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Effect of three different flour types on growth and development of *Tribolium castaneum* Herbst (Red Flour Beetle).

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ABSTRACT
Effect of three different flour types on development stages of stored product insect Red Flour Beetle (RFB) Tribolium castaneumHerbst.was studied for developmental duration experiment and numbers of days were measured on individual flour meal. The average (mean) egg incubation period was found to be 5.5 days, 6.0 days and 7 days on Wheat flour, Sorghum flour and Rice flour respectively. Similarly, the total development days for larval and pupal incubation were found 36, 37 and 40 days for Wheat flour, Sorghum flour and Rice flour respectively. Similarly, average weights of 1-4 weeks old larvae were found to be 5.71, 5.27 and 4.58 mg for Wheat flour, Sorghum flour and Rice flour respectively. The average weights of 24-48 hours old Pupae were found to be 65.73,63.43and 62.91 mg and the average weights of 24-48 hours old adults were found to be 61.64, 60.07and 58.91 mg for Wheat flour, Sorghum flour and Rice flour respectively.
Keywords: *Flour, Red Flour Beetle (RFB), Tribolium castaneum, Wheat, Sorghum, Rice*

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INTRODUCTION

India produces more than 163 commodities including cereals, pulses, spices, oil seeds, tubers etc. and herbals besides 900 processed foods.Food grain production in India is around 200-210 million tonnes (MT) comprising of rice (85 MT), wheat (74MT), coarse cereals (36MT), and pulses (14MT), oilseeds (25MT).70% of the food grains produced is stored in the rural sector in the traditional storage containers. The marketable surplus of 30% is handled and stored in the urban sector. Food grains have to be stored for varying periods due to its seasonal production, food security concerns and for seed purposes. Cereals, pulses and oilseeds are the most important food and commodity from seed storage purpose as well as for stored product from it like flour, suji, maida and grains. Wheat and other cereals are good source of food as they contain nutritious elements. Other cereals like Jowar, Bajra and Flour grade 1 and 2 contain 5 and 10 per cent bran respectively. The bulk of harvested cereal grains are stored in the godowns on large or small scales as storage of food grain is inevitable both in times of deficit and surplus production [6].Dried Distiller's Grains with Solubles (DDGS) is a co-product of the ethanol- production process, with high nutritional content and is used in animal feed as a substitute for corn and other grains. Demand for DDGS in an international market and in United States has increased during the past few years. At 50% relative humidity the grounded DDGS was found to be

vulnerable to *Tribolium castaneum* infestation [9].During the storage condition of grains and other cereals several biotic factors and abiotic processes poses the problem of grain damage according to [14]. In storage, food loss is mainly due to insects, rodents, and fungi. In India, estimates of food loss in transit and storage vary from 15 to 25% [7]. *Tribolium castaneum* is the pest which attacks many types of cereals, grains, beans, seeds, nuts and stored grain products such as flour, meals, crackers, cake mix, pasta, dried pet food etc. cereals, beans, spices, dried flowers, nuts, seeds and even dried museum specimens [11]. Adult beetle and larva feed on stored food stuffs *viz.* dry fruits, pulses, bran, coat, germ, grain dust and prepared cereal foods [3].

The flour beetle may elicit an allergic response [2], but is not known to spread disease and does not feed on or damage the structure of a home or furniture. Wheat especially is attacked by several stored grain pests including *Tribolium castaneum* Herbst.They are attracted to grain with high moisture content and can cause a grey tint to the grain they are infesting [1]. *Tribolium castaneum* (Herbst) is a cosmopolitan and serious pest of cereal grains and their products. Adult beetle and larva does considerable loss to grains damaged by other insects and flour and other products [8]. The beetles give off a displeasing odor, and their presence encourages mold growth in grain. The infestation levels of *T. castaneum* have been studied on whole grains and their products like flour and maida etc. The study of infestation of the insects on these grains and their flours especially gives an idea about the resistance of the pests and index of infestation [11]. The present study of red flour beetle *T. castaneum* culturing on the different flour types as a culture medium and their influence on population and development on/in different cereal foods would be helpful to find out quick and mass laboratory culture of RFB, which may be needed in other scientific experiments.

MATERIAL AND METHODS

Wheat flour, Jowar flour, and Rice flour were selected for biological parameters *viz.* development time taken and change of weight during the life cycle by red flour beetle, *T. castaneum* (Herbst.).The experiment was carried under laboratory conditions (28±2 °C and 60±5% RH) at Dept. of Zoology, Shivaji University, Kolhapur. For experimentation purpose the population of *T. castaneum* was maintained uniformly in laboratory.The fresh flours were purchased from local market.In case of biological parameters, 25 adults of *T. castaneum* were released into the plastic jars of 25-gram capacity. The jars were examined regularly at an interval of 24 hrs. for the oviposition or egg laying activity. Eggs were collected and adult separation from the flour 0.8 µ size mesh sieve was used.These eggs were placed in petri dish and further observed for the hatching. With the help of soft hair brush (camel brand) newly hatched first instar larvae were carefully transferred in glass vials of 2 gm capacity containing 1 gm of Wheat flour, Jowar flour, and Rice flour individually and respectively. The pupation takes place in flour. Then duration of each life cycle stage was recorded. The observation was taken on alternate day up to adult emergence twice a week till the adult emergence. The weighing of each stage was taken on weighing balance with weighing capacity range of 0 to 220gm (Make – Shimadzu Model-AUW 2200). The numbers of individuals taken for weighing were 25 from each stage. The experiment was repeated for three times with three replicates for each flour type.

Formula for calculating Development time =Egg incubation period + Larval stage duration + Pupal stage duration

RESULTSAND DISCUSSION

It is evident that variability is seen among different flour types tested with respect to the weight of larvae, pupae and adults that emerged and development time of *T. castaneum*. The results on duration of development time and weight of different life cycle stages of red flour beetle, *T. castaneum* in different flour varieties are presented in **Table 1 and 3** respectively.

In case of egg incubation period, wheat flour (5.5 days) and sorghum flour (6.0 days) exhibited significantly minimum time, whereas Rice flour (7.0 days) exhibited maximum time. In case of larval developmental period, wheat flour (25.0 days) and sorghum flour (26.0 days) exhibited significantly minimum time, whereas Rice flour (27.0 days) exhibited maximum time. In case of pupal stage period, wheat flour exhibited significantly minimum period of 5.0 days followed by sorghum flour (6.0 days). The rice flour exhibited significantly maximum period of 7.0 days (**Table 2 and Figure 1**). The development of *T. castaneum*

neonate larvae to adult beetles was found to be quicker in Wheat flour in comparison with Sorghum and Rice flours respectively. All the 25 larvae took 35, 38 and 41 days to become adult beetle from neonate larvae in Wheat, Sorghum, and Rice flour respectively (**Table 1 and Table 2, Figure 2)**.

Simultaneously, the weight change of individual life cycle stages of *T. castaneum* was showing variability in Wheat, Sorghum and Rice flours. Comparative analysis of the three different culture medium on *T. Castaneum* life cycle stages was studied and the significant difference was observed between 3 types of culture medium.

In case of larvae, Wheat flour exhibited significantly maximum weight of 5.71 mg followed by sorghum 5.17. Rice flour exhibited significantly minimum weight of 4.58 mg.

In case of pupal weight, there is no significant difference was observed as sorghum and Rice flour exhibited weight of 63.43 mg and 62.91mg respectively. However, wheat flour exhibited significant maximum weight of Pupae 65.75 mg.

In case of Adults, Wheat flour exhibited significantly maximum weight of 61.64 mg followed by sorghum 60.07. Rice flour exhibited significantly minimum weight of 58.91 mg **(Table 3 and Table 4, Figure 3).**

This Comparative study shows that preference of red flour beetle, *T. castaneum* for feeding is more on wheat flour followed by Sorghum flour and Rice flour wheat and its products. Similar results for what flour preference by *Tribolium castaneum* was seen in an experiment carried out by Jamil and Aslam [13], where no variability in different wheat cultivars for feeding preference was noted.

It was found that reproductive potential and adult eclosion of *T. castaneum* was significantly high in whole wheat flour with 5 percent yeast followed by 10, 15, 2 and 1% yeast and whole wheat flour alone [5]. The present experiment carried out on three different flours showed the similar kind of results.In an experiment carried out by Khattak and Shafique, 1986 [4], the adult progeny of developed*T.castaneum*, weight loss of flour of 10 different wheat cultivars varied significantly. In present experiment similarly, the weight loss has been recorded from pupal stage to developed Adult emerged in three different flour types. In an experiment carried out by Khattak and Shafique, 1986 [4], among the products wheat flour grade 1, 2, branand maida emerged as the most preferred food whiledry and tempered wheat was liked the lowest by the*Tribolium castaneum* beetle.

To explore the food preferences of the red flour beetle*Tribolium castaneum*, Maqsood and et al.,2014 [10] used flour cereal foods, namely corn flake, white flour, semolina and biscuit. Their results revealed that wheat flour was most preferred food to *Tribolium castaneum* with highest mean population compared to corn flake, semolina and biscuit. In present experiment similar patterns of preference towards wheat flour was seen by *Tribolium castaneum* compared to jowar and rice flours.

The reproduction of confused flour beetles, *Tribolium confusum* significantly varied depending on the wheat species and its products. In an experiment carried out by Radmila Almaši and Danijela Poslončec [12], higher mortality was recorded in common wheat. The highest mortality was recorded in pasta, then in kernels and the lowest in flour. The paper shows that confused flour beetles develop extremely well on spelt wheat or flour, even better than on common wheat which is widely grown in Serbia. The present experiment showed similar patterns of preference towards wheat flour by *Tribolium castaneum.*

The present study hence showed the maximum preference of *Tribolium castaneum* towards wheat flour as a food or preferred culturing medium. The present experiment carried out on three different flours showed the similar kind of results as the Tribolium life cycle stages showed good optimum growth time and weight range on wheat flour as a culture medium.

Table 1: Duration of Development (days) of Immature stages of *T. castaneum* reared on three different flours

Flour type	Average Egg incubation period in days	Average Larval period days	Average Pupal period days	Average Development period from neonate Larvae to Adult	Average Total development days taken
Wheat	5.5	25	5.0	35	35
Sorghum	6.0	26	6.0	38	38
Rice	7.0	27	7.0	41	41

Table 2: Duncan's Test (Homogenous subsets) for Developmental Period of the three different stages of *T. castaneum* reared on three different types of flours

# Treatments	Average Egg Incubation Period (days)*	Average Larval period (days) *	Average Pupal period (days) *
1	5.5 a	25.0 a	5.0 a
2	6.0 a	26.0 a	6.0 b
3	7.0 b	27.0 b	7.0 c

*Mean of 3 experiments with 3 replicates each; Means followed by similar alphabets are not statistically
different by ANOVA (Duncan's test α = 0.05); # 1- Wheat; 2- Sorghum; 3- Rice
*Uses Harmonic Mean Sample Size = 9.000.

Table 3: Weight (mg) of the three different stages of *T.castaneum*reared on three different types of flours

Flour type	Weight of 1-4 weeks old larvae (mg)			Weight of 24-48 hours old pupae			Weight of 24-48 hours old Adult		
	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.
Wheat	5.71	5.86	5.52	65.75	66.64	65.19	61.64	61.74	61.50
Sorghum	5.27	5.31	5.20	63.43	64.88	62.50	60.07	60.25	59.94
Rice	4.58	4.82	4.25	62.91	63.94	62.25	58.91	59.76	57.80

Table 4: Duncan's Test (Homogenous subsets) for Weight (mg) of the three different stages of *T. castaneum* reared on three different types of flours

# Treatments	Larval weight (mg)*	Pupal weight (mg)*	Adults weight (mg)*
1	5.71 a	65.75 a	61.64 a
2	5.17 b	63.43 b	60.07 b
3	4.58 c	62.91b	58.91 c

*Mean of 3 experiments with 3 replicates each; Means followed by similar alphabets are not statistically
Different by ANOVA (Duncan's test α = 0.05); # 1- Wheat; 2- Sorghum; 3- Rice
*Uses Harmonic Mean Sample Size = 9.000.

Figure 1: Development Period for *Tribolium castaneum* Life Cycle Stages in days on three Different Culture Medium

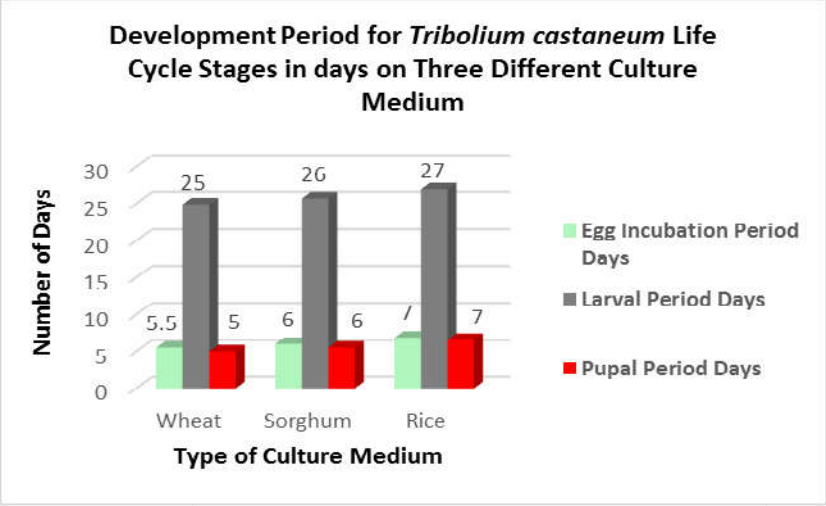


Figure 2: Summary Development Period for *Tribolium castaneum* Life Cycle Stages in days on three Different Culture Medium

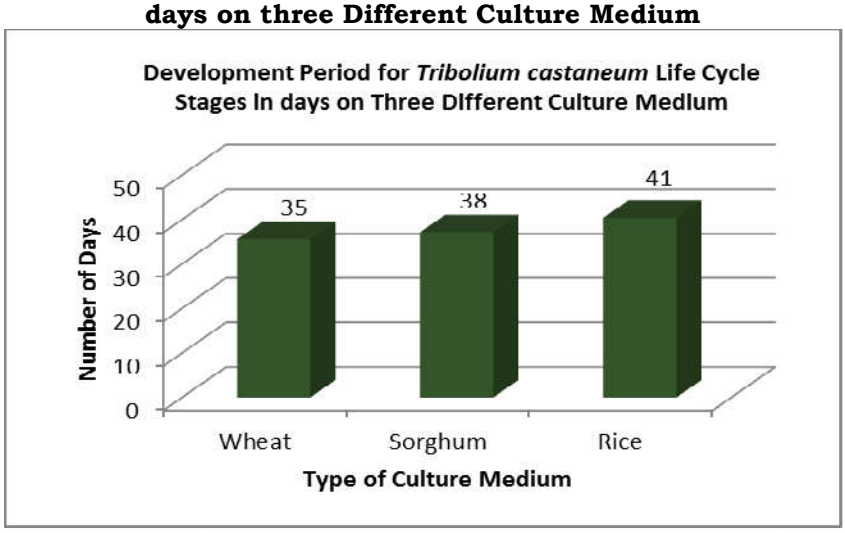
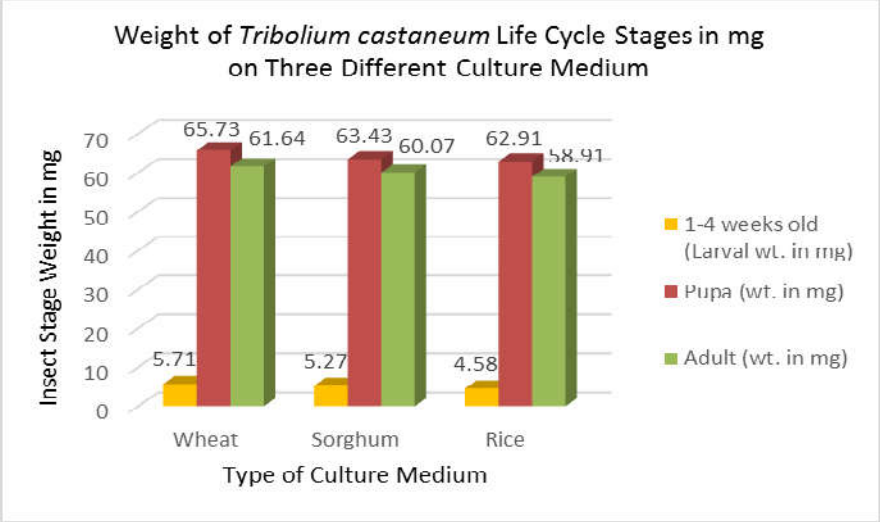


Figure 3: Weight of *Tribolium castaneum* Life Cycle Stages in days on Three Different Culture Medium



CONCLUSION

The present data may be useful to find out quick and mass laboratory rearing of *Tribolium castaneum*(RFB.)

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