

## Physicochemical Properties Of Sesame Oil And Varietal Susceptibility To *Tribolium Castaneum* Herbst (Coleoptera: Tenebrionidae) Infestation

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**Abstract:** Five improved sesame varieties (*Sesamum indicum*) namely E8, 01M, 02M, 03L, and Ex-Sudan were screened in the laboratory for varietal susceptibility to the rust red flour beetle, *Tribolium castaneum* (Herbst). The physicochemical properties of fixed oil extracted from each variety were also determined. Weight of 100 seeds and mortality of *T. Castaneum* in different sesame varieties were significant ( $P < 0.05$ ). The number of emerged  $F_1$  larvae from the seeds was significantly different ( $P < 0.05$ ) among the five varieties with the large-seeded variety (03L) recording the lowest number (1.15). Percentage adult mortality of *T. castaneum* was positively correlated to percentage oil content of the sesame varieties ( $r = 0.56$ ;  $p < 0.01$ ); negative correlation was observed between oil pH and larva emergence ( $r = 0.47$ ;  $p < 0.05$ ). The importance of some physicochemical parameters of sesame oil as indicators of resistance in sesame seeds to *T. castaneum* and their potential use to generate resistant lines is implied by this work.

**keywords:** *Sesame indicum*, Susceptibility, *Tribolium castaneum*, Varietal resistance

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### I. Introduction

In most developing countries of the world like Nigeria, agriculture forms the main stay of the economy since it is the major occupation of the people; consequently, it remains the driving force for economic growth. However, the profile of agriculture has not changed significantly in most of these countries as it is dominated by small scale farmers; and if the ever increasing human population is taken into consideration, the reason why food scarcity, hunger, and malnutrition have not abated in them can be understood (Aitken, 1975; FAO, 2005b).

One of the problems posed to small scale farmers throughout the world is that of insect pest damage to stored-grains and grain products which can be up to 20-30% in the tropical regions (Nakatita, 1998). *Tribolium castaneum* (Coleoptera: Tenebrionidae) is a widespread and destructive secondary pest which attack stored products grains and grain products (Aitken, 1975; Weston and Rattlingourd, 2000). Not only is it capable of breeding throughout the year in warm areas, the insect can live for more than two years, during which the female can produce about 1000 eggs (Pugazhvendon *et al.*, 2009; Shukla *et al.*, 2010).

Sesame (*Sesame indicum* L.) seed is one of the world's most important and oldest oilseed crops known to man (Abou-Gharbia *et al.*, 2000). Though sesame seeds were chiefly used in oil and wine production, they are mostly used for oil extraction and edible purposes (El Khier *et al.*, 2008; Ghandi, 2009). Sesame seed is not only rich in methionine, it similarly has approximately 50 percent oil (out of which 35% is monounsaturated fatty acids and 44% polyunsaturated fatty acids) and 45 percent meal (of which 20% is protein) (Ghandi, 2009; Hansen, 2011). World production of sesame seeds as estimated by FAO was 3.3 million metric ton as at 2006; in this figure, China and India are the largest producers (USAID, 2009). Africa grows 26% of the world's sesame, with Sierra Leone, Sudan, Nigeria and Uganda being the key producers (Abou-Gharbia *et al.*, 2000). Sesame has become an important component of Nigeria's agricultural export crop as it is cultivated commonly in Northern part of the country (Chemonics, 2002). The Nigerian market potential for sesame seed production has been increasing and the production figures of 98,000,000 to 152,000,000 kg from 2003 to 2007 confirms this (CBN, 2009).

Nigeria as a country has a great market potential for sesame production for both domestic and export markets; the highly priced lighter varieties of sesame such as white, yellow and black are found in the country (Fariku *et al.*, 2007). With many uses of sesame and the existence of several varieties of the plant developed in Nigeria, it has become important to investigate their comparative susceptibility, to stored product insects. Therefore, the objective of this study is to evaluate the susceptibility or resistance of five improved Nigeria varieties of sesame to infestation of *Tribolium castaneum* and the physicochemical properties of fixed oil extracted from each hybrid as possible basis for the inherent resistance.

## II. Materials And Methods

### Collection of Samples and Storage

Five varieties of Sesame seeds were obtained from National Cereal Research Institute, Badegi, Bida, Nigeria. The varieties namely, E8, 01M, 02M, 03L, and Ex-Sudan were disinfected by storage at 40°C for two weeks before use.

### Determination of Seed Weight

Seed weight was determined by putting a hundred seeds of each sesame variety into 9 cm diameter Petri dish and weighed using a sensitive weighing balance (Ohaus®). Seed weight determination was repeated four times and the mean values determined.

### Culturing of *Tribolium castaneum*

*T. castaneum* adults were obtained from a culture maintained in the Storage Entomology Unit of the Department of Crop and Environmental Protection, Ladoko Akintola University of Technology (LAUTECH), Ogbomoso, Nigeria. They were collected and reintroduced into plastic jars containing milled sorghum bought from Sabo market in Ogbomoso. The jars were kept in the laboratory under ambient temperature of 25-35°C and relative humidity of 68-80%. With the emergence of larvae after 42 days of infestation, the emerged larvae and adults were separated. The emerged larvae were raised to produce F<sub>1</sub> generation of beetles. The adults were used for subsequent infestation to maintain insect culture throughout the period of the experiment.

### Antixenosis prescreen

Antixenosis prescreen was done according to Babarinde et al. (2008) with little modifications. A white cardboard paper was cut into a circular shape of radius 15.5 cm and divided into 5 equal parts with a smaller internal circle radius 5 cm at the center. This divided cardboard was placed in a large bowl container of same radius 15.5 cm. The five sesame varieties were randomly allocated to each subdivision. Thirty *T. castaneum* adults were introduced into the inner circle and data on number of insects attracted to each variety was determined. The experiment was replicated four times.

### Sesame varietal susceptibility of sesame seeds to *T. castaneum* infestation

Twenty grams of each sesame variety was separately weighed into 150 ml glass jar with perforated lids covered with a muslin cloth. Ten mixed sex *T. castaneum* adults (3 day old) were introduced into the jar. After seven days of oviposition, the dead and live insects were removed and counted. Thereafter, the samples were kept for 42 days for the emergence of F<sub>1</sub> progeny. The experiment was replicated four times.

### Oil extraction

Oil extraction was done with Soxhlet apparatus. Fifty grams of each sesame variety was ground with mortar and pestle and extracted with 200 ml n-hexane at 60°C for 4 h. Oil was recovered by subjecting the solution into heat for 30 min so as to allow the solvent to evaporate.

### Physico-chemical analysis

Total Ash and moisture content of each sesame variety and free fatty acid of the sesame oil were determined using AOAC methods (AOAC, 1990): Total Ash, Moisture content, and free fatty acid.

### pH determination

Seeds of each sesame variety were milled using a mortar and pestle. Two grams of each sample was weighed and dispersed in 30 ml of distilled water. The suspension was manually stirred with a glass rod until an equilibrium pH value and temperature were observed, with the aid of a pH meter.

### Experimental Design and Statistical analysis

The experiments were set up in completely randomized design (CRD) and data were subject to one way analysis of variance (ANOVA) with the aid of statistical software, SAS (SAS Institute, 2000)

## III. Results

### Determination of Seed Weight

There was a significant difference ( $p < 0.05$ ) in the weight of each of the 100 seeds of the five sesame varieties. The highest seed weight (0.61 g) was recorded in 02M and 03L was significantly higher than the values obtained in Ex-Sudan (0.56 g), 01M (0.53 g) and E8 (0.55 g) (Table 1).

#### **Antixenosis prescreen**

There was no significant difference among sesame varieties with regard to free choice antixenosis. O3L had the highest mean number (2.09) of attracted *T. castaneum* adult, while O2M had the smallest mean number (0.79) of attraction (Table 1).

#### **Effect of Sesame varietal resistance on mortality, larval and adult emergence**

Sesame variety significantly ( $p < 0.05$ ) affected mortality. The highest percentage mortality was observed in O3L (29.35%), followed by O1M (26.20%), Ex-sudan (22.50%) and E8 (18.40%). The least percentage mortality observed in O2M (13.30%) was significantly lower than mortality observed in O3L. There was significant difference among varieties with regards to adult emergence. The least adult emergence was observed in O3L (0.84) which was significantly lower than the adult emergence observed in Ex-sudan (1.99). Significant difference ( $p < 0.05$ ) was also recorded with regards to larva emergence. The highest number of emerged larva was observed in O1M (3.71), followed by Ex-sudan (3.56), E8 (2.28) and O2M (1.99). The least number of emerged larvae (1.15) was observed in O3L, which was significantly lower than 3.71 and 3.56 observed in O1M and Ex-sudan respectively (Table 1).

#### **Physico-chemical properties of the experimented sesame varieties**

There was significant difference among sesame varieties ( $p < 0.05$ ) with regards to pH. The highest pH (0.8) was recorded in variety O3L and this was followed by O2M, Ex-Sudan (0.79) and E8 (0.78) in that order. The smallest pH was recorded in O1M (0.76). FFA contents varied significantly ( $p < 0.05$ ) among the five sesame varieties. The highest FFA was recorded in O2M variety (34), followed by O1M (30:23), Ex-sudan (27.54) and E8 (19.54). The lowest FFA was recorded in O3L (12.69).

The highest oil content was recorded in variety O3L (0.65), which was significantly higher than what was obtained in O1M (0.61), Ex-sudan (0.52), O2M (0.28) and E8 (0.26). The ash content observed in variety O2M (14.39), significantly higher than what was obtained E8 (12.54) and O1M (11.96). There was significant difference among varieties with regards to moisture content. The moisture content observed in Ex-sudan (15.36%), E8 (15.25%), O2M (15.05%) and O1M (14.49%) was significantly higher than 14.03% obtained in O3L (Table 2).

#### **Correlation of physiochemical properties of sesame and reproductive parameters of *Tribolium castaneum***

There was a positive correlation between mortality and oil content ( $r = 0.558$ ;  $P < 0.01$ ). Positive correlation was observed between adult emergence and larva emergence ( $r = 0.624$ ;  $P < 0.05$ ). The ash content and pH of oil extracted from sesame were negatively correlated to mean seed weight ( $r = -0.471$ ;  $p < 0.05$ ;  $r = -0.716$ ,  $p < 0.01$ ) (Table 3).

### **IV. Discussion**

The sesame variety with the lowest moisture content and highest oil yield (O3L) recorded the least larva and adult emergences and highest percentage mortality. These observations are similar to the findings of Rahman *et al.*, (2003) who reported that sesame with high oil content result in lower infestation, less emergence of adult, less seed damage, and a higher inhibition rate upon attack by *T. castaneum*. In a similar study in another Coleopteran, Khaire *et al.*, (1992) reported that sesame oil inhibited the emergence of adult *Callosobrunchus chinensis*. In addition, Mohuiddin *et al.*, (1993) reported the toxicity of oil of different plants including *Sesamum indicum* on *T. castaneum*.

*T. castaneum* as an insect pest is known to complete its development from eggs to imago stage in about 28 days under optimal temperature condition and moisture content of 31<sup>o</sup> C and 15% respectively. Consequently, lower moisture contents are inimical to the proliferation and infestation by these beetles (PHPG, 1986). The important role of lower moisture content could be one of the reasons for the least values posted for adult and larval emergences of the beetles in O3L variety. Furthermore, the variety posted the highest adult mortality.

The positive correlation between percentage mortality of *T. castaneum* with oil content of sesame implies that large seeded variety with high oil content inhibits infestation by *T. castaneum* beetles. Therefore, breeding for high oil yield can be precursory to inherent resistance against *T. castaneum* infestation.

Of the five studied varieties, O3L showed greater potentials for inherent resistance against *T. castaneum* than others. This variety is, therefore, recommended for farmers in areas that are prone to *T. castaneum* infestation. Since O3L is a large seeded variety with high oil yield, it will not be difficult for farmers to adopt, provided it does not have any other negative agronomic qualities on the field. The most attractive feature of using varietal resistance is that it does not require extra technical skill or financial costs (Babarinde *et al.*, 2008). Breeders can also utilize this variety for crosses to produce better quality sesame hybrids.

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Table 1. Sesame seed weight and effect of varietal difference on adult mortality, antixenosis, larval and adult emergence

Variety	Weight of 100 Seeds	Mortality (%)	Antixenosis	Larva emergence	Adult emergence
01M	0.53 <sup>a</sup>	26.20 <sup>ab</sup>	1.51 <sup>a</sup>	3.71 <sup>a</sup>	0.97 <sup>b</sup>
02M	0.61 <sup>c</sup>	13.30 <sup>b</sup>	0.79 <sup>a</sup>	1.99 <sup>ab</sup>	0.93 <sup>b</sup>
03L	0.61 <sup>c</sup>	29.35 <sup>a</sup>	2.09 <sup>a</sup>	1.15 <sup>b</sup>	0.84 <sup>b</sup>
E8	0.55 <sup>ab</sup>	18.40 <sup>ab</sup>	1.39 <sup>a</sup>	2.28 <sup>ab</sup>	1.13 <sup>ab</sup>
Ex-Sudan	0.56 <sup>ab</sup>	22.50 <sup>ab</sup>	1.32 <sup>a</sup>	3.56 <sup>a</sup>	1.99 <sup>a</sup>
LSD	0.02	13.68	1.39	1.84	0.94

Mean followed by the same letter within the column are not significantly different (p<0.05) using LSD

Table 2: Selected Chemical Properties of the Five Sesame varieties

Variety	pH	FFA (%)	Oil	Ash (%)	Moisture Content (%)
01M	0.76 <sup>d</sup>	30.23 <sup>b</sup>	0.61 <sup>b</sup>	11.96 <sup>b</sup>	14.97 <sup>a</sup>
02M	0.79 <sup>b</sup>	34.00 <sup>a</sup>	0.28 <sup>d</sup>	14.39 <sup>a</sup>	15.05 <sup>a</sup>
03L	0.80 <sup>a</sup>	12.69 <sup>e</sup>	0.65 <sup>a</sup>	13.42 <sup>ab</sup>	14.03 <sup>b</sup>
E8	0.78 <sup>c</sup>	19.54 <sup>d</sup>	0.26 <sup>c</sup>	12.54 <sup>b</sup>	15.25 <sup>a</sup>
Ex-sudan	0.79 <sup>b</sup>	27.54 <sup>c</sup>	0.52 <sup>c</sup>	13.68 <sup>ab</sup>	15.36 <sup>a</sup>
LSD	0.01	0.3	0.004	1.74	0.81

*Physicochemical Properties Of Sesame Oil And Varietal Susceptibility To Tribolium Castaneum*

Means followed by different superscripts within the column are not significantly different ( $p < 0.05$ ) using LSD.

Table 3: Correlation (r) of physicochemical properties of sesame and reproductive parameters of *T. castaneum* studied sesame varieties

	pH	Ash	Moisture	Mortality	Antixenosis	Adult emerge	Larva emerge	FFA	Weight	Oil content
pH	1	0.404	-0.225	-0.026	-0.107	0.009	-0.470*	-0.410	-0.716**	0.050
Ash		1	-0.072	-0.011	-0.293	-0.129	-0.429	0.125	-0.471*	-0.182
Moisture			1	-0.242	-0.414	0.157	0.322	0.411	0.280	-0.372
Mortality				1	0.117	-0.231	-0.268	-0.350	0.109	0.558**
Antixenosis					1	-0.021	0.062	-0.399	0.018	0.357
Adult emerge						1	0.624**	0.128	0.164	0.016
Larva Emerge							1	0.418	0.416	0.114
FFA								1	0.156	-0.297
Weight									1	0.078
Oil content										1

\*Significant correlation at 5% probability level

\*\* Significant correlation at 1% probability level