TECHNICAL REPORT

Effect of different artificial diets on the biology of adult green lacewing (*Chrysoperla carnea* Stephens.)

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Abstract

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Chrysoperla carnea **(Green lacewing) is voracious predator of insect eggs and varieties of soft-bodied arthropods such as caterpilllars, aphids, jassids and mealy bugs. It is currently mass-reared and used in biological control of insect pests. Experiments were conducted to find out a better and cheaper artificial diet for mass-rearing of adult *C. carnea*. Three adult diets were tested in the laboratory conditions in comparison with standard diet; that was mixture of yeast extract, casein, honey, sugar and distilled water. Parameters were fecundity, larval period, pupal period and adult longevity. The results revealed that the mixture of egg yolk, milk and honey was better than all other diets.**

Key words : artificial diets, adult green lacewing, *Chrysoperla carnea* Stephens.

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Most vegetable and cereal crops are attacked by lepidopterous and homopterous insects causing quality deterioration and yield loss. This reduces farmers income drastically and farmers resort to using insecticides, which increases the cost of production. Pesticides have been the backbone of crop production since early 1950s when organo-chlorines were first introduced. The pesticides which are currently used are mostly non selective and are affecting the biotic and abiotic components of the environment. The indiscriminate use of pesticides created a number of problems such as environmental pollution, resistance in insect pests, upsurge of the secondary pests due to elimination of their natural enemies, increased cost of crop production and hazards for human beings and animals. According to an estimate, pesticides adversely affected the health of about 400,000 to 2,000,000 people every year. Out of these 1,000 to 40,000 die mostly in the developing countries (Robert *et al*.,1985)

Biological control is relatively permanent, safe, economical and environmentally friendly. It can be defined as "the action of parasites, parasitoids, predators and pathogens to keep the pest populations at a lower average than the economic injury level". The safety of biological control is outstanding because many natural enemies are host-specific or restricted to a few closely related species. Therefore the non-target species are not affected. Efficient natural enemies often continue to have a suppressing affect year on insect pests (DeBach, 1964).

Chrysoperla carnea Stephens (Green lacewing) also known as Aphid lion belongs to family Chrysopidae, order Neuroptera. It is found in most of the environments throughout the world. Larvae of *C. carnea* are a voracious predator of exposed eggs, small larvae of beetle and lepidopterous pests. It also feed on slow moving, soft-bodied arthropods such as aphids, jassids, thrips, whitefly, scales, mealy bugs and mites (Carrillo *et al*., 2004). It can be mass reared in the laboratory and used against vegetable pests. It is a very important biological control agent due to its tolerance to the wide ranges of ecological factors.

C. carnea is found in different agricultural habitats (Zelany, 1984) in high relative frequency of occurrence. (New, 1984). It has broad prey range and effective searching abilities (Ridgway and Murphey, 1984) and high resistance to many widely used pesticides (Bigler, 1984). Rearing techniques which enable it to produce of large numbers of eggs and larvae needed for inundative release of *C. carnea* have been developed (Tulisalo, 1984). In order to start a biological programme using *Chryosperla carnea*; mass-rearing techniques which are economical as well as posses higher biological efficiency need to be worked out. Keeping there needs in view, this experiment was conducted to find out the cheaper, more effective and easily available adult diet.

Material and Methods

The experiment was conducted at the Entomology Division of Nuclear Institute for Food and Agriculture (NIFA), Peshawar, Pakistan. Experiment was designed in Randomized Complete Block Design (RCBD) with three replications each having five pairs of adult *C. carnea*. These adults were confined in a the glass chimney (6 cm dia. × 8 cm dia) which was placed in the petri dish (9.0 cm. dia.). Another small petri dish (5.0 cm. dia.) was placed in the bigger petri dish for holding cotton soaked in distilled water to maintain moisture. The upper open end of glass chimney was covered with black muslin cloth and was tightened with rubber band. The different adult diets were provided inside the glass chimney with the help of small of plexi glass strips, each strip being drilled at three points to make pits for holding drops of diet. The all diets were provided with the interval of 24 hours.

Eggs laid by female green lacewing on the walls of chimney and muslin cloth were harvested with sharp razor and one egg per test tube (7.5 × 1 cm. dia.) was placed with the help of camel hair brush. The test tubes were covered with cotton swab. After hatching the newly hatched larvae were fed on frozen eggs of *Sitotroga cerellela* (0.2 gm/tube) that were provided with the interval of

Table 1. Different diets used in the experiment.

Diet	Ingredients	Weight/Volume
Standard diet	Sugar: yeast extract : honey: distilled water : casein	3g : 2.5 gm : 2.5 gm : 10 ml : 2.0 gm
A	Hen's egg yolk : milk : honey	5 ml : 10 ml : 5 ml
B	Hen's egg white : milk : honey	5 ml : 10 ml : 5 ml
C	Mixed hen's egg : milk : honey	5 ml : 10 ml : 5 ml

fours days. The process was continued until the formation of cocoons. The cocoons formed were removed gently with camel hair brush from the test tubes and were shifted to other empty glass chimneys to observe and record the emergence of adults. Three different diets were tested against standard diet (Table 1).The different ingredients used in all the diets were mixed with a stirrer to make them homogeneous.

The experiment was conducted at 27±2ºC and 60±5 % RH as done by Ashfaq *et al*. (2002). Daily observation was made the following parameters recorded:

1. Fecundity (number of eggs laid per female)
2. Larval period
3. Pupal period
4. Adult longevity

Data recorded was analyzed by a computer software package Mstat c.

Results and Discussion

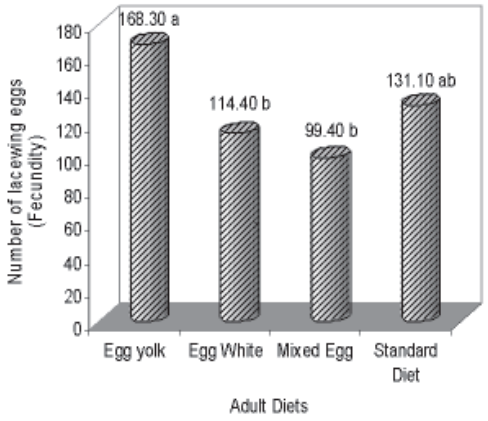
Fecundity

The results showed that the mean number of eggs laid by female *C. carnea* fed on diets containing egg yolk, egg white and mixed egg were 168.30±0.98, 114.40±0.44 and 99.40±0.36 respectively, as compared to the standard diet where the mean number of eggs were 131.10±0.59.

It is obvious from the Figure 1 that fecundity was not significantly higher for the females fed on diet containing egg yolk (168.30±0.98) from standard diet (131.10±0.59) but it was significantly higher than the other diets containing egg white (99.40±0.36) and mixed egg (114.40±0.44). Whereas fecundity was not significantly different for the diets containing egg white, mixed egg and standard diet.

So in the present experiment the diet containing egg yolk, milk and honey in the ratio of 5ml : 10ml : 5ml proved to be the best resulting in significantly higher egg laying by the female *C. carnea* as compared to the other diets under the same laboratory conditions. This diet consists of three components and each component has the promoting effect on egg production. As reported by Hill (1989), sugar is a very important component in adult diet for the insects that has pronounced effect on the egg production. Similarly McEwen and Kidd (1995) had recommended yeast and sugar for maximum egg production. Honey is also a very important component regarding fecundity, McEven and Kidd (1995) and Kubota and Shiga (1995) analyzed that a mixture of honey and yeast autolysate is a suitable adult diet for production of fertile eggs. Last but not the least component is yolk that is the most important one. Milevoj (1999) reared adults of *C. carnea* on adult diet consisting of milk, eggs, fruits sugars and yeast and found a favourable effect on fecundity. Higher fecundity observed in diet containing egg yolk is because as egg yolk is rich in protein (amino acids). There is 15.5% amino acids as compared to egg white and mixed egg which contain 9.8% and 11.95% respectively (Norioka *et al*., 1984).

Vitamin A, niacin, riboflavin B12, pantothenic acid, thiamin, pyridoxine, folic acid, Vitamin E and D are present in greater quantity in egg yolk than in egg white and mixed egg. Similarly folic acid, which is particularly more important for egg productions is much higher (117 µ g) in egg yolk



*Means followed by the same letter are not significantly different from each other ($p<0.05$), using LSD

Figure 1. The effect of different adult diets on the fecundity of *C. carnea*

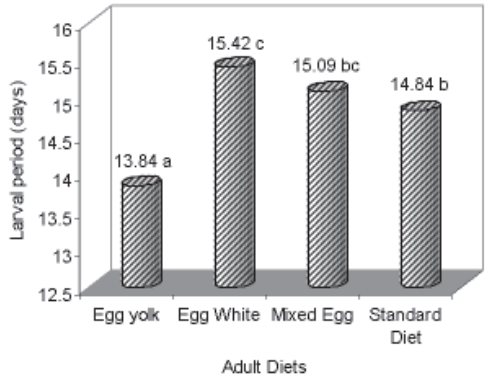


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Figure 2. The effect of different adult diets on the larval period of *C. carnea*

than in mixed egg (73 µ g) and an egg white (3 µ g). Egg yolk also has higher amount of saturated, mono unsaturated, polyunsaturated oils and lipids than mixed eggs, whereas egg white has no lipids at all. Also the egg yolk has greater caloric value (303 calories per 100 g) than mixed egg (148 calories per 100 g) and egg white (117 calories per 100 g). The cholesterol level is particularly very high (1075 mg) in egg yolk as against (432 mg) in mixed egg and no cholesterol in egg white (Rolfes *et al*., 1978).

Larval period

The mean total larval period of lacewing derived from adults fed on diets containing egg yolk, egg white and mixed egg was 13.84±0.20, 15.42±0.32 and 15.09±0.29 days respectively, as compared to standard diet where the total larval period was 14.84±0.41days (Figure 2)

Analysis of the data revealed that total larval period of adults fed on diet containing egg yolk was significantly shorter (13.84±0.20 days) as compared to standard (14.84±0.41days) and other diets, where as the larval period was not significantly different for the diet containing mixed egg (15.09±0.29 days) when compared with standard diet. The larval period of the adults fed on diet containing egg white (15.42±0.32 days) was significantly longer than standard diet.

Different scientists had reported that adult

and larval diet has reared effect on the larval period of green lacewing. Stelzl *et al.* (1992), Mishra *et al.* (1996), Sarode and Sonalkar, (1998) and Saminathan *et al.*, (1999) tried different adult and larval diets and concluded that the larval period can be greatly effected by these diets.

Diet containing egg yolk is quite rich in proteins, minerals, vitamins and lipids as compared to the diets containing egg white and mixed egg (Rolfes *et al.*, 1978 and Norioka *et al.*, 1984), which promoted quick growth and quick completion of the larval period. The shorter larval period is because of the better chemical composition of the diet containing egg yolk.

Pupal period

Mean pupal period of *C. carnea* offspring developed from the adults fed on different adult diets is shown in Figure 3. It can be seen that pupal period of *C. carnea* was 6.33±0.40, 7.11±0.34 and 7.22±0.38 days when adults were fed on diet containing egg yolk, mixed egg and egg white respectively as compared to standard diet where pupal period was 6.97±0.34 days.

Statistical analysis of the data showed that mean pupal period developed from the adults fed on diet containing egg yolk was significantly shorter than standard and all other diets. Whereas diets containing mixed egg and egg white were not significantly different from standard diet.

The shorter pupal period of *C. carnea* in the case of feeding on a diet containing egg yolk was due to the rich nutritive value of egg yolk (Norioka *et al.*, 1984), which promoted the quick growth, and complateion of pupal period. Mishra *et al.*, (1996), Mannan *et al.*, (1998), Cohen and Smith, (1998), Sarode and Sonakar, (1998), Saminathan *et al.*, (1999) and Choi *et al.*, (2000) have also reported the same results when larvae and adults of *C. carnea* were fed on different types of diets.

Longevity (adult life)

The data showed that the mean longevity of male *C. carnea* which were fed on a diet containing egg yolk was 28.22±0.28 days followed by 27.72±0.60, 26.62±0.43 and 25.82±0.43 days in standard diet, diet containing mixed egg and diet containing egg white, respectively (Figure 4) Analysis of the data showed that there was no significant difference among longevity of these male lacewings.

The mean longevity of adult females fed on diet containing egg yolk, egg white, and mixed egg was 29.52±0.35, 26.02±0.51 and 26.22±0.42 days respectively, whereas it was 26.92±0.39 days in females fed on standard diet (Figure 5)

Statistical analysis showed that adults who were fed on diet containing egg yolk lived significantly longer compared to the adults that were fed on egg white. When the means life span of female fed on these four different diets were compared, there was also no significant difference.

The studies showed that different adult diets have significant effects on the longevity of the both male and female *C. carnea*. McEwen and Kidd (1995) reported that adult life of *C. carnea* is affected directly by the adult diet and found that the adults receiving only sugar as adult diet lived longer than those receiving sugar and yeast (yeast was added to the adult diet for more eggs production). Adult life including pre oviposition, oviposition and post oviposition periods can be prolonged directly by the use of suitable adult diet (Ribeiro *et al.*, 1997). Adult nutrition is a very important factor for egg production and longevity in the case of insects (Morales *et al.*, 1996).

The adult diet containing egg yolk in addition to milk and honey used in this experiment prolonged adult life probably because of good nutritive value, as egg yolk contains plenty of essential and non-essential amino acids, carbohydrates, oils, vitamins, and minerals.

Conclusion

The adult diet containing egg yolk seems to be best among all the diets for resulting highest fecundity, shortest larval and pupal period and for longer longevity of *C. carnea* adults. This is because this diet contains higher proteins (amino acid), lipids, carbohydrates, ash, vitamins, and caloric and cholesterol contents. Greater longevity

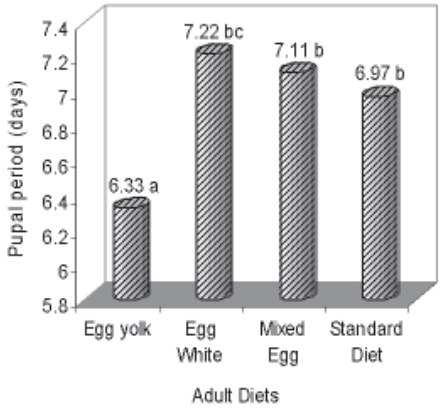

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Figure 3. The effect of different adult diets on the pupal period of *C. carnea*

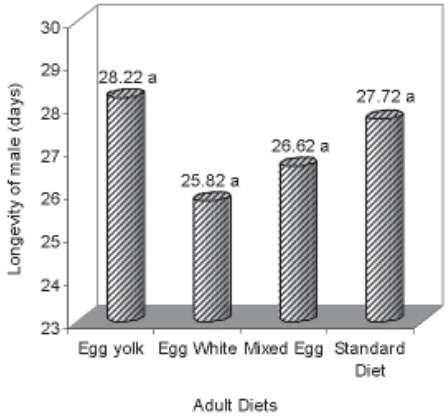

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Figure 4. The effect of different adult diets on the longevity of male *C. carnea*

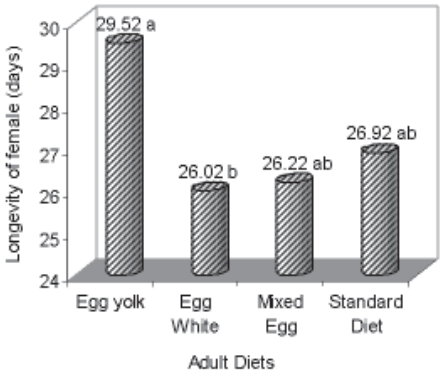

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Figure 5. The effect of different adult diets on the longevity of female *C. carnea*

is desirable because with a longer adult life more eggs will be laid and as hatching period is just 3-4 days in green lacewing so more larvae will be available. The cost for preparing one Litre of standard diet is Rs. 11000 as compared to the other three diets which is only Rs. 600 for preparing same amount of diet. So there is significant difference between the cost of standard diet and diet containing egg yolk, which is far cheaper and easily available. All the parameters obtained from the adult diet containing egg yolk are desirable for mass production. Hence this diet is recommended for mass production of *C. carnea*.

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