number of beetles i.e. 4.52% followed by peppermint (3.09%). The minimum number of repelled alive beetles was observed in the extract of sage i.e. 0.71 % however; no repellency was noted in control. Fever few and peppermint had non-significant differences but significantly better from sage. Both sage and control show non-significant differences from each other. While it is evident from the Table III that all plant extracts played significant role on the repellency of *Sitophilus oryzae*. The maximum number of insects were repelled by Fever few i.e. 5.95 % followed by sage (2.14%). Peppermint extract caused minimum repellency i.e. 0.95% while, in control no repellency was observed. Table also reveals that fever few gave significantly better result than all other extracts. Sage remained non-significant from peppermint but significantly better than control. Peppermint shows non-significant differences from control.

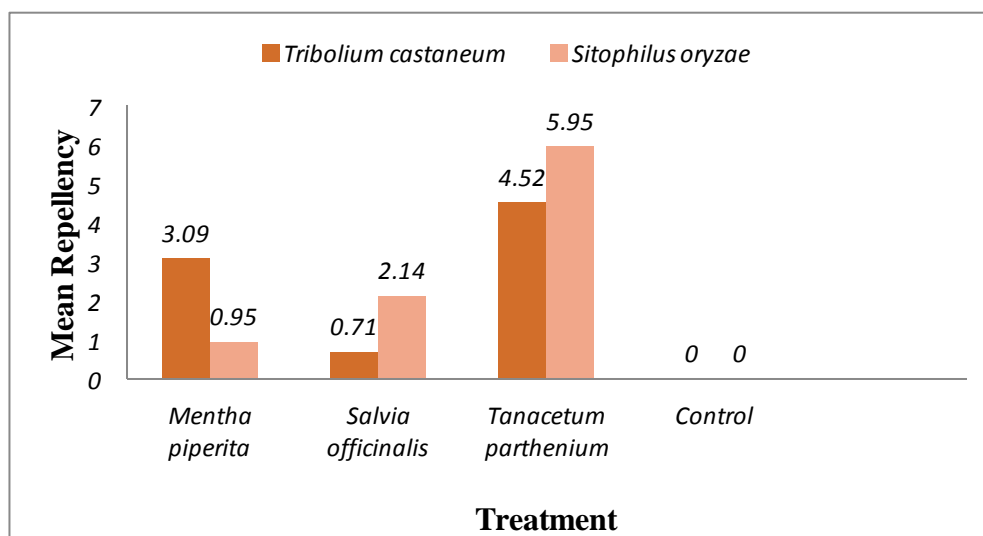


Fig. 2. Comparison of Mean repellency values of *Tribolium castaneum* and *Sitophilus oryzae* against different Treatments

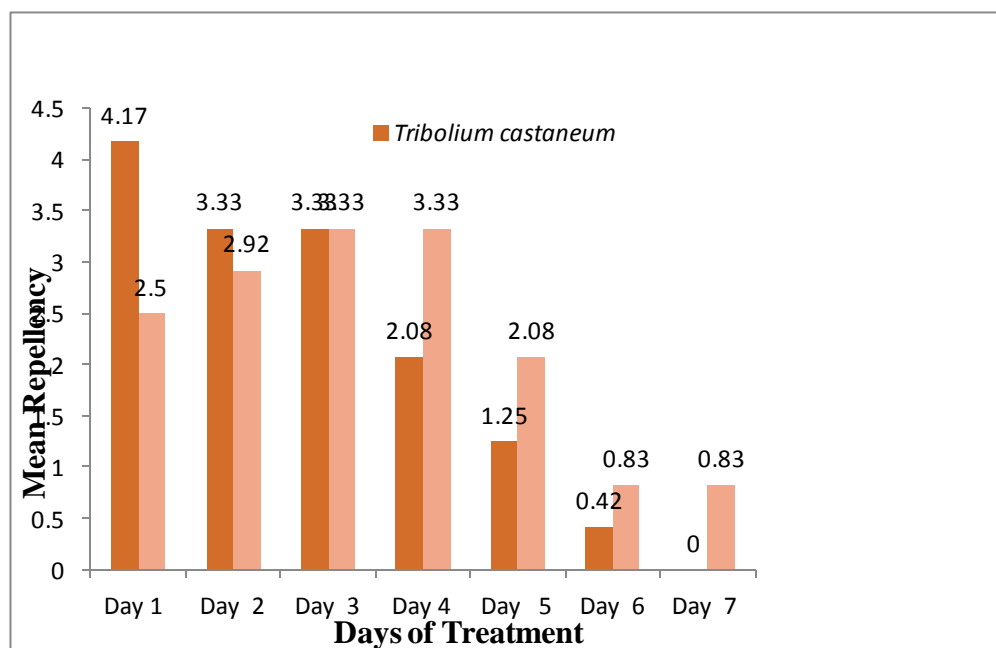


Fig. 3. Comparison of mean repellency values of *Tribolium castaneum* and *Sitophilus oryzae* on different days

The comparison of mean repellency values of *Tribolium castaneum* and *Sitophilus oryzae* on different days is depicted in Fig. 3 and Table IV shows that the maximum number of repelled red flour beetles was

observed on D1 which amounted to 4.17%. However, the effect gradually reduced with increasing exposure time till 0.00% on the 7<sup>th</sup> day of observation. Table also reveals that highest repellency of *Sitophilus oryzae* was observed on D3 and D4 which amounted to 3.33%. However, the minimum number of repelled weevils was observed on D6 and D7 i.e. 0.83%

**Table IV.** Comparison of mean repellency values of *Tribolium castaneum* and *Sitophilus oryzae* on different days

| Days  | Mean repellency of <i>Tribolium castaneum</i> | Mean repellency of <i>Sitophilus oryzae</i> |
|-------|---|---|
| Day 1 | 4.17 a  | 2.50 ab                                     |
| Day 2 | 3.33 ab                                       | 2.92 a                                      |
| Day 3 | 3.33 ab                                       | 3.33 a                                      |
| Day 4 | 2.08 abc                                      | 3.33 a                                      |
| Day 5 | 1.25 bc                                       | 2.08 ab                                     |
| Day 6 | 0.42 c  | 0.83 b                                      |
| Day 7 | 0.00 c  | 0.83 b                                      |

*Tribolium castaneum*-LSD value  $\alpha$  0.05 for days (D) = 2.48; *Sitophilus oryzae*-LSD value at  $\alpha$  0.05 for days (D) = 1.69; Means with different letters show significant differences ( $P < 0.05$ )

## DISCUSSION

Plants have been used in different parts of the world for controlling pests including stored grain pests. We can compare some previous studies with the present results.

In the present work, among the three different plant extracts, *Mentha piperita* proved as the most effective treatment showed maximum mortality of 35.5% in *Tribolium castaneum* and 38.3% in *Sitophilus oryzae*. The present results receive support from Shaaya *et al.* (29) who reported that peppermint is effective against *T. castaneum*. This result also agrees with the findings of Saljoqi *et al.* (30) who documented that mint extracts had lethal effects against *Sitophilus oryzae*. The above finding was somewhat in conformity with Bakr *et al.* (31) who reported that peppermint oil presented the maximum toxicity to adults and larvae of both carpet beetle and cigarette beetle. However present result was not in agreement with Manzoor *et al.* (23) who concluded that mint was least effective to cause mortality of *Tribolium castaneum*.

Karaborklu *et al.* (32) tested the toxicity of ten aromatic plant essential oils against red flour beetle and observed that sage essential oils showed very little mortal effect on the red flour beetle after 24 hours. Abou-Elnaga (33) tested the insecticidal properties of three plants, Gerba Egyptian mint and Halama, against Rice weevil, *Sitophilus oryzae* and concluded that tested plants could be used as safe alternative source for the control of *Sitophilus oryzae*.

Present study also revealed that all the tested plant extracts significantly repelled the insects. Fever few, *Tanacetum parthenium* exhibited high repellency of 4.52% and 5.95 % against *Tribolium castaneum* and *Sitophilus oryzae* respectively. This result agrees well with the findings of Panezai *et al.* (27) who tested same plant extracts against bruchids and reported that fever few showed strong repellent action against *Acanthoscelides obtectus*.

Kundu *et al.* (21) tested repellent action of some other plant extract against the same insect and investigated that Bishkatali plant extract showed strong repellency against *T. castaneum*. Kanvil *et al.* (34) tested the repellent effect of three plant extracts i.e *Saussurea lappa*, *Peganum harmala* and *Valeriana officianalis* against *Tribolium castaneum* and concluded that all the three plant extracts indicated <25% average repellency. Othira *et al.* (35) evaluated the repellent effect of *Hyptis spicigera* against *Sitophilus zeamais* and *Tribolium castaneum*. They reported that *Hyptis spicigera* could be useful against both insect pests. In present study the maximum number of repelled alive pests was observed on D1. However, the effect gradually reduced with the increasing exposure time. These results from the present study are similar to findings of Panezai *et al.* (27) who reported that mortality increased with increasing exposure time. Saljoqi *et al.* (30) tested six herb extracts for repellent effects against *Sitophilus oryzae* L. and observed that the number of repelled weevils being decreased slowly with increasing exposure time. El. Lakwah *et al.* (36) tested acetone

and petroleum ether extract of *Withania somnifera* leaves and fruits for mortality and repellency effects against adults of *Sitophilus oryzae*, *Rhyzopertha dominica* and *T. castaneum* and reported that toxic effects in insect increased with increasing concentration and exposure period.

## CONCLUSION

It is concluded that methanol extracts of *Mentha piperita*, *Salvia officinalis* and *Tanacetum parthenium* possesses significant insecticidal effect and could be a potential grain protectant against stored grain pests. Results also revealed that peppermint caused highest mortality and fewer few illustrated maximum repellency against both coleopteran pests.

### Conflict of Interest:

Authors have no conflict of interest.

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