A REVIEW OF DIGESTIVE ENZYME ACTIVITY IN PENAEID SHRIMPS

BY

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ABSTRACT

The purpose of this article is to present an overview of the digestive enzymes of penaeid shrimp. The review also covers the effects of circadian rhythms and variations according to moulting cycles on the activities of the various digestive enzymes.

RESUMEN

El objetivo de este artículo es presentar un panorama de las enzimas digestivas de los camarones peneidos. Esta revisión cubre también aspectos sobre el efecto de las variaciones circadianas y del ciclo de la muda en las actividades enzimáticas.

INTRODUCTION

The digestive enzymes of penaeid shrimps have been studied over the last decades for various applications in nutritional physiology and biochemistry. An adequate nutrition of this crustacean is essential for a profitable aquaculture, and the effectiveness of the feeds administered depends on our knowledge of how organisms use various components of their diet. The types, properties, and regulation of the digestive enzymes of shrimp define their digestive capabilities and, hence, the ingredients to be included in the diets. The nutritional biochemistry and physiology of several shrimp species have received increasing attention.

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recently, and digestive enzymes still are the focus of many scientific papers around the world. This review identifies, from the authors’ point of view, relevant papers, and contributes to ordering the information that has been generated in this complicated field over the years.

PROTEINASES AND PEPTIDASES

A comprehensive review on the presence of these enzymes in crustaceans was published by Gibson & Barker (1979) and specifically for shrimp by Dall (1991). The detection and characterization of these enzymes has been approached in different ways. In very few cases, these studies have been carried out through the purification of the enzymes (Galgani et al., 1985; Honjo et al., 1990; Iida et al., 1991; Jiang et al., 1991; Tsai et al., 1991; Van Wormhoudt et al., 1992). In most studies, presence of the enzymes has only been detected in raw extracts, using synthetic substrates and specific inhibitors for each enzyme.

Authors agree on the high content of serine proteinases in the hepatopancreas (Tsai et al., 1986a), although the presence of some metalloproteinases has been reported as well (García-Carreño et al., 1994). One of the serine proteinases has been characterized as a typical trypsin (Gates & Travis, 1969; Zwilling & Neurath, 1981), which is considered as one of the most important enzymes in decapods. In *Marsupenaeus japonicus* (Bate, 1888) and *Melicertus kerathurus* (Forskål, 1775), this enzyme accounts for 40-50% of the total proteolysis (Galgani et al., 1984), whereas it is reported to be about 50-60% in *Penaeus monodon* Fabricius, 1798, *Marsupenaeus japonicus*, *Fenneropenaeus penicillatus* (Alcock, 1905), *Metapenaeus monoceros* (Fabricius, 1798), and *Euphausia superba* Dana, 1852 according to Tsai et al. (1986a), and 33% in *Uca pugilator* (Bosc, 1802) (cf. Eisen & Jeffry, 1969). In the detection of trypsin-like activity in the hepatopancreas of various decapods, the use of synthetic substrates such as α-p-toluenesulfonyl-L-arginine-methyl ester (TAME), Nα-benzoyl-L-arginine ethyl ester (BAEE), Nα-benzoyl-arginine-p-nitroaniline (BapNA), and N-benzoyl-DL-arginine-β-naphthylamide (BANA), has been performed, in all cases with positive results. Specific synthetic and natural inhibitors have been also used for trypsin. In *Marsupenaeus japonicus*, TAME hydrolysis is affected by phenylmethylsulfonylfluoride (PMSF), N-tosyl-L-lysine chloromethyl ketone (TLCK), and soy inhibitor of Kunitz (SBTI), where the first two are specific for trypsin and the third one is specific for serine proteinases, while N-tosyl-L-phenylalanycchloromethyl ketone (TPCK) (specific for chymotrypsin) and 1,10-phenanthroline (1,10-Phe chelating agent) did not have any inhibitory effect (Galgani et al., 1985). In *Farfantepenaeus californiensis* (Holmes, 1900), TLCK, PMSF, and SBTI inhibited