INFLUENCE OF ADULT NUTRITION ON THE FITNESS OF THE EGG PARASITOID *TRICHOGRAMMA EVANESCENS* (Westwood)

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Abstract

Experiments were conducted to determine the best nutritive source to be used for improving the quality of *Trichogramma evanescens* (Westwood) reared on eggs of *Sitotroga cerealella* (Olive). Various nutritive solutions were tested: pure sugar cane honey (Blackstrap Molasses), pure bee honey, 10% sucrose solution, 10% yeast extract solution, a mixture of sugar cane honey with yeast extract solution and water. Longevity, fecundity, percentage of parasitoid emergence, sex ratio (female percentage) and general productivity were investigated. Trichogrammatids fed on pure sugar cane honey parasitoized the highest number of eggs (58.2 eggs/ female), lived the longest life span (5.35days) and produced the highest percentage of emerged adults (96.86%) with more female offspring (78.17%). Unfed females parasitoized the lowest *Sitotroga* eggs (30.55 eggs/ female) and lived the shortest life span (1.8 days). The least percentage of emerged progeny was produced when parents were fed on mixture of sugar cane honey and yeast (87.77%), whilst females fed on yeast only produced the lowest rate of female offspring (61.82%). Generally, the highest productivity of *T. evanescens* reached 44.07 females/ female by feeding adults on pure sugar cane honey, while reduced drastically to 19.60 females/ female when adults were unfed.

Key words: *Trichogramma evanescens, Sitotroga cerealella*, nutritive sources, productivity.

INTRODUCTION

Egg parasitoids of the genus *Trichogramma* (Hymenoptera: Trichogrammatidae) are widely used in inoculative and augmentative release programs to regulate pest populations mainly lepidopteran pests. Trichogrammatids are mass reared on factitious hosts as they can adapt to broad range of hosts (Smith 1996). The level of parasitoidism in field requires releasing high numbers of *Trichogramma* females. Protocols for mass rearing and release often take sugar requirements into account. Nevertheless, the choice of food sources is usually based on trial and error because basic information on food sources in nature of beneficial insects is scarce (Wackers, 2005). Several authors have determined that feeding of adult *Trichogramma* species with honey or sugar in the laboratory influence parasitoids longevity and fecundity (Leatemia *et al*. 1995, Abd El-Hafez *et al*. 1999, Gurr and Nicol 2000 and Karimi & Hatami 2010). It is expected that improvement of

parasitoids fitness components will reduce the numbers of released individuals required.

In this study, the effects of six nutritive sources on fecundity, longevity, percentage of emergence, female percentage and general productivity of *T. evanescens* were investigated aiming to improve the fitness components of the produced parasitoids.

MATERIALS AND METHODS

Experiments were conducted at Fayoum Laboratory, Plant Protection Research Institute, Agriculture Research Center. All experiments were conducted at 27± 1°C and 75 ± 5% relative humidity with a photo period of 14:10(L:D). *T. evanescens* was reared on the Angoumois grain moth, *S. cerealella* (Oliv.) eggs.

Rearing of *Sitotroga cerealella* (Oliv.)

The method of rearing *S. cerealella* was a modification of those reported by Hassan (1995) where soft wheat was chosen as the rearing medium.

Rearing of the parasitoid *Trichogramma evanescens*

T. evanescens was reared on Angoumois grain moth, *S. cerealella* eggs. For efficient mass rearing of the parasitoid, *S. cerealella* eggs (<24 hrs. old) were glued to paper cards (21×15cm.) and exposed to *T. evanescens* adults in glass jars (2 liters capacity) provided with 10% sucrose solution for nutrition and covered with cloth-wrapped cotton kept in position by rubber band. Egg sheets were renewed daily to avoid super-parasitoidism and the parasitoized egg sheets were kept in clean glass jars.

Experimental Techniques

The experiment was conducted to determine the effect of six nutritive sources on the fitness components of *T. evanescens* parasitoid females. The six nutritive sources were water, pure bee honey, pure cane honey (Blackstrap Molasses), 10% sugar solution, 10% yeast extract solution and a mixture of yeast extract solution and sugar cane honey. Unfed trichogrammatids were the control.

For each nutritive source, twenty newly emerged and mated parasitoid females were placed individually in rearing glass vials (4×8.5cm) containing about 70 host eggs. The vials, each was provided with a piece of filter paper on which four drops of the tested diet was put on with a thin dissecting needle. A group of twenty females were kept unfed as control. Females were checked twice a day to determine mortality and longevity. Parasitoized eggs were renewed daily and kept in clean vials. The numbers of parasitoized eggs (blackened host eggs) were counted and recorded as fecundity. After emergence, the percentage of emerged adults and sex ratio (female percentage) were determined. In addition, the general productivity (GP) was calculated according to Tshernyshev and Afonina (1995).

GP= [rate of emergence × rate of produced females in progeny × fecundity]

Analysis of variance (ANOVA) was used to process all data and means were separated by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Influence of nutritive source on female fecundity

Fecundity of parasitoid females differed significantly ($P<0.05$) in all tested nutritive sources Table (1). Unfed females had the lowest fecundity with the mean value of (30.55±1.0). Access of water increased fecundity significantly to (37.4±1.5). The highest fecundity of females was induced by feeding on pure sugar cane honey (58.2±2.5) followed by pure bee honey (52.8±2.1). Fecundity of females fed on yeast extract solution averaged (41.2±1.9), whereas adding pure sugar cane honey to yeast extract enhanced fecundity (49.1±1.1) of *T. evanescens* females significantly ($P<0.05$).

Influence of nutritive source on females longevity

Unfed *T. evanescens* females lived significantly the shortest period (1.8 ± 0.41). Feeding females on 10% sucrose solution or water only caused elongation in life span with the mean average of (2.95±0.69) and (3.15±0.37) respectively. Females fed on pure honey bee lived significantly longer period (4.5±0.51) than those fed on yeast extract (3.7±0.47). In general, females lived the longest period (5.35 ± 0.49) when fed pure sugar can honey or mixture of pure sugar can honey and yeast extracts (Table1).

Influence of nutritive source on percentage of emerged progeny

The lowest percentage of offspring (87.77% ± 0.47) emerged when mother female fed on mixture of pure sugar can honey and yeast extract followed significantly by those emerged from females fed on yeast extract only (90.27%±0.45). Among treatments, the maximum percentage of emergence was recorded with females fed on pure sugar cane honey (96.86%±1.45). Feeding females of *T. evanescens* on pure honey or water showed the same rate of emergence with the mean values of (94.72%±1.51) and (94.63%±0.24) respectively. In addition, the same rates of emergence with the mean values of (93.41%±1.09) and (93.22%±1.04) were recorded when mother females were unfed or fed on 10% sucrose solution, respectively (Table1).

Table 1. Effect of different nutrition sources on female fecundity, longevity, emergence rate and sex ratio of *T. evanescens* reared on *S. cerealella* eggs.

Nutrition Source	Fecundity mean±SD	Longevity mean±SD	Emergence mean±SD	Female% mean±SD
Unfed	30.55 ± 1.0g	1.8 ± 0.41e	93.41± 1.09c	68.7 ± 2.6d
Water	37.4 ± 1.5f	3.15 ± 0.37d	94.63± 0.24b	74.44± 3.77b
Sucrose solution	44.2 ± 2.6d	2.95 ± 0.69d	93.22± 1.04c	71.6 ± 2.9c
Pure bee honey	52.8 ± 2.1b	4.5 ± 0.51b	94.72± 1.51b	74.52± 1.32b
Sugar cane honey	58.2 ± 2.5a	5.35 ± 0.49a	96.86± 1.45a	78.173±3.32a
Yeast extract	41.2 ± 1.9e	3.7 ± 0.47c	90.27± 0.45d	61.82 ±4.43e
Yeast+ cane honey	49.1 ± 1.1c	5.35 ± 0.49a	87.77± 0.47e	68.5 ± 1.71d

Means within columns followed by different letters are significantly different at the $p < 0.05$ level by Duncan's multiple range test.

Influence of nutritive source on sex ratio (female percentage)

The lowest rate of female percentage in progeny (61.82%±4.43) was produced from parent females fed on yeast extract. However, the highest percentage (78.17%±3.32) was produced when they fed on pure sugar can honey. Parent females produced the same percentage of females on progeny when they were unfed (68.7%±2.6) or fed on a mixture of sugar cane honey and yeast extract (68.5%±1.71). In addition, females fed on pure bee honey (74.52%±1.32) or water only (74.44%±3.77) produced the same percentage of females on progeny (Table1).

Influence of nutritive source on general productivity (GP)

The general productivity of *T. evanescens* was shown in figure (1) females' productivity was drastically reduced when they were unfed (19.6 females/ female). In fed females, the highest GP (44.07 females/ female) was recorded with pure sugar can honey followed by pure bee honey (37.3 females/female), while the lowest GP (22.99 females/ female) was recorded with yeast extract solution. Whilst, adding pure sugar can honey to yeast extract solution increased females productivity to 29.52 females/ female and this number was equal to that produced with 10% sucrose solution (29.5 females/ female). Productivity reached (26.35 females/ female) when fed on water only.

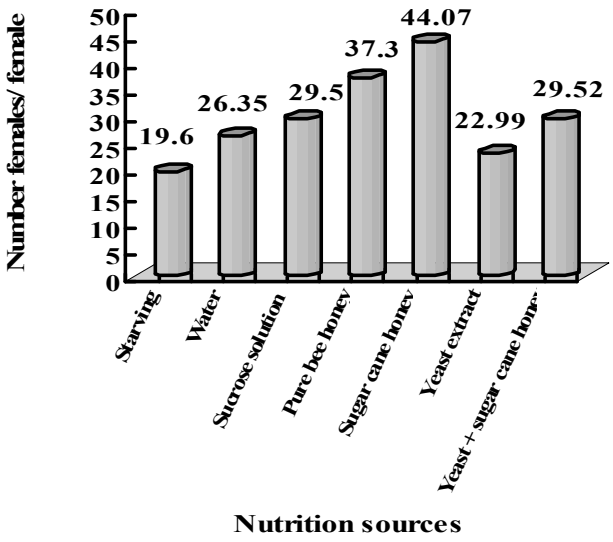

Figure 1. General productivity of *T. evanescens* females fed on different nutrition sources.

In this study, sugar cane honey used as a cheap source of carbohydrates to explore the idea that it could serve as a supplemental food source for *T. evanescens* to improve parasitoid fitness components. Sugar cane honey which locally known as the black honey (Blackstrap Molasses) is the final byproduct of the third boiling cycle in sugar making process, with a very dark color and extremely viscous texture. This variety of molasses is poor of lipids and proteins, contains the least sugar, the highest concentration of vitamins and minerals, WHF (2012).

Tuncbilk *et al*. (2012) reported that *T. euproctidis* females were affected by the food type when they tested different food sources comprising grape molasses, beet molasses, honey, glucose, sucrose syrups and egg yolk. In addition, our results revealed that *T. evanescens* females fed on pure honey parasitoized the highest numbers of host eggs, survived long periods and produced more offspring females followed by sugar solution fed females over unfed females Abd El Hafez, Alia *et al*. (1999) supported our observations as they advised provision either honey with yeast, pure honey or sucrose solution with yeast as a nutritive diet to *T. evanescens* mass rearing in the laboratory to improve parasitoid quality. In addition, our findings are in consistence with those of Lundgren and Heimpel (2002) who conducted experiment on quality assessment for commercially produced *Trichogramma*. They concluded that, percentage of emergence was over 75% when honey was provided to *Trichogramma* adults. Salijoqi and Khajjak (2007) confirmed that honey fed females of *T. chilonis* parasitoized higher numbers of *Sitotroga* eggs as compared with other treatments and the sugars (glucose, fructose and sucrose) increased their

parasitoidism efficiency but significantly lower than honey. In addition, Karimi and Hatami (2010) reported that fecundity of honey fed adults increased approximately four folds compared to unfed females adults fed on honey showing highest percent emergence over unfed females, Paraiso *et al*. (2011) recommended provision honey to *Trichogramma* females in mass rearing programs to establish a sustainable population of *T. fuentesi* in the laboratory., other authors advised sucrose diets, for instance, Hegazi and Khafagi (1998) stated that honey with water is superior to pure honey or honey based protein foods in its effects on longevity. Tuncbilk *et al*. (2012) reported that, fecundity and percentage emergence were enhanced by sucrose diets which were superior to honey diets, on contrary the work of Reznik *et al*. (1997) who showed that, the presence of honey reduced the percentage of ovipositing females and reduced mean number of eggs laid during two days leading to decrease in progeny production. Others recommended pure honey or sugar solution as diets for *Trichogramma* species as, Leatemia *et al*. (1995) for *T. minutum*, Gurr and Nicol (2000) for *T. carverae* & *T. brassicae* and Wackers (2005) for *T. carverae.*

Conclusion

The availability and quality of food available play an important role in determining the effectiveness of parasitoids as control agents. From the above mentioned findings it may be concluded that pure sugar cane honey or pure bee honey can be used as a favorable laboratory diets to adult parasitoids in mass rearing programs to establish a sustainable population of *T. evanescens.*

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تأثير تغذية الأفراد البالغة على كفاءة طفيل *Trichogramma evanescens* (Westwood)

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أجريت تجارب لتقدير أفضل مصدر غذائي يمكن استخدامه لتحسين جودة طفيليات ترايكوجراما إيفانسنس *Trichogramma evanescens* المرباة على بيض فراشة الحبوب *Sitotroga cerealella* حيث تم اختبار محاليل غذائية مختلفة هي: العسل الاسود، عسل النحل، محلول سكرى١٠%، محلول الخميرة، خليط من العسل الاسود مع محلول الخميرة وكذلك التغذية على الماء. وتم تقدير فترة حياة الأنثى، الخصوبة، نسبة خروج النسل الناتج ونسبة الإناث بالاضافة الى معدل النتاج العام من الإناث بعد تغذية الأطوار الكاملة على أي من تلك المحاليل.

أظهرت النتائج أن الأفراد البالغة لطفيل الترايكوجراما التى تم تغذيتها بالعسل الاسود كانت الاعلى فى التطفل على بيض فراشة الحبوب بمتوسط ٥٨.٢ بيضة/ للأنثى والتى كانت الأطول عمرا بمتوسط ٥.٣٥ يوم وبلغت نسبة الخروج للنسل الناتج منها ٩٦.٨٦% والذي بلغت نسبة الإناث فيه ٧٨.١٧% مقارنة باناث الترايكوجراما التى لم يقدم لها اى تغذية حيث انها أظهرت اقل متوسط للتطفل على بيض فراشة الحبوب بنسبة ٣٠.٥٥ بيضة للانثى والتى كانت الاقصر عمرا بمتوسط ١.٨ يوم .أيضا، أظهرت النتائج ان أقل نسبة خروج للأفراد سجلت مع التغذية بخليط العسل الأسود والخميرة بمتوسط ٨٧.٧٧% بينما سجلت أقل نسبة للاناث في النسل الناتج بمتوسط ٦١.٨٢% نتيجة التغذية بمحلول الخميرة فقط، وعموما، فان أعلى معدل انتاج عام لاناث طفيل الترايكوجراما بلغ ٤٤.٠٧ انثى/انثى نتيجة التغذية بالعسل الأسود بينما أقل معدل نتاج عام للاناث بلغ ١٩.٦٠ أنثى/ أنثى مع الاناث التى لم يقدم لها أى تغذية.