EUROPEAN ACADEMIC RESEARCH
Vol. V, Issue 1/ April 2017

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Effect of Artifical Diets on the Development of Immature Stages of *Chrysoperla Carnea* (Stephens) under Laboratory Conditions

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Abstract:

Study was conducted to determine the effect of artificial diets on the development of immature stages of Chrysoperla carnea (stephens) under laboratory conditions during 2015 at Temperature 26±2 and Relative humidity 65±5 % in the Bio-control laboratory of

Entomology Department, FCPT, SAU, Tandojam. The artificial diets from jelly of different flavors were prepared. Five treatments i.e. T_1 = Mango jelly, T_2 = Banana Jelly, T_3 = Pudding T_4 = Mix jelly (Banana jelly 10 g+3 g egg whitish+3g Yeast+80 ml water) and T_5 = Control (eggs of S. cerealella). The result presented that first instar larvae of C. carnea survived on different artificial diets in plastic tube as well as glass tube. Maximum larval development was recorded 12.08 ± 1.08 and 10.5 ± 1.11 days reared in plastic and glass tube on diet D_4, followed by diets D_1, D_2 and D_3, respectively. The third instar larva not survived longer in both plastic and glass tube. Similarly minimum development time was observed 8.6 ± 0.56 and 8.5 ± 0.76 days reared in plastic and glass tube on diet D_5 (control), whereas, the pupal period was seen 1.8 ± 0.77 and 5.3 ± 1.33 days reared in plastic and glass tube on same diet. The results further revealed that when second instar larvae of C. carnea reared on artificial diets in plastic and glass tube it indicated the maximum larval development was recorded 13.10 ± 1.03 and 10.2 ± 1.12 days reared on diet D_4, followed by diets D_4, D_1 and D_3, respectively. Similarly, third instar larvae not lined more in both plastic and glass tube and not transformed into subsequent stage.

Key words: Chrysoperla carnea, artificial diets, development, temperature, humidity.

INTRODUCTION

The common green lacewing, *Chrysoperla carnea* (Stephens) Order "Neuroptera" is predator of soft bodied insects. A group of insect having soft bodies, two pairs of similar wings (roof like) along with abdomen and biting mouth parts consisted in this order. A large colony of aphids in the tropics found rarely. Five hundred aphids may demolish by one larva in life, there is no doubt that in natural control of homopterous pests they play major role [2]. Lacewing species are broad habitation and 1200 species are known worldwide. Among these the common species are: *Chrysoperla carnea* (Stephens),*C. plorabunda* (Fitch), *C.*

rufilabris (Burmeister), *C. mediterranea* (Hölzel), *C. oculata* (Say),*C. johnsoni* (Henry , Wells and Pupedis), *C. adamsi* (Henry, Wells and Pupedis), *C. nigricornis*, *C. downesi* (Smith),*C. lucasina* (Lacroix), C. comanche (Banks), *C. Formosa* (Brauer), C .pallens (Rambur),C. mohave (Banks), *C. scelestes* (Banks). *Chrysoperla* spp. *C. lacciperda* (Kimmins) Especially *C. carnea* and *C. rufilabris*, by producers and suppliers these are sold commercially [1] provided for controlling the arthropods insect pest.

The example of the species which are not predacious in adults stage is *C. carnea,* while in some species adults are predators, larval stage is predatory stage [3]. *C. carnea* larvae are commonly known as social predator and also known as aphid lion, generally *C. carnea* eats 100-600 aphids [6]. Lacewing adults generally feed on nectar juice, pollen and honeydew of aphids. Adults of *C. carnea* have pale green to golden or copper-colored eyes about 12-20 mm long antennae. Adults having delicate body, pale green wings which are transparent. *C. carnea* has special characteristics of fluttering flights and mostly they are active at evening and night time [8]. Adults may fly 3 to 4 hours having strong flight urge. Eggs are oval shaped laid singly at the tip of silken stalks, initially pale green, turned grey in 2-3 days. Eggs hatch after 6-7 days. Larvae are active, having three instars, grey or brownish, with well-developed legs. At the time of prey lacewing sucks the body fluid of prey with the help of pincers. Larvae of lacewing grow from less than 1 mm to 6-8 mm. Third mature instar of larvae moves round in silken cocoon in hidden places and pupates inside the cocoons. Lacewing adults emerge in 8 to 10 days. There are two to several generations in a year [10]. Green lacewing, *Chrysoperla carnea* (Stephens) (Chrysopidae: Neuroptera) is considered as predator of soft bodied insects mostly aphid species. Larva of this predator feed on insect eggs, arthropods including mealy bugs, jassids, and caterpillars. It is

used as Bio-control agent [7]. In America and Europe it is mass reared on broad scale as Bio-control agent. Predaceous larvae feed prey through sucking body fluids by sickle shaped mouth parts. Rearing of predator on insect is quiet expensive. Therefore, the need of efforts to develop synthesis diets for *Chrysoperla.*

MATERIALS AND METHODS

The present study was conducted in the Bio-Control Research laboratory, Department of Entomology, Faculty of crop Protection, Sindh Agriculture University, Tandojam to determine the effect of artificial diets on the development of immature stages of *Chrysoperla carnea* (stephens) under laboratory conditions during 2015 at Temperature 26±2 and Relative humidity 65±5 %. In this experiment we find out most suitable artificial diet for mass rearing of immature stage and development period of *C. carnea.*

In this experiment the materials was used i.e. Glass vials, Plastic vials, Beaker, Measuring cylinder, Weight machine, scissor, Hole needle, Camel hair brush, Lobster, Jelly of different flavors, Eggs, Yeast and Electric boiler. The larvae of *Chrysoperla carnea* was obtained from the stock culture of biocontrol laboratory of the Entomology Department. The experiment was Completely Randomized Design (CRD) with ten replications. The artificial diets from jelly of different flavors were prepared according their prescribed procedure and formulas. Five treatments i.e. T_1 = Mango jelly, T_2 = Banana Jelly, T_3 = Pudding T_4 = Mix jelly (Banana jelly 10 g+3 g egg whitish+3g Yeast+80 ml water) and T_5 = Control (eggs of *S. cerealella*). Each larval instar 1st, 2nd and 3rd were released in the ten plastic tubes and ten glasses vials separately and reared on different jelly diets as well as natural diets (eggs of *S. cerealella*). The diets were changed after 24 hrs. The

experiment was conducted at 26±2ºC and 60±5 % RH as reported Ashfaq *et al.,* (2002). The observation was taken daily on the development period and survivor % age of *C. carnea* larvae. The collected data was subjected for statistical analysis by using (Statistix. 8.1) software.

RESULTS

The result presented in Table 1 indicated that first instar of *C. carnea* survived on different artificial diets in plastic tube as well as glass tube. The first instar lived 3.4 ± 1.06 days followed by 3.7 ± 1.11 and 4.2 ± 1.18 days second and third instar larvae reared on diet D_1 in plastic tube. Similarly, the same cohorts was reared on same diet in glass tube it showed that the first instar survived 3.5 ± 1.08 days followed by 3.4 ± 1.06 and 2.3 ± 0.88 days second and third instar larvae, respectively. The third instar no lived longer in both plastic and glass tube and not reached into subsequent pupal stage. The results further showed that the first instar larvae survived 3.2 ± 1.08 days followed by second and third instars 5.1 ± 1.06 and 0.8 ± 0.05 days, respectively, when larvae fed with diet D_2 in plastic tube. In glass tube rearing it was observed that the first instar lived 3.2 ± 1.03 days followed by 4.6 ± 1.24 and 1.1 ± 0.61 days second and third instar larvae, respectively, reared on D_2 diet. The third instar was not survived in both plastic and glass tube and not transform into pupal stage. The results indicated that the first and second instar larvae lived 4.7 ± 1.25 and 2.2 ± 0.86 days, respectively, when larvae fed with diet D_3 in plastic tube. The first and second instar larvae survived 3.5 ± 1.08 and 1.8 ± 0.77, respectively, on D_3 diet. In this diet second instar not transformed into next subsequent stages in plastic as well as glass tubes. The results further revealed that the first instar larvae of *C. carnea* survived 3.6 ± 1.10 days followed by second and third instars 7.0 ± 1.53 and 2.2 ± 0.86 days, respectively,

when larvae reared on diet D_4 in plastic tube. Similarly, the larval instars reared in glass tube displayed that the first instar survived 3.7 ± 1.11days followed by second and third instar larvae 6.2 ± 1.44 and 0.6 ± 0.45 days, respectively, when fed with D_4 diet. The third instar

Table 1 Mean development time (days) of first instar of *C. carnea* on different diets.

Diets	Life stages	Plastic tube	Glass tube
D_1	1st instar	3.4±1.06	3.5±1.08
	2nd instar	3.7±1.11	3.4±1.06
	3rd instar	4.2±1.18	2.3±0.88
	Pupa	0±0.00	0±0.00
D_2	1st instar	3.2±1.08	3.2±1.03
	2nd instar	5.1±1.06	4.6±1.24
	3rd instar	0.8±0.88	1.1±0.61
	Pupa	0±0.00	0±0.00
D_3	1st instar	4.7±1.25	3.50±1.08
	2nd instar	2.2±0.86	1.80±0.77
	3rd instar	0±0.00	0.00±0.00
	Pupa	0±0.00	0.00±0.00
D_4	1st instar	3.6±1.18	3.7±1.11
	2nd instar	7±1.53	6.2±1.44
	3rd instar	2.2±0.86	0.6±0.45
	Pupa	0±0.00	0±0.00
D_5 (control)	1st instar	2.5±0.91	2.8±0.97
	2nd instar	2.3±0.88	3.4±1.06
	3rd instar	3.8±1.13	2.3±0.88
	Pupa	1.8±0.77	5.3±1.33

was not survived more cause death in both plastic and glass tube. The results further indicated that the first instar larvae survived 2.5 ± 0.91 days followed by second 2.3 ± 0.88, third instar 3.8 ± 1.13 and pupa 1.8 ± 0.77 days, respectively, reared on diet D_5 in plastic tube. Similarly, glass tube rearing showed the survival of first instar 2.8 ± 0.97 days followed by second instar 3.4 ± 1.06, third instar 2.3 ± 0.88 and pupa lived 5.3 ± 1.33 days when larvae fed with diet D_5. It was found that in the 1st instar larval instar survival on artificial diets displayed

that the longest development was recorded in the artificial diet D_4 followed by D_1, D_2 and D_3, respectively. Whereas, the lowest development was observed on diet D_5 (Control). The larval instar lived longer in the plastic tube and shortest in the glass tube on all diets, whereas, pupa lived longer in glass tube as compare to plastic tube reared on D_5 (Control). The analysis of the results showed that there is significant difference in the development period of larval instars and pupal stages when reared on different diets ($P<0.05$).

Rearing of second instar larva of *Chrysoperla carnea* on different diets.

The result depicted in Table 2 displayed the development period of second instar larva of *C. carnea* reared on different artificial diets in plastic and glass tube. The second instar larva lived 3.8 ± 1.13 and third instar 6.80 ± 2.37 days reared on diet D_1 in plastic tube. Similarly, the in glass tube it showed that the second and third larval instars lived 3.2 ± 1.39 and 5.2 ± 1.70 days, respectively, reared on D_1 diet. The third instar not transformed into subsequent next stage in both plastic and glass tube. The results further indicated that the second instar larvae lived 5.8 ± 1.39 days and third instar 7.3 ± 1.70 days reared on diet D_2 in plastic tube. In glass tube rearing it was observed that the second instar lived 4.3 ± 1.20 days and third instar larva was observed 5.9 ± 1.14 days reared on D_2 diet. The third instar was not survived in both plastic and glass tube and not transform into pupal stage. Furthermore, it was observed that

Table 2 Mean development time (days) of second instar larvae of *C. carnea* on different diets.

Diets	Life stages	Plastic tube	Glass tube
D_1	2nd instar	3.80±1.13	3.2±1.39
	3rd instar	6.80±2.37	5.2±170
	Pupa	0.00±0.00	00±0.00
D_2	2nd instar	5.80±1.39	4.30±1.20
	3rd instar	7.30±1.70	5.90±1.14
	Pupa	0.00±0.00	0.00±0.00
D_3	2nd instar	4.20±1.60	3.45±1.02
	3rd instar	3.70±1.11	2.63±0.60
	Pupa	0.00±0.00	0.00±0.00
D_4	2nd instar	6.3±1.20	5.4±1.21
	3rd instar	4.2±1.48	3.8±1.68
	Pupa	0±0.00	0±0.00
D_5 (control)	2nd instar	3.4±1.21	4.1±1.17
	3rd instar	4.8±1.26	3.1±1.06
	Pupa	3.3±0.88	4.7±1.25

second and third instar larvae lived 4.2 ± 1.60 and 3.7 ± 1.11 days, respectively, when larvae fed with diet D_3 in plastic tube. In the plastic tube showed that the second instar larvae lived 3.45 ± 1.02 and third instar larva 2.63 ± 0.61 reared on diet D_3. The same observation was recorded that the third instar not transformed into next subsequent stages in plastic as well as glass tubes. The results displayed that the second and third instars survived 6.3 ± 1.20 and 4.2 ± 1.48 days, respectively, fed on diet D_4 in plastic tube. In glass tube rearing the second and third instar larvae lived 5.4 ± 1.21 and 3.8 ± 1.68 days, respectively, larvae reared on D_4 diet. The third instar was not transformed into next subsequent stage of *C. carnea*. The results further depicted that second instar larva lived 3.4 ± 1.21 and third instar 4.8 ± 1.26 and pupa lived 3.3 ± 0.88 days, respectively, when fed with diet D_5 in plastic tube. Similarly, the larvae reared into glass tube showed the second instar lived 4.1 ± 1.17 days, third instar 3.1 ± 1.06 and pupa lived 4.7 ± 1.25 days when larvae reared on diet D_5. It was observed that in the 2nd instar larval survival was displayed the maximum

development period on the artificial diet D_2 followed by D_4, D_1 and D_3, respectively. However, the lowest development was recorded on diet D_5 (Control). The maximum development was seen in the plastic tube and minimum in the glass tube fed on all artificial diets. Therefore, pupal stage survived longest in glass tube and lowest in plastic tube on diet D_5 (Control). The analysis of variance of present results indicated that there is development period of larval instars and pupal stages significantly different when fed with different diets ($P<0.05$).

Rearing of third instar larva of *Chrysoperla carnea* on different diets.

The result described in Table 3 showed that the development time of third instar larvae of *C. carnea* fed with artificial diets in plastic as well as glass tube. The results indicated that third instar larvae lived 7.8 ± 1.81 days after that it transform successfully into next subsequent stage pupa lived 3.0 ± 0.82 days when fed with diet D_1 in plastic tube. However, the third larval instars lived 5.8 ± 2.24 and pupa survived 2.6 ± 0.63 days, reared on D_1 diet in glass tube. The results of present study indicated that the third instar larvae lived 8.4 ± 2.48 days reared on diet D_2 in plastic tube. Whereas, the glass tube rearing showed that third instar larva survived 7.7 ± 1.60 days fed with diet D_2 diet. The third instar was not survived further in both plastic and glass tube and not transform into pupal stage. Moreover, it was observed that third instar larvae survived 7.1 ± 1.76 and pupa lived 2.5 ± 0.71 days, when larvae reared on diet D_3 in plastic tube. In the glass tube reared third instar larvae lived 6.12 ± 1.97days and pupa showed 1.97 ± 0.55 fed with diet D_3. The results further revealed that third instar larvae lived 6.6 ± 1.88 and pupae developed adult after 3.2 ± 0.63 days when fed with diet D_4 in plastic tube. The similar diet was provided in glass tube third instar larvae survived 5.1 ± 1.83 days on D_4 diet. The third instar larva was not transformed

into subsequent stage. The results depicted that third instar lived 5.4 ± 1.34 and pupa lived 2.5 ± 0.91 days reared on diet D_5 in plastic tube. In the glass tube rearing it displayed that third instar lived 4.7 ± 1.25 and pupa 5.1 ± 1.30 days when fed on diet D_5. The findings of present result indicated the 3rd instar larval lived longer when fed with artificial diet D_2 followed by D_1, D_3 and D_4, respectively. Therefore, the lowest development time was observed on diet D_5 (Control). Furthermore, it was also defined that plastic tube reared larvae passed maximum time in development as compare to glass tube on all artificial diets. The analysis of variance showed that there is significant difference in the larval and pupal development when reared on different diets (*P<0.05*).

Table 3 Mean development time (days) of third instar larvae of *C. carnea* on different diets.

Diets	Life stages	Plastic tube	Glass tube
D_1	3rd instar	7.80±1.81	5.8±2.24
	Pupa	3.00±0.82	2.6±0.63
D_2	3rd instar	8.40±2.48	7.70±1.60
	Pupa	0.00±0.00	0.00±0.00
D_3	3rd instar	7.10±176	6.12±197
	Pupa	2.50±0.71	1.97±0.55
D_4	3rd instar	6.60±1.88	5.10±1.83
	Pupa	3.20±0.63	0.00±0.00
D_5 (control)	3rd instar	5.4±1.34	4.7±1.25
	Pupa	2.5±0.91	5.1±130

Survival percentage of first instar larva of *Chrysoperla carnea* on different diets.

The result further revealed that Fig.1 indicated that in first instar larval development period the highest survivor % was recorded in the first instar (90.0%), second instar (82.0%), third instar (78.0%) and pupa (75.0%) in plastic tube rearing on D_5 (control), whereas, in glass tube rearing on same diet this showed that survivor % of first instar (95.0%), second instar (85.0%), third instar (81.0%) and pupa (76.0%). In all artificial

diets showed that maximum survivor % of larvae of *C. carnea* was obtained in first instar followed by second and third instar, respectively. Third instar not survivor more and found unable to transform in the subsequent stage.

Survival percentage of second instar larva of *Chrysoperla carnea* on different diets.

The result presented Fig.2 displayed that in second instar larval development period, the highest survivor % was observed the second instar (85.0%), third instar (80.0%) and pupa (76.0%) in plastic tube fed on diet D_5 (control), while, in glass tube rearing on same diet it indicated that survivor % of second instar (80.0%), third instar (74.0%) and pupa (72.0%). The results further revealed that the maximum survivor % of larvae of *C. carnea* was found in second and third instar when fed with artificial diets. This study also showed that third instar not survived more to transform into next subsequent stage.

Survival percentage of third instar larva of *Chrysoperla carnea* on different diets.

The result described in Fig. 3 displayed that during the development of third instar larval, the highest survivor % was found in third instar (90.0%) and pupa (86.0%) in plastic tube when larvae reared on diet D_5 (control), while, in glass tube rearing on same diet this showed that survivor % of third instar (88.0%) and pupa (81.0%). Furthermore, it was observed that the maximum survivor % of third instar larvae of *C. carnea* was found when reared on artificial diets. However, maximum survival % of pupa was recorded on diet D_1 followed by D_3 and D_4, respectively. Therefore third instar reared on diet D_2 was not to transform into next stage.

Fig. 1 Survival percentage of first instar larvae of *C. carnea* reared on artificial diets

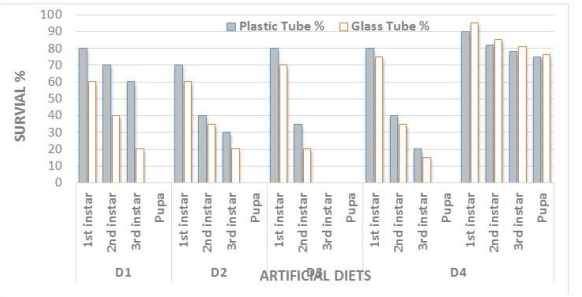


Fig. 2 Survival percentage of second instar larvae of *C. carnea* reared on artificial diets

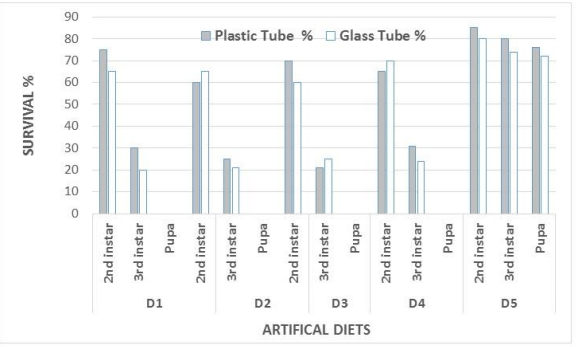
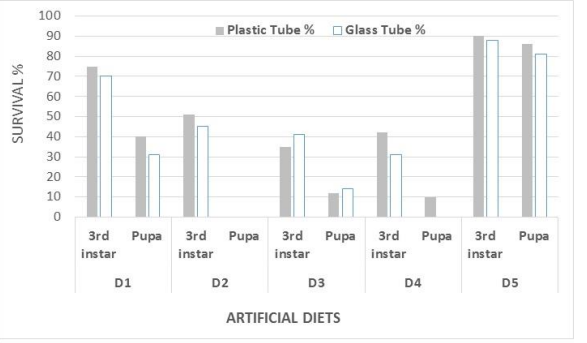


Fig. 3 Survival percentage of third instar larvae of *C. carnea* reared on artificial diets



DISCUSSION

The findings of present study indicated that 1st instar larval instar rearing on artificial diets displayed that the longest development was recorded in the artificial diet D_4 followed by D_1, D_2 and D_3, respectively. Whereas, the lowest development was observed on diet D_5 (Control). The larval instar lived longer in the plastic tube and shortest in the glass tube on all diets, whereas, pupa lived longer in glass tube as compare to plastic tube reared on D_5 (Control). The results further revealed that in the 2nd instar larval survival was displayed the maximum development period on the artificial diet D_2 followed by D_4, D_1 and D_3, respectively. However, the lowest development was recorded on diet D_5 (Control). The maximum development was seen in the plastic tube and minimum in the glass tube fed on all artificial diets. Therefore, pupal stage survived longest in glass tube and lowest in plastic tube on diet D_5 (Control). The findings of present result indicated the 3rd instar larval lived longer when fed with artificial diet D_2 followed by D_1, D_3 and D_4, respectively. Therefore, the lowest development time was observed on diet D_5 (Control). Furthermore, it was also defined that plastic tube reared larvae passed maximum time in development as compare to glass tube on all artificial diets. The result further depicted that the highest survivor % was recorded in the first, second, third instar and pupa reared in plastic and glass tube on diet D_5 (control). The maximum survivor % of larvae of *C. carnea* was obtained in first instar followed by second and third instar, respectively reared on artificial diets, while third instar not survivor more and found unable to transform in the subsequent stage. Furthermore, it was observed that the maximum survivor % of third instar larvae of *C. carnea* was found when reared on artificial diets. However, maximum survival % of pupa was recorded on diet D_1 followed by D_3 and D_4, respectively. Therefore third instar

reared on diet D_2 was not to transform into next stage. The findings of present study have more or less conformity with those of [9] reared 10 generations on larval semi-synthetic diets containing egg yolk (32.3%), honey (16.1%), soybeans hydrolyzed powder (1.3%), water (38.7%), yeast extract (1.3%), petroleum jelly (0.7%) and paraffin wax (9.6%). Larval developmental period was recorded longer on semi-synthetic diet than on *C. cephalonica* eggs. There were two different means of *C. carnea* reared on semi-synthetic diet and *C. cephalonica* eggs were 56.7 and 82.5%, respectively. As *C. carnea* was developed, food consumption was also increased. First larval stage of *C. carnea* fed more on *Aphis gossypii* nymph, sterilized eggs of *C. cephalonica* than on *H. armigera* 54.05, 53.90 and 43.05, respectively. [4] evaluated the different biological parameters on adult diet of *C. carnea*. (A) pollen grains + honey distilled water, (B) honey distilled water, (C) royal jelly and pollen grains + honey distilled water and (D) royal jelly + honey distilled water. The overall results of egg hatching, larval survival rate, pupal survival rate, adult emergence and overall developmental period from egg to adult (89.3%, 92.6%, 95.1%, 98.1% and 77%) were observed in treatment (D), respectively. Pre-ovipositional period, long-ovipositional period and shortest total development duration (3.6, 14, and 19.3 days) were recorded on treatment (D), respectively. Highest values of net reproductive rate, intrinsic rate of natural increase, and finite rate of increase were also recorded on treatment (D). [5] reported that Crysoperla is predator of soft bodied insect pests. Therefore, *C. carnea* was reared on artificial diets to compare with natural diets. *Aphis craccivora* and eggs of Corcyra cephalonica were used as artificial diet. Artificial diets having some composition were used, in diet 1 (eggs and ginger) and in diet 2 (chemical antimicrobials and egg yolk). The predator population was significantly higher in diet 1, as compare to diet 2. On diet 2

higher pupal period was observed. In the head capsule and in body length there were no significant. IN the third instar body length was higher with diet of *C. cephalonica* eggs. Whereas, the emergence % of adult no difference were found in both diets. Therefore, diet 1 is suggested for rearing due to significantly higher population.

CONCLUSION

First and second larval instars of *C. carnea* were survived separately on artificial diets in less numbers but after third instar it was not transformed into subsequent stage. Third instar larvae were successfully reared on artificial diets and transformed into pupation only reared on D_1, D_3 and D_4, respectively. The highest survival % of 1^{st}, 2^{nd}, 3^{rd} and pupae were recorded when reared on diet D_5 (control) as compare to artificial diets. The larval instars lived shorter when reared in glass tube as compared to plastic tube.

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