Role of Artificial Diets in Mass Production of Insects

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ABSTRACT

Artificial insect diets are man-made food sources designed specifically for insects. Constituents like carbohydrates, lipids, proteins, vitamins, minerals, and substrate form the basis of these diets, providing a balanced nutritional profile for insect development. Artificial diets are essential in insect rearing, providing a practical alternative to natural host rearing methods. They effectively address limitations associated with natural hosts, such as time-consuming processes, labor-intensive requirements, seasonal dependencies, and increased mortality rates during handling. Nutrient levels in artificial diets can be adjusted to optimize insect performance. Artificial diets are vital in pest management, aiding in the rearing of natural enemies, producing attractants and pheromones, and implementing techniques like the Sterile Insect Technique (SIT). Research on developing diverse and cost-effective artificial diets is crucial. This will not only improve our understanding of insect biology but also lead to more effective pest management and a sustainable future for mass insect production.

INTRODUCTION

Finney and Fisher (1964) defined mass rearing as the efficient production of large quantities of beneficial insects in a controlled environment, aiming to maximize fertile female production while minimizing labor, space, and time, and reducing costs. Insects are mass produced for various applications like biocontrol programs, sterile insect programs (SIT). Rearing an insect on its natural host throughout the year is a tedious job. It has many constraints like, unavailability of the host, presence of pesticide residue, storage, and logistic issues. Artificial diets give us an alternative to these shortcomings. Artificial diet is any man-made food source for the insect used for growth, tissue maintenance, and reproduction (Kraus et al. 2021). *Calliphora vomitoria,* blue bot fly was the first insect reared on an artificial diet throughout the larval stage. (Bogdanow 1908). The three main types of artificial diets are holidic, meridic, and oligidic diets, and these have distinct compositions and applications in insect rearing. Holidic diets consist entirely of inorganic chemicals, with the chemical composition of all the constituents being known. These are used for critical nutritional studies. Meridic diets are composed of defined chemical along with one or more unrefined plant or animal substances, which are generally used for laboratory rearing. Oligidic diets are made up of crude natural materials like host plants or prey and are used for large scale rearing projects. Understanding the constituents of artificial diets, such as carbohydrates, lipids, proteins, vitamins, minerals, substrate, is crucial for optimizing insect growth and development. Artificial diets were initially developed for entomological research and soon became essential for bioassays of insecticides, entomopathogens, and plant resistance traits. (Stone and Sims, 1992; Cohen, 2001; Grenier, 2009). Their potential was soon recognized for use in sterile insect technique and augmentative biological control strategies for insect management (King et al., 1985; Knipling, 1992; Cohen, 2001, 2004; Grenier, 2009). Mass rearing is complex, and its complexity increases with multiple species. Artificial diets aim to simplify this by eliminating the need for host/prey rearing, reducing system complexity to manageable levels.

Constituents of artificial diets

Nutrition is the most basic subject relevant for artificial diet development. Diets must provide all essential nutrients to allow complete development and reproduction of insects.

Carbohydrates: Carbohydrates are an important energy source for insects. In addition, they are required to produce chitin (Chippendale 1978). Wang et al. (2022) reported that when different species of *Trichogramma* were fed with a honey diet, had higher fecundities than when fed with water and hence concluded that carbohydrate-rich diet significantly enhanced the biological control efficacy of *Trichogramma spp.*

Lipids: Lipids form important component of cell membrane. They store and provide metabolic energy and act as a barrier against desiccation in the cuticle.

Proteins: Proteins are large biomolecules composed of one or more long chains of amino acid residues. These amino acids serve a variety of functions. Tyrosine is a major component of sclerotin and is required in large quantities during molting (Hopkins and Kramer 1992). Proline is important during flight initiation by elevating sugar metabolism (Lundgren 2009). Serine, Cysteine, Glycine, Aspartic acid, and Glutamic acid are crucial for growth (Chapman, 1998).

Vitamins: Water soluble vitamins like, Vit B serve as co-factors of enzymes and Vit C functions as antioxidant, detoxicant, required during moulting and protects against microbial infections. Fat soluble vitamins like, Vit A and Vit E are required for pigment synthesis and reproduction respectively.

Minerals: Cohen (2004) reported that some elements like Iron is important in several enzyme pathways, including synthesis of DNA, while Calcium is required in muscular excitation.

Substrate: It serves as a medium through which food is delivered to the insect. House (1966) compared the role of concentration of agar in artificial diet of larvae of two dipteran flies. He observed that at 0.75% agar concentration, *Agria housei* larvae survived well, while *Musca domestica* larvae drowned. Increasing the agar concentration to 1.5% created a rigid diet that allowed air flow, resulting in successful larval survival.

Role of artificial diets:

- Mass production for biocontrol programmes.
- For nutritional studies.
- For various control programmes like SIT.
- Production of insect pathogens, attractants, hormones and pheromones.
- Mass production of economically important insects.
- Year-round rearing, independent of seasonally available natural food sources.
- Logistic benefit like ease of transport, reduced storage space, easy handling and preparation.

Biocontrol of pests:

Sahayaraj and Balasubramanian (2009) compared the biocontrol potential of *Rhynocoris marginatus* (assassin bug) reared on artificial diet its natural hosts, viz. *Dysdercus cingulatus* (red cotton stainer), *Spodoptera litura* (tobacco cutworm) and *Corcyra cephalonica* (rice meal moth). They reported that *R. marginatus* reared on artificial diet had a great biocontrol potential for control of *S. litura* and *D. cingulatus.*

Sterile insect technique:

Enkerlin et al. (2017) reviewed a success story of area wide SIT application for eradication of *Ceratitis capitata* in Central America. The control programme consisted of four phases, Phase 1, 2, 3 and 4. By 1985, the pest had been eradicated from areas in Guatemala at border with Mexico. Success of this programme was due to the mass rearing of these flies with the help of artificial diet. The mass rearing facilities at Metapa, Mexico produced about 300 million to 600 million pupae weekly (Schwarz et al. 1985).

CONCLUSION

Artificial diets support insect growth, tissue maintenance, and reproduction, overcoming seasonal constraints of natural hosts for year-round mass production. This approach facilitates research on beneficial insects for biological control and supports apiculture and sericulture industries. Rearing insect pests on artificial diets allows controlled studies of their nutritional needs, revealing vulnerabilities for targeted pest management strategies. Continued research to optimize artificial diet composition is crucial for maximizing insect health and productivity while minimizing costs, ensuring sustainable and affordable mass insect production.

REFERENCES

Bogdanow EA. 1908. Uber die Abhangigkeit des Wachstums der Fliegenlarven von Bakterien und Fermenten und uber Variabilitat und Vererbung bei den Fleisch-fliegen. *Archiv. Anat. Physiol. Abt. Suppl* 1908: 173-200

Chapman RF. 1998.The insects: structure and function. *Cambridge university press.*

Chippendale GM. 1978. The functions of carbohydrates in insect life processes. *Biochemistry of insects* 1-55.

Cohen AC. 2001. Formalizing insect rearing and artificial diet technology. *Am. Entomol* 47:198–206.

Cohen AC. 2004. Insect Diets Science and Technology. *CRC Press*.

Enkerlin WR, Gutiérrez Ruelas JM, Pantaleon R, Soto Litera C, Villaseñor Cortés A, Zavala López JL, Orozco Dávila D, Montoya Gerardo P, Silva Villarreal L, Cotoc Roldán E and Hernández López F. 2017. The Moscamed Regional Programme: review of a success story of area-wide sterile insect technique application. *Entomologia Experimentalis et Applicata* 164(3):188-203.

Fraenkel G and Blewett M. 1946. Linoleic acid, vitamin E and other fat-soluble substances in the nutrition of certain insects, *Ephestia kuehniella, E. elutella, E. cautella* and *Plodia interpunctella* (Lep.). *Journal of Experimental Biology 22*(3-4): 172-190.

Grenier S. 2009. In vitro rearing of entomophagous insects—past and future trends: a minireview. *Bulletin of insectology* 62(1):1-6.

Hopkins TL and Kramer KJ. 1992. Insect cuticle sclerotization. *Annual review of entomology* 37(1): 273-302.

House HL. 1966. The Role of Nutritional Principles in Biological Control. *The Canadian Entomologist 98*(11): 1121-1134.

King EC, Hopper KR and Powell JE. 1985. Analysis of systems for biological control of crop arthropod pests in the US by augmentation of predators and parasites.

Knipling EF. 1992. Principles of Insect Parasitism Analyzed from New Perspectives, Practical Implications for Regulating Insect Populations by Biological Means. *Agricultural Handbook No. 693 USDA-ARS, Washington, DC* 337.

Kraus S, Monchanin C, Gomez-Moracho T, Lihoreau M. 2022. Insect diet. *Encyclopedia of animal cognition and behavior* 3471-3479.

Kumar M and Abrol DP. 2022. Optimization of artificial diets for management of Apis mellifera L. colonies. *Environment and Ecology* 40: 320-328.

Lundgren JG. 2009. Nutritional aspects of non-prey foods in the life histories of predaceous Coccinellidae. *Biological Control* 51: 294–305.

Sahayaraj, K., & Balasubramanian, R. (2009). Biological control potential of artificial diet and insect hosts reared Rhynocoris marginatus (Fab.) on three pests. *Archives of Phytopathology and Plant Protection* 42(3), 238-247.

Schwarz AJ, Zambada A, Orozco DH, Zavala JL and Calkins CO. 1985. Mass production of the Mediterranean fruit fly at Metapa, Mexico. *Florida Entomologist* 467-77.

Stone TB and Sims SR. 2021. Insect rearing and the development of bioengineered crops. *Advances In Insect Rearing for Research and Pest Management* 33-40.

Wang Y, Iqbal A, Mu MY, Zang ZY, Hou YY and Zang LS. 2022. Effect of carbohydrate nutrition on egg load and population parameters of four *Trichogramma* species. *Agronomy* 12: 3143.