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Modulatory role of phyto-products in foraging behaviour of *Drosophila sp* leading to altered reproductive strategies*:* a novel experimental approach

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Abstract

Fruit flies are important in genetic purview but sometimes are nuisance to household commodity. Therefore, to restrict their uncontrolled trolling a preliminary experiment was conducted using several food items mixed with control (banana) to seek their attractiveness towards the food. Additionally, a thorough observation was made to analyze whether these preferred food items play any significant role in their life cycle stages/phases. The overall data of the present work clearly reveal that phyto products like lemon and turmeric had significant modulatory effects in the life cycle of fruit flies. Further, lemon induced a contrasting feature in fruit flies which was not observed using other food items. Although, the fruit flies were more attracted towards the lemon extract containing food item (higher than any other food item), but after conducting further experiment, it was observed that lemon extract enhanced their phase 1 and phase 3 time period thereby increasing the moulting time taken, however in case of turmeric, the result was opposite. Flies of turmeric set reached adulthood much earlier when compared to control and other experimental set. Thus, these results clearly suggest that lemon extract may have promising usage as natural insecticide for not only fruit flies but also in agriculture industry for various other insects to be investigated in future.

Keywords: *Drosophila* sp., feeding preference, phyto products, life cycle stages.

Introduction

Phyto-products often play an important role in modulating physiology of animals. From time immemorial several plant extracts are known to be in use against myriads of diseases. With the advent of modern technology, these herbal extract are being profusely tested in various forms, sometimes as curative drug to counter the ill effects of toxic chemicals in environment or sometimes as preventive molecule against several forms of cyto-toxicity ranging from genotoxicity to cancer

biology to diabetology to reproductive failure (Samadder et al., 2012; Das et al., 2012; Samadder et al., 2017). Additionally, the abundance of these phyto-products in nature are often preferred naturally in food chain of animals thereby implying an impact on the overall selectivity of the plant product by various forms of animals for their struggle for existence.

Lemon is one such kind of plant product whose availability and abundance all throughout the year is remarkable. Several research reports have already revealed its impact on various aspects of physiology even in many life forms including the insects. Richly loaded with vitamin C, magnesium, potassium, calcium, etc, makes lemon a strong antioxidant which makes it globally in use.

Lemon or lemon extract has been used as a safe alternative to pesticide against ants, wasps, mites, moths, flies, mosquitoes, etc (Oshaghi et al., 2003). The essence of lemon extract might attract insects for foraging whilst their active ingredients might play a counter role thereby promoting insecticidal efficacy. Already there are several reports which clearly state that lemon or lemon juice may have contraceptive effect in reproductive females both for human (Chijoke-Nwauche and Dede, 2010) and animals. Therefore, this particular potential of lemon or lemon extract needs to be explored for scientific validation of the link between foraging preference and modulation in reproductive life cycle phases of insects which might lead to reproductive failure.

Thus to bridge this gap a preliminary experimental study was conducted using the fruit flies *Drosophila s*p which has natural foraging preferences for aromatic plant product (Nath et al., 2017). In addition to lemon several other food additives like turmeric, neem, egg and camphor were chosen with several objectives: i) to assess whether the fruit flies have any selective foraging preference for plant/ plant product containing food additive; ii) to assess whether the selected food item have modulatory effect in their life cycle stages; iii) to demonstrate a link between the foraging preference behaviour with that of reproductive strategies through proper scientific protocols.

Materials and methods

The food items and other necessary items were purchased from local market.

Experimental procedure

The experiment was conducted as per protocol followed by Nath et al., (2017). The food items were grouped as follows: SET 1: Control; SET2: Lemon extract; SET3: Turmeric extract; SET4: Neem extract; SET5: Egg; and SET6: Camphor. The control (SET1) and experimental sets (SET2 to SET6) were kept in natural environment for 7 days and 8hr per day. The data were collected at 1h interval.

Assessment of reproductive strategy in *Drosophila* sp.

The Life Cycle Stages of *Drosophila* sp were assessed by following the protocol described in Das et al., (2017). Phase 1: Egg to larvae; Phase 2: Larvae to pupae; and Phase 3: Pupae to Adult fly, stages were observed for each set.

Statistical analysis

All the data thus collected after conducting three independent experiments were statistically analysed using Student's t-test from their mean values by following the procedure of Nath et al., (2017).

Results

Foraging activity

The foraging activities of fruit flies were found to be different for each food item. Result clearly shows that the flies preferred lemon extract (***$p<0.001$) and turmeric extract (**$p<0.01$) as compared to other sets and control and rejected camphor altogether (Figure 1).

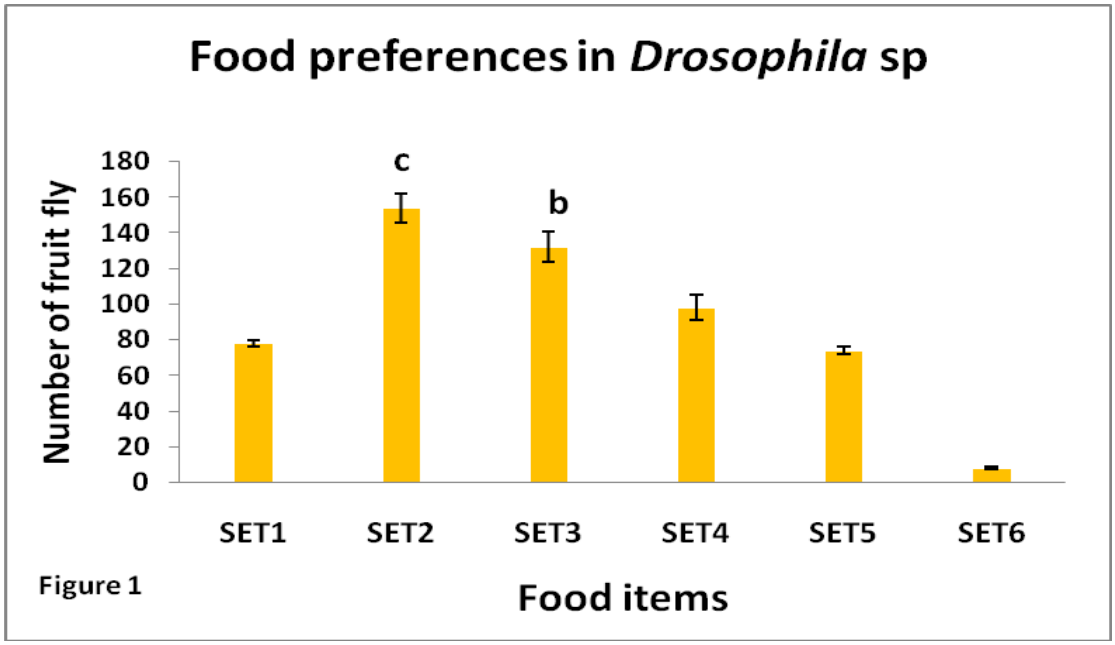

Figure 1. Graphical representation of food preference of *Drosophila sp*. (*p<0.001 denoted by 'c'; **p<0.01 denoted by 'b').**

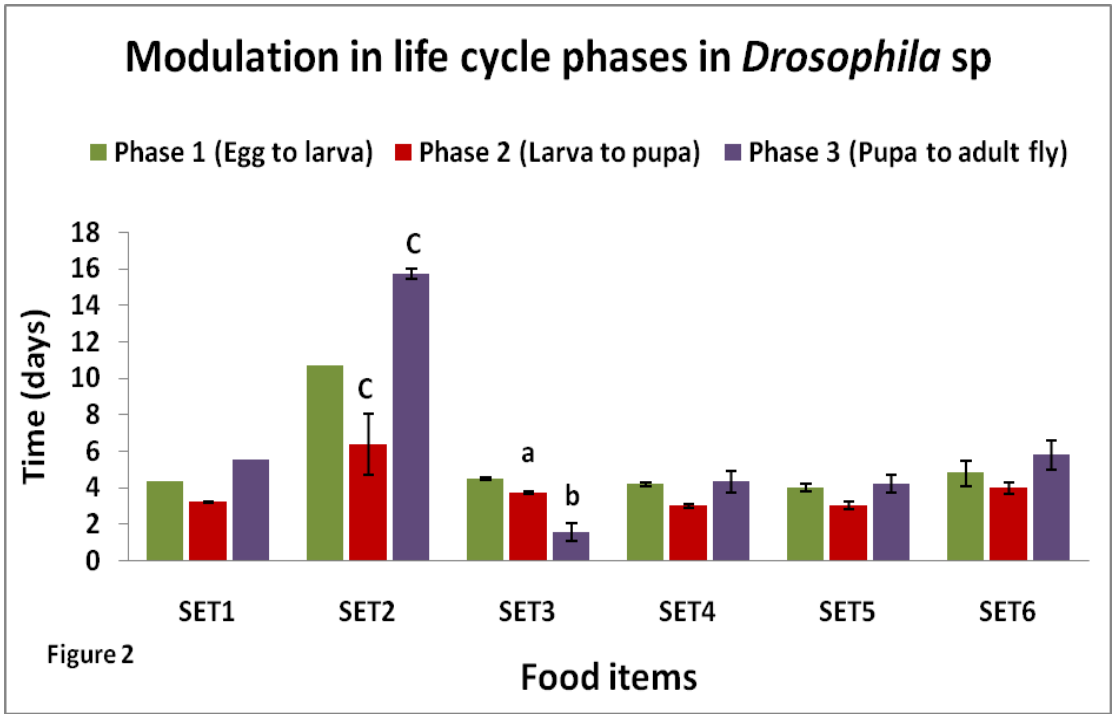

Figure 2. Graphical representation of alteration of life cycle of *Drosophila sp*. induced by different food items. (*p<0.001 denoted by 'c'; **p<0.01 denoted by 'b'; (*p<0.05denoted by 'a').**

Alteration in life cycle stages

The life cycle stages/phases varied differently in different food items ranging from SET2 to SET6 when compared to SET1 control. However, completely different events were observed in SET2 and SET3. In SET2 (Lemon extract) it was observed that although the flies preferred lemon extract but they reached their adulthood at a much later time than that of other sets. On the contrary the 2nd preferred SET3 (Turmeric extract) was found to promote reduction of moulting time from pupae to adulthood. Thus, there was an enhancement of time for Phase 1 (***$p<0.001$) and Phase 3 (***$p<0.001$) stage in SET2 and a reduction in Phase 2 (*$p<0.05$) and Phase 3 (**$p<0.01$) stage in SET3. Since SET6 could not attract any fly when compared to SET1 control and other experimental sets, thus, the stages of their life cycle was considered non significant in each case till the experiments were over (Figure 2).

Discussion and Conclusion

The overall piece of work clearly shows that phyto-products play a vital role in the foraging behaviour and food selectivity of insects. However, this food preference activity is not always profitable for their survival which on the contrary was detrimental for their existence.

There has been an outbreak worldwide for using chemical pesticide which often results in environmental pollution leading to toxicity in all life forms causing severe damage. Results of this preliminary work pave a new insight to readily deal with this severity of chemical pesticides. Lemon which was found to have vital role in restricting the overall growth, development and maturation of the fruit files can readily be used as an alternative source of naturally derived and environmental friendly insecticide in future based on further studies. Oil of citrus has been in use from long past for killing insect pest (Oshaghi et al., 2003). Results of our present study clearly shows that not only the lemon extract containing food item play potential role in attracting fruit flies towards them but on the contrary it helped in slowing down the process of egg hatching (phase 1) and final emergence of adult fly form pupae (phase 3). Additionally, the role of turmeric cannot be left unperturbed as it possesses the capacity of growth promoter which may have prolific demand in insect related sericulture, apiculture, lac-culture, etc oriented industrial usage. Further, in depth studies are warranted at molecular, physiological and biochemical level that would unravel the cascade of genes and hormones that are involved in up-regulating or down-regulating the moulting system, which would definitely serve as an important mechanistic tool for designing benign environmental hazard free pesticides for a wide range of crop infesting insets globally.

Conflict of Interest

None to declare

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