

Weight gain performance of *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) larvae and adults in different diets

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Abstract

Tribolium castaneum, the red flour beetle, is a serious pest of stored food and has a broad host range. The composition of rearing media determines the suitability for breeding as well as the convenience of handling the insects. Their breeding success in different food media is reported but weight gain is often neglected. The objective of this research was to determine the success of using different food ingredients either alone or in combination for the optimum weight gain by *T. castaneum* larvae and adults. Locally-available food materials were tested alone and in combination for the weight gain by larvae and adults of *T. castaneum*. The *T. castaneum* adults were introduced to each medium, maintained for 2 weeks and sifted out. The weight of progeny larvae and adults were determined. In many cases, multi-ingredient diets performed better than the single ingredient. Presence of corn flour alone or in combination reduces weight gained by larvae and adults of *T. castaneum*. Future studies need to explore the possibility of incorporating alternative ingredients to further increase the success of food media found in this study.

Keywords: *Red flour beetle, diet, ingredients, mass, food*

1. Introduction

The increased losses occurred during post-harvest operations of agricultural commodities is a burning issue, and a serious threat to the food security throughout the world [1]. In Sri Lanka, the losses occurred due to the activities of insects during storage of grains reach 80% of losses occurred [2]. The red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) is a serious pest insect in stored grains and other durable products [3,4] and occurs in many places of postharvest handling and processing of grains [5,6]. The feeding preference of *T. castaneum* varies among food [7,8,9]. In previous studies, mostly the infestation of *T. castaneum* in a given food commodity has been assessed [10]. However, its breeding ability in multi-ingredient food is lacking. Many food in the market have more than one ingredient, and thus the identification of potential of these food as source of infestation by *T. castaneum* is important on two grounds. First, this helps to protect them from destruction of this pest. Secondly, identification of media having higher development would help using them in mass culturing for research purposes as the issues on the same are often reported. Many studies report the success of a food medium in terms of the number of progeny individuals emerged but the important fact on their weight which has direct impact on their performance is often neglected. Therefore, the objective of the current study was to determine if the weight gained by *T. castaneum* larvae and adult varies with the rearing medium and the number of ingredients used in the food medium.

2. Material and Methods

2.1 Insects

The red flour beetle *T. castaneum* used in the experiment were originally collected from Thambuttegama, Sri Lanka and maintained in the Entomology Laboratory of Faculty of Agriculture, Rajarata University since 2014 following routine culturing. From this insect culture, 200 unsexed adults were introduced into 250g of wheat flour and maintained in the incubator (FH-1200, Hipoint Laboratory, Taiwan) at $30\pm 1^\circ\text{C}$, $65\pm 1\%$ relative humidity (r.h.) for 2 weeks later. The flour medium was sifted through sieve (#20) to remove parent adults. The progeny adults emerged from these cultures were used in the study.

2.2 Food media

Wheat flour, broiler feed, Corn flour, dog feed, Chickpea, greengram, rice flour, samaposha and milk powder were used in the study. These media were used alone and in different combinations as mentioned in Table 1. To ensure equal particle size, broiler feed, dog feed, chickpea and greengram were first ground and sifted through sieve (600 μm) (W.S. Tyler, USA). Food media having more than one component were thoroughly mixed and hand tumbled for 1 min. All the media were used 1 day following preparation. From each medium, 4 replicates were used and replicate weighed 100 g. Unsexed, 20 *T. castaneum* adults were introduced into each replicate medium and maintained in the incubator for 14 days. Subsequently, from each medium all the parent adults were removed and the media were continued to keep inside the growth chamber. The larvae and progeny adults emerged in each replicate medium were weighed.

Table 1. Composition of food media tested.

Food media	Weight of food ingredients (g)								
	Wheat flour	Crushed dog feed	Crushed broiler feed	Corn flour	Chickpea flour	Greengram flour	Rice flour	Samaposha	Milk powder
Brand	Seven star	Pedigree	Prima	Motha			Ruhunu	CBL	Anchor
Company and Origin	Serendib Flour Mills (Pvt.) Ltd., Colombo, Sri Lanka.	Mars Incorporated, Virginia, USA.	Ceylon Grain Elevators PLC, Sri Lanka.	Motha Confectionary Works (Pvt) Ltd., Colombo 13, Sri Lanka.					
A	100								
B		100							
C			100						
D				100					
E					100				

F				100
G				100
H				100
I				100
J	50	50		
K	50		50	
L	50			50
M	50	25	25	
N	50		25	25
O	50	25		25
P	25	25	25	25

2.3 Data analysis

The weight of larvae and progeny adults emerged in each food medium was analyzed by using ANOVA procedures of Statistical Analysis System [11]. The means were separated by Tukey's test and the significance was tested at $p=0.05$ level.

3. Results and Discussion

3.1 Weight of larvae in a single medium

When a single flour type was used, the weight of an individual larva emerged varied significantly among the different flour types ($F_{3,12}=41.65$, $p<0.0001$). No larvae emerged in corn flour. A previous study conducted using corn flour also resulted in no *T. castaneum* adult emergence [10]. This indicates either inadequacy of nutrients or some other negative impact on their development in corn flour. This needs to be explored in future research.

Table 2. Weight (Mean \pm SE) of *Tribolium castaneum* larvae emerged in different media used alone (n=4).

Media	Larval weight (mean \pm SE) ^a (mg)
A	43.25 \pm 5.81a
B	47.40 \pm 2.87a
C	39.15 \pm 2.01a
D	0 \pm 0b

^ameans followed by the same letter do not significantly differ at according to Tukey's test following ANOVA in SAS ($P=0.05$).

3.2 Weight of larvae in multi-ingredient media

When *T. castaneum* was reared in a media having more than one flour type, the weight of an individual larva emerged varied significantly among the flour types ($F_{6,21}=8.71$, $p=0.0002$). Similar to the results obtained when a particular flour was used alone (Table 2), the lowest larval weight was obtained when corn flour was used in higher amount (Media L). The larval weight of remaining media also follow a trend that the larval weight is higher in the absence of corn flour as an ingredient (media J,M, O). Previous studies reveal that *T. castaneum* breeding is higher in diets having yeast [12] than carbohydrate-based cassava [13].

Table 3. Weight (Mean±SE) of *Tribolium castaneum* larvae emerged in different media used as combinations (n=4).

Media	Larval weight (mean±SE) ^a (mg)
J	53.33±1.74a
K	47.83±2.25ab
L	41.53±2.40b
M	54.90±1.01a
N	47.70±1.82ab
O	51.13±0.26a
P	53.95±1.55a

^ameans followed by the same letter do not significantly differ at according to Tukey's test following ANOVA in SAS (P=0.05).

3.3 Weight of adult in single media

The weight of an individual adult emerged in different flour types varied significantly among the flour types ($F_{5,18}=8.71$, $p=0.0002$). The maximum weight of adults obtained in the medium H (Samaposha) may be due to the presence of several ingredients in that medium (corn, rice, soya and green gram). This agrees with the previous study that *T. castaneum* is better bred in multi-grain mixture than bleached white flour [14].

Table 4. Weight (Mean±SE) of an individual *Tribolium castaneum* adult emerged in different flour types (n=4).

Flour type	Weight (mean±SE) of an individual adult ^a (g)
A	1.355±0.031b
E	1.495±0.057b
F	1.326±0.035b
G	1.355±0.216b
H	2.1286±0.099a
I	1.688±0.066ab

^ameans followed by the same letter do not significantly differ at according to Tukey's test following ANOVA in SAS (P=0.05).

4. Conclusion

The development of *T. castaneum* larvae and adults is higher in multi-ingredient food media than in a single ingredient. Furthermore, corn flour has negative impact on the development of *T. castaneum*.

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