THE EFFECTS OF FUNGAL MEDIUM ON HATCHING RATE OF BITING MIDGE

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Abstract

The little black mosquitos, *Forcipomyia taiwana*, bite human and become one of the most annoying pests in Taiwan. Recently, the population of *F. taiwana* increases and invades urban and countryside. In order to effectively prevent the harassment of *F. taiwana*, develop control strategy is urgent and necessary. Our study found that the fungal medium influenced the length and width of the *F. taiwana* eggs. It also significantly decreased the hatching rate of *F. taiwana*. Besides, this artificial diet was more non-toxic and environment-friendly than general chemical pesticides. Thus, this study provided critical information to develop potentially useful bait of *F. taiwana* in the future.

Keywords: Artificial diet, bait, biting midge, hatching rate

Introduction

Forcipomyia taiwana (Diptera: Ceratopogonidae), known as little black mosquito, is annoying blood-sucking pests in Taiwan and Southern China (Perich et al., 1995). In recent years, the population of this pest increases shortly and harasses human recreational and outdoor activities (Chuang, Lin, Wang & Yeh, 2000). One of common control methods to decline the pest hazard is chemical pesticides (Mishra et al., 1987). It is necessary to seek for alternative strategy. Trap bait system is an efficient way to attract, trap and monitor pest problems (Kline, 1999; Müller, Kravchenko & Schlein, 2008). Four chemicals, octenol, lactic acid, acetone, and carbon dioxide are assessed for *F. taiwana* attractiveness. The result shows that Octenol is the most effective chemical to lure *F. taiwana* (Liu, Lee & Yang, 2009). However, no study focuses on the influence of bait on

the fitness of *F. taiwana*. Therefore, investigating an effective bait to decrease the fitness of *F. taiwana* is urgent and necessary.

Nutrition source and energy content often impact the fitness of insects. Both the parasitoid's longevity and fecundity are usually affected by the energetic limitation or carbohydrate source. However, one kind of sugar, rhamnose, declines the survival of *Cotesia glomerata* (Leatemia, Laing, & Corrigan, 1995; Wäckers, 2001). Furthermore, the amino acid also plays a key role to influence the reproduction and lifetime of insects (O'Brien, Boggs, & Fogel, 2003). In addition, carbohydrate and amino acid are two abundant components of nectars (Baker & Baker, 1973; Dupont, Hansen, Rasmussen & Olesen, 2004). Therefore, the fitness of these sugar-feeding insects may be regulated by the components in nectar. Many studies indicate that the adults of *F. taiwana* eat nectar as their nutrition (Chen, Lien, Lin & Hsu, 1981). There is no study to explore the influence on of yeast extract as food on the fitness of *F. taiwana*. Our study used fungal medium as diet to feed the female adults of *F. taiwana* and evaluated whether it affects the hatching rate of this pests.

Material and methods

Female adults of *Forcipomyia taiwana* were collected from Changhua County, Taiwan. Their were attracted and captured by human bait method. All the captured female adults were full-blooded and then deposited in containers used for oviposition. There were about 10 individuals in each container.

In the control group, 200 μl of algae suspension and sterilized water were added respectively at first day as a nutrient resource while 200 μl of algae suspension and YPD medium (1 % yeast extract, 2 % peptone, and 2 % dextrose) were added in the experimental group. Then, half of the amount of the food was added after the second day. The eggs would hatch about 4 days after they were laid (Yeh & Chuang, 1996). Therefore, the eggs hatching rate was calculated at fifth day, and each group had six repeats. The greatest length and width of each unhatched egg were measured.

Results

The eggs color of the experimental group, light red and transparent, was obviously different from the control group, black and opaque (Fig. 1). The average length and width of eggs were 269.20 ± 10.92 and 82.67 ± 7.01 μm (Fig. 2) in the control group, and 242.12 ± 32.53 and 70.89 ± 7.39 μm (Fig. 2) in the experimental group, respectively. Both of the length and width in these two groups had significant difference ($p<0.01$), while the width divided by the length was similar (0.31 ± 0.02 and 0.30 ± 0.09 of control and experimental group) (Fig. 2).

The hatching rate of *F. taiwana* was calculated based on the hatching eggs divided by the number of total eggs in each container at fifth day (Fig. 3). The egg number in control group was 483, and 466 in experimental group. The average hatching rate in the control group was 35.64% ± 19.91% (mean ± SD). However, the average hatching rate was significantly decreased, and all the eggs were not hatch in the experimental group. The results showed that the female adults of *F. taiwana* were fed with fungal medium and lay the immature eggs.

Discussion

In this study, we found the female adults of *F. taiwana* fed with fungal medium influenced their eggs hatching rate. The fungal medium is composed of yeast extract, peptone, and dextrose. The latter two components are the most important factors in insect development and fitness (Beenakkers, 1969; Tsiropoulos, 1983; Jacob & Evans, 1998). The amino acids composition impacts the fitness of many insects, eg. *Myzus persicae*, *Macrosiphum euphorbiae*, *Ceratitis capitata*, and *Araschnia levana* (Douglas, 1993; Karley, Douglas & Parker, 2002; Chang, 2004, Mevi-Schütz & Erhardt, 2005). It is worth to study further if the peptone used in this study resulted in the decreasing egg hatching rate of *F. taiwana*.

Sugar supplements are regarded as a role to impact parasitic wasps oviposition (Heimpel & Collier, 1996; Lee & Heimpel, 2008). Sugar utilization in parasitoids also promotes its longevity. The longevity is significantly increased when parasitoid wasp, *Cotesia rubecula*, fed with higher sugar concentration (86%) (Siekmann, Tenhumberg & Keller, 2001). Moreover, it is well-known that glucose is one of the prevalent sugars in nectars and honeydews (Baker & Baker, 1983; Koptur, 1992; Dupont et al., 2004). However, there are little studies indicate the role of glucose in nectar to the sugar-feeding insects. In our study, the dextrose (glucose) in fungal medium may impact the egg development of *F. taiwana* and cause the eggs unhatched.

In this study, it is the first time found the fungal medium effectively decrease the egg hatching rate of *F. taiwana*. This artificial diet is more non-toxic and easy-decomposable than pesticides in the wild. The study provides useful information that can be used in the development of control strategy in the future.

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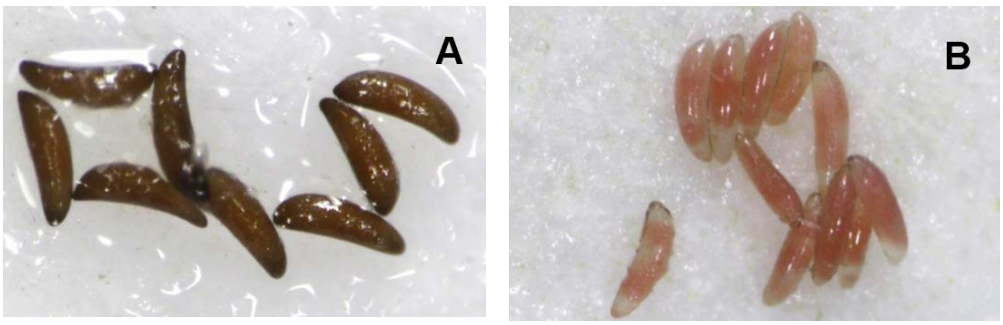

Figure 1. Effects of fungal medium on egg morphology. (A) The eggs were black and opaque in control group. (B) The eggs were light red and transparent in experimental group.

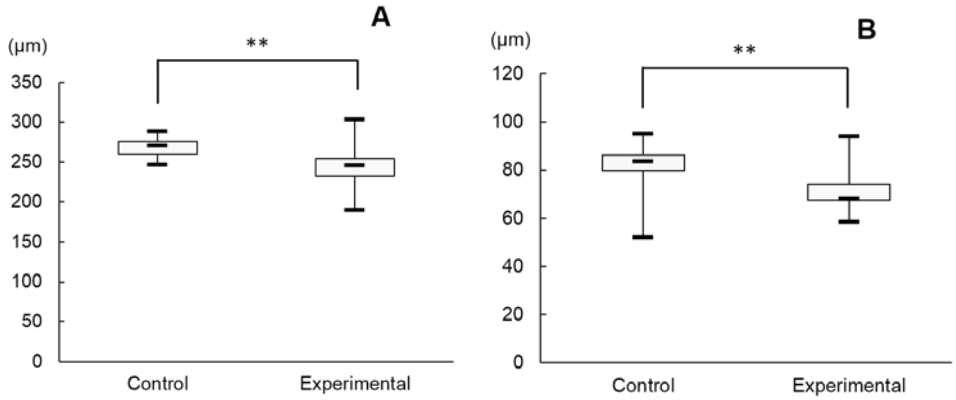

Figure 2. Effects of fungal medium on the length and width of egg. Box plot representing length and width of eggs in control and experimental group. (A) The length of eggs was showed in each group. (B) The width of eggs was showed in each group. The significance of differences between groups was determined using Student t tests and analyses of variance. **p<0.01.

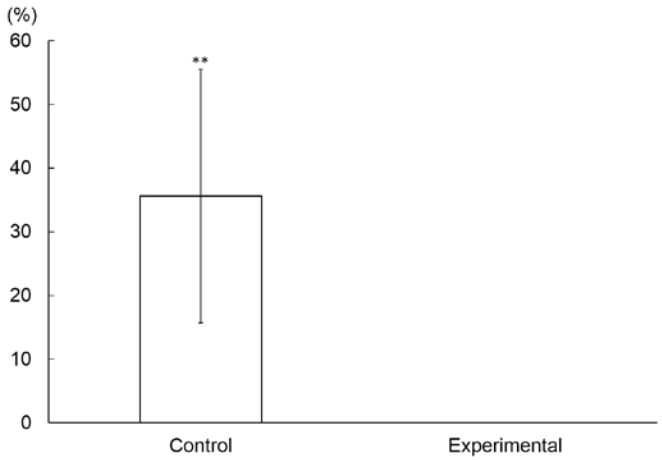

Figure 3. Effects of fungal medium on egg hatching. The egg hatching rate was calculated by the formula: hatching eggs/total laid eggs. Data show mean ± standard deviation (SD) from six containers in each group. In control group, the egg hatching rate was 35.64% ± 19.91% and 0% in experimental group. The significance of differences between groups was determined using Student t tests and analyses of variance. **p<0.01.