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Research Article

Biology of red flour beetle, *Tribolium castaneum* (Herbst, 1797) in two flour media under laboratory conditions

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Abstract

The research was conducted with meticulous attention to detail. The study aimed to discern the food precedence and investigate the various life stages of *Tribolium castaneum*. The research was carried out in two flour media, wheat (*Triticum indicum*) and rice (*Oryza sativa*), at an average temperature of 30°C and 50% R.H. The study found that larval and pupal development time was comparatively faster in wheat flour (23 to 27 days) as compared to rice (33 to 37). Oviposition was observed higher in rice flour than in wheat flour. Instars were discerned as six and seven in wheat and rice flour, respectively. The pace of reproduction, development, and growth was higher in the warmer seasons from April till the start of September, especially in June and July, but with the cessation of all these activities in fall and cold seasons, even adult beetles were found dead in extreme cold.

Key-words: *Tribolium castaneum,* Life Cycle, Humidity, Behaviour, Coleoptera

Introduction

Tribolium beetles are known insect pests on stored grains and products (Ahmed, 2002). The approximate destruction caused by beetles is 5% to 10% worldwide, about 50% in tropical areas, and, on average, 10% to 40% worldwide. Ambient conditions of storage areas, Storage facilities, Pest control methods, and Bulk purification increase the possibility of infestation of insects (Bachrouch *et al.*, 2010). *Tribolium castaneum* utilizes a variety of foods: chocolate, spices, flour, cereals, meal, crackers, beans, spices, pasta, cake, mixed dried pet food, dried flowers, nuts, and seeds, and even stored food; beetles feed on specimens in insect collection

(Weston & Rattlingourd, 2000). Beetles feed on already broken grains caused by other insects but cannot feed on intact grains (Li & Arbogast, 1991).

Beetle occurs in the life cycle of holo metamorphosis (egg, larva, pupa, and adult). The most prolific duration in females is from one week to 2 months after ejection (Park, 1949). Beetles lay 3 to 4 hundred ova in different food media during their five to eight months of life (Bennet, 2003). Noticeably, a beetle gives 2 dozen ova in a day, 4.5 days is the average incubation time, and a beetle undergoes7 instars during the larval stage, 7.5 days means the time of pupa, and the overall development is completed in 76.5 days (Devi & Devi, 2015).

Diet is a substantive agent that sways the biology, fertility, development, growth, and even behavior of beetles. The number of ova and growth of beetle is greater in greater amounts of flour, but it decreases as the size of the flour decreases (Campbell & Runnion, 2003). The apt diet can lower the time that nymph is being developed, indispensable for fitness and an excellent state for spending life (Price *et al.,* 1980). The existing work is interested in investigating the Biology of *T. castaneum* at all life stages, fecundity, and duration on two types of food conditions.

Material and methods

In the current studies, adult beetles and *Tribolium* were acquired from metallic bins and gunni bags commonly used in grocery shops, kitchens, and houses for storing grain and flour. A small quantity of stored grains or flour was taken in a petri dish, and beetles were sorted out with the assistance of a camel hair brush from time to time and were relocated into culturing jars in the laboratory. Among 20 adult beetles, the equivalent number of males and females were put in each glass jar that contained 25 gm of infested free flour of two different conditions, wheat, and rice, and were wrapped up with muslin cloth at 4±30°C and 4±50 humidity. They were left for a few days for copulation and laying eggs and then kept out (Shrikant *et al.,* 2016). A pair of adult male and female beetles were kept in a beaker that contained 20 gm of infested free flour and were allowed to lay eggs. Some eggs were continuously observed on account of hatching per day. The acquired *T. castaneum* from each medium was put into a sifter and were allowed to lay eggs. After 3 days, white dots appeared in the sifter, which were eggs. Then, the eggs are shifted with the assistance of a glass slide in order to calculate the size under the light microscope; some of these eggs are moved into new jars with the assistance of camel hair with dissimilar flour media (Wheat and Rice), then the eggs hatched within the time span of 2 to 4 days. (Mason, 2003). Then the eggs hatched after 8 to 10 days from the time when beetles were cultured. Then, every newly hatched larva was moved onto new flour media containing

10 gm of flour for further study and measurements. The temperature and humidity of the atmosphere were calculated using a maximum minimum thermo-hygrometer. The measurements of size and dimension were noted by oculomotor and foot scales (Devi, 2015). A small number of instars were examined on account of a number of exuviae, sloughed off the skin (Good, 1933).

Results

In order to find the end results of two types of foods on the fertility and development of different stages of *T. castaneum*. The *T. castaneum* and beetles were cultured (grown) into two flour media. The data of all developmental stages of *T.castaneum* in two flour conditions are depicted in Table. 1 and figure 1. Ova are whitish, oval, and small in size, with 0.6±0.03mm and 0.4±0.02mm in length and width, respectively, and noticed more in rice than wheat flour.

Table 1. Comparative numerical data of morphological measurements of life stages of *Tribolium castaneum* in wheat and rice flour

Wheat Flour						Rice Flour				
Life Stage	Length of Stages in Days	Length Mean±SD Mm	Width Mean±SD mm	Min: to Max:Temp: °C	R.H %	Length of Stages in Days	Length Mean±SD Mm	Width Mean±SD mm	Min: to Max:Temp:°C	R.H %
Egg	2-4	0.6±0.03	0.4±0.02	28 – 34	46%	5-7	0.6±0.03	0.4±0.02	28 – 34	47%
1st instar	2-3	1±0.1	0.2±0.03	27 – 32	51%	3-4	1±0.1	0.2±0.03	27 – 35	46%
2nd instar	3-4	1.8±0.15	0.26±0.02	28 – 34	46%	2-4	1.3±0.11	0.25±0.03	27 – 31	50%
3rd instar	4-5	2.7±0.13	0.31±0.05	27 – 33	47%	2-4	2.1±0.13	0.3±0.02	27 – 33	48%
4th instar	3-4	3.3±0,.09	0.4±0.04	28 – 34	46%	3-5	3.3±0.15	0.4±0.04	27 – 34	48%
5th instar	3-4	4±0.1	0.5±0.03	26 – 31	50%	3-4	3.8±0.9	0.45±0.01	28 – 31	50%
6th instar	2-3	5.6±0.15	0.6±0.1	29 – 34	46%	4-5	4.8±0.13	0.55±0.04	28 – 34	47%
7th instar						2-4	5.7±0.15	0.6±0.3	29 – 34	48%
Pupa	3-4	3.7±0.03	0.65±0.04	29 – 34	47%	4-5	3.7±0.03	0.65±0.02	29 – 34	47%
Adult	2-3	3.8±0.03	0.55±0.02	28 – 33	50%	3-4	3.8±0.03	0.55±0.02	28 – 33	49%
Total	23-27					33-37				

As hatched, the larva is creamy yellow in color; its body is cylindrical, covered by fine hair, and possesses a pair of pro-antennae on the head, 3 pairs of pro-legs on three segments behind the head, and a pair of cirri on the last segment. The size of newly hatched larvae was about 1±0.1 mm in length and 0.2±0.03 mm in width in wheat and rice flour. The length of time of the first instar is 2–3 and 3–4 days in wheat and rice flour, respectively. Second instar was

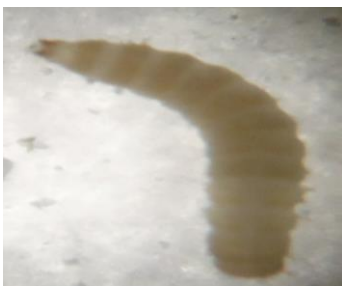
darker in color, 3–4 days, and 2–4 in wheat and rice flour, respectively, 1.8±0.15 and 0.26±0.02 mm in width in wheat while 1.3±0.11 mm in length and 0.25±0.03 mm. Instar third 3–4 and 2 to 4 days in wheat and rice flour, respectively, 2.7±0.13 mm length and 0.31±0.05 mm in width in wheat while 2.1±0.13 mm length and 0.3±0.02 mm width in rice. Instar four 3–4 days and 3–5 days in wheat and rice flour, respectively, 3.3±0.09 mm length and 0.4±0.04 mm width in wheat while 3.3±0.15 mm length and 0.4±0.04 mm width in rice. Fifth instar 3 to 4 days in both wheat and rice flour,4±0.1 mm length and 0.5±0.03 mm width in wheat while 3.8±0.9 mm length and 0.45±0.01mm width in rice.

Instar six 2–3 days and 4–5 days in wheat and rice flour, respectively, 5.6±0.15 mm length and 0.6±0.1mm width in wheat while 4.8±0.13 mm length and 0.55±0.04 mm width in rice. Instar seven was not observed in wheat flour but in rice flour for 2 - 4 days.

The pupa was white at the start, then steadily moved yellow and later yellow-brown. It observed half a grain of rice. The eyes first seemed to be small black spots and then looked larger. The wings were initially closed to the body and readily separated later, and both are sclerotized appendages. Development time is 3 – 4 days and 4 – 5 days in wheat and rice flour, respectively. The pupa's size is 3.7±0.04 mm long and 0.65±0.04 in both flour media. Adults first emerge creamy yellow and then change into rust in color within 2–4 days. Size3.8±0.03 mm and 0.55±0.02 mm in length and width, respectively, in both wheat and rice media.

Appropriate nutrient conditions play a vital job in stimulating the hormonal system for the development and production of ova, grub, pupa, and adult. It is deduced by outcome that, ova were white and noticed greater in rice flour than wheat flour. Seven instars in rice flour but six in wheat flour were noticed. Growth was observed more rapidly daily in wheat flour than in rice flour. Movement of instars became fast after molting but slows when gone to molt.





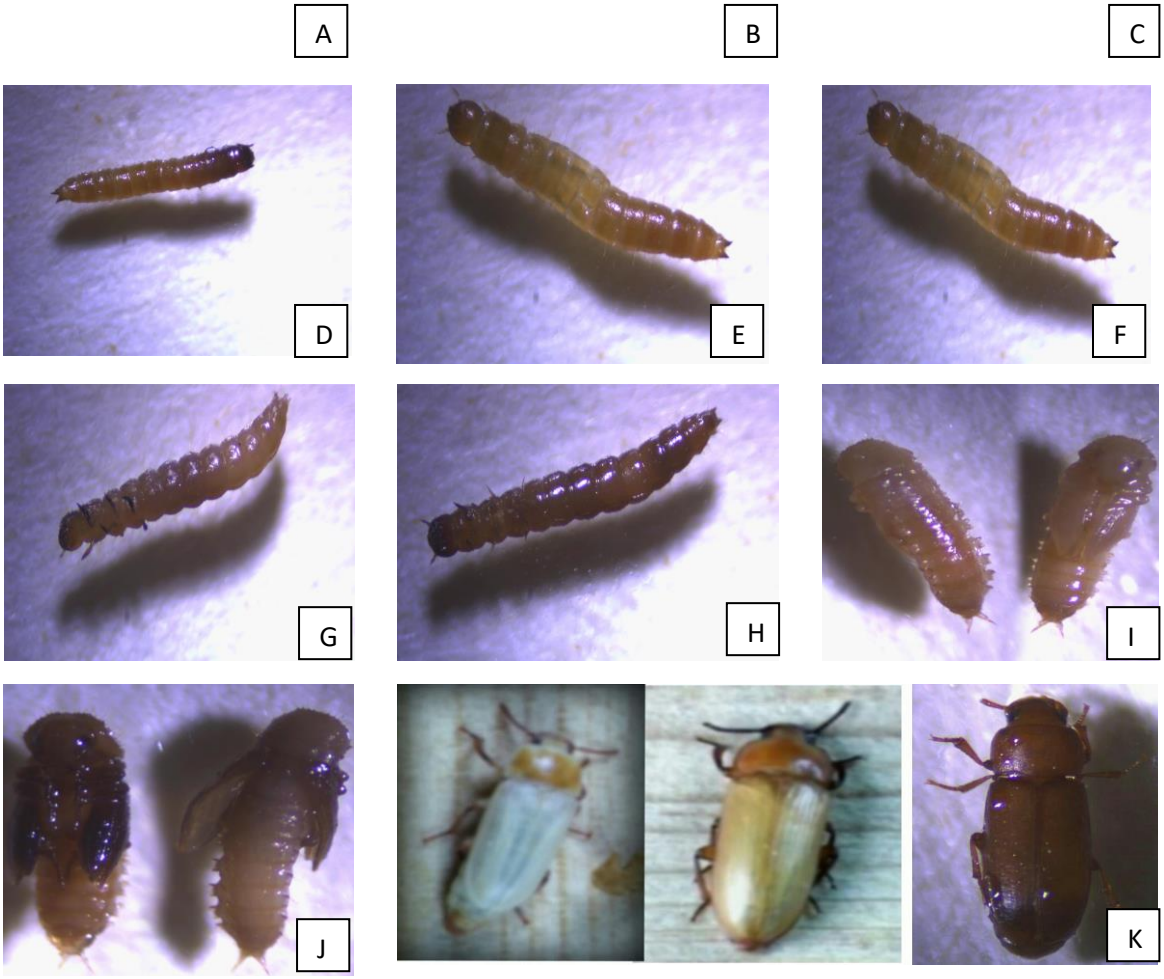


Figure 1. A) Eggs, B) First instar grub, C) Second instar grub, D) Third instar grub, E) Fourth instar Grub, F) Fifth instar grub, G) Sixth instar grub, H) Seventh instar, I) Initialpupal stage, J) Late Pupal Stage, K) Initial to late adult

Discussion

To determine the effects of two types of food on the fertility and development of different stages of *Tribolium castaneum*, beetles were cultured in two flour media. The data on all developmental stages of *T. castaneum* in both flour conditions are presented in Table 1 and Figure 1. The ova are whitish, oval, and small, measuring 0.6 ± 0.03 mm in length and 0.4 ± 0.02 mm in width, with a higher occurrence in rice flour than wheat flour. Li and Arbogast (1991) found greater fertility, vitality, growth, and population in maize flour. Khatak *et al.*, (1986) reported increased productivity with a 5% yeast addition to wheat flour. Larvae emerged within 2–4 days in wheat flour and 3–5 days in rice flour. Bennet (2003) noted a larval emergence time of 5–8 days. According to Leelaja *et al.* (2007), the size of ova is 0.61 mm in length and 0.3 mm in width. Devi and Devi (2015) reported an ova hatching time of 4–7 days

in wheat flour. Beeman *et al.* (2012) observed 2- and 3-day discernment times in wheat flour at 34°C and 30°C, respectively. Upon hatching, larvae are creamy yellow, cylindrical, covered with fine hair, with a pair of pro-antennae on the head, three pro-legs on the segments behind the head, and a pair of cirri on the last segment. Newly hatched larvae measure approximately 1 ± 0.1 mm in length and 0.2 ± 0.03 mm in width in wheat and rice flour. The first instar lasts 2–3 days in wheat flour and 3–4 days in rice flour. The second instar is darker in color and lasts 3–4 days in wheat flour and 2–4 days in rice flour, measuring 1.8 ± 0.15 mm in length and 0.26 ± 0.02 mm in width in wheat flour, and 1.3 ± 0.11 mm in length and 0.25 ± 0.03 mm in width in rice flour. The third instar lasts 3–4 days in wheat flour and 2–4 days in rice flour, measuring 2.7 ± 0.13 mm in length 0.31 ± 0.05 mm in width in wheat flour, and 2.1 ± 0.13 mm in length and 0.3 ± 0.02 mm in width in rice flour. The fourth instar lasts 3–4 days in wheat flour and 3–5 days in rice flour, measuring 3.3 ± 0.09 mm in length and 0.4 ± 0.04 mm in width in both flour media. The fifth instar lasts 3–4 days in both wheat and rice flour, measuring 4 ± 0.1 mm in length and 0.5 ± 0.03 mm in width in wheat flour and 3.8 ± 0.9 mm in length and 0.45 ± 0.01 mm in width in rice flour.

The sixth instar lasts 2–3 days in wheat flour and 4–5 days in rice flour, measuring 5.6 ± 0.15 mm in length and 0.6 ± 0.1 mm in width in wheat flour, and 4.8 ± 0.13 mm in length and 0.55 ± 0.04 mm in width in rice flour. A seventh instar was not observed in wheat flour but lasted 2–4 days in rice flour. William (2000) reported that the larval phase lasts from 22 days to over 3 months. Bennet (2003) observed a total larval duration varying from 22 days to over 3 months. Dhaliwal (2006) found that grub duration in different food habitats ranges from 70 to 83 days. Shafique (2006) reported that larvae take 24 days to reach the pupal stage in grade 1 and 2 bran, but 25 and 28 days in maida and suji, respectively. Devi and Devi (2015) reported durations of 6–18 days for the first instar, 10–14 days for the second instar, 8–9 days for the third instar, 8–10 days for the fourth, fifth, and sixth instars, and 9–11 days for the seventh instar in wheat flour. Initially, the pupa is white, gradually turning yellow and then yellow-brown, resembling half a grain of rice. The eyes appear first as small black spots, then grow larger. The wings, initially closed to the body, separate later, with both becoming sclerotized appendages. Development time is 3–4 days in wheat flour and 4–5 days in rice flour, with a size of 3.7 ± 0.04 mm in length and 0.65 ± 0.04 mm in width in both flour media. William (2000) reported an average pupal duration of 8 days. Bennet (2003) observed pupae emerging into adults within a week. Devi and Devi (2015) reported a pupal duration of 6–7 days in wheat flour. Adults emerge creamy yellow, turning rust-colored within 2–4 days, with a size of 3.8 ± 0.03 mm in length and 0.55 ± 0.02 mm in width in both wheat and rice media. Rebecca and

Thomas (2003) reported a life cycle duration of 1.5 to 3 months in various food media. Dhaliwal *et al.* (2006) observed a total development time of 26–30 days in wheat flour during summer, which increases with colder temperatures and changes in food conditions. Shafique (2006) reported a total development time of 24–70 days in wheat flour. Singh and Singh (2006) stated that adult red flour beetles can survive up to 3 years and complete their life cycle in 30–80 days in stored grain conditions. Appropriate nutrient conditions are crucial for stimulating the hormonal system to develop and produce ova, larvae, pupae, and adults. The study concludes that ova are more abundant in rice flour than wheat flour. Seven instars were observed in rice flour, while only six were in wheat flour. Growth was faster in wheat flour than rice flour, with instar movement increasing after molting but slowing before the next molt.

Conclusion

This study investigated the effects of two different flour media, wheat, and rice, on the fertility and developmental stages of *Tribolium castaneum*. The results demonstrate significant variations in the reproductive and developmental parameters of *T. castaneum* based on the type of flour used. This study highlights that *T. castaneum* develops more rapidly in wheat flour than rice flour, suggesting that wheat flour provides a more conducive environment for the growth and development of this species. These findings have important implications for pest management and control strategies in stored grain products, as the choice of storage medium can significantly impact the lifecycle and proliferation of *T. castaneum*. Further research could explore the underlying nutritional or environmental factors contributing to these differences, potentially informing more effective pest control measures.

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