

Digestive Gland as a Feed Index for Juveniles of Queen Conch *Strombus gigas* Reared with Formulated Food

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ABSTRACT

The queen conch *Strombus gigas* is a marine resource of ecological and economical importance in all the Caribbean countries. A severe depletion of most populations due to over-fishing is forcing the establishment of regulatory measures and closure of fishing areas in most Caribbean countries. Aquaculture programs are developing in Mexico as well as in the USA and some other countries. However, one of the bottlenecks for Queen Conch culture is the lack of well adapted formulated food for optimal growth in high density rearing. Nutrient requirements for conch, as well protein and energy level as micronutrient are unknown. The digestive gland tissues of conchs fed with nine formulated feeds from 19.3 to 38.1% of proteins and 2.6–8.2% of lipids were studied by histological techniques *versus* the digestive gland from conchs fed with natural algal diet. Digestive gland was fixed in alcoholic Bouin solution and sections stained with a trichrome method including Alcian blue. This histochemical method permitted a detection of proteoglycan molecules. In wild juveniles fed on a natural algal diet, the larger columnar cells contain large proteoglycan granules that occupy most of the volume of the cells. In the digestive gland of conchs fed with various artificial diets, the granular content of the digestive cells is very scarce when compared with conchs fed on natural algal diet. Therefore, the Alcian blue staining may discriminate the nutritional status much better than a simple growth index and help to adjust better the feed formulation and the frequency of feeding to the real need of the juveniles according to their age and size.

KEY WORDS: *Strombus gigas*, culture, digestive gland, feed index.

Glandula Digestiva como un Indicaor de la Nutrición de *Strombus gigas* Cultivado con Dietas Formuladas

El Caracol rosa *Strombus gigas* es un recurso marino de importancia ecológica y económica en el Caribe. El colapso de sus poblaciones ha propiciado la implementación de diversas medidas de manejo y el cierre de áreas a la pesca. Ante esa situación la acuicultura de esta especie comenzó a desarrollarse en Harbord Branch Institute y en la granja de Turk and Caicos y en Mexico. Sin embargo uno de los cuellos de botella para el cultivo de esta especie es el diseño de dietas formuladas óptimas para el crecimiento de esta especie. Los requerimientos nutricionales son poco conocidos. El tejido de la glandula digestiva de juveniles alimentados con 9 diferentes dietas entre 19.3 a 38.1% de proteínas y de 2.6 a 8.2% de lipidos fue estudiada con tecnicas histoquímicas *versus* la glandula digestiva de juveniles alimentados con alimento natural. La glandula digestiva fue fijada en solucion Bouin y los cortes histologicos tenidos con tecnica de trichrome y azul alcian . Este método permite la detección de moléculas de proteoglicanos. Para los juveniles del medio natural con alimento natural, las células columnares de la glándula digestiva presentaron gránulos de proteoglicanos grandes; los cuales ocupan el mayor volumen de la célula. Contrariamente la glándula digestiva de los caracoles alimentados con las dietas formuladas, el contenido granular de la glándula digestiva fue escaso comparado con lo que presentan los caracol juveniles del medio natural. El azul anciano discrimina mucho mejor el status nutricional de los organismos comparado con la información de crecimiento, permitiendo a su vez ajustar la formulación de los alimentos balanceados, la frecuencia de alimentación de los juveniles en cultivo de acuerdo a su talla y edad.

PALABRAS CLAVES: *Strombus gigas*, acuicultura, dietas, indice alimenticio

INTRODUCTION

The queen conch *Strombus gigas* is a marine resource of ecological and economical importance in the Caribbean region. It has been a main source of food for the precolombian inhabitants of Caribbean coast and islands. However, queen conch meat which is a popular staple food is now consumed most as a tourist delicacy. Queen conch aquaculture has been developed in Turks and Caicos conch farm and in Florida Harbour Branch Oceanographic Institution (HBOI) (Davis, *et al.*, 1997, 2000). However, one of the bottlenecks for intensive conch farming is the

lack of formulated food for optimal growth. However, real nutrient requirements for queen conch, in terms of energy level, protein and additional micronutrients requirements are unknown (Moreno and Aldana Aranda, 2005; Shawl, *et. al.*, 2006). Shell growth and meat production are not precise enough indices of optimal food and good health. The goal of this study is to analyze the histological structure of digestive gland in various nutritional conditions as a feed index useful to evaluate and improve formulated feed for queen conch aquaculture.

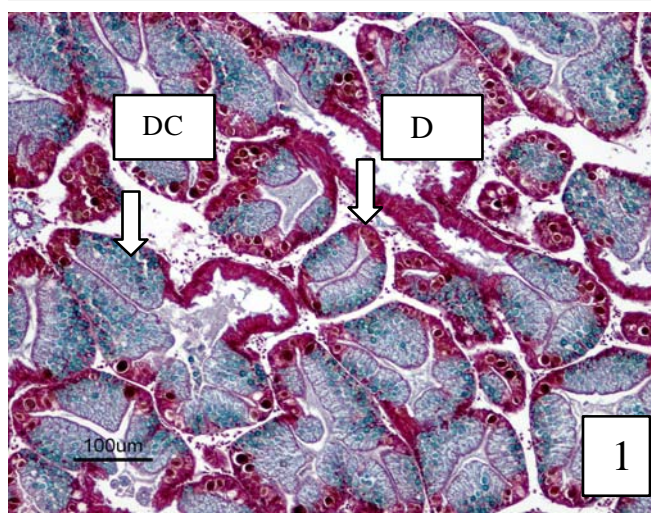


Figure 1. Structure of digestive gland of wild juvenile of *Strombus gigas*. The digestive gland is composed of branching ducts connecting the glandular tubules to the stomach. vacuolated cells containing large granules stained by Alcian blue (arrow), ducts (D), and crypt cells (*).

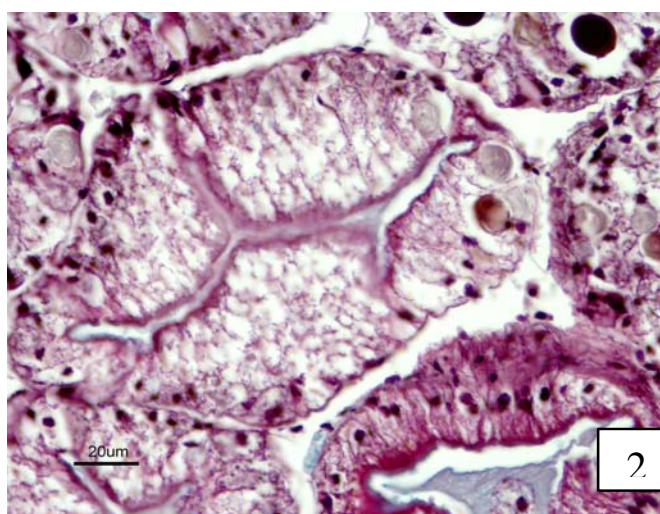


Figure 2. Structure of digestive gland of juvenile of *Strombus gigas* reared with diet 8. Blue granules of vacuolated cell have disappeared giving the cell a completely destroyed aspect.

MATERIAL AND METHODS

An experimental aquaculture facility was organized in Xcaret marine park aquarium to raise juvenile queen conchs received from Turks and Caicos hatchery. Nine formulated feeds were designed, containing three levels of protein, each one with three levels of energy. Juveniles of *S. gigas* were measured and weighted at T₀, +21, +42, +63, +84 days. The histological study was performed only on 84 day-old juveniles. The visceral hump of each sampled individual was cut into three parts. They were fixed in alcoholic Bouin fluid, and then processed through standard histological techniques. Sections were stained by a trichrome method with Alcian blue to detect proteoglycan components. The digestive gland tissues of queen conchs fed with the nine formulated feeds were analyzed *versus* the digestive gland from juvenile conchs of similar size class collected from the wild. They were also compared with the characteristics of juveniles reared on formulated food that were regressed to a diet of red and green algae common in the area of the park, offered *ad libitum* during 20 days.

RESULTS

In wild juvenile conchs, the digestive gland structure is much similar to the adult conch one. It is an array of composed tubules communicating with small ducts which join larger ducts connected to the stomach. The functional glandular structure comprises two cell types: digestive cells containing large granules stained by Alcian blue organized as functional groups alternate with crypt cells. These crypt cells contain large round yellow-brown inclusions identified in adult digestive gland as Apicomplexa organisms

(Baquero Cardenas *et al* (2007)). The mucous lining of the stomach, as well as some connective tissue cells are stained by Alcian blue, giving a positive control to the histochemical reaction.

The digestive gland of juveniles reared with various formulated feed have a different aspect.

All the experimental series are characterized by the lack of blue granules or by granules unstained by Alcian blue. Formulation 2 and 5 correspond to a normal structural aspect of the cells. However, the large granules of digestive cells are not stained blue. With formulation 8, cell membranes and intracellular granules have almost completely disappeared in the digestive and crypt cells giving the tubules a destroyed aspect.

Formulation 7 appears as the best one of the 9 tested, as the digestive gland structure still possess some blue granules which are smaller and less numerous than normal ones.

In a complementary experiment some individuals from the feeding experiment were given natural food. The digestive gland was restored to a normal status with digestive cells containing numerous blue granules.

DISCUSSION

Strombus gigas is a grazer, feeding usually on macroalgae when available and on biofilm (Davis, 2003). Feeding on formulated pellets is a very important modification of its feeding habits; however, the pellets are ingested and have been identified in the stomach. For experimental nine formulated pellets, an optimal nutritional status corresponds to the best digestive gland structure identified in diet 7 as well as to shell and flesh best growth. However

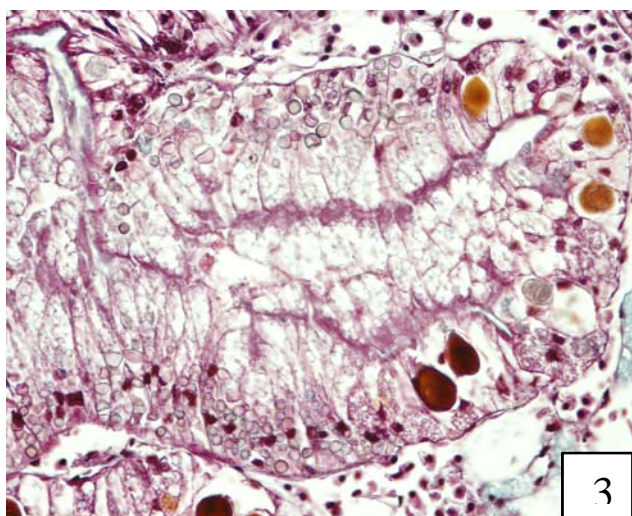


Figure 3. Structure of digestive gland of wild juvenile of *Strombus gigas* reared with diet 2. Granules of vacuolated cells are not stained blue.

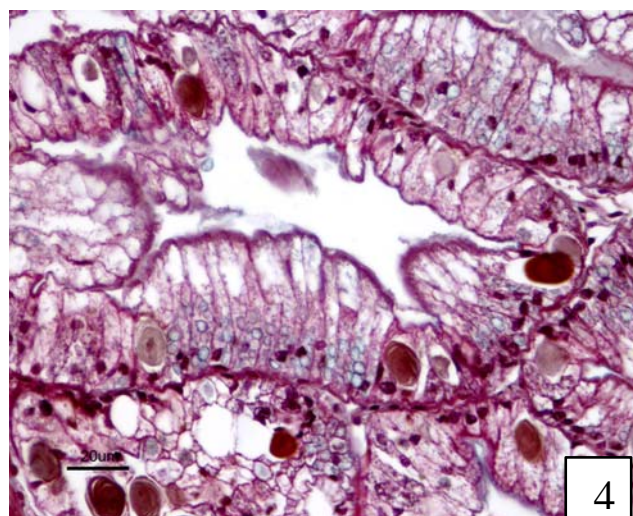


Figure 4. Structure of digestive gland of juvenile of *Strombus gigas* feed with diet 7. Vacuolated cells of digestive gland exhibits small blue granules (arrow).

the histological structure of the digestive gland demonstrates that even if the best of 9, this formulation is not optimal and has to be improved as demonstrated by the structure of the digestive gland of individuals eating natural food. Therefore, next trial will include various proportions of algae added to the best formulated pellets.

The digestive gland histological structure appears as sensitive enough to nutritional status to be elected as a feed index giving a precise evaluation of adaptation of formulated feed to the real needs of juveniles.

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