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Sclerotization in Insects

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Abstract: **The cuticular sclerotization is the process of stabilizing the cuticle by the incorporation of phenolic compounds. The sclerotized structures are found throughout the animal kingdom from protozoa to chordates. Sclerotized cuticles vary considerably in terms of hardness and stiffness depending upon their role. However, all have mechanical strength and resistance to chemicals. The phenomenon of sclerotization often takes place immediately after eclosion, sometimes may also happened before ecdysis or in connection with the formation of puparium. The success of insects in evolving flight mechanisms and colonizing in wide range of terrestrial habitats resulted in large part from the development of a light-weight organically hardened exoskeleton more than 300 million years ago. The organic structure was much better adapted to terrestrial insects than in the mineralized exoskeleton of marine insects.**

Keywords: **Cuticle, Sclerotization, tanning, Tyrosine, Insect, etc.**

I. INTRODUCTION

Cuticle acts as an exoskeleton which covers the entire body surface of the insect. It provides protection against desiccation, Microorganisms and predators as well as it provides attachment sites for muscles. Cuticular sclerotization is a process by which certain regions of the insects cuticle changes irreversibly from a pliant material into a harder structure. Which characterized by decreased deformality and increased resistance to enzymatic degradation. Sclerotized structures are seen throughout the animal kingdom form protozoa to chordate [1]. However, insects have sclerotization more extensively than any other group of animals for hardening of their exoskeletons, eggs, shells, oothecae, cocoons etc. The exocuticle is highly resistant to digestion, but some pathogenic fungi can penetrate through less sclerotized areas.

II. SCLEROTIZATION

Sclerotization or tanning is a complex phenomenon that stabilizes protinaceous insect structure through the reaction of quinones with the functional groups of the proteins. Proteins bonded covalently together by the process of quinon tanning were first named sclerotins [2]. During sclerotization two acyldopamines, N-acetyldopamine (NABA) [3] and N-ß-alanyldopamine (NBAD) [4] are oxidatively incorporated into the cuticle.

The first step in the sclerotization are hydroxylation of tyrosins to dopa and decarboxylation of dopa to dopamine followed by synthesis of two acyldopaminaes, NADA and NBAD [14]. NADA and NBAD are transported from the epidermal cells to form its corresponding orthoquinones. Which rearranged to para-quinone methides [15]. Which reacts with nucleophilic groups, and the NADA-para-quinone methide can be enzymatically rearranged to a side chain-unsaturated catechole, α, ß-dehydro-NADA, which further oxidized to form unsaturated quinoid derivatives. It can react with available catechols to yield dehydro-benzodioxine derivatives and can react with two different nucleophilic groups and cross links are formed.

Sclerotization in fly pupa

Tyrosine and phenylalanine:

Tyrosine and its precursor phenylalanine play a central role in sclerotization. Both amino acids are mainly acquired by insects from their food and are released by digestion for absorption into the haemolymph. In several species, a large amount of tyrosine and its conjugates are sequestrated prior to sclerotization [5]. Tyrosine commonly sequestrated in haemolymph as water – soluble conjugates of glucose or phosphate [6]. Hence protect the free amino acid from metabolism by other competing pathways.

Tyrosine glucoside has been found in all the species of Lepidoptera and in two species of Diptera, while tyrosine O-phoshate has been found only in Drosophila [7]. These conjugates accumulate highest levels prior to pupal or puparil tanning but may also serve as precursors for the cuticle sclerotization of adult. In Lepidoptera and Diptera, the tyrosine has also been found sequestered in fat body vacuoles of the larvae [8].

Catecholamines:

In insect cuticles, catechole are the immediate precursors for quinonoid sclerotizing agents. Cockroaches sequester conjugates of catecholamines in haemolymph during the nymphal feeding stages for latter use as precursors for tanning [9].

Specialization:

Some cuticles are characterized by having various specific features, which are depend upon the functions of local cuticular regions, but it is not sure whether or not the features are related to the sclerotization process. The mandibular cuticle of many insect species have significant amounts of zinc and in some cases also manganese [10] and these metals have also present in mandibles of many non-insect vertebrates, such as spiders [11] and in marine polychaete worms [12]. The metals contribute to the hardness and prevent the abrasion of the cuticles, but they are present in amount only. The catecholic residues incorporated into the cuticle during sclerotization are also important for binding the metal ions. In some types of sclerotized cuticle contain the halogen-substituted amino acids, 3-chlorotyrosine and 3,5-dichlorotyrosine [13].

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