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Comparison of enhanced artificial diets for mass rearing of *Helicoverpa armigera* (Hubner) under laboratory conditions

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Abstract

In few decades the insect management has changed its form i.e. natural control, bioassay based, for that a large number of laboratory reared insects are needed. The rising needs of insects also need a good amount of artificial diet, rather than natural host plants. Overcome the problem of mass rearing studies on artificial diets has been done. An ideal artificial diet should be preferred by the insect as well as cost effective. Focusing on the needs of insect mass rearing the present study was conducted to compare the enhanced artificial diets for the mass rearing of *Helicoverpa armigera*. Six diets were prepared by adding enriched Protein-X and Bio-D₃ Max capsules on six different flours viz. chickpea, corn, soybean, rice, groundnut, sago powder and control (tomato pulp). The larval duration of *H. armigera* was observed minimum in soybean flour mediated diet i.e. 13.5 days and maximum in Sago powder mediated diet i.e. 20.3 days, subsequently per cent larval mortality was minimum in the soybean flour mediated diet 2.1 % and maximum in Sago powder mediated diet 20%. However, maximum % pupal recovery and adult emergence was observed in soybean based artificial diet which exhibited 92.6% and 90.5% respectively.

Keywords: *Helicoverpa armigera*, artificial diets, insect rearing

1. Introduction

The tomato fruit borer, *Helicoverpa armigera* (Hubner) is the polyphagous pest that can feed on a variety of crops particularly on tomatoes, chickpea, corn, and cotton. Worldwide, *H. armigera* has been reported on over 180 cultivated hosts and wild species in at least 45 plant families [9]. In India almost all major states like Andhra Pradesh, Madhya Pradesh, Karnataka, Assam, Punjab, Bihar, West Bengal, Haryana and Gujarat are reported to have considerable damage by *H. armigera* wherein the losses estimated vary from year to year and from crop to crop which mostly depends on the pest population density. The pest causes highest loss approx 80% in cotton, around 72% in chickpea and upto 40% in tomato [5, 7]. To manage this widely spreaded pest careful laboratory studies on different biological and toxicological parameters are required. To supply the demanded numbers of laboratory reared insects low cost and efficient artificial diets are preferred. The basic components of any artificial diet are viz. proteins, carbohydrates, fats, vitamins, minerals and preservatives that helps in growth and development of insects. Different nutritive values of the diet may influence the rate of development of larvae as well as reproduction. Though various artificial diets has been already prepared by various researchers focusing on various aspects of the life cycle, first successful aseptic rearing was done for a phytophagous lepidopteran, the European corn borer, *Ostrinia nubilalis*, on a meridic diet [3] also the formulataion of a meridic diet used for the pink bollworm, *Pectinophora gossypiella*, without a plant adjuvant [8]. Later, other workers developed a satisfactory artificial medium supplemented with wheat germ for the rearing of pink bollworm [2] however, some researchers verified chickpea based diet as better artificial diet in terms of growth and feeding of larvae [10]. In present studies six enhanced artificial diets were prepared and compared for mass rearing of *H. armigera* including control (tomato pulp).

2. Material and Method**2.1 Diet preparation**

Enhanced artificial diets were prepared by adding enriched Protein-X and Bio-D₃ Max capsules (Table 1.1) on six separate flours viz. chickpea, corn, soybean, rice, groundnut and

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sago powder each quantitating 150g, along with that a control larvae was maintained in each replication which was fed on tender tomato leaves and pulp. All the ingredients were boiled in distilled water and blended to get a homogenous mixture.

Table 1: Composition of enhanced artificial diet (1 litre)

Chickpea flour/Corn flour /Soybean flour /Rice flour /Groundnut flour /Sago Powder	150g
Dried active yeast	60g
Sucrose	25g
Formaldehyde-10%	5ml
Choline chloride-5%	10ml
Sorbic acid	12g
Streptomycin sulphate	0.1g
Vit. E capsules (400mg)	2 no.
Distilled water	1000ml
Protein-X	5g
*Bio-D3 Max (500mg)	2 no.

Table 1.1: Composition of Bio-D₃ Max

Calcitriol	0.25 mcg
Eicosapentaenoic acid (EPA)	180 mg
Docosahexaenoic acid (DHA)	120 mg
Mecobalamin	1500 mcg
Folic acid	400 mcg
Boron	1.5 mg
Calcium carbonate	500 mg

2.2 Rearing of Insects

Fresh larvae were gathered from field for culture maintenance. After adult emergence pairing was done to get eggs and the subsequent neonate larva. Thereafter, separated into five replicates keeping 10 larvae in twelve well tray containing artificial diet (Table 1) with the help of camel hair brush. At every three day interval diet was changed up to pupation. The rearing temperature was kept 25°C, 12:12 hours Day: Night cycle and relative humidity 65 ±5°C per cent was maintained [4]. Data on different parameters such as larval duration, weight, percent mortality also the pupal duration, weight, percent pupal recovery and the adult emergence was observed regularly.

3. Results and Discussion

Results in Table 2 showed that the life variables of *H. armigera* differed significantly among the treatments. The data indicated that minimum larval duration (13.5 days) was

observed in soybean flour based artificial diet whereas maximum larval duration (20.3 days) was observed in sago powder based artificial diet. The rest of the diets including control viz. Chickpea, Corn, Rice, Groundnut, Tomato pulp exhibited larval duration between 14.3 to 17.6 days. The correlation studies revealed that the larval duration of *H. armigera* fed on different diet had negative correlation ($r = -0.7884$) with the protein content of the diet, implying that increase in protein content in artificial diet decreases the larval duration. Perusal of data on larval weight revealed that highest weight (0.5500g) was recorded in soybean based artificial diet and it was found comparable with chickpea and groundnut based artificial diet, while sago powder based artificial diet had lowest weight (0.3407g) followed by control, corn, rice which exhibited 0.3467g, 0.3676g, 0.4032g respectively. Moreover, the larval weight showed a positive correlation ($r=0.6359$) with protein content of different diets. The larval mortality was observed lowest (2.1%) in soybean based artificial diet and it was at par with groundnut based diet (2.3%) whereas highest larval mortality was observed in sago powder based artificial diet (20%). The rest of the diets including control viz. Chickpea, Corn, Rice, Tomato pulp registered larval duration between 8.5 to 16.3 %. However, the protein content of different diets showed negative correlation ($r = -0.8224$) with per cent larval mortality of *H. armigera*. The observations on pupa indicated that minimum pupa duration (10.2 days) was observed in soybean flour based artificial diet, it was found statistically at par with chickpea (10.5 days) and groundnut (11.0 days). However, maximum pupal duration (13.8 days) was observed in sago powder based artificial diet. The correlation studies revealed that the pupal duration had negative correlation ($r = -0.6931$) with the protein content of diet consumed by larvae. The data on pupal weight revealed that highest weight (0.4605g) was recorded in soybean based artificial diet and it was found comparable with chickpea, corn and groundnut based artificial diet, while sago powder based artificial diet had lowest weight (0.3568g). Moreover, the pupal weight showed positive correlation ($r=0.6404$) with a protein content of diet consumed by the larvae. The per cent pupal recovery was observed highest (92.6%) in soybean based artificial diet consumed by larvae and it was at par with groundnut based diet (89.3%) and chickpea based diet consumed by larvae (87.1). While lowest pupal recovery was observed in sago powder based artificial diet (66%).

Table 2: Different parameters of *H. armigera* (Hubner) lifecycle fed on enhanced artificial diets

Main Diet Ingredient	Larvae				Pupa			Adult
	Protein content (per 100g)	Duration (days)	Weight (g)	% Mortality	Duration (days)	Weight (g)	% Pupal recovery	% Emergence
Chickpea	19	14.5	0.5478	10.3	10.5	0.4376	87.1	84.1
Corn	9.0	15.0	0.3676	14.3	13.5	0.4070	76.0	71.6
Soybean	36	13.5	0.5500	2.1	10.2	0.4605	92.6	90.5
Rice	2.6	15.5	0.4032	16.3	13.0	0.3688	73.6	68.2
Groundnut	26	14.3	0.5436	2.3	11.0	0.4576	89.3	83.1
Sago	0.2	20.3	0.3407	20.0	13.8	0.3568	66.0	56.3
Control (Tomato pulp)	4.3	17.6	0.3467	8.5	13.6	0.3599	72.1	71.5
S.Em.±	0.41	1.57	0.02	0.44	1.41	0.02	1.95	1.99
C.D. at 5%	1.21	4.63	0.05	1.31	4.16	0.05	5.67	5.86
C.V. %	11.45	10.09	9.07	11.02	9.86	8.85	3.79	3.84
Correlation (r) at 5%		-0.7884	0.6359	-0.8224	-0.6931	0.6404	0.7412	0.8365

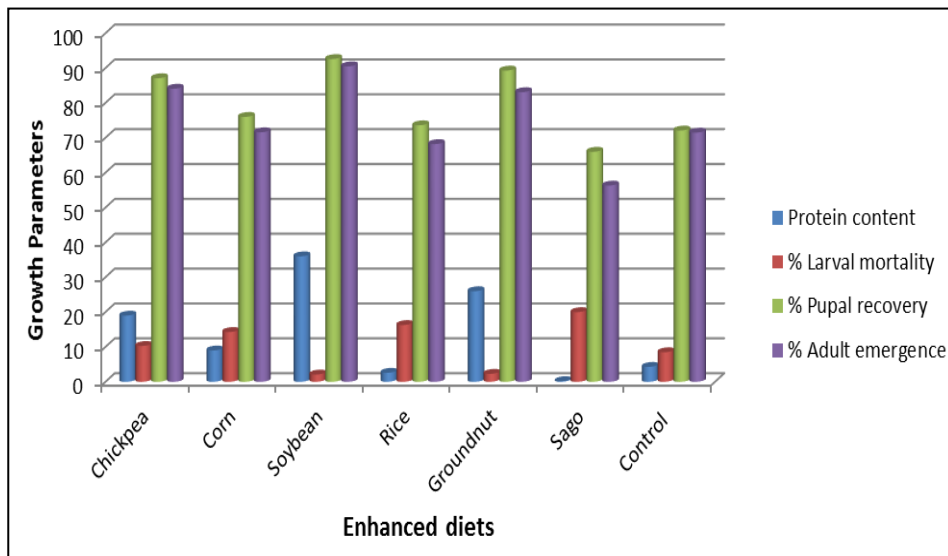


Fig 1: Impact of different treatments on various parameters of the lifecycle of *H. armigera*

The rest of the diet based pupal recovery including control viz. Corn, Rice, Tomato pulp registered pupal recovery between 72.1 to 76%. However, the protein content of different diets showed positive correlation ($r = 0.7412$) with protein content of diet consumed by larvae. There was a higher percent normal emergence of adults in soybean flour based diet (90.5%) which was found comparable with chickpea and groundnut based artificial diet while lowest was observed in sago powder based artificial diet (56.3%). Whereas, all other diets including control reflected moth emergence ranged between 68.2% - 71.6%. The correlation studies also revealed that the moth emergence had positive correlation ($r = 0.8365$) with the protein content of the diet. Moreover, the graphical representation (Fig 1) showed clearly that the protein content of the diet had a positive impact on various parameters of the lifecycle of *H. armigera*. It clearly reveals that diets mediated with rich protein along with Bio-D₃ Max capsules (Table 1.1) had lower larval mortality and higher pupal recovery as well as adult emergence.

The results presented here agree partially with reference to previous studies done to test the rearing of *H. armigera* on vitamin mixture based artificial diets and recorded pupal recovery ranging from 71.2 to 83.7% and adult emergence from 59.6 to 78.4% it was in agreement with our results on adult emergence that ranged from 56.3 to 90.5% [1]. Other studies done on chickpea flour mediated Protein-X enriched diet was found suitable to overcome the drawbacks during egg laying and helpful in obtaining appropriate successive generations also it showed that higher protein favors the larval feeding [6] thus it supports our studies done on various protein enriched artificial diets.

4. Conclusion

Present studies concluded that soybean flour mediated diet enriched with Protein-X and Bio-D₃ Max capsules along with other ingredients optimizes the mass rearing of *H. armigera* in the laboratory while chickpea and groundnut based diet can be proved as good artificial diet. In the present studies 50% of the enhanced artificial diets gave better results over control (tomato pulp) while sago power mediated diet was least preferred by the larvae. Moreover, results indicates that higher protein doses are more effective for insect development and adult emergence. Hence, Protein-X and Bio-D₃ Max capsules along with common diet is a better and convenient option for efficient mass rearing of *H. armigera*.

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