

Suitability of different types of food stuffs for mass rearing of rice moth, *corcyra cephalonica* (stainton) and saw-toothed grain beetle, *oryzaephilus surinamensis* (l.) under laboratory conditions

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Abstract

Mass rearing of *Corcyra cephalonica* and *Oryzaephilus surinamensis* adults on six different types of foodstuffs namely, wheat germ, complete wheat flour, rice flour, corn flour, basbousa flour and wheat flour (zero) were evaluated. Our results obtained reveal that mean developmental period (MDP) of *C. cephalonica* and *O. surinamensis* from egg lay to emerge adult on different foodstuffs was ranged between 44.00 & 55.33 and 30.33 & 41.33 days, respectively. Longest MDP was occurred on corn flour and rice flour illustrating 55.33 and 41.33 days, resp. While, the shortest period reaching to 44.00 and 30.33 days on wheat germ. Wheat germ was recorded the maximum adult emergence (AE) % (25.33 and 69 % progeny of *C. cephalonica* and *O. surinamensis*, resp.), While, wheat flour (zero) and basbousa flour were recorded the minimum AE %, 12.33 and 27.33 %, respectively. *C. cephalonica* and *O. surinamensis* caused highest weight loss (WL) % on wheat germ and corn flour (31.88 % 13.73 %), while, corn and basbousa flours were recorded the minimum of WL % (11.43 and 4.05 %) respectively., which the least preferred foodstuffs to *C. cephalonica* and *O. surinamensis*. In comparison between the growth index (GI) of different foodstuffs, our results showed that wheat germ was the most preferred by *C. cephalonica* and *O. surinamensis*, whereas, rice flour was the least preferred host. From results chemical analysis, there was a strong correlation between GI of *C. cephalonica* and *O. surinamensis* and chemical characters. This relationship was expected as a large carbohydrate, total protein, potassium and magnesium mounts. Our results provide suitable foodstuffs to mass rearing of *C. cephalonica* and *O. surinamensis* as the large scale production.

Keywords: food type, *Corcyra cephalonica*, *Oryzaephilus surinamensis* .

INTRODUCTION

Stored foods products such as wheat flour, wheat germ, corn flour, and rice flour are the major and least expensive source for diet of humans containing certain minerals and vitamins needed for the structure and function of various cells in living organisms (**Salunkhe, et al. 1985**). However, these commodities frequently lose quality and quantity due to infection the stored-product insect pests. The storage environment is very rich sources of food that attracts many insects to growth, and The Saw-toothed Grain Beetle, *O. surinamensis* (L) (Coleoptera: Silvanidae) is a serious pest for stored products and identified by the toothed lateral margins of the pronotum. It is cosmopolitan pest and attacks a wide variety of stored grains, wheat, maize, rice and their products. Also, dried fruits such as raisins, figs and other dried fruits stored for long periods (**Deong, 1918**). It is mainly secondary insect on stored products following more destructive primary pests. *O. surinamensis* enter damaged grains and feed specially on the embryos.

The aims of this work was to evaluate preferences of *Corcyra cephalonica* (Stainton) and *Oryzaephilus surinamensis* (L.) to different foodstuffs there is a preference for some stored materials than other. The reduction in quality and quantity of the human food are the results of insect's infestation to stored food materials (**Rajendran, 2005**). Damage caused by these insects include: weight loss, changes of flavor, mold, fermentation, reduced nutritional value and reduction the germination of grains due to feeding on embryo (**FAO, 1985**). Also, insects contaminants grains by its secretions and webbing (**Rajendran, 2005**). Stored products are subject to infested by many stored insects such as rice moth *Corcyra cephalonica* (Stainton) and saw-toothed grain beetle *Oryzaephilus surinamensis* (L.).

The rice moth, *Corcyra cephalonica* (Stainton) (Lepidoptera Pyralidae) is economically important stored products insects in Africa and other many regions (**Atwal and Dhaliwal, 2008**). *C. cephalonica* recorded as first record by **Ayyar (1919)** and stated its a major insect of rice but also infest and feed on wheat, maize, sorghum, groundnut, cotton seeds and cocoa beans (**Allotey, 1991; Kumar and Kumar, 2001**).

MATERIALS AND METHODS

1. Insect culture:

The stocks of insects used in this experiment {*Corcyra cephalonica* (Lepidoptera: Pyralidae) and *O. surinamensis* (Coleoptera: Silvanidae)} were reared and multiplied for two generations on wheat grain products in stored grain insect Dep., Plant Protection Research Institute, Agriculture Research Center, whereas they are reared at $28 \pm 2^{\circ}\text{C}$ and 65 ± 5 R.H.

2 - Used different types of foodstuffs

Wheat germ, complete wheat flour, rice flour, corn flour, basbousa flour and wheat flour (zero). All previous foodstuffs were sterilized before use by continuous freezing (-10°C) for at least one months, then kept under laboratory conditions for 12 hrs. before use.

3. Mass rearing:

One hundred grams of each wheat germ, complete wheat flour, rice flour, corn flour, basbousa flour and wheat flour (zero) were put in glass jars (250 ml each capacity), 25 newly unsexed adult of *O. surinamensis* (0 -48 day) and 3 pair of *C. cephalonica* moth were introduced in separate glass jars. The jars were covered with muslin cloth and fixed by rubber band to prevent cross infestation and possible pest escape and were left inside incubator (with average $28 \pm 2^{\circ}\text{C}$ and 65 ± 5 R.H) till F1-progeny. The previous design was reported three times. After one month, the glass jars were daily examined to record adult emergence, date of first adult emergence and counting and was recorded until no adult emergence. The mean developmental period (MDP) was estimated from the time of eggs laying up to adult emergence (AE) from foodstuffs. Also, when adult emergence ceased the sample reweighed again to record the damage expressed wet weight loss. **The weight loss (WL) (%)** was calculated according to the equation of **Khare and Johari (1984)**

$$\text{WL} = (\text{initial fresh weight} - \text{final fresh weight}) / \text{initial fresh weight} \times 100$$

Growth index (GI):-

The duration of developmental period of the immature stages were taken as criteria for calculating the growth indices according to the method described by **Dobie (1974)** as follows:

$$\text{Growth index} = (\log F) / D \times 100$$

Where: F= total number of adult emergence D= mean of development period

4-Chemical analysis of foodstuffs:

All different types of tested foodstuffs samples were taken sound (uninfested) to determine chemical components as follows: Total Protein content was estimated by the method of **Bradford (1976)**. Protein content was expressed as μg protein/g weight. Total carbohydrates content was determined according to **Dubois et al. (1956)**. Total carbohydrates content was expressed as μg glucose/g weight. Total potassium and magnesium content was determined according to **Chapman and Pratt (1961)**.

5-Statistical Analysis:

The data were then analyzed using the SPSS computing program using ANOVA, as described by **Snedecor and Chachran (1981)**

RESULTS AND DISCOISION

Mass rearing of *C. cephalonica* and *O. surinamensis* adults on different type of foodstuffs was evaluated based on mean development period and total number of moth resulted in each foodstuff. The results concerning with the mass rearing of *C. cephalonica* and *O. surinamensis* on six of different types of foodstuffs can be explained and discussed as follows:-

1 - Mass rearing of rice moth, *C. cephalonica* on different types of foodstuffs

Highest F1 progeny and shortest developmental period are considered as important factors for mass production of any insect. Our results presented in **Table (1)** revealed that MDP of *C. cephalonica* from egg laying to adult emergence that reared on different types of foodstuffs. It is clear that there is no a great variation between the foodstuffs for mean developmental duration that ranged between 44.00 and 55.33 days. Longest MDP was occurred on corn flour illustrating 55.33 days. While, the shortest period reaching to 44.00 days on wheat germ. However, statistically the differences among foodstuffs were not significant. The results in this work are comparable to other researchers. **Carmona (1958)** found that development of *C. cephalonica* on wheat flour (66 days) and maize flour (60 days) was more rapid than on the respective whole grain (wheat 76 days and maize 63 days). **Arun Kumar, et al. (2018)** they found that mean developmental period of rice moth from egg laying to death of adult was 54.20 days. The longest developmental period of 64.33 days was observed on treatment T5 (Wheat 1000 g + ground nut 50g) and the minimum developmental period of 47.33 days was on T6 (Sorghum 1000 g + ground nut 50 g). **Azalekor (1999)** who found that *C. cephalotiica*

bred better on crushed cocoa than whole cocoa beans. Developmental period of *C. cephalotiica* was 33.8 days on crushed cocoa beans, while 37.9 days were recorded on whole cocoa beans.

In case of **adult emergence**, it is noticed there is significant difference between the different foodstuffs to adult emergence. Wheat germ, complete wheat flour and rice flour were recorded the maximum AE % (25.33, 21.33 and 19.67 % progeny, respectively without significant differences between them), While, wheat flour (zero), basbousa flour and corn flour were recorded the minimum AE %, 12.33 and 10.33 and 15.00 %, respectively without significant differences between them. Also, results showed significant differences between the GI of *C. cephalonica* on different types of foodstuffs, it was comparatively higher in the foodstuffs wheat germ, complete wheat flour and basbousa flour than foodstuffs corn flour, rice flour and wheat flour (zero), which produced a lower number of progeny and longer developmental periods. These results agree with those of **Kumar and Shenhmar (2001)** they mentioned that rearing *C. cephalonica* on efficient food media resulted in production of robust adults and eggs. **Pathak, et al., (2010)** found maximum of 37.02% adult emergence when reared on sorghum only. **Mehendale, et al., (2014)** reported that maximum of 52% adults emergence of *C. cephalonica* occurred when reared on sorghum, groundnut and powdered yeast. **Kumar and Kumar (2002)** reported that adult emergence of *C. cephalonica* were 37.04 and 31.99 % when reared on sorghum and pearl millet, resp.

In respect WL %, *C. cephalonica* was caused highest weight loss (%) in wheat germ foodstuff (31.88 %), while the least weight loss (%) was achieved with corn flour (11.43 %), which the least preferred foodstuffs to *C. cephalonica*. These results were confirmed with obtained by **Senguttuvan et al., (1995)** who stated that larvae of rice moth, *C. cephalonica* cause quantitative and qualitative loss and reduce the germ inability of seed stocks. The serious troubles caused by this pest had encouraged the investigators to find out safe method achieving satisfactory control.

Table (1): Food preference of *C. cephalonica* on six different types of foodstuffs for one generation

Different foodstuffs	Mean developmental period (MDP) (days) ± SE	No. Adult emergence ± SE	Growth. Index (G.I) ± SE	Weight loss (%) ± SE
Wheat germ	44.00 ± 0.00 ^a	25.33 ± 0.88 ^a	3.19 ± 0.03 ^a	31.88 ± 1.73 ^a
Complete wheat flour	46.67 ± 2.41 ^a	21.33 ± 1.33 ^{ab}	2.86 ± 0.14 ^{ab}	22.38 ± 3.15 ^{bc}
rice flour	54.67 ± 1.77 ^a	19.67 ± 2.41 ^b	2.35 ± 0.14 ^{bc}	30.17 ± 2.69 ^{ab}
Basbousa flour	49.00 ± 1.33 ^a	10.33 ± 0.88 ^{cd}	2.26 ± 0.54 ^{bc}	24.53 ± 3.92 ^{ab}
corn flour	55.33 ± 2.97 ^a	15.00 ± 2.00 ^{bc}	2.11 ± 0.04 ^{bc}	11.43 ± 1.40 ^c
Wheat flour (zero)	53.67 ± 1.54 ^a	12.33 ± 1.86 ^{cd}	2.02 ± 0.17 ^c	18.11 ± 2.25 ^{bc}
LSD 0.05	11.88	4.79	0.69	7.864

Means in each column followed by different letters are significantly different from each other at $P < 0.05$ (Duncan's test)

2- Mass rearing of saw-toothed grain beetle, *O. surinamensis* on different types of foodstuffs.

The results concerning with determination mass rearing of *O. surinamensis* on six different types of foodstuffs discussed as follows:-

It seems clearly from the results of **Table (2)** revealed the MDP of *O. surinamensis* from egg laying to adult emergence on different types of foodstuffs. It is demonstrate that there is a great variation between the foodstuffs for MDP that ranged between 30.33 and

41.33 days. The longest MDP was occurred on rice flour illustrating 41.33 days. While, it shortest reaching to 30.33 days on wheat germ. These results confirmed by **(Sahito, et al. 2017)** which found that adult saw-toothed grain beetle can live with average 6 to 8 months at temperature of 30°C and their life cycle from egg laying to adult emergence was approximately 30 to 40 days. In case of **adult emergence**, the results showed that corn flour, Wheat germ, wheat flour (zero) and complete wheat flour were recorded the maximum AE % (73.33, 69.00, 53.00 and 46.67 % progeny, resp. without significant differences), While, rice flour and basbousa flour were recorded the minimum AE %, 29.00 and 27.33 %, resp., without significant differences. This result supported the finding by **Musa and Lawal (2013)** who stated that higher level of adult emergence and weight loss reach 53.0 % as a result of insect infestation with *T. castaneum* on biscuit within 120 days after infestation. **Babarinde, et al., (2010)** illustrated that *T. castaneum* infestation level affected weight loss and final insect count, when chips were stored for 2 months.

In comparison between the GI of different foodstuffs, the results showed that wheat germ was the most preferred by *O.surinamensis*, whereas, rice flour was the least preferred host of *O.surinamensis*, which produced a lower number of progeny (29.00) and a longer MDP (41.33). Concerning of WL, the results showed the WL% due to *O.surinamensis* fed on different types of foodstuffs for one generation. The highest WL% was recorded for corn flour (13.73 %) followed descending without significant differences wheat germ (11.01 %), complete wheat flour (7.00 %). While, rice and pass flours were recorded the minimum of WL% without significant differences, since WL% was 4.36 and 4.05 % respectively.

This result supported the finding by **Trematerra and Sciarretta (2004)** they reported that of the saw-toothed grain beetles in foodstuffs cause quantitative and qualitative losses that make it unsalable or unpalatable and loses caused by this insect are often significant. Also, the beetle is nearly omnivorous. Also, **Zulaikha, et al. (2018)** stated that saw-toothed grain beetles produce a serious problem to food product during storage particularly in the developing country.

Jang, et al. (1982) they showed that host preference is a single criterion in determine suitability of various food products to stored product insects. This result supported the finding by **Hill (2008) and Levinson and Levinson (1998)** which mentioned that *O. surinamensis* is fit to food was largely due to the presence of carbohydrate. Saw-toothed grain beetle prefers products higher in carbohydrates such as stored grains and cereal products **Johnson (2013)**.

Table (2): Food preference of *O.surinamensis* on six different types of foodstuffs for one generation

different foodstuffs	Mean developmental period (MDP) (days) ±SE	No. Adult emergence(AE) ±SE	Growth. Index G.I.	Weight loss (%)
Wheat germ	30.33 ± 0.33 ^a	69.00 ± 3.79 ^a	6.06 ± 0.14 ^a	11.01 ± 2.87 ^a
corn flour	37.67 ± 0.88 ^b	73.33 ± 6.13 ^a	5.02 ± 0.27 ^b	13.73 ± 3.63 ^a
Wheat flour	36.33 ± 1.45 ^b	53.00 ± 1.86 ^{ab}	4.68 ± 0.19 ^{bc}	5.47 ± 0.31 ^{ab}
Complete wheat flour	39.67 ± 0.33 ^b	46.67 ± 5.18 ^{abc}	4.18 ± 0.19 ^{bcd}	7.00 ± 1.86 ^{ab}
rice flour	41.33 ± 4.85 ^b	29.00 ± 1.55 ^c	3.51 ± 0.74 ^{cd}	4.36 ± 0.71 ^{ab}
basbousa flour	38.67 ± 0.67 ^b	27.33 ± 3.79 ^c	3.66 ± 0.31 ^{cd}	4.05 ± 1.66 ^b
LSD 0.05	5.92	21.95	0.98	6.82

Means in each column followed by different letters are significantly different from each other at $P < 0.05$ (Duncan's test)

3. Chemical composition for different types of foodstuffs

The obtained results in **Table (3)** showed there was clear correlation was found between chemical characteristic and growth index of two tested insects on different foodstuffs.

The obtained results in **Table (3)** showed there was clear correlation was found between chemical characteristic and growth index of two tested insects on different foodstuffs. In comparison between the growth index of two tested insects on tested foodstuffs, the results

showed that wheat germ foodstuffs was cause higher degree of growth in two tested insects as a result higher percentage of carbohydrates, Protein, potassium and magnesium, whereas, corn flour was cause lower degree of growth in *C. cephalonica* and basbousa flour in *O. surinamensis* as a result lower rates of potassium and magnesium. Generally, each foodstuff had its own effect on preference where, total carbohydrate, total protein, potassium and magnesium as chemical characters may be provide or reduce preferred of *C. cephalonica* and *O. surinamensis*. However, regarding the duration of developmental period of insects, wheat flour (zero) and corn flour could be considered as the most unsuitable foodstuffs for the rearing of *C. cephalonica* and rice and basbousa flour in *O. surinamensis*, while, wheat germ foodstuff was the most suitable to mass rearing in two insects. This result supported the finding by **Cohen (2004)** who reported that wheat germ to have a high content of protein, and also contains lipids and carbohydrates that are rich in phytosterols and fatty acids which contribute to energy levels required for flight muscle functioning.

Finally, there was a strong correlation between MDP and chemical characters. This relationship was expected as a large carbohydrate, total protein, potassium and magnesium mounts. This is in line with the findings of **Hussain (2008)** showed that amry date cultivar was marked higher degree of susceptibility in *E. cautella* and *O. surinamensis* and marked a higher percentage of carbohydrates, Protein and lipids whereas, Frihi cultivars was higher degree of susceptibility in only *O. surinamensis* and marked a lower rates of chemical characters. Also, **Amira negm (2020)** stated that using wheat germ in an artificial diet for mass rearing of *B. Zonata* larvae played a great role in inducing some biological and biochemical characters as the wheat germ is therefore a unique source of concentrated nutrients, highly valued as a food supplement.

Table (3): Some chemical characters of tested foodstuffs

different foodstuffs	Total carbohydrate ml/gm	Total protein ml/gm	potassium ml/gm	magnesium
Wheat germ	711.67 a	257.67 a	9.4 a	5.37 a
Complete wheat flour	603.67 c	114.0 c	3.33 b	0.84 c
rice flour	578.33 d	80.33 e	1.80 cd	1.27 b
Wheat Flour (zero)	645.00 b	136.0 b	2.24 c	1.30 b
corn flour	579.33 d	84.67 de	2.28 c	0.69 c
Basbousa flour	590.00 cd	99.0 cd	1.26 d	0.58 c
LSD 0.05	17.72	16.20	0.61	0.34

Means in each column followed by different letters are significantly different from each other at $P < 0.05$ (Duncan's test)

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الملخص العربي

ملانمة الأنواع المختلفة من المواد الغذائية المخزونة للتربية الكمية لكل من حشرة فراشة الأرز

وحشرة خنفساء السورينام المنشارية تحت الظروف المعملية

حسن بكري حسن حسين ، رشا أحمد زينهم ، ايناس مصطفى قطب قاسم

معهد بحوث وقاية النباتات – مركز البحوث الزراعية

في هذه الدراسة تم اختبار التفضيل الغذائي لحشرة فراشة الأرز وحشرة خنفساء السورينام المنشارية التي تعتبران من أهم الآفات الحشرية الي تصيب الدقيق في المخزن لسنة مواد مختلفة من الغذاء وهم جنين القمح ، دقيق قمح كامل ، دقيق الأرز ، دقيق الذرة ، دقيق البسبوسة ، دقيق القمح الزيرو وقد تمت الدراسة بطريقة الأختبار الأجباري علي المواد الغذائية حيث تم أخذ 100 جرام من كل عائل غذائي المذكورة سابقا وعمل عدوي صناعية لها بثلاثة أزواج حديثة الخروج في حالة فراشة الأرز و25 حشرة في حالة خنفساء السورينام عمر 15 يوم وتم وضعهم لمدة ثلاثة أيام ، وبعد ذلك تستبعد الحشرات وتحضن علي درجة حرارة 30 م ± 2 ، 65±5 ٪ رطوبة نسبية ويتم الانتظار حتى خروج F1 progeny ثم يتم تسجيل متوسط فترة النمو ، عدد الحشرات الكاملة الخارجة ، دليل النمو ، الفقد في الوزن . وأوضحت النتائج المتحصل عليها ما يلي :-

فترة النمو : متوسط فترة النمو لكلا الحشرتين فراشة الأرز وخنفساء السورينام من وضع البيضة الي خروج الحشرة الكاملة علي المواد الغذائية المختلفة تراوحت بين 44,00 ، 55,33 يوم & 30,33 ، 41,33 بالترتيب. وكانت أطول فترة علي دقيق الذرة والأرز حيث سجلت 55,33 ، 41,33 يوم لفراشة الأرز وخنفساء السورينام علي الترتيب ، بينما سجلت أقصر فترة علي جنين القمح حيث سجلت 44,00 ، 30,33 يوم. بالترتيب.

معدل خروج الحشرات: أعلى معدل لخروج الحشرات الكاملة كان علي جنين القمح والتي سجل 25,33 ، 69,00 ٪ لفراشة الأرز وخنفساء السورينام علي الترتيب ، بينما سجل أقل خروج علي دقيق القمح الزيرو ودقيق البسبوسة والتي كانت 12,33 ، 27,33 ٪ بالترتيب.

النسبة المئوية للفقد في الوزن: أعلى نسبة مئوية للفقد سجلت في جنين القمح ودقيق الذرة حيث كانت 31,88 ، 13,73 ٪ لفراشة الأرز وخنفساء السورينام علي الترتيب ، بينما كانت أقل نسبة مئوية للفقد سجلت في دقيق الذرة ودقيق البسبوسة حيث كانت 11,43 ، 4,05 ٪ للحشرتين علي الترتيب.

أيضا من خلال التحليل الكيماوي للمواد الغذائية المختبرة وجد من النتائج أن هناك علاقة قوية بين محتوى المادة الغذائية من العناصر الغذائية وبين نمو الحشرة. حيث يعتبر جنين القمح من أفضل المواد الغذائية المختبرة في النمو والتربية الكمية لكل من فراشة الأرز وخنفساء السورينام المنشارية وذلك لمحتوائه العالي من الكربوهيدرات والبروتين واليوتاسيم والماغنسيوم، بينما يسبب دقيق الذرة أقل درجة من النمو لفراشة الأرز ويسبب دقيق البسبوسة أقل درجة من النمو لحشرة خنفساء السورينام ويرجع ذلك لمحتوائهم علي معدلات منخفضة من اليوتاسيوم والماغنسيوم.