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Annals of Biological Research, 2015, 6 (7):7-10
(http://scholarsresearchlibrary.com/archive.html)

Annals of Biological Research
Scholars Research Library
ISSN 0976-1233
CODEN (USA): ABRNBW

Effect of sex differentiation on *Tribolium castaneum* development reared on four selected grain flours

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ABSTRACT

Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae), the red flour beetle, is an important cosmopolitan pest of stored grains. Three ratios of male to female (3:7, 7:3 and 5:5) were reared on four flours, viz: millet, maize, sorghum and wheat, and the experiment which based on the various life stages were noted for larval development, pupal and adult. The results showed significant difference (P<0.05) between the maize grains and the other grains in larval, pupal and adult development of T. castaneum with different sex ratios. Thus the preparation and storage of ready to use flour, especially maize, for prolonged periods, should be de-emphasized amongst farmers, food handlers and households in Nigeria and Africa where facilities to keep abate T. castaneum are not available.

Key words: Maize, millet, sex differentiation, sorghum, *Tribolium castaneum*, wheat.

INTRODUCTION

The genus *Tribolium* is flour beetle which belong to the Order Coleopteran and the family Tenebrionidae. Members of the family Tenebrionidae have been found associated with stored products in tropical and sub tropical countries [1]. The flour beetles are commensals with man and natural populations are found associated with stored products [2]. They are pest of cereals and some important leguminous crops such as cowpea, groundnut, peas, cocoa and flour [3]. *Tribolium* is a secondary pest of grains (it infects grains already infested by other insects) [4].

Tribolium species are usually curved with a heavy coat of horn-like elytra. There are two major species of *Tribolium* namely *Tribolium castaneum* (Herbst) (Rust red flour beetle), 2.3 to 4.4mm in length. It is reddish brown in color and has a pair of antennae, each with three segmented club. The distance between the two compound eyes is about equal to the transverse ventral diameter of an eye. It is cosmopolitan but particularly common in tropical and subtropical regions [4]. The second species is *Tribolium confusum* (j.duval) (confused flour beetle) with the length of 2.6 to 4.4mm. It is depressed, black or dark brown in color and has a pair of loose, indistinct five or six segmented club shaped antennae which may not be club shaped but thickened gradually towards the apex. Head has ridges above the eyes, and the eyes are separated ventrally by a space equal to two or three times the traverse ventral diameter of an eye [4].

The red flour beetle infests flour and cause considerable losses in quantity and quality. Feeding directly could result in weight loss [5], by secretion of benzoquinones from a pair of abdominal defense gland [6].

Stored product pests, especially *T. castaneum* cause damage to grains in the store by eating some portions of the grains which could subsequently lead to losses usually manifested by reduction in weight and by contaminating produce with trass, exuviae and mummified bodies of dead insects, altering their biochemical constitution, or by outright reduction in the amount of important nutrients [7]. *T. castaneum* (Herbst) is one of the most widespread and destructive pests of stored products, feeding on different stored grain and grain products in the hot humid tropical regions of the world [8]. In Nigeria, the host range of the rust-red flour beetle includes a wide range of food stuffs such as milled cereal products like wheat, sorghum, millet, acha, benniseeds, oil seed cake, cowpea, groundnuts, dried roots and tubers of yam, cassava, cocoyam, plantain among others [9-12]. It has also been noted that food quality has profound effect upon the population growth rate of *T. castaneum* [13]. Sorghum, maize, millet and wheat are all found in Nigeria and are widely consumed by most households especially in the northern parts, and are used by various industries. Maize is mainly used by the poultry industry as a raw material for feed while sorghum is used by breweries for producing beverages. Sorghum and millet are important for households in the northern part of Nigeria, particularly the border market where millet is also heavily traded with Niger. However, if inappropriately stored, the grains suffer considerable losses in quantity, quality and viability in storage from *T. castaneum* [5]. General post-harvest losses from the beetle have been reported to be in the range of 25-40% for the tropics [14]. FAO [15] estimated that out of the 10 million tonnes of cereal product in Nigeria annually, 1.5-2.0 million tonnes are lost due to poor storage.

Because of the damages caused by these insects on stored grains, especially by rendering the grains unsuitable for human consumption, an attempt to test the survival and developmental rate of *T. castaneum* in four selected grain flours viz: maize, millet, sorghum and wheat. Flours, were evaluated to ascertain which of the flour gives *T. castaneum* a favorable condition for their survival and development.

MATERIALS AND METHODS

Establishment and Maintenance of Stock Culture of *T. castaneum*

T. cataneum used for the experiment was collected from infested semovita grits in the market store in Yola, Adamawa State. Stock culture of *T. castaneum* was maintained on semovita grits in the laboratory, under favourable laboratory conditions.

Sources of Grains and Flours Preparation

Maize, millet, sorghum and wheat were obtained from Yola market of Adamawa State. The grains were put in an ovum for about three days at 35-37°C and subsequently air-dried before grinding. This was done in order to free the grains/powder from any foreign infestation by *T. castaneum* before the start of the experiment.

Sexing and Infestation Procedure

Males and females were differentiated using dissecting microscope and kept in two different jars containing 50g of wheat flour each for further use. The adult males were distinguished from the females by a hairy puncture on the ventral surface of the anterior femur [11]. At the start of the experiment, different pairs (male and females) of freshly emerged *T. castaneum* adults were carefully introduced into a jar with about 50g of millet, maize sorghum and wheat flour. The top of the jar was screened with fine mesh to prevent the escape of insects and allow aeration.

Study Design

Randomize complete block design (RCBD) was used for the experiment. Treatments were made up of sex pairs in ratio as follows: 5:5, 7:3, 3:7, of males and females respectively. The treatments were replicated three times

Data Collection

The number of larvae, pupae and adults that developed on each of the samples were counted at weekly interval of five weeks after which F1 generation is expected.

Statistical Analysis

Data collected was analyzed using ANOVA, and the treatment means were separated using Duncan Range multiple test. $P<0.05$ was considered significant.

RESULTS

Larval development of *T. castaneum* on different grain flours

Table 1 shows the larval development of *T. castaneum* in varying sex on different grain flours. For the ratio of 3:7 of male and female respectively, the mean difference was significant (P<0.05) between the maize and the other grain flours. Although, wheat and millet flours did not differ significantly at 5% level of significance, similar trend was recorded for the sex ratio of 7:3 and 5:5.

Pupal development of *T. castaneum* on different grain flours

In Table 2, the development of the pupal stage of *T. castaneum* in different sex ratio over time on different grain flours is shown. The result shows that, there was no significant difference between sorghum, wheat and millet across the three different sex ratios (3:7, 7:3 and 5:5 of male and female respectively), but differ significantly (P<0.05) higher from the maize grain flour across the three male to female sex ratios.

Adult development of *T. castaneum* on different grain flours

Table 3 shows the F1 progeny emergence of *T. castaneum* under different grain flours. There was a high significant difference (P<0.05) in the number of F1 adult emergence of *T. castaneum* observed over time for different sex ratios on maize flour and other grain flours tested when compared. Meanwhile, there was no significant difference between the adult F1 emergence for different sex ratios observed on sorghum and millet flours over time at P<0.05.

Table 1: Larval development of different sex ratios of *T. castaneum* reared on different grains observed over time

	Ratio (Male: Female) (Mean±SE)		
Grains	3:7	7:3	5:5
Maize	134.33±3.18^{a}	137.33±2.91^{a}	154.67±8.57^{a}
Sorghum	401.67±50.04^{b}	548.33±26.33^{b}	443.33±38.55^{b}
Wheat	298.00±14.00^{c}	307.67±17.68^{c}	343.33±32.27^{c}
Millet	252.00±16.197^{c}	330.33±15.33^{c}	289.67±8.51^{c}

Means carrying similar superscript alphabet along the columns, are not significantly different at P<0.05.

Table 2: Pupal development of different sex ratios of *T. castaneum* reared on different grains observed over time

	Ratio (Male: Female) (Mean±SE)		
Grains	3:7	7:3	5:5
Maize	21.67±1.86^{a}	29.67±8.99^{a}	29.00±2.08^{a}
Sorghum	85.00±50.95^{b}	205.67±46.48^{b}	206.67±63.74^{b}
Wheat	94.00±6.66^{b}	103.67±28.49^{b}	109.33±9.35^{b}
Millet	103.00±9.61^{b}	152.67±26.54^{b}	108.00±5.77^{b}

Means carrying similar superscript alphabet along the columns, are not significantly different at P<0.05.

Table 3: Adults F1 progeny emergence *T. castaneum* in different sex ratios reared on different grains observed over time

	Ratio (Male: Female) (Mean±SE)		
Grains	3:7	7:3	5:5
Maize	0.67±0.67^{a}	1.00±1.00^{a}	1.67±1.20^{a}
Sorghum	22.33±10.27^{b}	79.33±17.29^{b}	80.33±29.17^{b}
Wheat	34.00±8.02^{ab}	27.00±10.50^{ab}	41.33±3.38^{ab}
Millet	29.33±4.67^{b}	53.00±9.29^{b}	47.00±5.51^{b}

Means carrying similar superscript alphabet along the columns, are not significantly different at P<0.05.

DISCUSSION

From the previous studies, it has been reported that food quality has a major factor on developmental rate of *T. castaneum* [16],[17],[5]. Development of *Tribolium* sp. generally takes about 20 days on a good qualitative diet with other factors being optimal [4]. However, where the diet presented for development is of less quality, developmental periods takes a longer time and it can be as long as 45days or more [4]. Much of the work that has been reported on the rearing of *T. castaneum* in the laboratory has been on mixture of diet of wheat and oaths resulting in shorter developmental period [4]. According to Campbell and Runnion [18], a small difference in the quality of flour can cause a significant difference in the development of *T. castaneum*. *Tribolium castaneum* has been reported to be well adapted to dry conditions and therefore regarded as unspecialized feeders [4].

From the result of this study as shown in Table 1, the mean difference was highly significant (P<0.05) between the maize and the other grain flours. Wheat and millet flours did not differ significantly at 5% level of significance. Similar trend was recorded for the sex ratio of 7:3 and 5:5. This agrees with the report of Dawson [19] who reported maize as unsuitable food for *T. castaneum*, but wheat flour and other grains flours are suitable foods for *T. castaneum*.

Results on the mean pupal development of *T. castaneum* as shown in Table 2 showed a significant difference (P<0.05) between the maize flour and the other flours. This also agrees with the studies of Dawson [19] as discussed above in the larval development. Again, there was no significant difference between sorghum, wheat and millet across the three different sex ratios (3:7, 7:3 and 5:5 of male and female respectively), to further confirm that maize flour is not a suitable food for *T. castaneum* development compared with wheat and other grain flours.

The mean number of adult F1 adult's progeny emergence are shown in Table 3. The least number of adults was observed on maize grain flour, which also differed significantly higher from the other grains. But there was no significant difference between the adult F1 emergence for different sex ratios observed on sorghum and millet flours over time at P<0.05 as shown in Table 1. This continues to confirm the report by Dawson [20].

CONCLUSION

The fact that a household purchases a particular type of processed staple meals does not stop the produce from being infested by the store pest. Thus the preparation and storage of ready to use flour, especially flour from wheat, millet, sorghum maize etc. for prolonged periods, should be de-emphasized amongst farmers, food handlers and households in Nigeria and Africa, where facilities to keep abate *T. castaneum* are not available.

Acknowledgement
The authors wish to acknowledge the kind contributions of the management of American University of Nigeria, Yola for providing us access to their Laboratory where the research was conducted.

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