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Research Article

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Effect of different artificial diets on biological parameters of female *Chrysoperla carnea* under laboratory conditions

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ABSTRACT

Chrysoperla carnea (Neuroptera: Chrysopidae) is considered as a cosmopolitan polyphagous generalist predator. *Chrysoperla carnea* can be used in biological control programs. The biological parameters of *Chrysoperla carnea* were studied to check the effect different diets under laboratory conditions. The results indicate that preoviposition, oviposition and post oviposition periods were 8.2±1.25, 30.6±1.72 and 9.4±1.02 days, respectively.The highest mortalities were occurred reared at Water+ Sugar+ Yeast+ Evion diets while no mortality was observed at H_2O + Sugar +Yeast + Honey. The female longevity was 51.2 ± 2.18 days. The fecundity of female was 301.31 eggs per female with 10.36 eggs per day per single female on artificial diet, H_2O + Sugar +Yeast + Honey. The study revealed that H_2O + Sugar +Yeast + Honey was showed highest survival and fecundity while Water+ Sugar+ Yeast+ Evion least one.

Keywords: Neuroptera, Artificial diet, Biological Parameters, Survival Rate, Pakistan.

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INTRODUCTION

Green lacewings, *Chrysoperla carnea* (Stephens) belongs to the order 'Neuroptera' is an important predator of soft bodies insects. *Chrysoperla carnea* is found on every crop such as cotton, sweet corn, potatoes, tomatoes, peppers, okra, eggplants, leafy greens, apples, asparagus and many others where preys available. There are various biological control agents use for the management of insect pests. *C. carnea* is one of them, play key role in pest management. *C. carnea* is excessively studied due to various factors such as broad habitats with high relative frequency of occurrence, geo-graphical distribution, good searching ability and easily reared under laboratory conditions [9].

Adult is nectar, honey dew and pollen feeder while larvae of *C. carnea* feed on several insect pests such as aphids, thrips, spider mites, whiteflies, moths, leaf miners, small caterpillars, beetle larvae, eggs of leafhoppers and the tobacco budworm etc. [1,5,8,10,16,17,22]. The oval shape eggs are laid singly at the end of long silken stalks. The colour of eggs are pale green and turn gray before hatching. The larvae are very active with well-developed legs and gray or brownish in colour[13]. Adult of green lacewings are pale green, about 12-20 mm long, with long antennae andbright, golden eyes. They have large, transparent, pale green wings and a delicate body.During evening and night, adults are active fliers and havefluttering flight[14, 26]. There are several generations of *C. carnea* annually [23, 27].

The rearing of *C. carnea* on different artificial diets is the most important diagnostic means to provides a comprehensive description of the growth life cycle. Biological studies have their importance in mass raring program of natural enemies and integrated pest management (IPM)strategies. It is important to know about biological parameters such as growth, life table, variations in stages, longevity and fecundity for successful mass rearing of *C. carnea* in biological control program [6].Keeping in view the importance of *C. carnea*, the rearing of predator (*C. carnea*) was carried under laboratory conditions at different artificial diets.

MATERIALS AND METHODS

An experimental study was conducted out from August 2018 to June-2019 on *Chrysoperla carnea*, using four different artificial diets as feeding substrate to investigate their effect on adults' fecundity, survival or longevity at 24±1C° temperature and 30±5% relative humidity (RH) atBiocontrol Lab Department of entomology, University of Agriculture Faisalabad.The larvae were collected from fields and brought to laboratory for rearing purpose. After emergence of adults, five days old 4 pairs of adults were kept in different transparent rearing cage (Perspex cage, Wooden cage and Glass cage) to checked the effect of four different artificial diets on egg lying capacity (Table 1). The dimensions of cage were 6cm thick, 35cm long, 35 cm high and 20cm wide with 2mm holes on side walls. The experiment was repeated two times for each diet. The diets which were used for C. *carnea* given below in Table I.

Table I: Concentration of different diets used for *C. carnea* rearing

Sr. No.	Diet	Dose
1	Water+Sugar+Yeast+ Honey	4tsp+1tsp+2tsp+1tsp
2	Water+Yeast+Honey+ Egg yolk	4tsp+2tsp+1tsp+1tsp
3	Water+Sugar+Yeast+ Evion	4tsp+1tsp+2tsp+400mg
4	Water+Sugar+Yeast+ Egg yolk	4tsp+1tsp+2tsp+1tsp

Note: Tsp stand for Teaspoon

Data was statistically analyzed by using SPSS and least significant difference test (LSD).

Procedure for the preparation of diet

The diet was prepared in glass jar in such a way that at first take 4tsp of water in a jar. Then 1tsp of sugar and 2tsp of yeast were added, shake well to make homogenous mixture and then kept for fermentation. After 5-6 hours of fermentation period, 1tsp of honey was added. Then culture was placed in a zig-zag fashion in transparent plastic strips having 2mm chambers.

Culture Maintenance

1. Food provision
   Two time in a day, with the help of fine camel hair brush standard adult diet was provided in droplets on paper cards.
2. Egg harvesting
   Eggs were harvested black muslin cloth cover with the help of sharp razor blade.
3. Cleaning of cages
   All the cages were cleaned with wet cotton wig after that dried gently with the help of tissue paper.

RESULTS

The rearing of C. *carnea* was carried out under laboratory conditions at different artificial diets. The adult preference was different with different diets. The study indicates that pre oviposition and oviposition periodof C. *carnea* female was 5 and 45 days respectively, reared on artificial diet 1. No mortality was occurred during pre-oviposition period while mortality occurred in post-oviposition period. The oviposition period was 45 days at which maximum oviposition occurred on 22nd day while less or no oviposition occurred on 46th day. In this period the first female mortality was occurred on 20th day then 2nd on 27th day, 3rd on 30th day then on 36th day and last mortality studied in this period was on 43rd day. The first egg was observed at day 6 and maximum eggs (18 per female per day were observed on day 18. The graph representing increasing and decreasing zigzag pattern. The results were given in fig. 1.

The results given in Fig. 2indicate that the pre-oviposition period of C. *carnea* at diet 2 was 5 days and no mortality was observed.The oviposition period was 28 days at which maximum oviposition occurred on 15th day while less or no oviposition occurred on 28th day. In this period the first female mortality was occurred on 10th day then 2nd on 13th day, 3rd and last mortality in this period was recorded on 20th day. The post-oviposition period recoded on this diet was 2 days at which less mortality occurred.

The results indicate that the pre-oviposition period of C. *carnea* at diet 3 was 5 days having zero mortality.The oviposition period

Table 1: Egg-laying capacity of *C. carnea* in different types of cages under laboratory conditions

Cages	Mean±S.E.		Eggs percentage
	Drifted	On substrate	
Glass cage	11.99 ± 1.40^{c}	270.42 ± 20.06^{a}	3.90
Perspex cage	15.91 ± 2.67^{b}	199.8 ± 2.13^{b}	8.90
Wooden cage	40.27 ± 3.52^{a}	149.99 ± 15.89^{c}	17.26

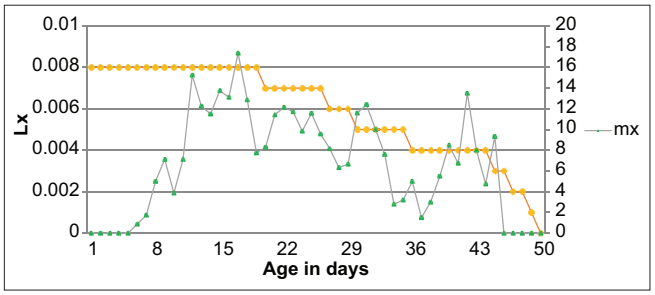

Figure 1. Age specific survival (lx) and fecundity (mx) of female *C. carnea* reared on artificial diet (H_2O + Sugar +Yeast + Honey)

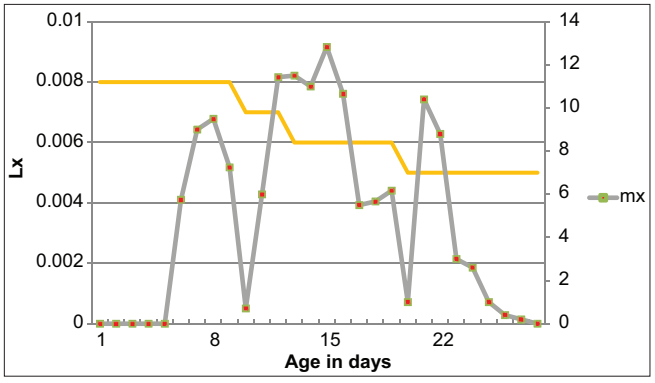

Figure 2. Age specific survival (lx) and fecundity (mx) of female *C. carnea* reared on artificial diet (Water+Yeast+Egg yolk+ Honey)

was 32 days at which maximum oviposition occurred on 17th day while less or no oviposition occurred on 35th day. In this period the first and second female mortality was occurred on 22th day then 3rd on 29th day, 4thon 30th day 5th, 6th and 38th day then 7thand last mortality in this period was recorded on 40th day.The post-oviposition period recoded on this diet was 3 days with highest mortalities. In the mentioned graph the oviposition period was 38th to 40th days and hence their life cycle was completed (Fig. 3).

The results indicate that the pre-oviposition period of *C. carnea* at diet 4 was 5 days having zero mortality.The oviposition period was 16 days at which maximum oviposition occurred on 19th day while less or no oviposition occurred on 15th day. In this period the first female mortality was occurred on 11th day then second on 15th day while 3rd and last mortality in this period was recorded on 22th day (Fig. 4). The post-oviposition period recoded on this diet was 5 days at which maximum mortality occurred.The glass cages proved to be a better substrate for egg-laying of *C. carnea.*

The diet 1 such as H_2O + sugar + yeast +Honey was the maximum preference of *C. carnea* while Evion 400mg (Vitamin E) least one. The adults fed readily on the diet and appeared to use the same type of feeding behavior or activity that they fed on natural diet. The capacity of egg lying was the same as in the natural diet. The effect of artificial diet on different stages was given in Table 2.

Table followed by same letter in a column are not significantly different from each other (P>0.05%).

DISCUSSION

Biological control is the part of integrated pest management strategy and play key role in pest population management [15].

Table 2: Impact of artificial larval diet on *Chrysoperla carnea*

Diet	Larval survival	Pupation	Emergence	Fecundity
1.	89.75[a]	87.77[a]	71.65[a]	301.31[a]
2.	64.00[b]	50.36[b]	25.99[b]	105.70[b]
3.	32.00[c]	23.09[c]	14.69[c]	51.67[c]
4.	17.75[a]	21.77[a]	20.65[a]	219.31[a]
LSD = 0.050	10.104	19.20	10.901	29.24

By using LSD test, means are not significantly different from each other (P>0.05).

Green lacewings, *Chrysoperla carnea* (Stephens) larvae are important predators of soft bodies insect pests such as aphid, mites and whitefly. An experimental study was conducted to reared the adult of *C. carnea* by using different artificial diets because this insect is useful as a predator of sucking pests [3]. Many chewing insect pests such as *Heliothis species* can be controlled by inundative releases of C. carnea eggs and larvae on cotton crop [21]. Many studies have been carried out on the rearing of *C. carnea* larvae on artificial as well as natural diets. The fecundity, longevity, reproductive age and many other reproductive as well as biological parameters of *C. carnea* have been examined on different diets[2].

Among all used artificial diet standards checked, diet No.1 showed good results for successful commercial based mass rearing of green lacewings (Fig. 1). During the study the highest survival, fecundity was showedand no mortality occurred on diet 1, followed by diets 2, 3 and 4. The similar findings was observed by earlier researchers [20]. Highest larval survival was observed (89.75) on diet No.1, followed by (64.00) on diet No. 2. Maximum pupation (87.77) showed in diet No. 1, while minimum (21.77) in diet No.4. Emergence was the highest (71.65) in diet No.1, followed by (25.99) in diet No.2, and the lowest (14.69) in diet-No. 3. The present study outcomes are similar with the earlier studies[20]. The predacious insects such as *C. carnea* feed well on the artificial diet as compared to natural prey [4]. The length of larval period was also affected with artificial diets.

During the study, it was observed that artificial diets effect the oviposition, post-oviposition periods and fecundity. The pre-oviposition and longevity periods were not influence through artificial diets [20]. The oviposition period ranged from 5.24 to 29.14 eggs/day when fed with different adult food supplements. Another study was carried out on *Coccinella septempunctata* at artificial diet under laboratory conditions [26]. The findings of the study were similar with the findings of current study.

Another study was carried in Pakistan resulted that pre oviposition, oviposition and post oviposition periods were 9.2±1.25, 34.6±1.72 and 7.4±1.02 days, respectively. Our findings were contrast with the earlier findings [11], reported a single female laid 11.16±1.31 eggs per day per.

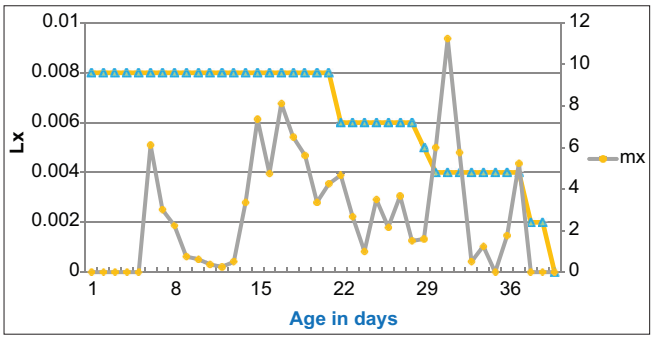

Figure 3. Age specific survival (lx) and fecundity (mx) of female *C. carnea* reared on artificial diet (Water+Sugar+Yeast+Evion)

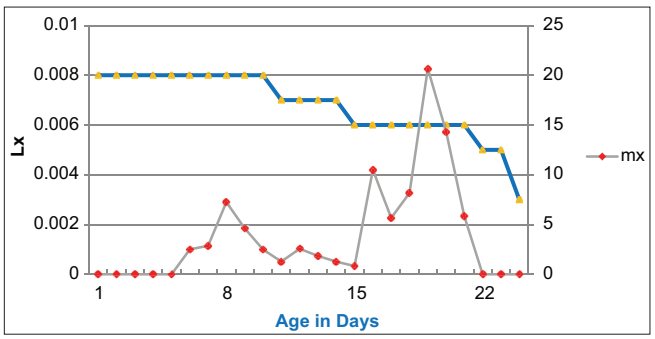

Figure 4. Age specific survival (lx) and fecundity (mx) of female *C. carnea* reared on artificial diet (Water+Sugar+Yeast+Egg yolk)

The similar observations have been reported by many workers[7, 12, 18, 19, 24]. The variations in results can occurred due to environmental conditions such as temperature, humidity and rainfall as reported by many researchers.

The findings of the present study about biological parameters of *C. Carnea* were suggested the use of predator as biological control agent in IPM strategies.Due to the greater searching and egg lying capacity to hosts, higher net reproductive rate, faster development, predator use as a biological agent in pests management.

CONCLUSION

Finding of present research conclude that among the tested different artificial diets standard diet is most suitable and effective for the biological parameters of female adults and further.

List of Abbreviations

IPM: Integrated pest management

LSD: Least significant difference

SPSS: Statistical Package for the Social Sciences

Tsp: Teaspoon.

CONFLICT OF INTEREST

Authors have no conflict of interest.

AUTHORS CONTRIBUTIONS

MR wrote the manuscript, GM conducted the study, FS, MAR, SS and MJ reviewed the manuscript.

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Significant Statement

The current study has very significance for entomologist and farmers because it provides well information about insect pest management through biological agents under changing climatic system.

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