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Artificial Diets and Rearing Techniques of Predatory Mites

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SUMMARY

Artificial diet if available could serve as an economically viable option for lab rearing of any insect pest, insect predator and non-insect predators such as predatory mites. Currently there are well defined artificial diets for mass rearing of phytophagous insects especially lepidopterans however, predatory insects and mites are mostly mass reared on host insects only. In this context, several diets comprising honey, sucrose, tryptone, yeast extract, fresh hen's egg yolk and distilled water as basic ingredients along with many supplementary components are being formulated to study survival and reproduction of predatory mites in laboratory. The composition, diet preparation and rearing procedure are discussed.

INTRODUCTION

Phytophagous mites causes serious damage to many agricultural and greenhouse crops.The indiscriminate use of broad-spectrum miticidesleads to development of resistance in mite pests, viz. *Tetranychus*spp. In several countries, phytoseiid mites have been commercially produced and utilized as bio control agents primarily against *Tetranychusurticae* and also against other species of mites, thrips and whiteflies (Bolckmans, 2007). The promising predatory mites which are being globally used as biocontrol agents are *Phytoseiuluspersimilis* Athias-Henriot, *Neoseiulusbarkeri* Hughes, *N.cucumeris* (Oudemans), *N. fallacis* (German), *N.californicus* (McGregor), *Galendromusoccidentalis* (Nesbitt), *Iphiseiusdegenerans* (Berlese), and *Amblyseiusswirskii* Athias-Henriot. In India, though about 217 species of phytoseiids have been recorded,*Neoseiuluslongispinosus* (Evans) is reported as the most potential obligate predator of many tetranychid mites (Mallik and Channabasavanna, 1983). Predatory mites are commercially produced usually in vivo by providing two-spotted spider mites, *T.urticae* or storage mite *Tyrophagusputrescentiae* as food source, which further involves the production cost of food for prey mites.The use of an artificial diet may represent a step toward, more cost-effective rearing of generalist predatory mites.

Artificial Diet (AD) for predatory mite

Hassan and Hagen (1978) formulated several diets for rearing larvae of *Chrysopacarnea.* One among those formulations consists of the following constituents; 5 g bee honey, 5 g sugar, 5 g food yeast flakes, 6 g yeast hydrolysate, 1 g enzymatic casein hydrolysate, l0 g fresh egg yolk, and 68 ml water. Kennett and Hamai (1980) used this formulation as artificial diet for testing oviposition and development in predaceous mites and found that predaceous mites could survive and oviposit when fed with diet but their performance was not better than those fed with natural diet. There after several researches developed several AD with modifications in the above diet composition.

Preparation of Artificial diet for predatory mite *Amblyseiusswirskii*. (Nguyen et al., 2012)

Materials: The Basic artificial diet was composed of honey, sucrose, tryptone, yeast extract, fresh hen's egg yolk and distilled water. Haemolymph of oak silkworm pupae was used as supplement. Following are the two types of diets have given below.

First diet (AD1): Comprises 5 % honey, 5 % tryptone, 5 % sucrose, 5 % yeast extract, 10 % egg yolk, and 70 % distilled water (w/w). Honey, tryptone and sucrose were dissolved in the distilled water, after which the egg yolk and yeast extract were added. All ingredients were then blended using a virtis mixer.

Second diet (AD2): Comprises 80 % AD1 supplemented with 20 % (w/w) haemolymph of pupae of oak silkworm. The pupalhemolymph was collected from live *Antheraeapernyi* pupae which were immersed in a water bath at 60°C for 10 min to avoid melanization of the haemolymph then it was lyophilized (Freezed). The lyophilizedhaemolymph was re-dissolved using distilled water before being added to the diet. Fresh diet was preparedfor both AD1 and AD2 every week and kept in a refrigerator at 5°C.

Experimental setup for rearing of individual *A. swirskii*.

Modified Munger cells were used as rearing microcosms. Each cell consisted of three boards, a top transparent acrylic board (40 × 40 mm, 2 mm thick) with a 19 mm diameter hole in the centre, a middle black acrylic board (40 × 40 mm, 5 mm thick) with a 18 mm diameter hole in the centre, and another bottom black acrylic board (40 × 40 mm, 2 mm thick) with a 1 mm diameter hole in the centre. Clear transparent film was placed between the top and middle boards and is pierced 4 times with a needle allowing ventilation but avoiding escape of the mites. The 1 mm diameter hole in the bottom board was plugged with a rolled piece of tissue paper saturated with water to serve as a water source for the mites. A paper clip was used to hold the boards together. The microcosms were placed on a plastic support containing tap water. Black threads were placed in the stock colony of*A. swirskii* on which they deposit eggs. Eggs deposited on the threads were thentransferred individually to the rearing microcosms. Artificial diets were absorbed on a small piece of filter paper (2 × 2 mm) which was placed on the bottom board of the cells on which the mites feed.

Evaluation of artificial diet for predatory mite *Neoseiuluscalifornicus*.

Khanamani et al (2017) evaluated different artificial diets for rearing the predatory mite *N. californicus.* The basic artificial diet (AD1) was prepared according to Nguyen et al. (2012), which consisted of 5 % honey, 5 % tryptone, 5 % sucrose, 5 % yeast extract, 10 % egg yolk, and 70 % distilled water (w/w). The other diets (AD2 to AD10) wereprepared by adding of20 % (w/w) of different supplements to 80 % AD1 as listed in Table 1. Liquid or soluble supplements such as serum albumin protein, bull sperm, haemolymph of *Plusia gamma*, multivitamin syrup and the contents of multivitamin capsule were directly mixed with the basic artificial diet (AD1) and then were centrifuged (at 12,000 rpm at 5 °C for 15 min). The other supplements (*Ephestiakuehniella* eggs, decapsulated*Artemiafranciscana* cysts, maize pollen, and *E. kuehniella* larvae) initially were ground in a ceramic mortar then mixed with the basic artificial diet (AD1) and then were centrifuged. The obtained diets were transferred to 2 ml micro tubes and frozen at -20 °C for long-term storage or refrigerated at 4 °C for up to 2 weeks during the experiments.

Table 1. Ingredients (%w/w) of different artificial diets.

Artificial Diets	Ingredients
AD1	5 % honey, 5 % sucrose, 5 % tryptone, 5 % yeast extract, 10 % egg yolk, and 70 % distilled water
AD2	80 % AD1 + 20 % *Ephestiakuehniella egg*
AD3	80 % AD1 + 20 % decapsulated*Artemiafranciscana*cyst
AD4	80 % AD1 + 20 % bull sperm
AD5	80 % AD1 + 20 % serum albumin protein (bovine serum albumin)
AD6	80 % AD1 + 20 % maize pollen
AD7	80 % AD1 + 20 % haemolymph of *Plusia gamma*
AD8	80 % AD1 + 20 % whole body tissue extracts of *Ephestiakuehniella*larvae
AD9	80 % AD1 + 20 % multivitamin capsule
AD10	80 % AD1 + 20 % multivitamin syrup

***AD, artificial diet; AD1, basic artificial diet.**

All enriched artificial diets with supplements (except AD10and AD5) increased the total fecundity of *N. californicus* compared with AD1, and the highest fecundity was observed on the diet supplemented with *Ephestiakuehniella* eggs (AD2) (Khanamani et al., 2017). Several experiments of rearing predacious mites on artificial diets were conducted to study the survival and fecundity. However, mass rearing of predacious mites for commercial scale production is still followed with prey mites such as two-spotted spider mites, *T. urticae* or storage mite *T.putrescentiae*as food source. Reason being, even though predacious mites can survive and reproduce when fed with artificial diet, their performance was poor when compared to natural diets such as pollen or live prey mites. Song *et al* (2019) reported that egg and larval periods of *N. californicus* did not differ among the natural prey (*Tetranychusurticae* Koch) and artificial diets, but the developmental times of the nymphal stages were significantly longer on any of the artificial diets than on the natural prey. The total

fecundity of *N. californicus* was reduced when the predator was fed on any of the artificial diets as compared with *T. urticae.*

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