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Nutritional indices of *Tribolium castaneum* (herbst) and its response to plant extracts in relation to three types of flours

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Abstract

Tribolium castaneum is a major pest of stored grains and processed commodities. The present experiments were conducted to check the nutritional indices of *T. castaneum* reared on corn, wheat and barley flour. Mortality effect of acetone extracts of various concentrations (5.0, 10.0 and 15.0%) of *Nerium oleander* from three different cultivars (yellow, pink and white) was also evaluated against *T. castaneum* at different exposure intervals (24, 48 and 72h). Maximum Consumption Index (CI) (15.57 mg/t), Relative Growth Rate (RGR) (0.027mg/t) and Approximate Digestibility (AD) (78.42 %) were observed in Corn flour and minimum CI (6.6 mg/t), RGR (0.024 mg/t) and AD (35.02%) was recorded in barley flour. Maximum and minimum value of Efficiency of conversion of ingested food (ECI) was observed in barley and corn flour respectively. Maximum and minimum adult weight and flour loss weight was observed in corn and barley flour respectively. The mortality of *T. castaneum* increased with increase in concentration and with increase in time interval. The results also revealed that highest percent mortality (24%) was achieved when extract of yellow cultivar of test plant with (15%) concentration apply for 72hrs and with white cultivar of test plant resulted in (0.0%) mortality at 5% concentration after 24hrs of application. From these results, it was concluded that corn flour could be a suitable rearing medium for the growth of *T. castaneum*, while yellow cultivar of *N. oleander* could be placed in IPM for the control of this pest.

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Introduction

Among many agricultural problems in Pakistan (Khan *et al*., 2013), *Tribolium castaneum* is the one of main issue for stored grains and damage food products which are stored in grocery stores, godowns, silos and houses (Zettler and Cuperus, 1990, Zettler, 1991, Sagheer *et al*., 2011). Furthermore, *T .castaneum* secretes lethal chemicals (Hodges *et al*., 1996) which directly attacks on the grains and as a result grains are contaminated mainly due to hydroxyl quinone (Campbell and Runnion, 2003).

Quality and quantity of stored products are adversely affected by *T. castaneum* (Hussain *et al*., 1996). Acaricidal and insecticidal properties of different plants have been proved and some plants which can also compete with synthetic pesticides (Hiiesaar, *et al.,* 2001; Khan *et al*., 2013). To reduce the use of pesticides and to minimize environmental pollution, natural repellent, deterrent and anti-feedant substances have been found for control of insect pest (Lindgren *et al*., 1996).

Nerium oleander Linn (Kanair) is present in different region of the world in which indo-pak region is also included and this plant also known for the treatment of many diseases (Zia *et al*., 1995). Analysis of different parts of *N. oleander* proved the presence of glycosides, terpenes, and straight chain compounds (Siddiqui *et al*., 1995). Different cultivars of N. oleander are known for their toxicity. All plant parts like leaves, stem, flowers, young shoots, nectar, and sap contain cardiac glycosides (Oji and Okafor, 2000). Present study was designed to evaluate the nutritional indices in relation to three different types of flour and the insecticidal effect of the *Nerium* extracts.

Materials and methods

The current study was carried out in the Grain Research, Training and Storage Management Cell, Department of Agri. Entomology, University of Agriculture, Faisalabad during the year 2013-14.

Collection and rearing of Insects

Red Flour Beetle, were collected from the grain market and flourmills, located in Faisalabad. Insect culture was reared on sterilized wheat flour in jars, which were kept in the incubator at temperature 30°C and 65±5 RH to get the homogenous population. The jars was covered with muslin cloth so that to avoid insect escape. After three days adults were separated and the egg containing flour was allowed to flourish in the incubator in order to achieve homogenous population.

Nutritional Indices of Tribolium castaneum on three different flours

Fifty adults of *T. castaneum* of homogenous age were released on 50 gm of flour of wheat, corn and barley in plastic jars. Three replication of each type of flour were used. The jars will be placed in cooled incubator at optimum growth conditions. Nutritional indices of *T. castaneum* were calculated after 45 days for each of the flour according to the equations given by Waldbauer (1968) as follow:

Consumption index (CI) = F/TA
Relative growth rate (RGR) = G/TA
Approximate digestibility (AD) = (F-E/F) x100

Where: A= Mean weight of insect during feeding period, E= Weight of exuvia
F= Weight of food eaten, G= Weight gain at the end of the feeding period
T= duration of the feeding time

Response of Tribolium castaneum against extracts of Nerium oleander

Preparation of extract of Nerium oleander

Fresh leaves of three cultivars of *Nerium oleander* (White, Pink and yellow) were collected; shade dried and grounded into powder. Acetone was used for preparation of extracts with the help of rotary shaker. Three concentrations (5, 10, 15 %) were prepared by diluting the stock solution of extract in acetone.

Bioassay for Percent Mortality

The experiment was carried out in 80 mm Petri dishes and Whatman's filter papers were used in for bioassay. (5, 10, 15 %) concentrations of plant extracts were applied on the filter paper and then the filter papers allowed to get dry. Twenty adults of *Tribolium* were released in petri dish and then the petri dishes covered with lid. Mortality of the adults recorded three times after equal intervals of 24 hours.

Statistical Analysis

After the completion of the experiments, the recorded data was analyzed using appropriate statistical software and their means compared by using Tuckey-HSD test.

Results

Results predicted a definite impact of food type on the consumption and as a result nutritional indices differed to a great extent.

Nutritional indices

Table 1 shows mean comparison of CI for *Tribolium castaneum* reared on different food type. Maximum value of mean CI (15.57) was observed when corn use as a diet followed by (12.04) calculated in wheat flour and minimum value (6.45) was observed when barley use as a diet. Maximum value of mean RGR (0.027 mg/t) observed when corn use as a diet while minimum value of mean RGR (0.024 mg/t) was observed when barley use as a diet. Maximum value of mean AD (78.42 %) was observed when corn flour use as a diet followed by (58.97 %) when wheat use as diet while minimum (35.02%) value was observed when barley flour use as a diet. Maximum adult weight (1.72 mg) was observed when corn flour use as a diet followed by (1.65 mg) when wheat flour use as a diet and minimum adult weight (1.56 mg) was observed when barley flour use as a diet. Maximum value of mean weight loss of flour (1002.01mg) was observed when corn flour use as a diet while minimum value of mean weight loss of flour (416.94 mg) was observe when barley flour use as a diet.

Effect of White Nerium Oleander

Extracts of White *N. oleander* also affected the biology of red flour beetle. Table 2 shows data regarding mean mortality of *T. castaneum* (Herbst) by interaction of different Time intervals and concentrations of White *Nerium Oleander* Lin. Maximum mortality (13.7%) shows when highest concentration (15%) was used with maximum time interval (72 hrs.) followed by (9.1%) mortality when highest concentration (15%) was used with time interval (48hrs.). Minimum mortality (0.0%) was observed when minimum concentration (5%) was use with time interval (24hrs).

Effect of Yellow Nerium Oleander

In case of Yellow *N. oleander*, Table 3 shows data regarding mean mortality of *T. castaneum* by interaction of different time intervals and different concentrations of yellow *N. oleander* extracts. Maximum mortality (16.7%) shows when highest concentration (15%) was used with maximum time interval(72hrs) followed by (10.7%) mortality shows when highest concentration (15%) was used with time interval (48hrs).Minimum mortality (1.7%) observe when minimum concentration (5%) was use with time interval (24hrs).

Effect of Pink Nerium Oleander

Pink *N. oleander* also affected biology of *T. castaneum*. Table 4, shows data regarding mean mortality of *Tribolium castaneum* by interaction of different time intervals into concentrations of pink *N. Oleander*. Maximum mortality (10.9%) shows when highest concentration (15%) was used with maximum time interval followed by (9.6%) mortality shows when highest concentration (15%) was used with time interval (48hrs).Minimum mortality (0.5%) observe when minimum concentration (5%) was use with time interval (48hrs).

Table 1. Nutritional indices of *Tribolium castaneum* reared on wheat, corn and barley flour: Consumption index (CI), Relative growth rate (RGR), Approximate digestibility (AD)

Food type	Mean CI (mg/t) ± S.E	Mean RGR (mg/t) ± S.E	Mean AD (%) ± S.E	Mean Adult wt. (mg) ± S.E	Mean Flour loss wt. (mg) ± S.E
Corn	15.57 ± 0.12	0.027 ± 0.0003	78.43 ± 4.10	1.72 ± 0.013	1002.01 ± 2.4
Wheat	12.04 ± 0.30	0.026 ± 0.0002	58.97 ± 2.00	1.65 ± 0.010	763.37 ± 11.39
Barley	6.6 ± 0.12	0.024 ± 0.0002	35.02 ± 1.51	1.56 ± 0.010	416 .94 ± 16.15

Table 2. Comparison of mean values of data regarding the interaction between concentration of white *N. oleander* and exposure time on percent mortality of *T. castaneum*

Concentration %	Exposure Time		
	24 (h) ± S.E	48 (h) ± S.E	72(h) ± S.E
5	0.00 ± 0.00	2.23 ± 1.14	5.75 ± 0.76
10	2.78 ± 0.88	6.18 ±0.89	9.19 ±1.95
15	5.00 ±1.18	9.01 ± 1.33	13.79 ± 1.72

Table 3. Comparison of mean values of data regarding the interaction between concentration of yellow *N. oleander* and exposure time on percent mortality of *T. castaneum*

Concentration %	Exposure Time		
	24 (h) ± S.E	48 (h) ± S.E	72(h) ± S.E
5	1.67 ± 0.83	3.95 ± 1.02	5.75 ± 1.43
10	3.33 ±1.18	6.78 ±1.20	9.77 ± 1.75
15	4.44 ± 1.30	10.73 ± 1.50	16.67 ± 2.20

Table 4. Comparison of mean values of data regarding the interaction between concentration of pink *N.oleander* and exposure time on percent mortality of *T. castaneum.*

Concentration %	Expoure Time		
	24 (h) ± S.E	48 (h) ± S.E	72(h) ± S.E
5	0.56 ± 0.57	0.56 ± 0.89	4.60 ± 1.25
10	1.11 ± 0.73	5.08 ± 1.20	6.33 ± 1.04
15	3.89 ± 1.39	9.60 ± 1.13	10.92 ± 1.15

Discussion

Experiments were performed to check the nutritional indices of *T. castaneum* reared on barley, corn and wheat flour and to check the best flour for the growth of *T. castaneum.* Mortality effect of acetone extracts of (5.0, 10.0 and 15.0%) concentrations of *N. oleander* from three cultivars (pink, white and yellow) was also calculated against *T. castaneum* with exposure times (24, 48 and 72h). The increase in mortality rate was observed when we increase the concentration of plant extracts.

Results were almost similar to findings of Shaurub and Gharsa (2012), who noticed that maximum weight of *T. confusum* larvae was observed, when these larvae were reared on corn flour. While showing lowest consumption index (CI) value the present results were contradictory to findings of (Waldbauer, 1968) who reported that high or moderate food utilization by insects not always relate with increase in growth rates. Likewise Xue *et al.* (2010) checked that the larvae of *T. castaneum* reared on flour of wheat or a mixture of yeast plus wheat flour developed generally while the larvae reared on starch

showed better growth. Nutritional values of flour also affect the food consumption rate of larvae of *T. confusum*. Resulted data showed that the maximum value of CI was observed when the test larvae feed on barley flour and the minimum CI value was in the larvae, which were reared on corn flour. Similarly Barnby and Klocke (1987) checked that increase in AD value while decrease in excreted faeces, showed that food consumed is engaged for a longer period in the gut.

Increasing trend of mortality of test insect also increased with increase in time interval. Results proved that highest percent mortality (24%) was noticed in *T. castaneum* against yellow cultivar of *N. oleander* plant extract with (15%) concentration used for 72 hours. And when extract of white cultivar of test plant proved minimum (0.0%) mortality when 5% concentration of test extract used for 24h. These results were contradictory to Hameed *et al.* (2012) who stated that LC_{50} value of an ethanolic extract of *N. oleander* against *T. castaneum* adults was 2.5% (25mg/mL) when they reared on the same feed with equal interval of time. Any decrease or increase in the susceptibility of insects to different insecticides may be due to the change in the diets. Present findings were almost similar to Mamun *et al.* (2009) who checked the insecticidal effect of extract of different parts of neem and Mahogoni against *T. castaneum*. The resulted data stated that extract of bark of tested plants had batter toxic effect, which shows mean mortality 52.50%, whereas leaves extracts of tested plants showed minimum mortality 22.24%.The mortality rate increased with increase in time interval. Similarly Jbilou *et al.* (2008) checked the insecticidal effect of four different plants. Different responses were noticed from all test plants. Extract of *P. harmala* was most effective against the grubs and adult of red flour beetle. Our experiments were almost similar when Pugazhvendan *et al.* (2012) who checked insecticidal activity of four different plants against *T. castaneum* after 72 hours. The plants which were used for extract preparation were *S. indicus, A. vulgaris, P. juliflora* and *T. purpurea,* and organic solvents were used for the preparation of extract. Resulted data stated that mortality rate decreased as in hexane *A. vulgaris* (58%), ethyl acetate extract of *T. purpurea* (52%) and chloroform extract of *S. indicus caused* (34%) mortality.

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