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New food medium for rearing *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

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ABSTRACT

Tribolium castaneum, the red flour beetle, is basically a granivorous insect species having a broad host range. The rearing media affects convenient handling of insects while its composition determines the success of progeny adult emergence. The objective of this research was to develop a food medium for rearing *T. castaneum* using dietary materials available at the local market and test the same for their success in producing the progeny. Wheat flour, crushed broiler feed, crushed dog feed and corn flour were used either alone or in different combinations. Unsexed adults of *T. castaneum* were introduced to each medium, maintained for 2 weeks and sifted out. The progeny adults emerged varied among rearing media tested. The medium that contained wheat flour, crushed dog feed and crushed broiler feed at 2:1:1 ratio produced the maximum adult progeny.In general, poor adult emergence was observed in wheat flour and corn flour when used alone or in combinations. No progeny was observed when corn flour was used alone. Future studies on the nutrient composition of the food medium that produced higher progeny adults would ensure further development of rearing media for *T. castaneum*.

1. Introduction

In Sri Lanka, the storage losses of durable food commodities vary as 4-6% of harvested yield while 80% of the same occurs due to insect infestation [1,2]. The red flour beetle *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) larvae and adults do the feeding [3]. They cause serious damage to stored agricultural commodities including cereals, cereal products, nuts, spices, cocoa, coffee and sometimes pulses [4,5,6,7,8,9,10]. This species is found in warehouses, grain bins, grain elevators, flour milling/food processing plants, retail sales outlets and home level [11,12,13,14,15,16]. Due to its devastating role on durable stored food products, *T. castaneum* has become a major stored-product insect species for which management attempts are frequently researched. To conduct these numerous types of research, mass rearing of *T. castaneum* is a basic requirement. The common practice in rearing *T. castaneum* is to use wheat flour. Previous studies have shown limitation of *T. castaneum* progeny development in certain food media [17,18,19]. Therefore, the objective of this research was to develop alternative rearing media for *T. castaneum* and test the same for progeny adult emergence.

2. Material and Methods

2.1 Insect cultures

Tribolium castaneum originated in Thambuttegama, Sri Lanka and maintained in routine culturing in the Entomology Laboratory of Faculty of Agriculture, Rajarata University since 2014 were used in the experiment. Two hundred unsexed adults were introduced into plastic bottles containing 250g of wheat flour maintained in the growth chamber (FH-1200, Hipoint Laboratory, Taiwan) at 30±1℃, 65±1% relative humidity (r.h.). Two weeks later, the adults were removed by sifting through sieve (#20). The progeny adults emerged were used in the study.

2.2 Preparation of food media

Wheat flour, Crushed broiler feed, Corn flour and crushed dog feeds were used alone and in different combinations as food media as mentioned in Table 1. To attain similar particle size broiler feed and dog feed were ground and passed through sieve 20 mesh. Food media comprised of more than one ingredient were mixed and hand tumbled for 1 min to ensure the homogeneity of the media. Following this, all the media were kept for 1 day before the introduction of adults. Four replicates were used from each medium. Each replicate weighed 100 g. For each replicate medium, 20 unsexed *T. castaneum* adults were introduced and maintained in the growth chamber for 14 days. At the end of this period, the adults were removed from each medium, the food media maintained inside the growth chamber, and adults emerged in each replicate medium counted.

Table 1. Composition of food media developed and tested for progeny adult emergence in *Tribolium castaneum*.

Food media	Weight of food ingredients (g)			
	Wheat flour	**Crushed dog feed**	**Crushed broiler feed**	**Corn flour**
Brand	Seven star	Pedigree	Prima	Motha
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	50	50		
F	50		50	
G	50			50
H	50	25	25	
I	50		25	25
J	50	25		25
K	25	25	25	25

2.3 Data analysis

The number of progeny adults emerged in each food medium was analyzed by using ANOVA procedures of Statistical Analysis System (SAS) [20]. The means separation was done using Tukey's test and the significance was tested at P=0.05 level.

3. Results and Discussion

3.1 Progeny adults emerged in different food media one month following initial infestation

Emergence of *T. castaneum* adults significantly differed among food media in the first month (F=15.75, P<.0001).The progeny adults emerged was maximum (316) in the media having wheat flour+broiler feed+dog feed (2:1:1).The food media having wheat flour+broiler feed +corn flour (2:1:1) (130), wheat flour+broiler feed+dog feed: corn flour (1:1:1:1) (127) and wheat flour+broiler feed (1:1) (125) had higher adult emergence than wheat flour alone, the conventional rearing media for *T. castaneum* (Figure 1).

3.2 Progeny adults emerged in different food media two months following initial infestation.

In the second month also, there was a significant difference in the progeny adults emerged in different rearing media (F=13.79, P<.0001). The maximum

adult emergence was obtained in the medium having wheat flour+broiler feed+dog feed (2:1:1)(847). All the other media tested did not vary in the adult emergence from wheat flour used alone (Figure 2)

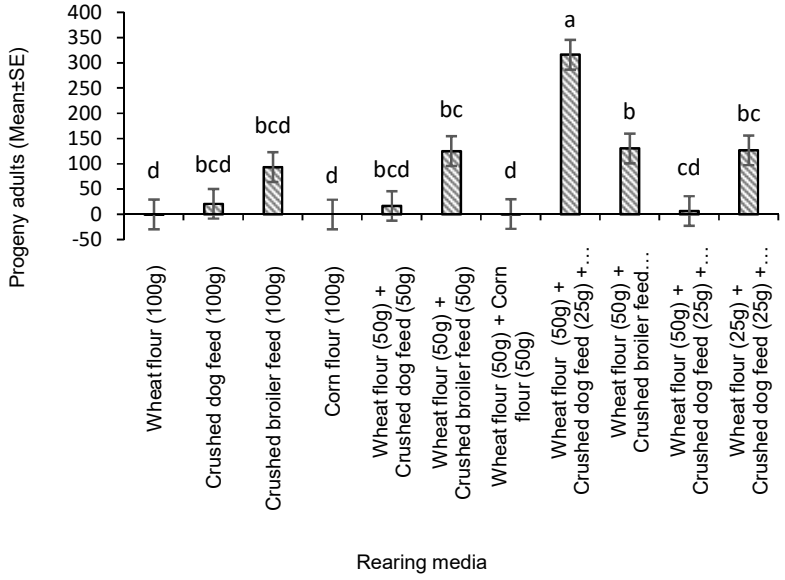

Figure 1. Progeny *Tribolium castaneum* adults (mean±SE) emerged on different rearing media one month following infestation (n=4). Means followed by the same letter are not significantly different according to Tukey's test.

3.3 Progeny adults emerged in different food media three months following initial infestation.

There was a significant difference in the progeny emergence three months following initial parent removal as well (F=6.33, P<.0001). The highest progeny was produced in the medium having wheat flour+broiler feed+dog feed (2:1:1)(962). This was followed by wheat flour+broiler feed+corn flour (2:1:1)(600) and wheat flour+broiler feed+dog feed: corn flour (1:1:1:1) (468) with no significant differences in between them (Figure 3). However, there was a high variation between the progeny adults emerged in different food media.

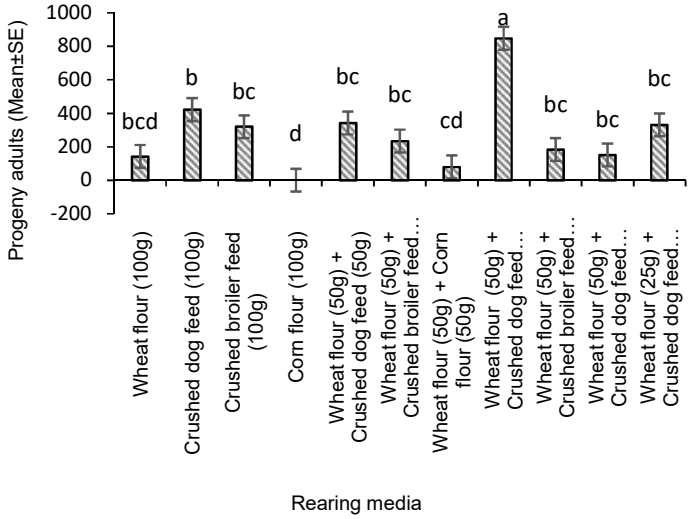

Figure 2. Progeny *Tribolium castaneum* adults (mean±SE) emerged on different rearing media two months following infestation (n=4). Means followed by the same letter are not significantly different according to Tukey's test.

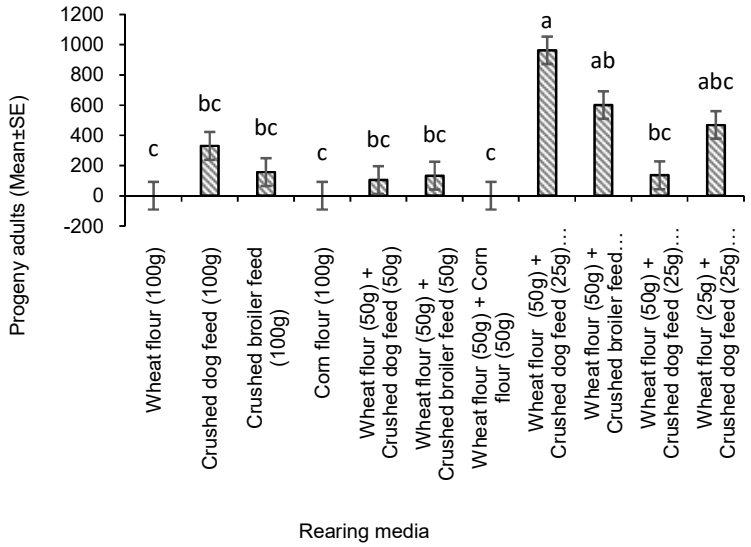

Figure 2. Progeny *Tribolium castaneum* adults (mean±SE) emerged on different rearing media three months following infestation (n=4).Means followed by the same letter are not significantly different according to Tukey's test.

3.4 Relevance of findings to previous research

In the current research, higher number of *T. castaneum* adults emerged in the food media that contained proteinaceous ingredients (broiler feed, dog feed) comapred to the other food media which are more carbohydrate based (used either alone or in combinations). This finding agrees with previous finding that multi-grain blend is a better rearing medium for *T. castaneum* over bleached white flour[18]. Similarly, Vaivanijkul[17] reported that *T. castaneum* poorly develops on cassava which is carbohydrate based. The finding by Xu et al.[19] indicates *T. castaneum* lays more eggs on diets containing yeast than those starch-based. The future research need to be focussed on the identification and quantification of nutrients in the food media that demonstrated higher adult emergence of *T. castaneum.* It is also suggested to test other possible combinations of individual medium which showed higher adult emergence. Furthermore, protein-based other food ingredients should also be tested for their suitability as rearing media for *T. castaneum.*

4. Conclusion

The development and adult emergence of *Tribolium castaneum* varies with the rearing medium. Combination of food ingredients perform better than used alone. The food medium having wheat flour+broiler feed+dog feed (2:1:1) facilitates the highest adult emergence in *T. castaneum.*

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