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COMPARATIVE EFFECT OF *RICINUS COMMUNIS* (L.), *MORINGA OLEIFERA* (LAM.) AND *CITRUS SINENSIS* (L.) EXTRACTS AGAINST *TRIBOLIUM CASTANEUM* (HERBST)

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ABSTRACT

The present investigations were conducted to evaluate the toxicity of leaf extracts of *Ricinus communis*, *Moringa oleifera* and *Citrus sinensis* against *Tribolium castaneum* (Herbst). Plant extracts concentrations viz, 5, 10 and 15% prepared in four solvents (Methanol, chloroform, petroleum ether and n-hexane) were applied on wheat flour, treated diet was placed in small plastic jars and data for mortality were recorded after 24, 48 and 72 hrs of the treatments application. The findings of mortality bioassays revealed that maximum mortality 70.06% was observed in the methanol extract while comparatively least 39.21% mean mortality was observed at 15% concentration in n-hexane extract of *R. communis* after an exposure period of 72 hr. In case of *M. oleifera*, the maximum mean mortality 37.32% in the methanol extract, while lowest mortality 21.07% was observed at 15% concentration with longest period of treatment application. From the other hand, the maximum mortality 24.69% was recorded in methanol extract of *Citrus sinensis* at highest concentration (15%) with longer (72 hrs) exposure time against the target insect pest of stored commodities. The outcomes of the conducted bioassays depicted that the mortality response of the tested insect was influenced by dose, exposure time and nature of solvent, used. The order of effectiveness of plant extracts was *R. communis*>*M. oleifera*>*C. sinensis* and methanol> chloroform> petroleum ether> n-hexane. Hence, from these results it is concluded that these botanicals could be a alternatives to synthetic insecticides in IPM stored products insect pests.

Keywords: Exposure period, Mortality, Plant extracts, Solvents, *Tribolium castaneum*

INTRODUCTION

Stored grains and their products are attack by different insect pests (Ahmedani *et al*., 2007). Around 10-25% postharvest losses have been assessed throughout the world due to infestation of insect, microbial deterioration and other factors (Boxall, 2001; Phillips and Throne, 2010). The red flour beetle, *Tribolium castaneum* (Herbst, 1797) (Coleoptera: Tenebrionidae) is a pervasive pest of stored commodities like wheat flour and crushed cereals (Lu *et al*., 2010). Larvae and adults of this insect feed on damaged grains (Boxal, 2001) resulting up to 1-10% losses in different stored varieties of sorghum (Majeed *et al*., 2016).

The incidence of *T. castaneum* chiefly controlled by fumigant insecticides (Field and White, 2002), but use of fumigants has become limited due to the development of resistance and environmental hazards due to their injudicious, consistent and repetitive use against this pest (Kumar *et al*., 2011). Other chemicals like pyrethroids are being used for the management of stored grain insect pests, but consistent use of theses insecticides may lead to serious problems related to biochemical and hematological changes in the human beings (Khan *et al*., 2012). Conventional insecticides also pose hazardous effect on non-target organisms, including beneficial insects (Desneux *et al*., 2007; Miller, 2004). Unfortunately, these synthetic insecticides are not easily degradable and get accumulated in the environment, resulting in polluted surrounding (Field and White, 2002) Therefore,

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biodegradable and ecofriendly insecticides are crucial needs of the contemporary scenario. Botanicals can be the possible alternative for the control of insect pest due to their potential insecticidal properties. The effect of plant products showed insecticidal, repellent and anti-feedant effect against insect pests (Hasan *et al*., 2016; Ali *et al*., 2017).

Plant extracts easily biodegradable and ecofriendly insect pest management tools and can be effectively applied against stored grain insects (Tapondjou *et al*., 2002). Many plant extracts have been screened for the toxic effects such extracts of *Moringa oleifera* and *Nicotiana tabacum* were found effective against *T. castaneum* (Ali *et al*., 2013). The use of garlic extract was proven effective for the control of *Sitophilus zeamais* and *T. castaneum* (Ho *et al*., 1996). Extract of *Azadirachta indica* and *N. tabacum* proved effective against *T.* castaneum (Hanif *et al*., 2016). Several indigenous plant extracts were recorded as repellent against *T. granarium* (Al-Moajel and Al-Fuhaid., 2003). Crushed seeds and leaves of plants have been found effective against *Rhyzopertha dominica* and *T. castaneum* (Talukdar *et al*., 2004). *A*. *indica* was found very effective against *T. castaneum* (Iqbal *et al*., 2015). Different varieties of citrus including *Citrus paradisi* have been used for the control of *T. granarium* (Sagheer *et al*., 2013). Castor bean, *Ricinus communis* was selected for the management of insect pests due to the presence of ricin, ricinine, N-demethylricinine, and flavonoids. Ricin is the most toxic bioactive component present in seeds but ricinine which is an effective insecticide is located in all parts of the plant (Singh and Kaur, 2016). These compounds have shown remarkable insecticidal, antifeedent and repellent activities. Studies have reported toxic effects of *R. communis* extract against arthropod vectors like ticks, mites and mosquitoes. Obeng-Ofori and Freeman (2001) used extracts of *Ricinus communis* (L.) and *Solanum nigrum* against *Tribolium castaneum* and *Sitophilus oryzae* and proved very effective against both beetles. An aqueous extract of this plant was also found effective against many other insects like larvae of *Culex pipiens*, *Aedes caspius*, *Culiseta longiareolata, Anopheles maculipennis* (Diptera: Culicidae) (Brahim *et al.*, 2006). The leaf extract of *R. communis* has been shown to possess insecticidal properties against insect pests like *Spodoptera frugiperda* (Rossi *et al*., 2012), *Callosobruchus chinensis* (Upsani *et al*., 2003) and *Cosmopolites sordidus* (Coleoptera: Curculionidae) (Tinzarra *et al*., 2006). Leaf extract of *R. communis* was proving very effective for the control *M. domestica* population (Singh and Kaur, 2016).

So, keeping in view the above experimentally proved facts, the research work presented herein was carried out to evaluate the toxic potentials of three plant extracts against *T. castaneum*.

MATERIALS AND METHODS

Collection and rearing of test insect

Mixed population of *Tribolium castaneum* was collected from grain markets located in Faisalabad. The population was acclimatized to laboratory in plastic jars of 1.5 kg capacity having commodity (wheat flour) sterilized for 30 min at 70 ºC using oven (Lab Line Instruments Inc. Model no 3512-1) and covered with the muslin cloths. The adults of the insect were sieved out after three days from commodity. Sieved commodities containing eggs of target insect were placed in jars and placed under optimum conditions (65±5% R.H, 30±2 ºC) to get the F_1 population that was considered as homogenous.

Plant materials

Leaves of *Ricinus communis*, *Moringa oelifera* and *Citrus sinensis* were collected from different localities in University of Agriculture Faisalabad (UAF), cleaned by washing with distilled water and shade dried in entomology lab of Punjab Bioenergy institute, UAF. Dried leaves were ground into powder form using electrical grinder and sieved through a mesh (40 mm) to get a fine powder. Plant materials were extracted by mixing 50 g powder of each plant separately in 250 ml of the methanol, chloroform, petroleum ether and n-hexane by using Rotary Shaker (IRMECO, OS-10) at 220 rpm. After filtration, the solvent from the filtrate was evaporated by placing the filtrate in the rotary evaporator (Hasan *et al*., 2012; Sagheer *et al*., 2014). After evaporation, the extracts obtained were considered as stock solution and were put in clean and air tight lid bottles and stored at 4.0 °C in refrigerator.

Toxicity bioassay

Three concentrations (5, 10 and 15%) of the plant extracts were diluted from the stock solution using the four solvents. The concentrations were applied on 20 g crushed grains, shaken for even distribution of concentrations, allowed to air dried and placed in small plastic jars. Thirty larvae were release in separately treated petri-dishes. The treated units were placed in incubator until the completion of mortality bioassay and data regarding mortality was recorded after 24, 48 and 72 hrs of the treatments application.

Statistical Analysis

Recorded data was subjected to Abott formula for calculation of percent corrected values (i.e. mortality), performed statistical analysis using statistica-8.1 software. Treatments means were compared by using Tuckey-HSD test at 5% significant level.

RESULTS

Leaf extracts of three plants i.e. *Ricinus communis*, *Moringa oelifera* and *Citrus sinensis* were used to assess their comparative toxicity against *Tribolium castaneum*. Extraction of plant materials was done using four solvents viz., methanol, chloroform, petroleum ether and n-Hexane.

Data in table (1.1) depicted that maximum mortality 70.06% of *Tribolium castaneum* was achieved at higher concentrations (15%) of methanol base extract of *Ricinus communis* followed 52.32% (by chloroform based extract of *R. communis*) and 46.12% (in case of petroleum ether based extract) after 72 hrs of exposure period. Lowest mortality (1.11%) was given by n-hexane based extract of *R. communis* at lowest treatment application rate (5%) after 24 hrs of exposure time. At concentration of 10%, mortality ranged from 4.43%-65.43%. Mortality response was found time, concentration and solvent nature dependent.

Table 1.1
Toxicity of leaf extract of *Ricinus communis* against *Tribolium castaneum*

Solvents	Concentrations (%)	Mortality (%) ± SE		
		24 hrs	48 hrs	72 hrs
Methanol	5	10.54±1.09	27.54±2.22	49.10±1.09
	10	34.43±1.11	43.10±1.11	65.43±2.87
	15	46.21±1.09	59.76±1.21	70.06±2.08
Chloroform	5	5.21±1.11	19.34±1.07	32.10±1.11
	10	10.23±1.11	31.55±1.10	41.10±1.59
	15	26.12±2.93	35.52±1.11	52.32±1.09
Petroleum ether	5	2.21±1.11	5.32±1.11	5.32±1.10
	10	4.43±1.11	9.43±2.21	25.43±2.11
	15	12.23±2.93	27.76±2.93	46.12±2.83
n-Hexane	5	1.11±1.09	3.32±1.11	8.87±1.11
	10	4.43±1.11	6.65±1.11	20.00±1.92
	15	10.21±2.93	24.23±2.93	39.21±2.93

Data in table (1.2) elaborated that maximum mortality values were 1.01, 1.05 and 1.11% at lowest concentrations (5%) of *Moringa oleifera* in solvents which reached 21.23% at 10% and 37.32% at 15% concentration of methanolic extract of *M. oleifera*. Comparatively low mortality was achieved at all three concentration of n-Hexane based extract of *M. oleifera*. Metholic extract was found comparatively more effective than the other three solvents and mortality response was influenced by exposure time and concentration of the plant extract.

Table 1.2
Toxicity of leaf extract of *Moringa oleifera* against *Tribolium castaneum*

Solvents	Concentrations (%)	Mortality (%) ± SE		
		24 hr	48 hr	72 hr
Methanol	5	1.11±1.09	3.36±2.27	7.36±2.27
	10	2.21±1.10	6.64±1.92	13.10±1.92
	15	9.27±1.92	21.27±1.12	37.32±1.92
Chloroform	5	1.11±1.07	5.31±2.11	6.35±2.17
	10	5.11±1.12	8.12±1.72	11.10±1.92
	15	6.29±1.82	20.23±1.82	33.42±1.72
Petroleum ether	5	1.05±1.00	2.25±1.13	5.72±1.94
	10	2.27±1.12	4.47±1.19	8.21±1.12
	15	5.24±1.32	18.43±1.42	32.65±1.94
n-Hexane	5	1.01±1.09	3.36±1.12	6.73±1.94
	10	1.27±1.11	4.48±1.12	10.21±1.12
	15	4.24±1.12	18.24±1.12	21.07±1.13

Data presented in table (1.3) showed that maximum mortality (24.69%) was recorded in methanolic extract of *C. sinensis* at 15% after time interval of 72 hrs. While comparatively low 14.13% (in case of methanolic extract) followed by 12.32% (by chloroform based extract) and 10.17% (as in case of n-Hexane extract) at 10% concentrations of the tested plant extract (*C. sinensis*). Methanolic extract was found comparatively more effective than other.

Table 1.3
Toxicity of leaf extract of *Citrus sinensis* against *Tribolium castaneum*

Solvents	Concentrations (%)	Mortality (%) ± SE		
		24 hr	48 hr	72 hr
Methanol	5	2.12±1.00	5.54±1.12	7.85±1.12
	10	4.67±1.11	6.12±1.92	15.71±1.82
	15	5.32±1.12	14.43±1.12	24.69±2.24
Chloroform	5	1.12±1.11	4.97±1.12	7.76±1.11
	10	2.10±1.11	6.89±1.92	12.92±2.23
	15	4.12±1.12	12.32±2.12	20.21±2.54
Petroleum ether	5	1.10±1.11	5.52±1.12	6.84±2.12
	10	1.27±1.11	5.89±1.92	9.89±1.52
	15	3.57±1.12	11.32±2.12	17.32±2.11
Hexane	5	1.00±1.00	3.29±1.11	3.29±1.11
	10	2.01±1.11	4.48±1.12	4.48±1.12
	15	5.17±1.12	10.17±1.12	11.17±1.12

DISCUSSION

Leaf extracts of three plant *Ricinus communis*, *Moringa oelifera* and *Citrus sinensis* were used to check their possible toxic effects against *Tribolium castaneum*. Extraction of plant materials was done using four solvents viz., methanol, chloroform, petroleum ether and n-Hexane. Extract of methanol was proved comparatively more effective and caused 70.06% of *Tribolium castaneum* at 15% concentration of *R. communis*. The finding of current study was close to Hanif *et al*. (2016) who found 68, 69 and 69% mortalities with extract of *Azadirachta indica* after 72 hours of treatment application. Our findings were similar to Singh and Kaur (2016) who found 72% mortality against *Musca domestica* with methanol extract of *R. communis*. Slight difference may be due to difference in insect species. Our result of 32.65% mortality of *T. castaneum* with Petroleum ether extract of *R. communis* was close to finding of Iqbal *et al*. (2015) who used similar solvent extract of *A. indica* against *T. castaneum*. Mortality results of current study (our) with C*itrus sinensis* were in confirmation with the Sagheer *et al*. (2014) who used citrus spp. against *Trogoderma granarium*. Slight difference may be due to different insect spp. and treatment (plant oils) than current study (plant extracts). The findings were close to Talukdar *et*. *al*. (2004) who used plant extracts against *T. castaneum* and found increased mortality with increased concentrations of extracts. The results of petroleum ether of our study were close to Singh and Kaur (2016). Obeng-Ofori and Freeman (2001) found increased mortality values at higher concentrations in confirmation with our study.

Conclusion: Plant extracts are effective and ecofriendly tools for the efficiently used in integrated way with other management tactics of stored product insects pests.

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