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Artificial Diets for Mass Rearing of Insects

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An artificial diet is defined as any diet that is not the natural food of an insect. It may be the mixture of lipids, plant material, protein substances and carbohydrates. First artificial diet was prepared by Bottger for *Calliphora vomitoria* (Linnaeus) which was reared axenically on a diet of meat extract, starch, peptone and mineral saltsl; the significant gain in rearing phytophagous insects. He developed diets using highly purified natural products for the european corn borer, *Ostrinia nubilalis* (Hubner) known as Beck's diet. A nutritionally complete diet for most of the insect in axenic culture must be contain all or most of the protein and amino acid including ten essential ones, carbohydrates, fatty acid, cholesterol, choline, inositol, pantothenic acid, nicotinamide, thiamine, riboflavin, folic acid, pyridoxine, biotin, vitamin B12, beta carotene or vitamin A, alpha tocopherol, ascorbic acid, several mineral and water.

Classification of Insect Diets

There are three basic groups of artificial diets with respect to their components:

1. Holidic diet: Diet in which the ingredient can be represented by chemical formulation is known as chemically defined or holidic diets. These diets are used mainly for nutritional studies. Most nutritional studies have been conducted with diets containing one or more of the following ingredients such as agar, protein (casein) vegetable oil, starch and cellulose. The appropriate descriptions, these diets could be designated as defined diets.

2. Meridic diet: Diets which contain one or more unrefined substances from plant, animals or microorganism such as plant tissue, liver extract, and yeast products. The main characteristic of these diets, the most of the nutrients are provided as pure or refined substances. The large number of diets for the laboratory rearing of insects is included in this group. These diets may also be highly complex.

3. Oligic diet: These diets are made up from crude material. They are designed to imitate the natural food and are assumed to have all the required nutrients with undigestible inert material. These diets are economical and are used of mass rearing of insects. Eg: Casein and yeast for a flour beetle and yeast, cholesterol & water for larval wax moth.

Major Dietary Components

Carbohydrates: Complex carbohydrates (polysaccharides) like starch and glycogen are break down by digestive enzymes into simple sugars such as glucose, galactose, or fructose, it can be used for construction of chitin, a major component of the insect's exoskeleton. In some overwintering insects, a high concentration of sugar (eg. trehalose) is present to protect the insect from extreme cold weather. Eg: Polysaccharides, starch, glycogen, chitin, cellulose (structural) oligosaccharide sucrose, trehalose, glucose, galactose and fructose.

Proteins: Protease enzymes help in the break down the protein into amino acid. Amino acid forms the enzymes and hormones as well as proteins require for muscle, ribosomes and cuticle. ATP can be formed by the conversion of amino acid into carbohydrate by the

removal of (NH4+) formed by the deamination process. Eg: Actin, myosin, resilin, arthropodin, enzymes, hormones, ribosomes, peptides, brain hormone, bursicon, amino acids like alanine, lysine, histidine and glycine.

Lipids: Fats serve primarily as energy storage molecules. Lipase enzymes break down the fat into glycerol and fatty acids in the midgut. Fatty acids also serve as cuticular waxes and the glandular synthesis of certain pheromones and defensive compounds. Eg: Oils, waxes, resins, fatty acids, cell membranes, pheromones, steroids, hormones and cholesterol.

Nucleic Acids: Sugars (ribose and deoxyribose), nucleotides (adenine, guanine, cytosine, uracil, and thymine) and phosphates are the major products of nucleic acid digestion. Individual cells again component for synthesis of new DNA and RNA-information-storage molecules that contain the cells genetic code for growth and reproduction. Eg: DNA, RNA, purines and pyrimidines, adenine, guanine, cytocine, uracil, mono and dinucleotides, ATPs, cyclic AMP, NAD, NADP, and FAD Other than four major components and insects also acquire water, vitamins, and minerals from their food. Some species can live for months on only the "metabolic" water they produce by product of protein synthesis or chitin synthesis.

Vitamins: Vitamins, particularly water-soluble B vitamins, including biotin (Vitamin H), folic acid (B11), niacin, pantothenic acid, pyridoxine (B6), riboflavin (B2), and thiamine (B1), or close chemical relatives of these, are essential nutrients for all insects. They serve principally as precursors for the coenzymes of intermediary metabolism. Regarding the fat-soluble vitamins, only tocopherol (E) and retinol (A) have proven beneficial for reproduction and vision, respectively, by some insects. Tocopherol also plays an important role as lipid antioxidant.

Ascorbic acid: L -ascorbic acid, vitamin C in vertebrate animals is an essential growth factor for many phytophagous insects. In its absence, these insects generally fail to grow and/or develop. In contrast to the vitamin C requirement of vertebrates, ascorbic acid is required by insects in relatively large amounts, although this may be in the part reflect the necessity for a high antioxidant activity in synthetic artificial diets employed for testing. Although there is little understood about the role of ascorbic acid in insects, beyond its potential antioxidant action, it may play the same role as in vertebrates as a factor necessary for enzyme activities involving hydroxylation. Deficiency in insects is often associated with abnormalities of moulting it may be possibly due to the absence of the effects of ascorbic acid on diphenyl oxidase.

Characteristics of Artificial Diet

1. The protein is a major component in the food acceptance and development of 1st and 2nd instar larvae of insect on artificial diets and the survival life span of larvae reared on the diet with added wheat germ was similar to the control group of insects on teaks leaves. Three generation of insect could grow successfully on the diet with added wheat germ. Addition of extra amounts of protein did not increase larval growth and may reduce the palatability of the diet.
2. Even though lipid is an essential factor in lepidopteron growth. The addition of lipid in the form of eggs yolk and coconut causing all the insect to die at the 1st instar stage. Hence the addition of extra amount of lipid was not a crucial factor for their survival of the larvae on the experimental artificial diet.
3. The addition of cholesterol also reduced the survival rate while increasing the life span by one and half times.

Advantages of Artificial Diets

1. Diets are used for studying insect nutrition.
2. It is used for studying, biochemistry, behaviour and other biological process.
3. This is very useful for mass rearing of predators and parasitoids at large scale.

4. Fast growth of the insects also reduce the food cost like; beneficial insect.
5. Testing of compound for physiological effects.
6. It improves the survival rate, fecundity of insect and also helps in analyzing the development rate, survival, longevity and reproduction of insects.
7. Mass rearing of various insects through specialised artificial diets leads to continuous availability for suppression in field through Sterile Insect Release Method (SIRM) and biological control using entomopathogenic fungi

Conclusion

The insect growth is better when insects feed on the artificial diet compared to the natural diet. It has been reported that insects were able to develop and reproduce when fed on artificial diet. The development of an appropriate artificial diet has needed a knowledge of the nutritional requirements of the specific cultured species in order to provide all nutritional needs. Requirements for individual nutrients are likely to vary between species and much insight into these requirements can be made via the investigation of natural feeding habits. Example: carnivorous insects usually require a higher proportion of protein in their diet in contrast to omnivorous or herbivorous insects.