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Evaluating the suitable artificial diet for rearing of the green lacewing adult *Chrysoperla carnea* (Stephens, 1836) (Neuroptera: Chrysopidae) under Laboratory Conditions

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Abstract: The common green lacewing, *Chrysoperla carnea* (Stephens, 1836) is best-known as bio-control agent. It is mass reared and released for biological control programs against sucking insect pests in Agricultural crops. A laboratory experiment was conducted to evaluate the artificial diets for the rearing of *C. carnea* was conducted in bio-control laboratory at Nuclear Institute of Agriculture, Tandojam. Different solution concentration of diets i.e.; Brewer yeast, Protein hydrolysate, Honey and Sugar were formulated at different (1, 2, 3, 4 and 5 grams) solution concentration with 20 ml water were offered to newly emerged *C.carnea* adults inside the four liter glass jars to observe different biological parameters. The shortest pre- oviposition period (3.5±0.09c) was recorded on brewer yeast 4 grams then, 2 3 and 5 grams followed by Protein solution and Honey solution whereas; longest pre-oviposition period (4.9±0.36a) was recorded on 1 gram Sugar solution. Moreover, significantly highest ($P \leq 0.05$) fecundity and fertility (215.6±6.18a, 194.2±5.55a) respectively were observed on 4 gram brewer yeast then 2, 3 and 5 grams followed by Protein solution and Honey solution. The longest longevity of *C.carnea* female and male 49.3±2.34a and 39.0±2.08a) respectively was recorded on 4 gram brewer yeast then 2, 3 and 5grams followed by Protein solution, Honey solution., whereas, shortest longevity of female and male (14.6.±1.67cd and 9.6±1.33d) respectively was observed on 1 gram sugar solution. The shortest incubation, larval and pupal duration (3.0±0.33d, 13.3± 0.48d and 4.1±0.10 c) respectively was recorded on 4 gram brewer yeast then 2, 3 and 5 grams, followed by Protein solution, Honey solution. The longest incubation, larval and pupal duration (4.95±1.20 a, 15.9± 1.50a and 6.7±0.80a) was observed on 1 gram Sugar solution The findings of this study can significantly persuade the better and cheapest artificial diet ingredients for the adult rearing of this predator in the laboratory and brewer yeast is very cheapest having significant role in adult rearing of *C. carnea*.

Keywords: Diet, *Chrysoperla carnea*, Incubation, Longevity, Fecundity

1. INTRODUCTION

Green lacewing, *Chrysoperla carnea* (Stephens) (Chrysopidae: Neuroptera) is an effective predator of soft bodied insects such as aphids, thrips, mealy bugs, immature white flies and small caterpillars and eggs as well. This is not predacious in adult stage feed only on pollens, nectar and aphid honey dew. The rearing of *Chrysoperla* adults on natural host is difficult and expensive because it involves added complexities and expenses of rearing of seasonality of host plants and host /prey arthropods further complicate efforts to produce the biological with natural or factitious host/prey (Cohen (1992) The effect of different diets i.e, concentrations of glucose, fructose and sucrose plus extract of the grain moth *Sitotroga cerealella* (Olivier, 1789) eggs, glucose, fructose, sucrose plus extract of the flour moth *Anagasta Kuehniella* (Zeller, 1879) eggs , mixture of honey, yeast and distilled water , honey, yeast plus extract of *S. cerealella* eggs and honey, yeast plus extract of *A. kuehniella* eggs was studied on Pre oviposition, oviposition and post-oviposition period, longevity of males and females, fecundity, egg hatchability. The mixture of honey, yeast and extract of *A. kuehniella* eggs influenced the biological traits of the predator more effectively than all other diets (Hassan *et al;* 2014) Three adult artificial diets i.e; water: honey: yeast, water: sugar: yeast and water: gur: yeast containing different grams were tested for rearing of *C. carnea* .adults in the laboratory .Investigations were recorded on reproductive phase i.e pre-oviposition period, oviposition period and post-oviposition period was recorded on D4, D9 and D1 respectively. The highest fecundity, larval, pupal survival and adult longevity were recorded on adults fed on D9. (Balouch *et al* .2016). The artificial adult food supplements comprising yeast products, sugar and water significantly influenced oviposition period, post oviposition period and fecundity of females which can be important for mass rearing program and results in the economic breakdown of costs for the production of this predator (McEwen *et al* .1999). The artificial die would not only be useful to produce bio-control agents but are also helpful for continuous production throughout the year; this would be helpful to manage the agricultural and green houses pests (Hunter 1994). Different workers reported several artificial adult diets to fecundity, fertility and adult longevity of the *C. carnea*. But due to expensive ingredients and management at large scale

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production in the laboratories is difficult. Therefore, they got sufficient results in augmentative rearing programme. The present study was undertaken to develop brewer yeast was cheapest and easily available in local markets as adult artificial diet for mass rearing of *C. carnea*. to meet the augmentative -requirement of insect pest management programme.

2. MATERIALS AND METHODS

The experiment was set in the bio-control laboratory at Nuclear Institute of Agriculture, Tandojam. Different formulations of artificial diets i.e; Brewer yeast, Protein hydrolysate, Honey solution and Sugar solution were tested for the adult rearing of *C. carnea* (**Table 1).** Newly emerged five pairs of adults, each were kept in glass chimneys and maintained in the laboratory at temperature (25± 2ºC, RH 60±10 % and lightening regime 16L: 8D). The different recipes of adult artificial diet were prepared and provided to adults in glass chimneys; diet was applied twice a day in the form droplet on white paper cards with the help of camel hairbrush. For water feeding clinical vial containing cotton plug dipped in water is placed in the center of each chimney. The experiment was replicated four times. Daily observations on Pre-oviposition, oviposition period, fecundity, fertility, pupal recovery, adult emergence, incubation, larval, pupal duration and adult longevity was recorded.

Table- 01.Composition of different adult diets of *Chrysoperla* carnea

S.No.	Ingredients	Diet No.1 (gram)	Diet No.2 (gram)	Diet No.3 (gram)	Diet No.4 (gram)	Diet No.5 (gram)
1	Brewer's Yeast	1 .0	2.0	3.0	4 .0	5.0
2	Protein Hydrolysate	1 .0	2.0	3 .0	4.0	5.0
3	Honey solution	1.0	2.0	3.0	4.0	5.0
4	Sugar solution	1.0	2.0	3.0	4.0	5.0
------	Water (ml)	20.0	20 .0	20 .0	20 .0	20.0

3. DATA ANALYSIS:

The data of all tested parameters were subjected by the statistix software version 8.1, Analytical software.

4. RESULTS:

Pre-oviposition of *Chrysoperla carnea*

The diets and solution concentrations were significantly affect the pre-oviposition period of *C. carnea* **(Fig-1).** The shortest pre-oviposition period i-e (3.5±0.09) was noted on brewer yeast at 4 g solution followed by protein solution, honey solution and sugar solution, respectively, then 2, 3 and 5 gram solutions whereas, the largest pre-oviposition period (4.5±0.22a) were recorded at 1g sugar solution.

Oviposition of *C. carnea*

Oviposition period of *C. carnea* was highly affected with diets, concentrations and variation in concentrations **(Fig-2).**The longest oviposition period i-e (41.6±2.08) was noted on brewer yeast at 4 g solution followed by protein solution, honey solution and sugar solution then 2, 3 and 5 gram solutions concentrations whereas, the shortest oviposition period i-e (17.3±1.16d) were recorded on sugar at 1g solution concentration.

Fecundity of *C. carnea*

The fecundity/ number of eggs laid by female C. *carnea* were significantly influenced with different diet and solution concentrations **(Fig-3).**The maximum fecundity i-e (215.6±6.18) was recorded in Brewer yeast at 4 g solution followed by Protein solution, Honey solution and Sugar solution then 2, 3 and 5 gram solution concentrations and the lowest fecundity i-e (66.3±2.85e) recorded in Sugar at 1g solution concentration. The fertility of C. *carnea* was affected with diet and solution concentrations **(Fig-4).**The maximum fertility was recorded in all diets at 4 g solution. In case of BY, PS, HS and SS the highest fecundity was (194.2±5.55, 116.0±4.59, 102.6±1.20 and 91.3±2.34), respectively were recorded at 4 gram solution concentration. However, the lowest fertility 52.6±3.85, 49.6.±1.00, 46.0±1.53 and 33.6±1.33 days were observed at 1g solution concentration. In overall compression of artificial diets the highest fertility i-e (194.2±5.55) was noted at 4 g BY, whereas, the lowest (33.6±1.33) was observed on 1g SS.

Pupal recovery of *C. carnea*

The pupal recovery of *C. carnea* .was also significantly affected with diet and solution concentrations **(Fig-5).** The highest pupal recovery was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the highest number of pupae 175.0±4.94, 90.6±3.72, 75.6±2.73 and 64.6±2.08 respectively were recorded at 4 gram solution concentration. However, the lowest pupal recovery i-e 45.0± 1.53, 24.0.±1.45, 26.6±1.20 and 18.0±0.67 days were observes at 1g solution concentration. In overall comparison of artificial diets the maximum pupae (175.0±4.94) was noted at 4 g BY while, the minimum pupae was (18.0±0.67) was noted on 1g SS.

Adult emergence of *C. carnea*

The adult emergence of C. *carnea* .was significantly influenced with diet and solution concentrations **(Fig-6).** The maximum adult emergence was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the highest number of adult emergence 157.3±4.64, 70.6±2.73, 56.3±2.61 and 46.0±2.08

respectively, were recorded at 4 gram solution concentration whereas, the lowest adult emergence i-e 26.6± 1.45, 17.0±1.00, 15.3±1.16 and 10.6±0.88 days were observed at 1g solution concentration. In overall comparison of artificial diets the maximum adult emergence (157.3±4.64) was noted at 4 g BY, while, the minimum pupae was (10.6±0.88) was noted on 1g SS.

Longevity of female *C. carnea*

Longevity of female *C. carnea* (in days) was significantly influenced with diets and solution concentrations **(Fig-7).** The longest longevity of female was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the longest longevity 49.3±2.34, 43.3±2.19, 38.3±2.03 and 31.0±2.34 days respectively were recorded at 4 gram solution concentration whereas, the shortest longevity of female i-e 20.3±1.20, 16.3±1,16, 17.6±1.00 and 14.6±1.67 in days were observesd at 1g solution concentration. In overall comparison of artificial diets the longest *C.carnea* female longevity (49.3±2.34) days was noted at 4 g BY, whereas, the shortest female longevity (14.6±1.67) was noted on 1 g SS.

Longevity of male *C.carnea*

Male longevity of C. *carnea* (in days) was significantly affected with diets and solution concentrations **(Fig-8)**. The longest longevity of male was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the longest longevity 39.0±2.08, 36.0±2.41, 33.0±2.41 and 25.0±2.19 days respectively were recorded at 4 gram solution concentration whereas, the shortest longevity of male 12.6±1.20, 11.0±1.00, 11.0±1.55 and 9.6±1.33 in days were observesd at 1g solution concentration. In overall comparison of artificial diets the longest *C.carnea*. male longevity (39.3±2.08) days was noted at 4g BY and shortest male longevity was (9.6±1.33) on 1g SS.

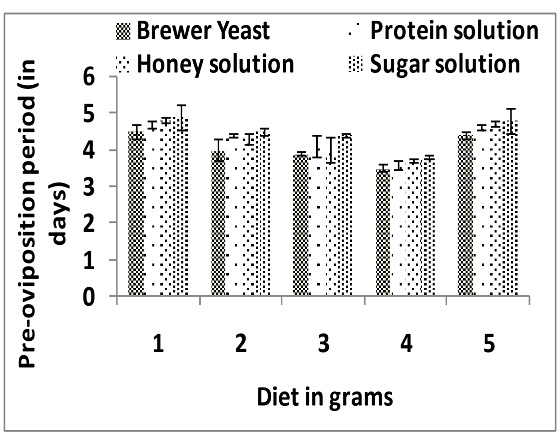

Fig-01.Pre-oviposition period (in days) of *C.carnea* female

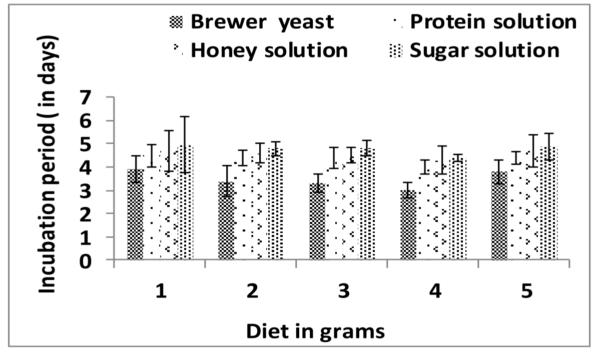

Fig-2.Oviposition period (in days) of *C.carnea* female

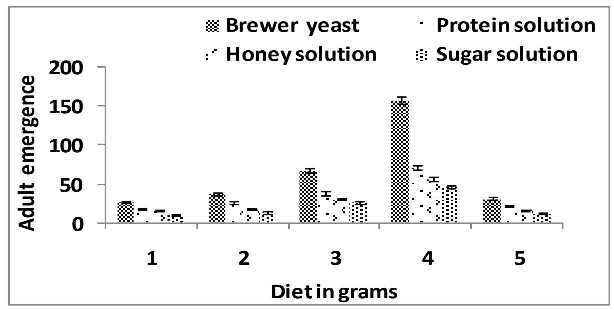

Fig-3.Fecundity /No. of eggs laid by *C.carnea* female

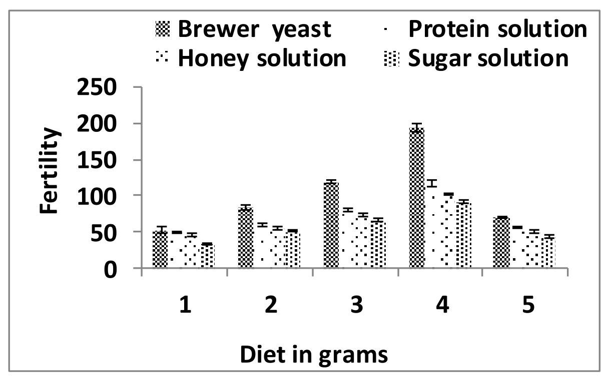

Fig-4 .Fertility of eggs laid by *C.carnea* female

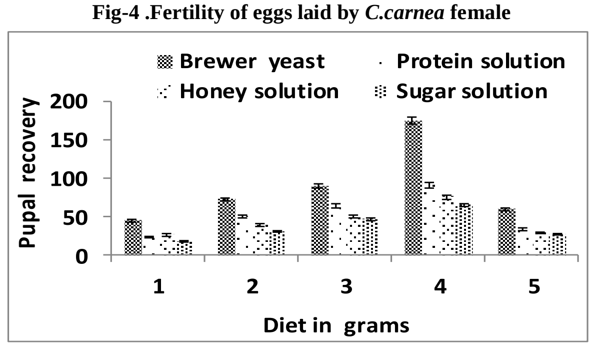

Fig- 5. No. of Pupae recovered of *C.carnea*

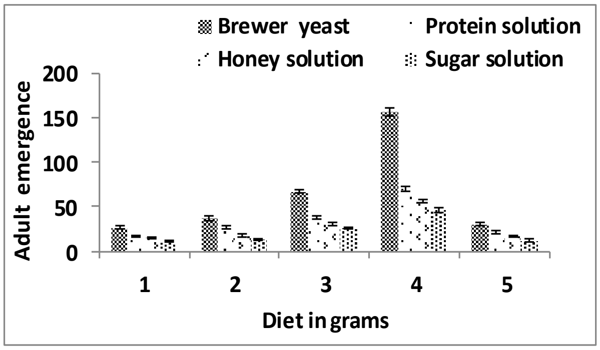

Fig-6. No. of adult emerged of *C.carnea*

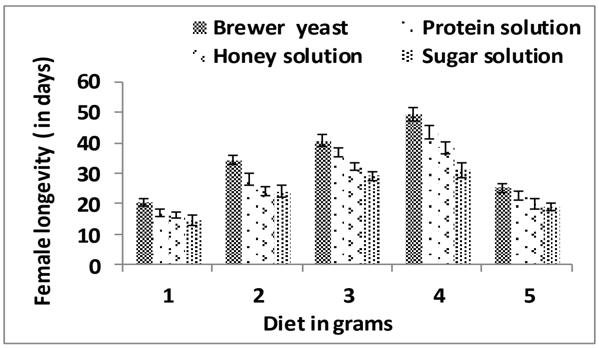

Fig-7. Female longevity (in days) of *C.carnea*

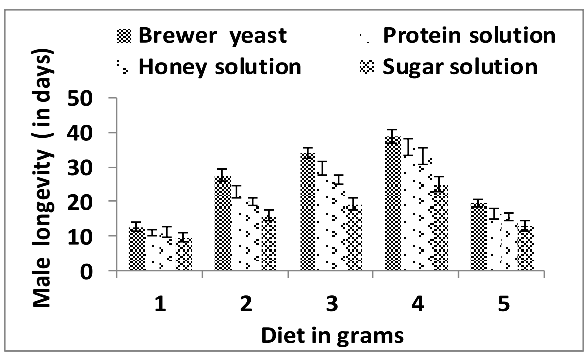

Fig-8. Male longevity (in days) of *C.carnea*

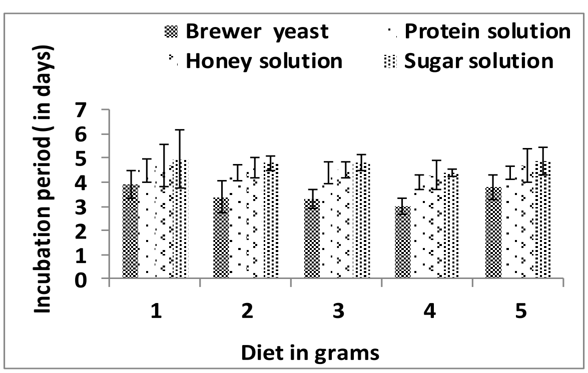

Fig-9. Incubation period (in days) of *C.carnea* female

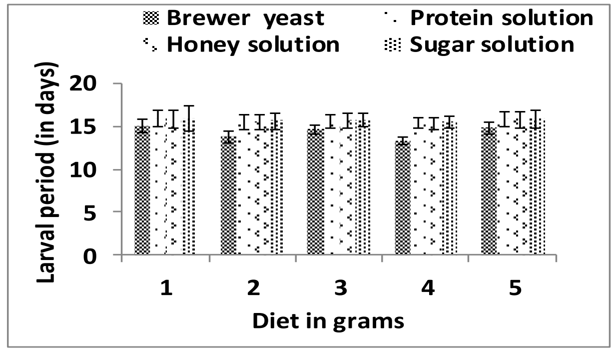

Fig-10. Larval period (in days) of *C.carnea*

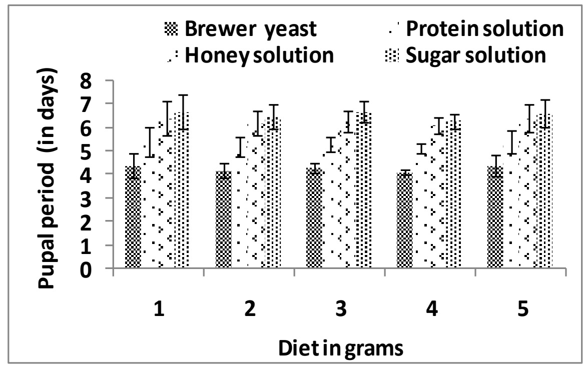

Fig-11 Pupal period (in days) of *C.carnea*

Incubation period of *C.carnea*

Incubation period of *C.carnea* .eggs was significantly influenced with diets and solution concentrations **(Fig-9).** The shortest incubation period was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the shortest incubation period 3.0±0.33, 4.0±0.29 , 4.3±0.61 and 4.39±0.16 days respectively were recorded at 4 gram solution concentration whereas, the longest incubation period i-e 3.8±0.58, 4.5.0±0.49, 4.7±0.88 and 4.95±0.120 in days were observesd at 1g solution concentration. In overall comparison of artificial diets the shortest incubation period of *C.carnea* .eggs was (3.0±0.33days) at 4 g BY while longest incubation period was (4.95±1.20) on 1 g SS.

Larval period of *C.carnea*

The larval period of *C.carnea* was significantly affected with diets and solution concentrations **(Fig-10).** The shortest larval period was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the shortest larval period 13.3±0.48, 15.4±0.65, 15.3±0.75 and 15.5±0.69 days respectively were recorded at 4 gram solution concentration whereas, the longest larval period 15.0±0.78, 15.6±0.89, 15.8±0.96 and 15.9±1.50 in days were observed at 1g solution concentration. In overall compression of artificial diets the shortest larval period i-e (13.3±0.48d) days was noted at 4 g BY and longest larval period was (15.9±1.50a) on 1 g SS.

Pupal period of *C.carnea*

The shortest pupal period was noted in all diets at 4 g solution. In case of BY, PS, HS and SS the shortest pupal period i-e 4.1±0.10, 5.1±0.21, 6.1±0.32 and 6.3±0.41 days respectively were recorded at 4 gram solution concentration whereas, the longest pupal period i-e 4.4±0.50, 5.4±0.60, 6.4±0.72 and 6.7±0.80 in days were observed at 1g solution concentration and shortest pupal period i-e (4.1±0.10c) days was noted at 4 g BY with longest pupal period was (6.7±0.80) on 1 g SS. **(Fig-11)**.

5. DISCUSSION

The artificial diets are widely used for the production of *Chrysoperla carnea* (Stephens, 1836) under laboratory conditions and released against population suppression of sucking insect pests in the crop filed. (Abdel-Samad and Salwa 2011). Our investigations on artificial diets i.e brewer yeast, Protein solution, Honey solution and Sugar solution at different grams (1, 2, 3,4 and 5) were tested that significantly affected the biology of *C.carnea* from egg to adult. The shortest pre- oviposition period in days was recorded on brewer yeast 4 grams solution concentration then 2,3 and 5 grams solution concentration followed by Protein solution and Honey solution. The longest pre-oviposition period was recorded on 1 gram Sugar solution concentration. Among the oviposition period longest period in days was observed on 4 gram brewer yeast then 2, 3 and 5 gram solution concentration followed by Protein solution and Honey solution. The shortest oviposition period in days was recorded on 1 gram sugar solution concentration. Tesfaye *et al.* (2002) repotted that honey solution, castor pollens and yeast at 50% combination for adult food supplements significantly influenced oviposition period, post-oviposition period while having no significant effects on pre oviposition period and longevity of *C. carnea*. The highest fecundity and fertility was also recorded on 4 gram brewer yeast solution concentration then 2,3 and 5gram concentration followed by Protein solution and Honey solution. Then female fed on 1 gram Sugar solution. Geetha *et al.* (1998) also reported that the yeast and vitamin affected on fecundity and fertility of *C. carnea*. According to the Carvalho *et al* (1996) females of *Chrysoperla* fed on yeast + honey (1:1) had greater fecundity than those fed on other diets, therefore enhanced the fecundity of *C. carnea* females when reared on yeast, protein hydrolysate. The maximum pupal recovery, adult emergence and adult longevity female and male was noted on 4 gram brewer yeast solution concentration then 2, 3 and 5 gram solution concentration followed by Protein solution and Honey solution .while minimum pupal recovery, adult emergence and adult longevity female and male was noted when female fed on 1 gram Sugar solution concentration . The shortest incubation, larval and pupal duration in days was recorded on female fed on 4 gram brewer yeast solution concentration then 2, 3 and 5 gram concentration followed by Protein solution and Honey solution. Neethu Nandan (2014) tested three adult diets yeast extracr, casein, honey , sugar and distilled water in the laboratory conditions the parameters were fecundity ,larval period, pupal period and adult longevity. He investigated the mixture of egg yolk, milk and honey was better than all other diets. In our study the enriched artificial diet i.e. especially brewer yeast is cheapest and easy to manage for providing necessary nutrition for adult maturation and fecundity of *C.carnea* .for laboratory rearing. All these reports are in conformity with the present investigation.

6. CONCLUSION

On the basis of findings of study it is concluded that the overall developmental performance of *C. carnea* was observed on 4 gram brewer yeast used for adult artificial diet reared under laboratory conditions.

ACKNOWLEDGEMENTS

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Table -1.Effect of different adult artificial diets on the Pre-oviposition and oviposition period of female *C.carnea* under laboratory conditions

Diets In (g)	Pre-oviposition period (In days) (Mean± SE)				Oviposition period (In days) (Mean± SE)			
	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution	Brewer Yeast	Protein solution	Honey Solution	Sugar Solution
1	4.5±0.22 a	4.7±0.09a	4.8±0.06a	4.9±0.36 a	29.0±1.20 e	25.3±0.88 e	19.0±0.58e	17.3±1.16d
2	4.0± 0.30 b	4.4 ±0.06b	4.3 ±0.15b	4.5±0.04bc	35.0±0.58 c	30.0±1.58 c	25.3±1.45c	22.0±1.20c
3	3.9±0.06bc	4.1±0.29c	4.0± 0.35c	4.4±0.05c	39.0±1.16 b	35.0±2.08 b	29.0±1.53b	26.0±1.00b
4	3.5±0.09 c	3.6 ±0.13d	3.7±0.05d	3.8±0.04d	41.6±2.08 a	38.0±1.16a	33.0±1.20a	30.0±0.58 a
5	4.4±0.03ab	4.6±0.07ab	4.7±0.08ab	4.8±0.33 ab	31.0±0.88 d	28.0±1.45d	22.0±1.16d	18.0±0.33cd

Table -2. Effect of different adult artificial diets on the Fecundity and Fertility of *C.carnea* under laboratory conditions

Diet in (g)	Fecundity (Mean ±SE)				Fertility (Mean ±SE)			
	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution
1	76.0±3.39 e	83.0 ±2.31e	79.3±2.85e	66.3±2.85e	52.6±3.85e	49.6±1.00e	46.0±1.53e	33.6±1.33e
2	136.3±14.76c	110.6±3.06c	98.0±1.73 c	95.0±5.87c	84.3±3.79c	59.3±2.41c	55.0±1.45c	51.0±1.20c
3	171.3±7.54b	130.6±2.03b	112.3±1.45b	106.6±1.77b	120.0±2.31b	80.3±3.06b	73.3±2.08b	67.0±2.08b
4	215.6±6.18a	149.0±5.57a	139.0±153a	128.6±3.18a	194.2±5.55a	116.0±4.59a	102.6±1.20a	91.3±2.34a
5	106.3±3.85d	93.6±1.20d	88.3±0.88 d	80.3±7.24d	70.3±1.45d	56.3±1.20cd	51.0±2.19d	43.6±1.67d

Diets in (g)	Pupal recovery (Mean±SE)				Adult emergence (Mean±SE)			
	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution
1	45.0±1.53 e	24.0±1.45 e	26.6±1.20e	18.0±0.67 e	26.6±1.45 e	17.0±1.00e	15.3±1.16e	10.6±0.88e
2	72.3± 2.34c	50.0±2.03 c	40.0±1.67 c	31.0±1.00 c	37.0±2.65 c	26.3±1.67c	17.3±1.45 c	13.0±1.20c
3	90.0 ±2.03b	64.0±2.19 b	50.3±2.34b	46.6±1.73 b	67.6±2.08 b	38.0±2.41 b	30.6±1.73b	26.0±1.45b
4	175.0±4.94a	90.6±3.72 a	75.6±2.73 a	64.6±2.08 a	157.3±4.64a	70.6±2.73a	56.3±2.61a	46.0±2.08a
5	60.0± 1.45d	33.3±1.77 d	29.3±1.53d	27.3±0.88 d	31.0±1.73 d	21.3±1.16 d	16.3±1.20d	12.3±1.53d

Table-3. Effect of different adult artificial diets on pupal recovery and adult emergence of *C. carnea* under laboratory conditions

Table-4.Effect of different adult artificial diets on adult longevity of *C.carnea* under laboratory conditions

Diets in (g)	Longevity female (in days) (Mean ±SE)				Longevity male (in days) (Mean ±SE)			
	Brewer Yeast	Protein Solution	Honey solution	Sugar Solution	Brewer Yeast	Protein solution	Honey Solution	Sugar Solution
1	20.3± 1.20e	17.0±1.16 e	16.3±1.00 e	14.6±1.67e	12.6 ±1.20e	11.0±1.00e	11.0±1.53d	9.6±1.33d
2	34.3 ±1.53c	28.0±1.86 c	24.3±1.45 c	24.0±1.86 c	27.6 ±1.77c	23.0±1.73 c	20.0±1.16bc	16.0±1.67c
3	40.6 ±1.86b	37.0±1.45 b	32.0±1.20 b	29.0±1.53b	34.0 ±1.55b	29,.6±2.08b	26.3±1.45ab	19.3±1.77b
4	49.3 ±2.34a	43.3±2.19 a	38.3 ±2.03a	31.0±2.03 a	39.0±2.08a	36.0±2.41 a	33.0± 2.41a	25.0±2.19 a
5	25.3±1.45 d	22.6±1.33 d	20.0±1.73 d	19.0±1.20d	19.6 ±1.16d	16.6±1.53 d	15.6±1.20cd	13.0±1.45cd

Table-5. Effect of different adult artificial diets on incubation and larval period of *C.carnea* under laboratory conditions.

Diets in (g)	Incubation period (in days) (Mean±SE)				Larval period (in days) (Mean ±SE)			
	Brewer Yeast	Protein Solution	Honey Solution	Sugar Solution	Brewer Yeast	Protein solution	Honey Solution	Sugar solution
1	3.8±0.58 a	4.5±0.49a	4.7±0.88 a	4.95±1.20a	15.0±0.78a	15.9±0.89a	15.8±0.96a	15.9±1.50a
2	3.4±0.67b	4.4±0.33c	4.6±0.40 b	4.8±0.29bc	13.7±0.68c	15.5±0.81c	15.5±0.88bc	15.6±0.98c
3	3.3±0.38 c	4.4±0.43 d	4.5±0.33c	4.8 ±0.33c	14.6±0.59b	15.5b±0.79c	15.6±0.85ab	15.7±0.79bc
4	3.0±0.33 d	4.0±0.29 e	4.3±0.61 d	4.39±0.16d	13.3±0.48d	15.4±0.65c	15.3±0.75c	15.5±0.69d
5	3.9±0.52b	4.4±0.27 b	4.7±0.70a	4.9±0.58 b	14.8±0.70ab	15.8±0.92ab	15.8±0.99a	15.8±1.00ab

Table-6. Effect of different adult artificial diets on pupal period (in days) of *C.carnea* under laboratory conditions.

Diets in Grams	Pupal period (in days) (Mean ±SE)			
	Brewer Yeast	Protein Solution	Honey Solution	Sugar solution
1	4.4±0.50a	5.4± 0.60 a	6.4±0.7 2a	6.7±0.80 a
2	4.2±0.30 bc	5.2±0.41 bc	6.2±0.53 bc	6.5±0.61 b
3	4.3±0.21 ab	5.3±0.34 ab	6.3±0.45 ab	6.7±0.50 a
4	4.1±0.10 c	5.1±0.21 c	6.1±0.32 c	6.3±0.41 c
5	4.4±0.43a	5.4±0.51a	6.4±0.60 a	6.6±0.71 a

REFERENCES:

Abdel-S., and S. M Salwa. (2011). Effect of Adult Nutrition on some Biological Parameters of the Green Lacewing *Chrysoperla carnea* Stephens (Neuroptera: Chrysopidae) Egyptian Journal of Biological Pest Control (21): 2, 173Pp

Balouch, S. Bukero, I. Ahmed, M. Ismail, L. Bashir. R. Ahmed, J. Ahmed, S, Ali (2016). Rearing of Adult Green Lacewing, *Chrysoperla carnea* (Stephens) on Different Artificial Diets in the laboratory *Journal of Basic & Applied Sciences, 12,* 289-292

Cohen, A. C. (1992), Using systematic approaches of developed artificial diets for predators. In Advances In Insect Rearing For Research And Pest Management (T .Anderson and N.C.Leppla, Eds.) 77-92. West views Press. Oxford.

Carvalho C. F, M. Canard and C. Alauzet (1996). Comparison of the fecundities of the Neotropical green lace wing *Chrysoperla externa* (Hagen) and the west – Palaearctic *Chrysoperla mediterranea* (Hoelzel) (Insecta: Neuroptera: Chrysopidae) In Canada M., Aspoeck H. & Mansell M.W (eds): Pure and Applied research in Neuropterology. Proceeding of the 5TH International Symposium on Neuropterology, Cario Egypt .Sacco, Toulouse, 103-104

Geetha, B. and M. Swamiappan, (1998). Improved adult rearing cages for the predator, Chrysoperlacarnea. adras Agric. J., 85 (5-6): 333-334.

Hunter, C. D. (1994). "Suppliers of Beneficial Organisms in North America". California Environmental Protection Agency. Department of Pesticide Regulation.

McEwen, P.K. and N.A. Kidd, (1995). The effects of different components of an artificial food on adult green lacewing (*Chrysoperla carnea*) fecundity and longevity. Entomologia Experimentalist Applicata. 77(3):343-346.

McEwen, P. K, N.A.C Kidd, E. Bally and L. Eccleston (1999). Small scale production of the common green lace wing Chrysoperla carnea (Stephen) (Neuroptera: Chrysopidae) minimizing cost and maximizing output. *Journal of Applied Entomology,* 123 (5) 303-306.

Mohammad H. S and M. Lakzaei (2014). Effect of different diets on some biological parameters of *Chrysoperla carnea* (Neuroptera: Chrysopidae). J. Crop Prot. 3 (4):479-486-479

Neethu N.; D. M. Korat, and M. R.Dabhi. (2014). Effects of artificial food on biological parameters of *Chrysoperla zastrowi* sillemi (Esben-Peterson) Insect Environment, Vol. 20 (2) 40-44.

Steel, R.G.D, J.H.Torrie and D.A.Dicky 1997. Principles and procedures of Statistics .A biometrical approach 3rd Ed. McGraw-Hill book international company Singapore.