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TO STUDY THE EFFECT OF SOME NON-CHEMICAL (PM) TREATMENTS ON CONTROLLING RUST FLOUR BEETLE *TRIBOLIUM CASTANEUM* (HERBST.)

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Abstract: This study was carried out in laboratory small glass containers to determine the effect of butanol (n- Butanol 99.5%) leave extracts of *Conocarpus lancifolius*, *Moringa oleifera*, *Acacia glauca*, *Eucalyptus comaldulensis* and *Nerium oleander*. As well as the effect of temperature on the adults of red rust flour beetle *Tribolium castaneum* (Herbst). The results showed the effectiveness of Eucalyptus extracts with a killing rate of 92% after 72 hours, Conocarpus and Oleander with killing rate of 89% and 77% after 48 hours, respectively. The killing rates for Acacia and Moringa were 28 and 25% after 72 and 24 hours, respectively. The killing rates were 91.7, 90.5 and 75%, after 72 hours, for Moringa, Acacia and Conocarpus leaves extracts, respectively, when they used to spray in glass boxes, the killing rates in both cases were at a concentration 3%. The insect is affected by low temperature, all adults died after 0.5, 1, 1.5 and 24 hours at a temperature of 3, 5, 10 and 15°C, respectively. While they died after 1, 5 and 48 hours at a temperature of 60, 55 and 50°C, respectively. It can be recommended to use extracts of the aforementioned plants or low temperatures to control rust flour beetle in wheat and flour warehouses as they are safe means and successful alternative to chemical pesticides.

Key words: *Tribolium castaneum* Herbst, Non-chemical treatments, *Conocarpus lancifolius*, *Moringa oleifera.*

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1. Introduction

The rust flour beetle *Tribolium castaneum* Herbst. is one of the most important warehouse insects. The flour affected by this insect loses many properties that make it not suitable for making bread, such as viscosity and softness. *Tribolium castaneum* is a major secondary pest of processed or damaged grains and causes economic loss of wheat flour. The Incorrect and dangerous use of pesticides on grains and flour, lead that plant origin pesticides have recently got great importance than the synthetic pesticides, against stored grains pests because of their lesser hazards to the environment and other related biomass. Various scientist across the world reported that plant derived materials do not cause resistance in insects, have broad spectrum activity, safe to natural enemies, compatible with bio-control agent for IPM and are non toxic to environment [Asifa Hameed *et al.* (2012)]. Plant materials have been used in many studies in various forms to control rust flour beetle, they were in the form of aqueous extracts or extracts with chemical solvents for different parts of plants. Sometimes in the form of powders or oils, they used as killing or repellant materials, food-preventing (antifeedants) or growth regulators, including Plant extracts for *Citrus colocynthis*, *Moriga olevera*, *Vinca rosea* and *Balanites aegyptiaca*, *Azadirachta indica*, *Nerium oleander* [Asifa Hameed *et al.* (2012)], *Eucalyptus globules* and *Lavendula stoechas* [Ebadollahi (2011)], *Nerium oleander* [Fatima and Mohammed (2018)], *Azadirachta indica* leaves [Gowri *et al.* (2018)], *Ricinus communis*, *Citrus paradise* and *Jaytopha curcus* [Habib-ur-Rehman *et*

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al. (2018)], *Allium sativum*, *Azadirachta indica* and *Eucalyptus globules* [Khan *et al*. (2013)], *Jatropha curcas* and *Ocimum sanctum* [Kota and Pulin (2017)], *Cinnamomum tamala*, *Rosmarinus officianalis* and *Pelaragonium graveolens* [Manonmani *et al*. (2017)], *Eucalyptus citriodora* B, *Eucalyptus camaldulensis* and *piper nigrum* [Naseem and Khan (2011)]. Many experiments that used essential oils and some plant oils have good efficacy on *Tribolium castaneum*, like, sesame oil [Md Shahidul Islam *et al*. (2019)]. Biological activity of many spices extracts were determined and some medicinal plants extracts were applied against *Tribolium castaneum*. This study was aimed to estimate the effects of leaves extracts of Conocarpus, Moringa, Acasia, Eucalyptus and Oleander, as well as the temperature on *Tribolium castaneum* (Herbst) adults in laboratory.

2. Materials and Methods

2.1 Breeding insect culture

The insect was raised in the laboratory on wheat flour placed in 1 kg plastic containers at temperature of 30±1°C, the flour is replaced every two weeks after sifting with a fine sieve that does not allow the passage of larvae and adults, adults insects are taken to carry out experiments by placing them on new flour that has been exposed to a temperature of 60°C for 24 hours to get rid of any insect phases that may be present.

2.2 Prepare the plant extract

The leaves extracts of Conocarpus, Moringa, Acacia, Eucalyptus and Oleander were prepared by weight of 50 gm of leaves and put them in electric mixer, add 250 ml of butanol (n-Butanol 99.5%) and run mixer for 10 minutes, the mixture was then filtered through a funnel containing a medical gause, the filterate was received in 1000 ml beaker and then put on a rotating heater for 24 hours at a temperature of 45°C, after it dried it was left in the refrigerator until use and preparing the required concentrations.

2.3 Treatment of rust beetle with extracts

The leaves extract of Conocarpus, Moringa, Acacia, Eucalyptus and Oleander had been used with three concentrations of 1%, 2% and 3%, the amount of extract was added to prepare the required concentration to 75 gm of flour, divided into three sections with weight of 25 gm and placed in glass containers, 10 adult insects were added to each container. The container were covered with soft cover from organza and closed tightly, three replicates for each concentration and three replication without adding extract as a comparison treatment according to complete random design (CRD).

2.4 Test the effect of some extracts on glass boxes

The high concentration (3%) of Conocarpus, Moringa and Acacia leaves extracts was used to treat the insect under storage conditions, where 250 gm of flour was placed as a pile in glass boxes with dimensions of 50×10×25 cm and 50 adult insects of rust beetle were placed on the flour after spraying the all box sides with the extract by small hand sprayer in a quantity of 25 ml. The above side of boxes were closed with a glass cover, then the number of live insects was recorded after 24, 48 and 72 hours of treatment at 30±1°C and the killing rate was calculated according to Hendrson-Telton equation.

2.5 Recording of data

The readings were recorded after 24, 48 and 72 hours, as the number of live insects was calculated for each treatment, then the killing rate of each concentration was calculated based on the Henderson-Telton equation

$$\text{Efficacy\%} = 1-\left(\frac{\text{Ta}}{\text{Tb}}\right)\times\left(\frac{\text{Ca}}{\text{Cb}}\right)\times 100$$

where,

Ta = the number of insects in the treatment after spraying.

Tb = the number of insects in the treatment before spraying.

Ca = the number of insects in the control treatment before spraying.

Cb = the number of insects in the control treatment after spraying.

The results were statistically analyzed and the averages were compared according to the least significant difference test (L.S.D).

2.6 Effect of temperature on rust beetle

The insects were exposed to low and high temperatures included (3, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60°C) by placing 10 adult insects on 25 gm of wheat flour placed in glass containers covered tightly with organza by three replicates. The number of live insects was then calculated after a period ranging from 0.25 to 72 hours, depending on the temperature and the time when the insects can live on the mentioned

Table 1: Effect of Conocarpus leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(1%)	10	11	9.7	10	9.6	10
T2 (2%)	3.3	63	3.0	67	2.3	74
T3 (3%)	3.0	67	3.0	89	3.0	89
Control	9.0		9.0		9.0	
LSD	1.87		1.87		1.7	
The reading represents an average of three replicates*						

Table 2: Effect of Moringa leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(1%)	9.3	4	9.3	4	9.3	4
T2 (2%)	8.3	14	8.3	14	8.3	14
T3 (3%)	7.3	25	7.3	25	7.3	25
Control	9.7		9.7		9.7	
LSD	0.0		0.0		0.0	
The reading represents an average of three replicates*						

temperatures, in order to determine the low and high temperatures that can be used as a means to killing the insects in the flour by exposing them to temperatures for the shortest possible time.

3. Results and Discussion

3.1 Effect of plant extracts in glass containers

Effect Conocarpus leaves extract: It is noted from the Table 1 that the killing rate was 89% for the concentration 3% after 48 hours of treatment and this percentage remained unchanged after 72 hours, while the killing rate was 74% for the concentration 2% after 72 hours and the lowest killing rate was for the concentration 1%.

Effect Moringa leaves extract: The highest rate of killing was in the concentration 3% as it reached 25%, while it was 4% and 14% for 1% and 2%, respectively after 24 hours and did not change with the passage of time (Table 2).

Effect Acacia leaves extract: Table 3 shows that the highest rate of killing was in the concentration 3% reaching 28% after 72 hours while it was 0.0% and 16% after the same period for 1% and 2%, respectively.

Effect Eucalyptus leaves extract: Table 4 shows an increase in the rate of killing with an increase in concentration and exposure time to the extract, as it reached 60%, 74% and 92% after 72 hours for the concentrations of 1%, 2% and 3%, respectively. Nebras (2016) demonstrated the high effectiveness of *Eucalyptus citriodor*a in killing the insect, while the effectiveness of oil extract from *Eucalyptus camaldulensi* was estimated by Naseem (2011), to

Table 3: Effect of Acacia leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(1%)	9	7.0	8.3	5.0	8	0.0
T2 (2%)	9	7.0	7.7	11	6.7	16
T3 (3%)	2.3	24	2.3	26	2.3	28
Control	9.7		8.7		8	
LSD	2.93		2.43		2.48	
The reading represents an average of three replicates*						

Table 4: Effect of Eucalyptus leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(1%)	4.3	54	3.7	57	3.3	60
T2 (2%)	4.3	54	2.7	69	2.3	74
T3 (3%)	2.7	71	1.3	58	0.7	92
Control	9.3		8.7		8.3	
LSD	1.65		1.38		1.87	
The reading represents an average of three replicates*						

Table 5: Effect of Oleander leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(1%)	7.0	25	6.3	32	6.0	35
T2 (2%)	6.3	32	6.0	35	4.3	54
T3 (3%)	2.7	69	2.0	77	2.0	77
Control	9.3		9.3		8.7	
LSD	1.8		1.73		1.9	
The reading represents an average of three replicates*						

control the insect under laboratory conditions. Also Khan *et al*. (2013) explained that *Eucalyptus globules extract* was effective in contact and as repellent and Ebadollahi (2011) mentioned the effectiveness of *Eucalyptus globule*s as antifeedant.

E. Effect Oleander leaves extract:

The highest killing rate was 77% for the concentration 3% after 48 hours and did not change with the passage of time while the killing rate increased for 1% and 2% as it reached 35% and 54%, respectively after 72 hours (Table 5). Asifa Hameed *et al*. (2012), indicated that killing rate reached 38% when using *Nerium oleander* in dose of 2.5% in period of 168 hours exposure and Fatima (2018) explained that green-synthesized silver nanoparticle have more larvicidal effect than *Nerium oleander* leaf extract.

From the forgoing data, the killing rate can be arranged which is 92%, 89%, 77%, 28% and 25% after 72 hours for Eucalyptus, Conocarpus, Oleander, Acacia and Moringa leaves extract, respectively. It is clear that the Eucalyptus leaves extract has exceeded the killing rate may be due to the toxicity of the extracted materials, including camphor oil. The killing rate of the other plant leaves extracts, especially the Conocarpus and Oleander, can increased by increasing the concentration.

3.2 The effect of plant extracts in glass boxes

Effect Conocarpus leaves extract: It appears from Table 6 that the rate of killing of Conocarpus extract increased over time, reaching 75% after 72 hours.

Effect Moringa leaves extract: The highest rate of killing was 91.7% after 72 hours (Table 7) and B, mentioned that *Moringa olevera* leaves extract had a harmful and antifeedant effect in addition to varying

Table 6: Effect of Conocarpus leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(3%)	28	44	14	71	12	75
Control	50		49		48	
The reading represents an average of three replicates*						

Table 7: Effect of Moringa leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(3%)	15	70	7	85	4	91.7
Control	50		48		48	
The reading represents an average of three replicates*						

Table 8: Effect of Acacia leaves extract and percentage of killing according to Henderson-Telton equation on *Tribolium castaneum*.

Treatments	Average number of insects after treatment*/Percentage of killing/Time in hours					
	24 Hours		48 Hours		72 Hours	
	Insects No.	% Killing	Insects No.	% Killing	Insects No.	% Killing
T1(3%)	5	88	4	90.5	4	90.5
Control	42		42		42	
The reading represents an average of three replicates*						

death rates on the red flour beetle *Tribolium castaneum*.

Effect Acacia leaves extract: The killing rate was 90.5% after 48 hours and it has not changed over time (Table 8).

It is clear from the above data that the killing rates in the glass boxes were 91.7%, 90.5% and 75% for the extracts of Moringa, Acacia and Conocarpus, respectively. Thus, the Moringa and Acacia have surpassed the Conocarpus in the rate of killing, compared to their effect inside the glass containers and this may be due to the increase exposure of insects to the fumes of two plants. Based on the above results, there is a possibility to use the extracts of Eucalyptus, Conocarpus, Moringa, Acacia and Oleander as safe materials to reduce the number of insects in the grain and flour stores by spraying them on warehouse walls and space in the store.

3.3 Effect of temperature

Table 9 shows that the number of adults insects is affected by the decrease in temperature, all insects died after 0.5, 1, 1.5 and 24 hours at a temperature of 3, 5, 10 and 15°C, respectively. All insects were killed after 1, 5 and 48 hours, at temperatures of 60, 55 and 50°C, respectively. While the effect of medium temperatures was less, so that insect numbers decreased slowly on the temperature 20, 25, 30, 35, 40 and 45°C, the temperature between 30 and 35°C is almost ideal for biology of the insect.

It is clear that the lower temperatures are most affecting the insect and using temperature below 3°C

Table 9: Effect of temperature on rust flour beetle *Tribolium castaneum* adults.

Temp. (°C)	Average number of live insects after treatment*									
	0.25 hour	0.5 hour	1 hour	1.5 hour	2 hour	3 hour	5 hour	24 hour	48 hour	72 hour
3	6.7	0.0	-	-	-	-	-	-	-	-
5	8.3	6.7	0.0	-	-	-	-	-	-	-
10	-	7.3	5.7	0.0	-	-	-	-	-	-
15	10	7.7	7.0	5.7	4.7	3.3	1.3	0.0	-	-
20	-	-	-	-	-	-	-	9.3	7.3	5.3
25	-	-	-	-	-	-	-	6.7	6.3	6.0
30	-	-	-	-	-	-	-	9.0	7.3	8.0
35	-	-	-	-	-	-	-	9.7	8.7	8.0
40	-	-	-	-	-	-	-	6.7	5.7	4.7
45	-	-	-	-	-	-	-	7.7	4.3	1.3
50	9.7	8.3	7.7	7.0	6.7	5.3	2.0	0.7	0.0	-
55	9.7	8.0	5.0	4.3	2.3	1.0	0.0	-	-	-
60	10.0	4.7	0.0	-	-	-	-	-	-	-
*The reading represents an average of three replicates										

may lead to higher killing rates and faster time, it can be used as an easy and safe way to protect wheat and flour or control the rust flour beetle.

4. Conclusion and Recommendations

There is an efficacy of Eucalyptus, Conocarpus, Moringa, Acacia and Oleander leaves extracts, as well as low temperature in controlling the rust flour beetle *Tribolium castaneum*, especially in warehouse. Subsequent studies can be conducted to use other concentrations of plant materials, to separate and diagnose components of plant materials, to identify active ingredients and to conduct studies on the possibility of using the extracts in warehouses under modified atmosphere.

References

Asifa Hameed, Shoaib Freed, Altaf Hussain, Muhammad Iqbal, Mussurat Hussain, Muhammad Naeem, Asif Sajjad, Hammad Hussnain, Muhammad Attiq Sadiq and Abdul Latif Tipu (2012). Toxicological effects of neem (*Azidirachta indica*), Kanair (*Nerium oleander*) and spinosad (Tracer 240 SC) on the red flour beetle (*Tribolium castaneum*) (Herbst). *African Journal of Agricultural Research*, **7(4)**, 555-560.

Ebadollahi, A. (2011). Antifeedant activity of essential oils from *Eucalyptus globules* Labil and *Lavandula stoechas* L. on *Tribolium castaneum* Herbst (*Coleoptera: Tenebrionidae*). *Journal of Biharean Biologist*., **5(1)**, 10-13.

Fatima S. Jafer and Mohammed R. Annon (2018). Larvicidal effect of pure and green-synthesized silver nanoparticles against *Tribolium castaneum* (Herbst) and *Callosobruchus maculatus* (Fab.). *Journal of Global Pharma Technology*, **10(3)**, 448-456.

Gowri, M.D., M.S. Nalina Sudari and R. Santhi (2018). Impact of cow urine extract of *Azadirachta indica* leaves on the digestive enzymes of stored product pest, *Tribolium castaneum*. *The Pharma Innovation Journal*., **7(11)**, 509-511.

Habib-ur-Rehman, Mansoor-ul-Hasan, Qurban Ali, Muhammad Yasir, Shahzad Saleem, Saima Mirza, Hafiz Usman Shakir, Abid Mahmood Alvi and Haviz Muneeb Ahmed (2018). Potential of three indigenous plants extracts for the control of *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (Fab). *Pakistan Entomologist*., **40(1)**, 31-37.

Khan, F.Z.A., H.T. Muhammad Sagheer Mansoor-ul-Hassan Safquat Saeed Kajam Ali Gul, S.A. Bukhari and S.A. Manzoor (2013). Toxicological and repellent potential of some plant extracts against stored product insect pest *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *International Journal of Bioscience*, **3(9)**, 280-286.

Kota Sathish and Pulin Patgiri (2017). Laboratory evaluation of some indigenous plant extracts as grain protectant against red flour beetle, *Tribolium castaneum* Herbst. *Journal of Entomology and Zoology Studies*, **5(4)**, 1600-1606.

Manonmani, P., R. Usha rani and M. Ramar (2017). Repellent activity of some selected aromatic plant extracts against rust-red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *International Journal of Current Engineering and Scientific Research* (*IJCESR*), **4(9)**, 38-46.

Md. Shahidul Islam., Nixon Chandral Pal, Amitabh Shuva Chakma, Sarder Md Shahriar Alam and Md. Anowar Hossain (2019). Insecticidal effect of botanical oils for protection of wheat seeds against red flour beetle (*Tribolium castaneum*). *Discovery Agriculture*, **5**, 89-97.

Naseem, M.T. and R.R. Khan (2011). Comparision of repellency of essential oils against red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae). *Journal of Stored Products and Post Harvest Research*, **2(7)**, 131-134.

Nebras, M. Sahi (2016). Evaluation of insecticidal activity of bioactive compounds from *Eucalyptus citriodora* against *Tribolium castaneum*. *International Journal of Pharmacognosy and Phytochemical Research*, **8(8)**, 1256-1270.