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ATTRACTANCY OF DIETHYLETHER AND HEXANE EXTRACTS OF MAIZE (ZEA MAYS L.) TO ORYZAEPHILUS MERCATOR (FAUVE1) *(Coleoptera: Silvanidae)*

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ABSTRACT
Diethylether and hexane extracts of maize attracted 1-7 and 28-42 day-old Oryzaephilus mercator adults. The 1-7 day-old adults were significantly more responsive than the 28- 42 day-old. Starvation of adults for up to 3 days progressively increased O. mercator response. Hexane extracts were more attractive than diethylether extracts. Within the extract concentration range of 0.02, 0.04, 0.06, 0.08, and 1.0ml, optimal response of O. mercator occurred at 0.06m1 and beyond this level, negative response was observed. There were significant interactions between age and solvent; age and starvation period; solvent and extract concentration; age and extract concentration; starvation period and extract concentration, and among age, solvent, and starvation period; age, solvent, and extract concentration; and solvent, starvation period, and extract concentration. Probable reasons for the results obtained are discussed.

INTRODUCTION
Stored-product insects can cause post harvest losses, estimated from 9% in developed countries to 20% or more in developing countries (Philips and Throne, 2010). One of such insects is the Merchant beetle, *Oryzaephilus mercator* (Fauvel), a serious storage pest in the tropics. In Nigeria, it is a major pest of maize (NRI, 1996) and other products including legumes, cereals, tubers, oilseeds, and dried shrimp (Mejule *et al*., 1990). Its small size enables it to invade cracks and crevices; its longevity and rapid population growth make it difficult to control once infestation is established. Early detection is crucial. Storage pests respond to volatile constituents and extracts of host foods (O' Donell *et al*., 1983; Mikolajaczak *et al*., 1984; Stubbs *et al*., 1985; Dudu *et al*., 1998; Umeozor *et al*., 2006; Collins *et al*., 2007). The use of attractants in insect traps leads to early detection of infestations, more accurate monitoring of populations level, and development of alternative control measures (Chambers, 1990). This study investigated the attractancy of different concentrations of diethylether and hexane extracts of maize to *O. mercator*.

MATERIALS AND METHODS
Milled seeds of maize (50g) were shaken vigorously with 50m1 of diethylether or hexane, left to stand for 2.5h, and the extract decanted and stored at -30°C. *O. mercator* was bred on rolled oats; adults 1-7 and 28-42 day-old were

placed in empty Kilner jars for up to three days until used.

Bioassay Procedure

The method described by Pierce *et al*. (1981) was adopted. Plastic Petri dishes (4.5cm diameter) were roughened on the inside bottom with sand paper to facilitate movement of the beetles. Two holes (6mm diameter), 30mm apart were made along the diameter of the Petri dish. A plastic vial (6 x 120mm) was inserted through each hole so that the mouth of the vial was flush with the bottom of the Petri dish. Filter paper, cut into strips (5 x 15mm), was treated with diethylether or hexane extracts of maize by dropping 0.02m1 of the extract on each strip of the filter paper. Strips of filter paper, treated with pure diethylether or hexane of similar volume, served as control. Four treated strips were placed at the bottom of one vial with a pair of forceps while four control strips were placed at the bottom of the other vial within a Petri dish. One Petri dish served as a replicate and there were four replicates per treatment. The bioassay dishes rested on boards in rows. Similar procedure was used in 0.04, 0.06, 0.08, and 1.0ml treatments. Twenty *O. mercator* adults were released into each Petri dish. Weights were placed on the lids of the Petri dishes to prevent the escape of the beetles. The dishes were then covered with black cloth for 2h before recording the insects in the treated and control vials.

The factors studied were:

(a) the effect of age: two groups, pre-oviposition (1-7 days) and peak oviposition (28-42 days);
(b) the effect of solvent: two solvents, diethylether and hexane, were tested;
(c) the effect of starvation period: adults were kept in empty 2-litre Kilner jars in the dark for 0, 1, 2, and 3 days without food; and
(d) the effect of the concentration of the extracts: 0.02, 0.04, 0.06, 0.08, and 1 .0ml were tested.

The percentage response data were subjected to a 4-way ANOVA, using Statistical Package for the Social Sciences (SPSS) Version 10.0. LSD was used to separate the means of starvation periods and concentrations of the extracts.

RESULTS AND DISCUSSION

The age of the insect, starvation period, solvent, and concentration of the extracts significantly affected *O. mercator* response to maize extract ($P< 0.01$) (Table 1). The extract attracted more 1-7 day-old adults than 28-42 day-old (Table 2). Dudu *et al*. (1998) found that 28-42 day-old *O. mercator* were significantly more responsive than 1-7 day-old to diethylether extracts of oilseeds – *Arachis hypogaea* (groundnut), Citrullus *lanatus* (bitter melon), and *Irvingia gabonensis* (African mango). Pierce *et al*. (1983) also obtained similar effects with beetle and frass volatiles. In the current study, the 28- 42 day-old adults probably had more food reserves and may have been searching for nutrients to maintain egg production, while the 1-7 day-old adults had lower food reserves. Hexane extracts of maize showed a significantly greater response than diethylether extracts (Table 2), presumably due to differences in their efficacy for the extraction of attractive constituents. Umeozor *et al*. (2006) observed that diethylether extract of cereals elicited a significantly greater response than acetone extracts. Thus hexane is probably a better solvent than either acetone or diethylether.

Starvation progressively increased the response of *O. mercator* (Table 2). Freedman *et al.* (1982) and Umeozor *et al*. (2006) made similar observations, while Dudu *et al*. (1998) found that with diethylether extracts of oilseeds, starvation for up to 24h affected response but beyond that period, there was no further increase. Increasing extract concentration, within the range, 0.02-0.06ml, correlated with increased response of *O. mercator*; beyond this range, negative response occurred (Table 2). Optimal response was recorded at an extract concentration of 0.06m1. Collins *et al*. (2007)

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identified E-2-nonenal and E-3-octen-2-one as volatile compounds which elicited behavioural response from *O. surinamensis*. These compounds are found in maize (Sayaslan *et al.*2000) and might have been responsible for the observed *O. mercator* response in this study. There were significant interactions between solvent and age; age and starvation period; solvent and extract concentration; age and extract concentration; starvation period and extract concentration, and among solvent, age, and starvation period; solvent, age, and extract concentration; and solvent, starvation period and extract concentration (Table 1).

Table 1. Response of *Oryzaephilus mercator* to maize extracts.

Source of Variation	df	Sum of squares	Mean of Squares	F-ratio
Age	1	1322.35	1322.35	24.12**
Solvent	1	733.56	733.56	13.38**
Starvation period	3	38463.92	12821.31	233.88**
Extract concentration	4	7102.38	1775.60	32.39**
Age x Solvent	1	293.57	293.57	5.36*
Solvent x Starv. Period	3	308.44	102.81	1.88NS
Age x Starv. Period	3	5934.20	1978.07	36.08**
Solv. x Age x Starv. Period	3	3069.71	1023.24	18.67**
Solv. x Extract conc	4	1115.20	278.80	5.09*
Age x Extract conc	4	962.20	240.55	4.39*
Solv. x Age x Extract conc	4	1563.51	390.88	7.13**
Starv. Period x Extract conc	12	2369.43	197.45	3.60*
Solv. x Starv. Period x Extract conc	12	1911.50	159.29	2.91*
Age x Starv. Period x Extract conc.	12	1268.40	105.70	1.93NS
Age x Solv. x Starv. Period x Extract conc.	12	657.86	54.82	-

Significant at ** P<0.01 and *P<0.05; NS = not significant.

Table 2. Effect of age, solvent, starvation period, and extract concentration on the response of *Oryzaephilus mercator* to maize extracts.

Factor		Mean % response ± S.E.
Age:	1-7 day-old	8.8 ± 5.3a
	28–42 day-old	0.6 ± 3.8b
Solvent:	Hexane	7.7 ± 4.5a
	Diethylether	1.7 ± 4.8b
Starvation (days):	0	-27.1 ± 3.5d
	1	- 3.9 ± 4.3c
	2	21.5 ± 5.2b
	3	28.3 ± 4.1a
Extract concentration (ml):	0.02	4.1 ± 7.7c
	0.04	11.9 ± 7.1b
	0.06	17.9 ± 7.0a
	0.08	-8.5 ± 7.1e
	1.00	-2.0 ± 6.4d

Within a factor, means with the same letter are not significantly different at $P < 0.05$.

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