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Antiovipositional and Antifertility Effects of Plant Extracts against the Flour Beetles, *Tribolium castaneum* (Herbst) and *T. confusum* (J. du Val)

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Abstract: *Effects of petroleum ether extracts of Trichosanthes palmata seed and Zingiber cassumunar rhizome on the fecundity and fertility of two stored grain insect pests, Tribolium castaneum and Tribolium confusum have been assessed. Laboratory studies indicated that all the doses of T. palmata seed extract reduced significantly the egg laying and hatching of both the insects in comparison with the control. The mean oviposition per female for 33 days in the untreated medium were 232.05 ± 9.91 for T. castaneum and 215.00 ± 14.43 for T. confusum respectively. The mean egg laying per female at the lowest (1000ppm) and the highest (16000 ppm) doses were 130.20 ± 11.52 and 52.95 ± 13.00 for T. castaneum; and 146.75 ± 17.66 and 52.35 ± 7.68 for T. confusum respectively. The mean hatching percentage of untreated T. castaneum and T. confusum were 69.90 ± 1.73 and 65.90 ± 2.98 respectively whereas the lowest mean value was 46.10 ± 1.73 for T. castaneum and 41.55 ± 2.35 for T. confusum at the highest dose (16000 ppm). Z. cassumunar rhizome extract also showed the toxic effect to both the insect species. Here the mean egg laying of control T. castaneum and T. confusum were 216.80 ± 12.14 and 223.85 ± 13.54 respectively. The mean oviposition of treated female at 1000 and 16000ppm were 111.90 ± 4.38 and 45.20 ± 7.62 for T. castaneum; and 126.55 ± 7.44 and 54.55 ± 8.10 for T. confusum. The egg hatch at the highest dose was 48.80 for T. castaneum and 50.80 for T. confusum while the control values were 71.63 and 73.42 respectively.*

Key words: *Trichosanthes palmata seed, Zingiber. cassumunar rhizome, Tribolium castaneum, T. confusum, fecundity, fertility.*

I. Introduction

The flour beetle, *Tribolium castaneum* (Herbst) and *Tribolium confusum* du Val are widely distributed throughout the world and are largely disseminated as grains are transported by commerce (Cotton 1947, Sokoloff 1974). The adults of these beetles are long lived and produce eggs continuously over a long period (Dick 1937, Good 1933). Fecundity and fertility are two important factors of paramount importance offering a great bearing on the number of offspring of an insect produced.

Golebiowska (1969) reported that intensive oviposition was depended on intensive feeding rate of the beetle. A number of plant products have been reported to reduce the fecundity in stored-products pests (Jacob and Sheila 1993, Chaiyaboot 1988, Rahman 1992, Amin 2000). Saxena *et al.* (1976) found that the vapours of *Acorus calamus* reduced fecundity and caused regression in the terminal follicle of the vitellarium in treated females of *T. castaneum*, *S. oryzae*, *C. chinensis*, *R. granarium* and *Anthrenus flavipes*.

Plants with aroma and smell generally contain essential oils and other smaller terpenoid molecules. Plants with exotic colours are more likely to contain various types of flavones, flavonoids and other plant phenolics. Similarly bitter testing plants are known to have various types of alkaloids (Rhaman and Choudhary 2005).

Khanam *et al.* (1999) reported the ovicidal activity of *Annona reticulata* against *T. castaneum* and *T. confusum*. Malek (2001) also reported the ovicidal activity of *Annona squamosa* seed oil and two new compounds on *T. castaneum*. Accordingly to Howe (1962), the intrinsic rate of increase of a pest is chiefly determined by the oviposition during its early life. The present experiment was aimed at determining the effects of locally available *T. palmata* seed and *Z. cassumunar* rhizome extracts on the reproductive potential of *T. castaneum* and *T. confusum* which will help in reducing the insect pest population in grain storage.

II. Materials and Methods

Fresh seeds of *T. palmata* and rhizomes of *Z. cassumunar* were utilized for preparing the extracts. The seeds and rhizomes dried in a well ventilated room under shade and finally dried in an oven at 40^{0}C. Dried plant parts were then powdered in a grinding machine and extraction was carried out with petroleum ether in a Soxhlet apparatus. Extracted materials were dried in a rotary evaporator and finally trace amounts of the solvent were removed by evaporating on a water bath, and then collected in a reagent bottle.

A large number of beetles (*T. castaneum* and *T. confusum*) were collected and put on a thin layer of wheat flour in a medium size beaker previously passed through a 60-mesh sieve and the eggs were collected on the following day incubated at 30^0C for hatching. Five different doses of seed and rhizome extracts of *T. palmata* and *Z. cassumunar* viz. 1000, 2000, 4000, 8000 and 16000 ppm were used. The required quantities of the extractives were dissolved in 5ml acetone and then added to wheat flour. A control sample was used with acetone only. The treated foods were dried by fanning, kept in an incubator at 30^0C for 24 hours and then put in a blender for proper mixing. Neonate larvae (<24hours) were transferred to glass beakers (500ml) containing treated food. A batch of control larvae was also similarly maintained. Larvae were checked from time to time for pupation. Pupae were sexed following Halstead (1963). Sexed pupae from different treatments were put on separate petridishes for adult emergence. Pairs of beetles of opposite sexes were introduced in different glass vials (3.5× 1.8cm.) containing different treated food media. For each treatment 20 pairs of adult were employed for opposition. Eggs laid by females were counted by sieving the contents of the vials at 3-day intervals for 33 days. Eggs were observed on separate petri dishes till hatching. Percentage values are transformed into angles according to Bliss (1937). The percent reproductive control (P.R.C.) was calculated following Rizvi *et al.* (1980). as:

$$\text{P.R.C.} = \frac{V_1 - V_2}{V_1} \times 100$$

Where V_1 = Eggs laid by control female, and

V_2 = Eggs laid by treated female

The experiment was conducted in an incubator at $30 \pm 1.5C^0$.

III. Results and Discussion

The effect of *T. palmata* seed extract on the fecundity and fertility of *T. castaneum* and *T. confusum* are given in Table I and illustrated in Fig. 1. Analyses of variance showed a highly significant (P<0.001) reduction in the fecundity of the beetles. Values of PRC also show a gradual reduction in oviposition of the insects depends upon the doses of the extracts. Fertility of beetles were reduced significantly (P<0.001) in comparison with the untreated controls. Results on fecundity and fertility of the above mentioned species due to the effect of *Z. cassumunar* rhizome extracts are presented in Table II (Fig. 2). All the treatment significantly (P< 0.001) reduced the egg lying of the beetles. Values of PRC shows a better protection in offspring production of the beetle. Fertility of the beetles were similarly affected by the treatment and reduced significantly (P< 0.001) in comparison with the untreated controls.

Secondary compounds from plants include alkaloids, terpenoids, phenolics, flavonoids, chromens and other minor chemicals can affect insects in several ways. They may disrupt major metabolic pathways, act as attractants, deterrents, phagostimulants, antifeedants and modify oviposition. They may also affect the insects' central nervous system and lifecycle of the insect in other ways (Smith 1989, Bell *et al.* 1990). Seeds of *T. palmata* contain cucurbitane glycosides, cucurbitacins and protease (Mohamed 1974). *Z. cassumunar* rhizome contain volatile oil, phenylbutenoid monomers, phenylbutenoid dimers and sesquiterpene zerrumbone (Poonsapaya *et al.* 1993, Masuda and Jitoe 1994, 1995, Jitoe *et al.* 1993, Kishore and Dwivedi 1992).

Increase mortality in a population is generally compensated by increasing its net reproduction and it is well established that the multiplication or out break is greatly influenced by the fecundity of the species. Fertility, on the other hand, constitutes one of the most important factors for the survival of an insect and fertility factors are normally studied to evaluate their frequency in nature to elucidate the evolutionary forces, that maintain the set limits and to describe at various levels, viz. morphological, cytological, physiological and biochemical or any other anomalies found (Trippa *et al.* 1980).

These findings receive support from the result of Amin (2000) who reported antiovipositional and antifertility effect of *Azadirachta indica* and *Vitex negundo* in *T. castaneum*. Similarly, Yadava (1985) reported that the oil at the concentration ranging from 40 to 50 mg/10gm of green gram completely inhibited oviposition and fertility in *Callosobruchus* species. Caffeine and castor oil also reduced fertility in *T. castaneum* (Akhtar and Mondal 1994). Chaiyaboot (1988) reported that the application of neem seed powder at the rate of 5% by weight decreased the number of eggs laid by *Rhyzopertha dominica*. Similarly Xu *et al.* (1993) observed Anise oil completely inhibited reproduction in *R. dominica* and *Tenebrio molitor* when mixed with wheat or wheat flour at concentration of 1% by weight. Cassia oils also completely inhibited reproduction in *Sitophilus zeamais*, *R. dominica* and *T. castaneum* (Xu and Zhao 1994). Khanam *et al.* (2008) noted that the acetone extract of *Sapium inducm* seed and petroleum ether extracts of *Thevetia neriifolia* seed kernel and *Jatropa gossypifolia* seed significantly reduced the reproductive potential of *T. castaneum* and *T. confusum*.

A perusal of the data clearly shows that *T. palmata* and *Z. cassumunar* rhizome extracts contain antiovipositional and antifertility components that could be used for the managements of storage pests. However, much more concerted efforts are very much to be directed toward this time.

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Table I. Effect of petroleum ether extract of *T. palmata* seed on the fecundity and fertility of *T. castaneum* and *T. confusum*.

Dose (ppm)	No. of females	Fecundity Mean ± SE	Mean daily eggs lay per female	Percent reproductive control P.R.C.	(No. of eggs) Fertility % Mean ± SE	d – values
Control	20	a)232.05 ± 9.90 b) 215 ± 14.43	a) 7.00 b) 6.53		a) (4641) 69.90 ±1.71 b) (4311) 65.90±1.79	—
1000	20	a)130.20±11.52 b)146.75±17.66	a) 3.95 b) 4.45	a) 43.57 b) 31.85	a) (2604) 60.05 ± 1.40 b) (2935) 62.5± 1.88	a) 2.54 N.S. b) 0.852N.S.
2000	20	a) 98.75 ± 4.23 b) 135.15 ± 18.99	a) 2.99 b) 4.10	a) 57.29 b) 37.21	a) (1975) 58.99±1.82 b) (2703) 58.08±0.856	a) 2.72** b) 1.96 N.S.
4000	20	a) 83.50 ± 10.89 b) 117.05±12.24	a) 2.53 b) 3.55	a) 63.86 b) 45.64	a) (1670) 50.35±1.69 b) (2641) 55.15±1.52	a) 4.83** b) 2.66**
8000	20	a) 59.95 ± 10.49 b) 117.05 ± 11.54	a) 1.82 b) 2.12	a) 74.00 b) 67.53	a) (1199) 47.40 ± 1.63 b) (1400) 51.82 ±1.37	a) 5.51** b) 3.46**
16000	20	a) 52.95 ± 13.00 b) 52.35 ± 7.68	a) 1.60 b) 1.59	a) 77.14 b) 75.65	a) (1059) 46.10 ± 0.994 b) (1047) 41.55 ±1.31	a) 5.84** b) 6.01**

** Significant at 1%; NS Not significant.
d = Standardized normal deviates.
a = *T. castaneum*
b = *T. confusum*

Table II. Effect of petroleum ether extract of *Z. cassumunar* rhizome on the fecundity and fertility of *T. castaneum* and *T. confusum*

Dose (ppm)	No. of females	Fecundity Mean ± SE	Mean daily eggs lay per female	Percent reproductive control P.R.C.	(No. of eggs} Fertility % Mean ± SE	d – values
Control	20	a) 216.80 ± 12.14 b) 223.85 ± 13.54	a) 6.57 b) 6.78		a) (4336) 71.63 ± 1.24 b) (4477) 73.42 ±1.28	– –
1000	20	a) 111.90 ± 4.38 b) (126.55 ± 7.44)	a) 3.39 b) 3.83	a) 48.40 b) 43.51	a) (2238) 63.75±2.14 b) (2531) 60.82 ±1.02	a) 2.07* b) 3.32**
2000	20	a) (91.90 ± 6.00) b) (122.25 ± 7.10)	a) 2.78 b) 3.70	a) 57.69 b) 45.43	a) (1838) 59.98±1.88 b) (2445) 58.24±0.915	a) 2.94** b) 3.79**
4000	20	a) (60.40 ± 5.34) b) (106.75 ± 9.68)	a) 1.83 b) 3.23	a) 72.15 b) 52.36	a) (1208) 54.42±2.08 b) (2135) 54.59±2.03	a) 4.27** b) 4.65**

8000	20	a) (47.75 ± 6.26) b) (57.35 ± 7.14)	a) 1.45 b) 1.74	a) 77.93 b) 74.93	a) (955) 49.77 ±2.11 b) (1147) 53.14±2.49	a) 5.37** b) 4.98**
16000	20	a) (45.20 ± 7.62) b) (54.45 ± 8.10)	a) 1.37 b) 1.65	a) 79.15 b) 75.66	a) (904) 48.80±3.11 b) (1089) 50.80±2.84	a) 5.60** b) 5.55**

*, ** Significant at 5% and 1% respectively; ^{NS} Not significant.
d = Standardized normal deviates.
a = *T. castaneum*
b = *T. confusum*

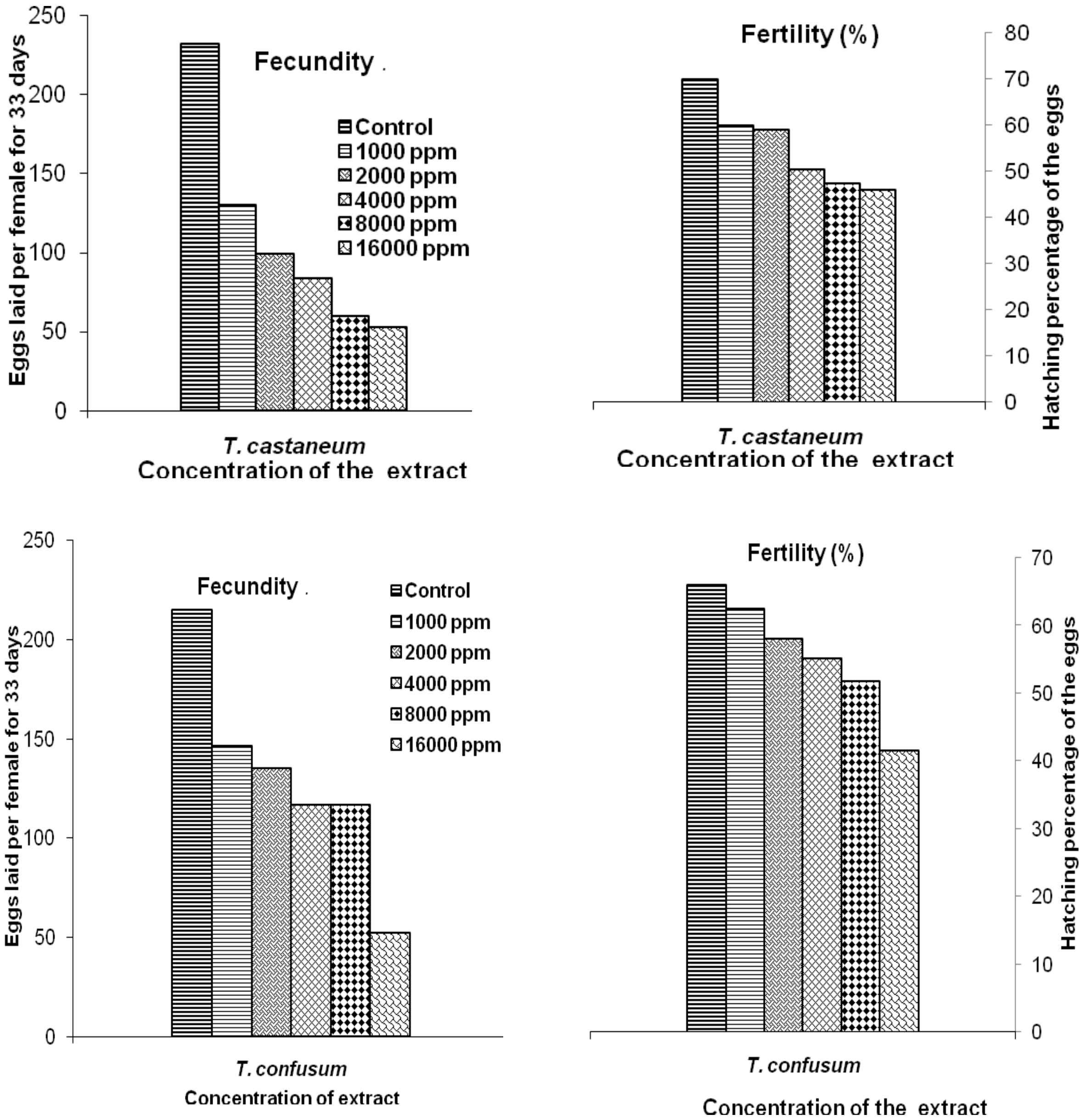

Fig-1. Showing the Effect of different doses of *T. palmata* seed extract on the fecundity and fertility of *T. castaneum* and *T. confusum*.

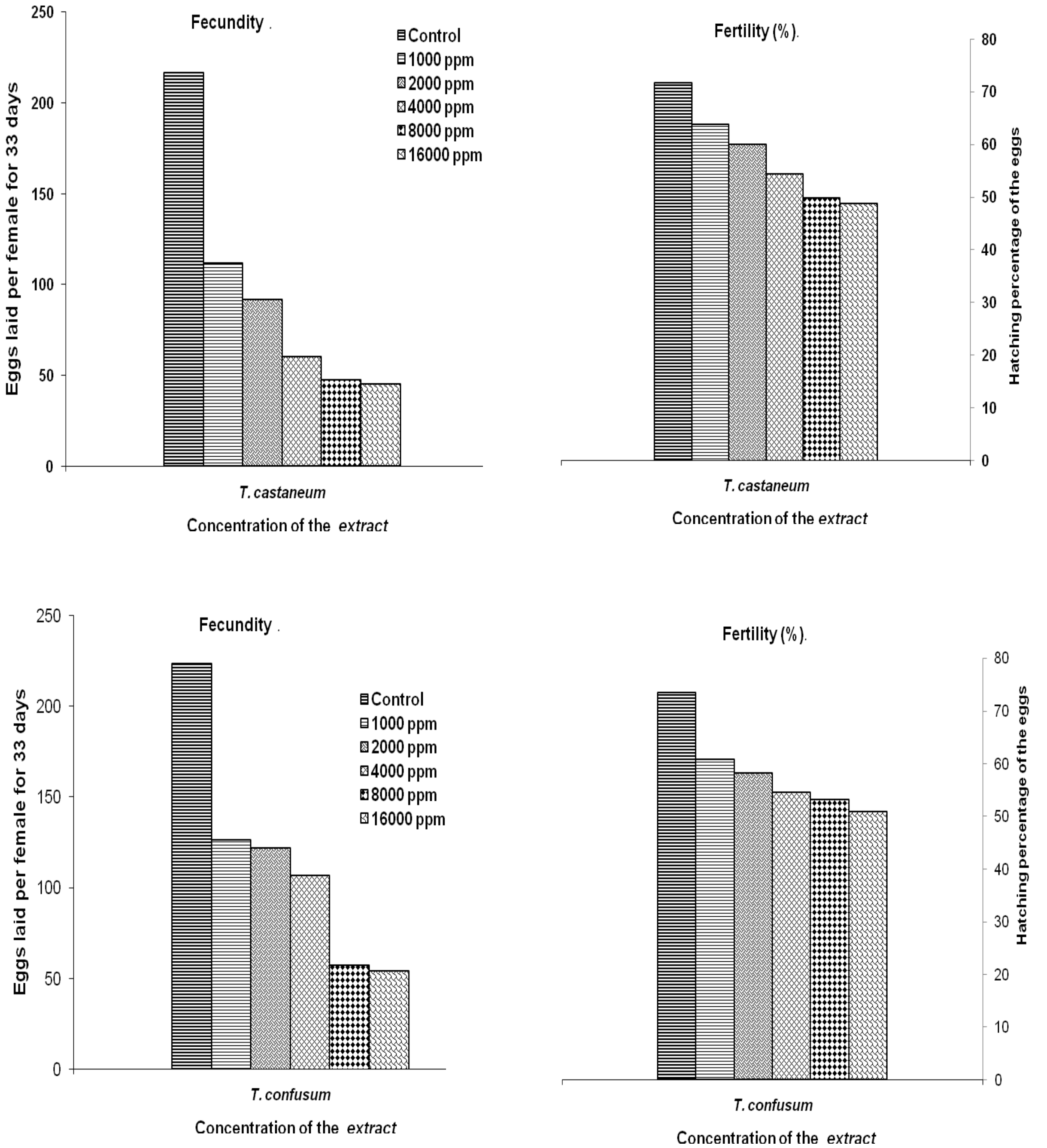

Fig-2. Showing the effect of different doses of *Z. cassumunar* rhizome extract on the fecundity and fertility of *T. castaneum* and *T. confusum*.