NUTRITIONAL ANALYSIS OF SEA CUCUMBERS FROM SABAH

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THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE REQUIREMENT FOR THE DEGREE OF BACHELOR OF FOOD SCIENCE WITH HONOUR (FOOD SCIENCE AND NUTRITION)

SCHOOL OF FOOD SCIENCE AND NUTRITION
UNIVERSITI MALAYSIA SABAH
KOTA KINABALU

2006

PUMS 99:1

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: NUTRITIONAL ANALYSIS OF SEA CUCUMBER FROM SABAH

IJAZAH: SARJANA MUDA SAINS MAKANAN (SAINS MAKANAN DAN PEMAKANAN)

SESI PENGAJIAN: 2003/2004

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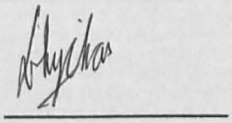

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ACKNOWLEDGEMENT

First of all, I wish to express my special appreciation for my research project supervisor, Dr. Muhammad Iqbal Hashmi. He had satisfied his time and energy and be dedicated to guide me in completing this research project. With the guidance and help from Dr. Iqbal, I could able to finish my research project.

Besides, I would like to thank the other lecturers who had kindly help me and advice me in doing this research project. I would also like to take this chance to thank all my friends who had gave me lots of help and encouraged me while doing the report. The experience of working together had brought a great memory for me. Of course, I will not forget about the dedication from my parents and family members. I manage to complete my research project with the help and encouragement from them. On the other hand, I would like to thank the lab assistants that gave me a hand while I was performing the analysis and also always help me to find out the chemicals that I needed.

It is grateful that I manage to complete my research project in time. Once again I want to thank my supervisor for his help and provided me many ideas to complete my research project. And thanks to those who have involved in my research project. Thank you.

ABSTRAK

ANALISIS PEMAKANAN ATAS TIMUN LAUT DARI SABAH

Perikanan timun laut di Malaysia adalah dieksploit di kawasan pantai laut Sabah. Timun laut yang ditangkap itu akan dijual di pasaran tempatan dan juga dieksport ke luar Negara. Timun laut diprocess dengan pendidihan dan evirasi. Timun laut dieksport dalam bentuk yang kering ataupun beku. Pengajian saintifik telah membuktikan bahawa timun laut mengandungi kandungan pemakanan serta nilai perubatan yang tinggi. Objektif yang utama bagi tesis ini adalah untuk mengkaji kandungan pemakanan dalam timun laut yang terdapat di pasaran tempatan dalam Sabah serta membandingkan komponen pemakanan di antara sampel-sampel yang telah dipilih. Sampel-sampel yang digunakan dalam kajian ini ialah *sandfish* (*Holothuria scabra*), *white teatfish* (*Holothuria fuscogilva*), *black teatfish* (*Holothuria nobilis*) dan kasut (*Holothuria fuscopunctata*). Analisis prosimat telah digunakan untuk mengkaji komposisi pemakanan yang terkandung dalam timun laut. Spektroskopi penyerapan atom digunakan untuk mengkaji kandungan mineral. Selain itu, UV spektrofotometer digunakan untuk mengkaji keterlarutan protein dalam timun laut. One-way ANOVA telah digunakan untuk menguji perbezaan signifikan dalam timun laut. Tahap signifikan telah ditetapkan pada $p<0.05$. Bagi ujian yang tidak memenuhi syarat one-way ANOVA, ujian Kruskal-Wallis telah digunakan untuk mengkaji perbezaan signifikan. Keputusan telah menunjukkan bahawa *Holothuria fuscogilva* mengandungi kandungan abu, lipid, sodium dan protein keterlarutan yang paling tinggi. *Holothuria nobilis* pula mempunyai kandungan karbohidrat, air dan besi yang paling tinggi disbanding kan dengan sampel-sampel yang lain. Selain itu, *Holothuria scabra* telah diputuskan mengandungi kandungan kalsium dan magnesium yang tinggi. Keputusan yang didapati telah menunjukkan *Holothuria fuscogilva* mengandungi protein, zink dan kuprum yang tinggi. Oleh sebab *Holothuria fuscogilva* mempunyai kandungan pemakanan yang lebih tinggi berbanding dengan spesis yang lain, kesimpulan boleh dibuatkan bahawa timun laut ini mempunyai kualiti dan kandungan pemakanan yang tinggi berbanding dengan sampel-sampel yang lain.

ABSTRACT

NUTRITIONAL ANALYSIS OF SEA CUCUMBERS FROM SABAH

Sea cucumber fisheries in Malaysia are exploited in the coastal water around the coral reef regions of Sabah. The sea cucumber which is caught in Sabah, apart from being consumed in the local market, are also exported to foreign countries. It is processed by boiling and evisceration. The exported sea cucumber is in the dried or frozen form. Scientific researches have proved that sea cucumber has high nutritional content and pharmaceutical value. The main objective of this thesis was to determine the nutritional content of sea cucumber which is available in the local market in Sabah and to compare the nutritional components among the different samples collected. The samples included sandfish (Holothuria scabra), white teatfish (Holothuria fuscogilva), black teatfish (Holothuria nobilis) and kasut (Holothuria fuscopunctata). Proximate analysis was done to determine the nutrition composition of sea cucumbers. Atomic Absorption Spectroscopy was used to determine the minerals contents. Meanwhile, UV spectrophotometer was used to measure the soluble protein content in sea cucumber. One-way ANOVA had been used to determine the significant difference among the nutritional components in sea cucumbers. Significant level was set to $p<0.05$. For the test that did not fulfill the requirement of one-way ANOVA, Kruskal-Wallis was used to determine the significant difference. Results showed that Holothuria fuscogilva had the highest content of ash, lipid, sodium and soluble protein. Holothuria nobilis had the highest carbohydrate, moisture and iron content compared to other samples. Meanwhile, Holothuria scabra had resulted in higher content of calcium and magnesium. Holothuria fuscogilva had been found to have high protein, zinc and copper content. Since Holothuria fuscogilva had high concentration of the nutrients as compared to the other species, we can conclude that it had the highest quality and nutrients content compared to the other samples.

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List of Abbreviations and Symbols

AAS	Atomic Absorption Spectroscopy
AOAC	American Official Analytical Chemist
BSA	Brovin Standard Albumin
FAO	Food and Agricultural Organization
g	Gram
m	mole
mg	Milligram
mL	Milliliter
MOH	Ministry of Health
N	Normality
nm	Nanometer
ppm	Part Per Million
p	Significant level
rpm	Revolutions per minute
SPC	South Pacific Commission
UK	United Kingdom
USA	United States of America
UV	Ultra Violet
WHO	World Health Organization
° C	Degree Celsius

CHAPTER 1

INTRODUCTION

1.1 Fisheries of Sea Cucumber in Sabah

Malaysians value sea cucumber for their medicinal benefits and also as culinary delicacies. Malays named the sea cucumber as *gamat*. They are traditionally utilized for their medicinal properties as some traditional medicines are also processed from sea cucumber. It is believed that sea cucumber is useful in wound healing, treatment of stomach ulcers and as a painkiller (Choo, 2004). Besides, the Chinese have long regarded sea cucumber as a general health tonic, beneficial for treating tendonitis and arthritis, and as an aphrodisiac. They also consider sea cucumber as culinary delicacies and is often called the "sea potato" (Fu, 1994).

The most important sea cucumber product is the dried body wall which is marketed as beche-de-mer which is also called trepang or hoi-som (FAO,1990). In Malaysia, medicines are produced by sea cucumber, for example "*gamat* oil" (Baine & Choo, 1999). Beche-de-mer fisheries have a long old story, as the Chinese and Japanese have sought sea cucumbers for a long time. As early as the Ming Dynasty (1368-1644 BC), sea cucumber was first recorded as a 'tonic food' in the Bencao Gangmu (Li, 1994). It is also recognized as a tonic and a traditional medicine in other ancient literature in China, such as Shiwe Bencao (1994).

Sea cucumbers in Malaysia are exploited off the coastal waters around the coral reef regions of Sabah in East Malaysia. The sea cucumber fishery is important in Sabah. It is because it contributes significantly to foreign exchange and provides a livelihood for the supplement of income. Sea cucumber caught in Sabah are consumed locally and exported to Peninsular Malaysia, Sarawak, Singapore, Thailand, Hong Kong, Taiwan and China (Choo & William, 2004). Besides, it also an important income for the poor coastal communities in Semporna, Sandakan, Kudat and Kota Kinabalu. The large tract of ungazetted coral reefs and reef flats in Sabah are suitable for sea cucumber collection (Choo, 2004).

Most of the sea cucumber landed in Sabah are collected by hand from shallow reef flats or by snorkeling or diving. Fishing is carried out during the day or at night as long as the weather permits and the tides are low enough to allow the fishers to walk on the reefs. The amount of days to collect sea cucumbers is about 20 days in a month (Anon, 1994). Teatfish, black fish, elephant's trunk fish and the bigger-sized sand fish are rarely found in the shallow reef flats due to over harvesting (FAO, 2004). In Kudat and Sandakan, sea cucumbers are collected with the trawl gear. Most of the sea cucumbers harvested by trawl gear are collected by trawlers of 10-24.9 gross tonnage and 25-39.9 gross tonnage fishing in waters within 30 nautical miles of the coast (Anon, 2000).

There are about 20 species of sea cucumber are commercially fished. The prices are related to the thickness of their body wall and their size. Species with a thick body wall, such as teatfish, will command a higher price than those with a thin body wall. For the "worm" species, the "large" comprises 25-30 pieces to a kilogram, the "medium

category" 70-80 pieces per kilogram, the "small category" 130-140 pieces per kg and extra small more than 180 pieces per kilogram (Anon, 2000). Semporna, Sandakan, Kudat and Kota Kinabalu are important areas for sea cucumber fisheries. Since 1990, Semporna has been the most important sea cucumber fishery area, with catches ranging from 29% to 62% of the total landings from Sabah. The landings of sea cucumber in Malaysia and Sabah are showed in Table 1.1 (Anon, 2000).

Table 1.1: Landing of Sea Cucumber in Malaysia and Sabah (metric tones)

Year	Landings (tones)	
	Malaysia	Sabah
1980		300
1981	168	300
1982	430	400
1983	435	400
1984	367	300
1985	1169	900
1986	687	500
1987	800	600
1988	616	400
1989	800	200
1990	800	400
1991	780	37
1992	800	90
1993		64
1994		142
1995		155
1996		105
1997		90
1998		123
1999		178
2000		159

1.2 Justification of Project

Various countries have implemented or conducted studies in determining the nutritional content, mainly in proximate components in the sea cucumber. However, there are very few researches done on the sea cucumbers in Sabah which relate to the nutritional content in sea cucumber. Sea cucumber is chosen as the sample due to its high commercial value and is widely consumed in Sabah. Besides, Sabah is the only state with a relatively important sea cucumber fishery which compare to the Peninsular Malaysia, there is no commercial scale sea cucumber fishery (FAO, 2004).

Human body requires a number of minerals in order to maintain good health. From the nutritional viewpoint, sea cucumber is an ideal tonic food. The presence of necessary trace elements makes it a healthy food item. Trace elements are essential for numerous human functions (Papageorgiou, 2002). The deficiency of one or more of trace elements leads to various pathologic conditions. Therefore, determination of trace elements, such as calcium, natrium, kalium, ferum, cuprum, magnesium and zinc, in sea cucumbers are performed in this project.

Soluble protein is among the water binding colloids which are large enough to remain within the intravascular space. It plays a key role in rational fluid therapy, generating sufficient colloid osmotic pressure gradient against the extravascular space to restore and/or maintain normal plasma volume. The soluble protein from sea cucumber can also used in the food industry to produce health products.

1.3 Objectives

Sea cucumber has very high commercial value and Sabah has a significant contribution to the fishery in Malaysia. Besides, it has high nutritional content. Therefore, it has chosen to be the sample for this research project. The research on the biology and ecology of the commercially important sea cucumber species will help to formulate regulations such as the minimum size for harvesting. There are 3 objectives to perform this research project which are:

a) To measure the fat, protein, crude fiber, moisture content, carbohydrate, ash and the minerals content in 4 different types of sea cucumbers.
b) To determine the content of soluble protein extracted by salt solution from the sea cucumber body wall muscle.
c) To compare nutritional values among different types of sea cucumber.

CHAPTER 2

LITERATURE REVIEW

2.1 Holothuroidea - Sea Cucumber

Sea cucumber is an abundant and diverse group of marine invertebrates (Fernandez, 2001). It has commercially exploited over a wide tropical and subtropical range for centuries. It can produce a high-value grade of beche-de-mer if processing is carried out well (Pitt & Duy, 2003). Sea cucumber plays very important roles in marine food chains. It is because sea cucumbers are detritus feeders, ingesting sediment by passing sediment through the gut (Colin, 1988) to gain nutrients from organic matter, bacteria and protozoa on mucous-covered tentacles centered around the mouth (Yang *et al.*, 2005). It can also inhibit algal blooms and decrease the content of organic matter deposited on the bottom of enclosed sea areas (Michio *et al.*, 2003). Therefore, it is named as "environmental cleaner" (Yang *et al.*, 2005).

Sea cucumber is from the phylum Echinodermata. The echinoderms are a large group of marine invertebrates processing an internal skeleton of calcareous plates and a water-vascular system of fluid-filled vessels and appendages. They are really biradially symmetrical but often appear to be radially symmetrically as adults. The body structure often consists of multiples of five in skeletal plates, spines, arms, etc. tube feet, the tactile extensions of the water-vascular system, occur on the arms and body (Colin, 1988).

Sea cucumber is an ectodermic animal. It buries itself at the bottom of the sea. It moves very slow speed by changing its body length (Motokawa, 1982; Motokawa, 1984; Eylers, 1982). It uses its radial and circular muscles to expand and contract the inside of the body wall. Two movements are available for sea cucumber, horizontal movement above the substrate and vertical movement associated with burrowing behaviour (Lokani *et al.*, 1996). The movement if start with the lifting up of front tube feet from the ground when the body is contracted. The front part of body moves forward when the body is expanded. After that, the front tube feet hold on to the ground. The rear part of the body is pulled forward when the body is contracted (Arakawa, 1990). It moves with the speed of 12 centimeters per minutes (Lokani *et al.*, 1996).

2.1.1 Morphology of Sea Cucumber

The colour of sea cucumber's body varies greatly from dark brown, dark purple, brown, grayish, yellowish to white. The body of sea cucumber is in cylinder shape with a slightly stretched posterior end. It forms a globule when it contracts. The tube feet are large and retractile, usually located on the ventral radials. Tube feet are one of the numerous external, fluid-filled muscular tubes of echinoderms, such as the starfish or sea urchin, serving as organs of locomotion, food handling, and respiration (Levin & Gudimova, 2000). Breathing is by means of the skin, tube feet or internal respiratory trees. Its body often contains a toxin, called "holothurin" which makes them distasteful (Colin, 1988).

Sea cucumber uses its twenty oral tentacles to collect food (Conand *et al.*, 1998). These tentacles are straight or curved rods and sometimes with single holes present (Levin & Gudimova, 2000). Its oral tentacles average 4.8 mm in length. The digestive

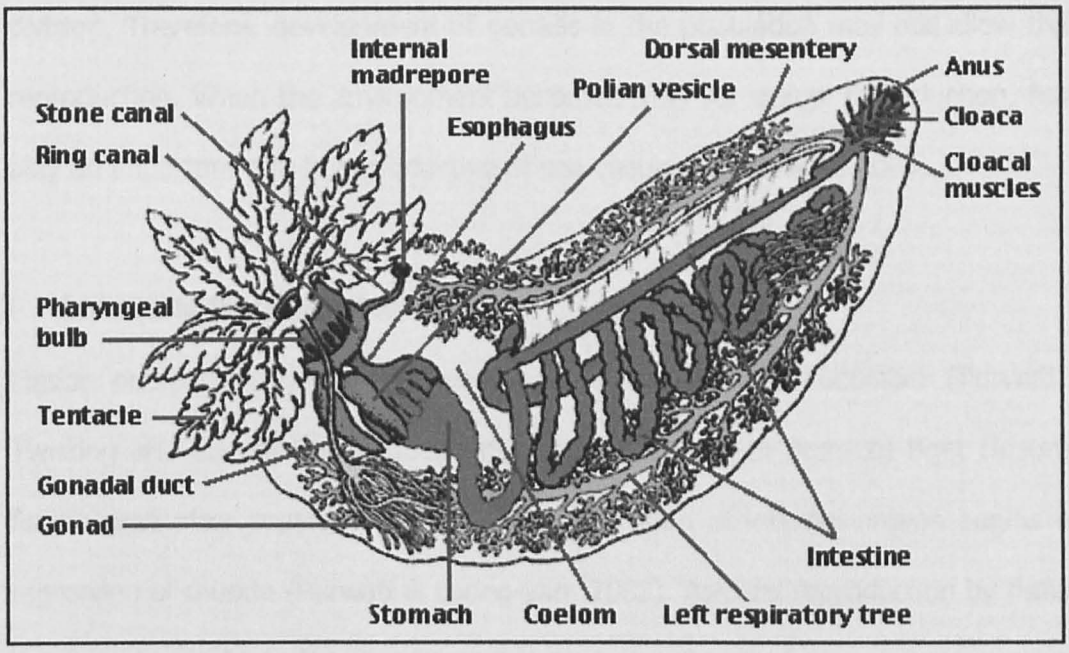
tract has a thin wall and formed three loops. The average length of the digestive tract is 302.4 mm. The transverse vessel links the first loop to the second. The *rete mirabile* is at the top of the second loop (Conand *et al.*, 1998).

Vascular system in sea cucumber is the water vascular system. The turgescence of the oral tentacles comes from the 20 vesicles of the oral podia situated in pairs around the peripharyngeal calcareous ring. The average length of the vesicles of the oral podia is 22 mm. The Polian vesicle is located under the peripharyngeal calcareous ring and its average length is 15 mm (Conand *et al.* 1998).

Genital glands are in the form of two tufts located on either side of the dorsal mesentery and attached by gonadal base. The gonads are in the form of the branch of tubules (Conand *et al.* 1998). The respiratory system is formed from the respiratory trees which is opened into the cloaca and extend into the coelomic cavity (Conand *et al.* 1998).

The body wall of sea cucumber is rigid and firm. Its mass constitutes up to 20% of the total mass of sea cucumber (Levin & Gudimova, 2000). Besides, it is composed of a thin pigmented outer layer of connective tissue with mutable mechanical properties (Motokawa, 1984*a*, 1984*b*,; Trotter & Koob, 1995). These properties can be altered by the nervous system (Motokawa, 1984*b*; Wilkie, 1984; Motokawa, 1988). Therefore, it able to change the properties of the dermis which is composed of collagen fibrils, proteoglycans, a microfibillar network, other protein and glycoprotein, nerve fibers and neurosecretory cells, in locomotion and protection (Hyman, 1955; Motokawa, 1984*a*,*b*; Thurmond & Trotter, 1996; Wilkie, 1984, 1996).

Figure 2.1: Anatomy of Sea Cucumber (Kerr, 2004)



2.1.2 Reproduction of Sea Cucumber

2.1.2.1 Sexually Reproduction

Sea cucumber can reproduce with both sexually by broadcast spawning and asexually by transverse fission (Conand *et al.*, 2003). Spawning in tropical sea cucumber such as the sea cucumber in Malaysia is usually induced through the application of short-term environmental stresses (Battaglene *et al.*, 2002). External factors involved in affecting the sea cucumber gametogenesis and spawning are temperature, light intensity, photo period, salinity, tidal flux, food availability and changes in food type (Smiley *et al.*, 1991). The sexual reproduction is important in sea cucumber due to the reduction of juveniles among the population (Purwati & Luong-van, 2003). The sea cucumber lifts the anterior end of the body from the substratum during spawning to facilitate dispersal of gametes and fertilization (McEuen, 1988). Males spawn before female and sperm is a proximal signal for females to spawn (McEuen, 1988; Smiley *et al.*, 1991). Sexual reproductive

efficiency may decrease when the sea cucumber becomes smaller in size due to self-division. Therefore, development of gonads in the population may not allow the sexual reproduction. When the environment becomes risky for sexual reproduction, fission will play an important role in reproductive of sea cucumber (Purwati, 2003).

2.1.2.2 Asexually Reproduction

Fission occurs throughout the year in populations of sea cucumber (Purwati, 2003). Twisting and constricting happen prior to fission. It is to promote tight closure of the fission area after separation of body. Regeneration of internal organs begins with the regrowing of muscle (Purwati & Luong-van, 2003). Asexual reproduction by fission helps to maintain the high-density of populations in small individuals, such as sea cucumber, or increase the density (Chao *et al.*, 1993; Conand *et al.*, 1998; Uthicke, 1997). Fission is also a secondary strategy when sexual reproduction is failed where insufficient number of breeders or failure during embryonic and larval stage (Purwati, 2003). According to Conand *et al.* (2002), males have a higher potential to undergo fission compare to the females. The diagram below shows the anatomy of the sea cucumber in the progress of regenerating.

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