

Research Article

Relative performance of different concentrations of mint (*Mentha longifolia* L.) against *Tribolium castaneum* (Coleoptera: Tenebrionidae) in wheat

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Abstract

The experiment on effectiveness of various concentrations of mint leaves *Mentha longifolia* L. was conducted at Sindh Agriculture University, Tando Jam. Mint powder was applied at 2.00%, 1.50%, 1.00% and 0.50% concentrations in 200 gm of wheat grains (variety TD-1) in plastic jars against *Tribolium castaneum*. The observations on efficacy of different concentrations as mortality of beetles was recorded after 24 hours, 48 hours and 7 days, whereas, population fluctuation was observed at monthly intervals for three months. Weight loss was also noted at the end of experiment. Although, no significant mortality of *T. castaneum* was recorded in any treatment, a rise in mortality was recorded after 48 hours of application as significantly higher mortality was observed in 2% mint concentration (4.33 ± 0.33), followed by 1.5 % (2.67 ± 0.33), 1 % (1.33 ± 0.33) and 0.5 % (1.00 ± 0.00). Overall at the end of week, the highest (66.70%) and lowest (26.70%) percentage mortality of *T. castaneum* was recorded in 2% and 0.50% mint concentrations, respectively. The population fluctuation of *T. castaneum* also showed that at the end of third month, control showed the highest population (45.67 ± 2.91 beetles) of beetles, whereas, 2.00% mint concentration treatment exhibited lowest population of beetles (16.33 ± 0.88). The maximum overall (50.33grams or 25.17%) and grain (63.00grams or 31.50%) weight loss was recorded in control, whereas, 2.00% mint concentration treatment exhibited overall (19.00 /9.50%) and grains (24.67 /12.33%) weight loss. Thus, it is suggested that 2.00% mint concentration should be included as protectant in store grains especially wheat against *T. castaneum*.

Keywords: Mint; Mortality; Population; *Tribolium castaneum*; Wheat

Introduction

Wheat (*Triticum aestivum*) holds a key role among all the cereals to fulfill the dietary

requirements of the peoples of the world especially in Pakistan [1]. It contributed about 8.9% value addition in agriculture

and 1.6% of gross development production (GDP) in Pakistan. During 2018-19, the total cultivated area of this crop was 8,740 thousand hectares showing a decline of about 0.6 percent compared to 8,797 thousand hectares during same period last year. The main reasons of decline are water shortages, delayed and prolonged sugarcane crushing season, fog and smog in the country [2]. In addition, after harvesting, the stored wheat is severally infested by different types of insect pests which degrade the quality and the quantity of the grain. The infested seeds are not suitable for consumption as well as for sowing purpose. In Pakistan, wheat grains are attacked by more than 23 insect species during storage; among them, 10 species are known to be very serious [3]. The major stored grain insect pests attacking on stored wheat include *Sitophilus granarius* L., *Rhyzopertha dominica* Fabr, *Tribolium castaneum* Herbst., *Prostephanus truncates* Horn, *Sitophilus oryzae* L., *Sitotroga cerealella* Olivier and *Plodia interpunctella* Hubner [4].

Red flour beetle, *Tribolium castaneum* Herbst (Coeloptera: Tenebrionidae) is considered as a destructive insect pest of wheat [5]. *Tribolium castaneum* cause huge damage to stored grains. It is the most common pest of wheat flour; however, it also infests the quality and quantity of the pulses and other stored cereal foods, dried fruits, such as pasta, cornflake, beans, nuts, biscuit, etc. [6]. The pest is found throughout the world but use protected places having heat conditions to survive extreme winters [7]. Both, larvae and adults cause damage to stored product and pass their whole life outside of the host [8].

Mostly, warehouse managers depend upon synthetic pesticides for the management of *T. castaneum*. However, high doses of pesticides have not only contaminated the stored products but also cause severe adverse environmental and health hazards [9]. Moreover, high pesticides application has depleted ozone layer; induce pesticide residues in food chains along with various

other problems [10]. During the recent years, botanicals are used as insecticides that can be obtain from natural products. These botanicals not only kill the pests but also protect our society from chemical pesticides and also protect the natural enemies [11]. Various kinds of botanicals are used as insecticides against store grain products. The stored product pests exhibit different levels of sensitivity or tolerance to plant extracts, a wide screening of these substances has been carried out to widen the available tools against these harmful organisms with promising results [12]. Among botanicals, mint extracts are used on wide scale to manage the populations of stored product pests throughout the world. The genus *Mentha* belongs to the family Lamiaceae that can be used in the pest management programs because of its insecticidal properties [13]. Mint oil is known to contain various monoterpenoids with piperitone, pulegone, α -limonene, piperitone oxide, β -caryophyllene, 1-8-Cineole, piperitenone, carvone, menthone, as major chemical components [14]. However, there have been some differences in the ingredients from various countries and a chemo-geographical variation has been observed in essential oil composition of this species [15]. Although, mint has shown many insecticidal activities, but studies on its effect in the management of *T. castaneum* in stored wheat are lacking. Therefore, this study was conducted to evaluate effectiveness of various concentrations of mint powder against *T. castaneum* in wheat.

Materials and methods

Study location

The experiment was carried out in the Stored Grain Research Laboratory, Department of Entomology, Sindh Agriculture University, Tandojam during the year 2017-2018.

Insect collection and rearing

The culture of *T. castaneum* was obtained from already maintained culture of the laboratory that was reared on the pure

wheat grains under controlled temperature (28±2°C) and 75±5% R.H

Selection of plant material and extract preparation

Mint (*Mentha longifolia* L.) leaves were collected from the local market of Tandojam, thoroughly washed and air dried under shade. The dried plant materials were then grinded by using electric blender and sieve by muslin cloth. The obtained fine powder was the stored in airtight plastic bottles to restore their freshness before usage in the experiment.

Experimental outline, data collection and analysis

Powder of mint leaves was applied at different concentrations i.e., 2%, 1.5%, 1% and 0.5% in 200 gm of wheat grain (Variety TD-1) in individual glass jars. The powder was shaken thoroughly in seed for about 3 minutes to create a homogenous mixture. In each container, ten pairs of freshly emerged adults of *T. castaneum* were released. The jars were covered with muslin cloth and tighten with elastic rubber band to restrict the beetles inside the jars. Experiment was laid down in a Completely Randomized Design where each treatment was replicated three times. The data on efficacy of different concentrations of mint to cause mortality of *T. castaneum* was recorded after 24 hours, 48 hours and 7 days of their application, whereas, population fluctuation of *T. castaneum* was observed at

monthly intervals for three months. At the end of experiment, overall and grain weight loss was recorded using the following formula:

$$\% \text{ damage} = \frac{[(\text{Original weight} - \text{Final Weight}) / \text{Original Weight}] * 100}{}$$

The obtained data was analyzed using Analysis of Variance whereas, the means with significant differences were compared using the Least Square Difference (LSD) at 0.5 probability level. All the analysis was done using STATISTIX computer software 8.1.

Results

Effect of different concentrations of mint on mortality of *T. castaneum* in wheat at different intervals

The mortality rate of *T. castaneum* in wheat due to the application of different concentrations of mint i.e., 2 %, 1.5 %, 1 % and 0.5 % at various time intervals (24 hours, 48 hours and 1 week) is given in (Table 1). The results indicated that all mint concentrations caused mortality immediately after their application. However, after 24 hours of application, a non-significant difference (F = 3.00, P = 0.0723) was recorded among various mint concentrations to elicit mortality of *T. castaneum*. After 24 hours, the highest mortality was recorded in 2% concentration (2.00 ±0.58 beetles), followed by 1.5 % concentration (1.00±0.58 beetles), whereas, no mortality was recorded in control.

Table 1. Effect of different mint concentrations on mortality of *T. castaneum* in wheat under laboratory conditions

Mint concentration	Population				Overall Mortality % after week
	Pretreatment	24 hours	48 hours	1 Week	
0.5 %	20	0.67±0.33b	1.00±0.00c	2.67±0.33c	26.70%
1 %	20	0.67±0.33b	1.33±0.33c	3.33±0.67bc	33.30%
1.5 %	20	1.00±0.58ab	2.67±0.33b	4.67±0.67b	46.70%
2 %	20	2.00 ±0.58a	4.33±0.33a	6.67±0.88a	66.70%
Control	20	0	0	0	0.00%

*Means followed by the same letters in same columns are not significantly different (LSD, P < 0.05)

An equal mortality (0.67±0.33 beetles) of *T. castaneum* was recorded in 1 % and 0.5 % concentrations. A rise in mortality was recorded after 48 hours of application as significantly higher (F =42.2, P < 0.001)

mortality of beetles was observed in 2% concentration (4.33±0.33), followed by 1.5 % (2.67±0.33), 1 % (1.33±0.33) and 0.5 % (1.00±0.00) concentrations. After one week of application, mortality of *T. castaneum*

observed in 2 %, 1.5 %, 1 % and 0.5 % was 6.67 ± 0.88 , 4.67 ± 0.67 , 3.33 ± 0.67 and 2.67 ± 0.33 , respectively. Therefore, a significant difference ($F=17.1$, $P < 0.0002$) was recorded in the mortality of *T. castaneum* due to the application of various mint concentrations.

Overall at the end of week, the highest and lowest percentage mortality of *T. castaneum* was recorded in 2% (66.70%) and 0.5% (26.70%) mint concentrations, respectively. No beetle mortality was recorded in control treatment (Table 1).

Effect of mint concentrations on the population development of *T. castaneum*

Results for the population fluctuation of red flour beetle in wheat treated with various mint concentrations are given in (Table 2 & Fig. 1). A highly significant difference in the population development of *T.*

castaneum was recorded in wheat treated with various concentrations of mint throughout three months of observations. After one month, the highest mean population of red flour beetle was recorded in control (20.67±1.76 beetles), followed by 0.5% (15.67±1.20) 1% (14.33±1.45 beetles) 1.5% (9.00±0.58 beetles) and 2% (5.67±0.88). In the following month, a steady growth was observed in all the treatments excluding control, where a rapid growth was recorded in control. Accordingly, at the end of month three, the highest population of *T. castaneum* was recorded in control (45.67±2.91 beetles), whereas, the beetle population observed in 0.5% 1%, and 2% concentrations was (31.33±2.33 beetles) (29.00±4.16 beetles) and (21.00±1.73 beetles) respectively.

Table 2. Weight loss of wheat mixed with different mint concentrations by *T. castaneum* under laboratory conditions

Concentration	Weight (Grams)			Weight loss (grams / %)	
	Initial	Overall Final	Grain	Overall	Grain
0.5 %	200	159.00±1.15c	150.00±1.15c	41.00(20.50%)	50.00(25.00%)
1 %	200	169.33±0.88b	162.33±1.45b	30.67(15.33%)	37.67(18.33%)
1.5 %	200	177.00±1.53a	170.33±1.45a	23.00(11.50%)	29.67(14.83%)
2 %	200	181.00±4.62a	175.33±3.48a	19.00 (9.50%)	24.67(12.33%)
Control	200	149.67±0.88d	137.00±2.65d	50.33(25.17%)	63.00(31.50%)

*Means followed by the same letters in same columns are not significantly different (LSD, $P < 0.05$)

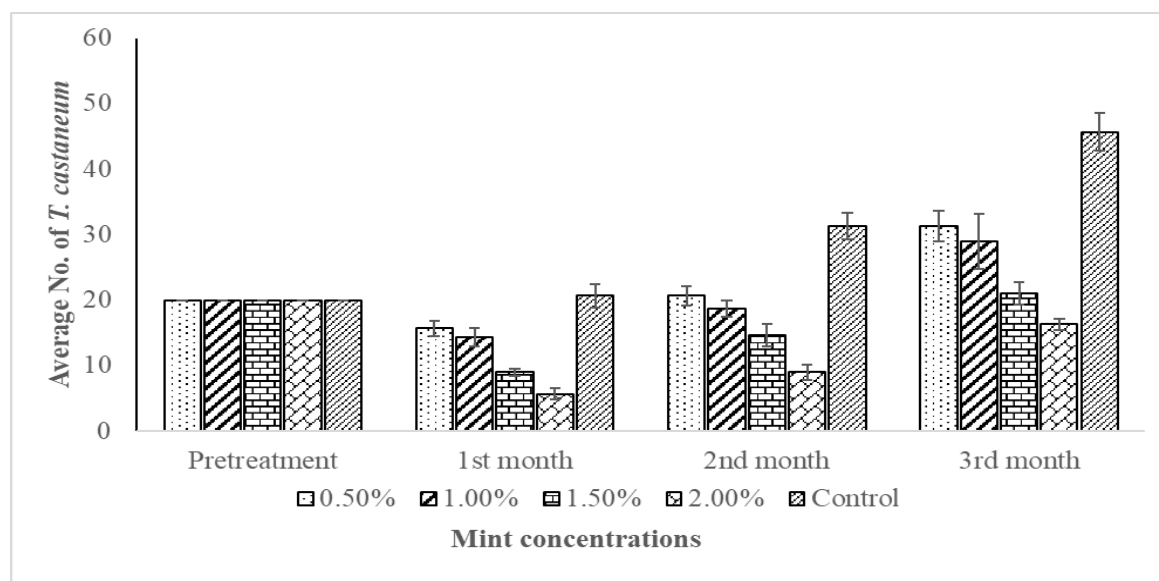


Figure 1. Effect of different mint concentrations on the population development of *T. castaneum* in wheat under laboratory conditions

Weight loss of wheat mixed with different mint concentrations by *T. castaneum*

The weight loss in wheat due to the feeding of *T. castaneum* under the effect of various mint concentrations is given in (Table 2). Results indicated that overall weight loss in various concentration differs significantly ($F = 31.3$, $P < 0.001$) due to feeding of *T. castaneum* as significantly the highest weight loss at the end of experiment was observed in control (50.33 grams or 5.17%), followed by 0.5% (41.00 grams or 20.50%), 1.00% (30.67 grams or 15.33%) concentrations. Overall, the lowest weight loss was recorded in wheat treated with 2% mint concentration (19.00 grams or 9.50%). In continuation with overall weight loss, the highest and lowest grain weight loss of wheat due to infestation of *T. castaneum* was also recorded in control (63.00 grams or 31.50%) and 2% mint concentration (24.67 grams or 12.33%) treatment. Thus, the various concentrations showed a highly significant ($F = 68.90$, $P < 0.001$) difference in grain weight loss occurred due to the infestation of *T. castaneum* on wheat mixed with different mint concentrations.

Discussion

It has been reported that many plants have insecticidal activities against many noxious pests of crops and stored products. Similarly, this study indicated the significant effect of different mint concentrations to cause mortality and effect population development of *T. castaneum* in wheat. Accordingly, the highest mortality was recorded in 2.00% concentration, whereas, the lowest population was also recorded in 2.00% concentration followed by 1.50% concentration. Furthermore, the highest and the lowest overall and grain weight loss was recorded in control and 2.00% concentration, respectively. The efficacy of mint plant extracts in the management of population of *T. castaneum* has previously been also reported. Khani and Asghari [16] studies while evaluating the toxic volatile performance of essential oils obtained from leaves of *M. longifolia*, *Pulicaria gnaphalodes*, and *Achilles wilhelmsii* against *Callasobruchus maculatus* and *T. castaneum* confirmed that in comparison to *T. castaneum*, *C. maculatus* were found to be more susceptible against the treatments used in the study. They also reported that oils of *A. wilhelmsii* and *M. longifolia* showed relatively similar and more toxicity against *T. castaneum* than oil of *P. gnaphalodes*. Along with mint,

various oil extractions of sesame, (*Sesamum indicum*), coconut (*Coccus nucifera*), rocket seed (*Eurica sativa*) and mustard (*Brassica campestris*) have also shown insecticidal properties against *T. castaneum* in wheat [17]. Although, relatively less population of beetles was recorded in wheat treated with above mentioned treatments than control, with minimum fecundity recorded in rocket seed treated wheat [17]. The fumigant and repellent properties of pennyroyal (*Mentha pulegium* L.) aerial parts and castor (*Ricinus communis* L.) stems essential oils were tested against *Lasioderma serricornis* and *T. castaneum*. The tested plant oils showed relatively strong fumigant properties against *R. communis* and repellent effects against *T. castaneum* [18]. Many other studies also showed promising impact of not only various mint species but also other plants in reducing the population development and thus, damage to stored grains, especially wheat [19-21].

Conclusion

It has been concluded that all mint concentrations used caused mortality of the targeted *T. castaneum* in wheat, as mortality increased as mint concentrations increased. Thus, 2% concentrations showed maximum mortality and least development of beetles in wheat, thus, minimum weight loss. Control exhibited maximum growth and weight loss due to the feeding of *T. castaneum*. Therefore, addition of mint at 2% concentration in wheat is suggested to lower the population development of beetles and thus, weight loss to wheat.

Authors' contributions

Conceived and designed the experiments: AA Ahmed & L Bashir, Performed the experiments: M Ahmed, Analyzed the data: JGM Sahito, Contributed reagents/ materials/ analysis tools: MU Brohi & SA Chandio, Wrote the paper: MU Brohi & AA Gilal

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