

Management of Sea Cucumber Fishery in Sri Lanka, Sustainable Utilization and Value Addition

By

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Ph.D.

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**Management of Sea Cucumber Fishery in Sri Lanka,
Sustainable Utilization and Value Addition**

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**Thesis submitted to the University of Sri Jayewardenepura for
the award of the Degree of Doctor of Philosophy in Zoology**

This thesis is dedicated

to

my parents

Mr. S. Ganeshan and Mrs. K.E.G. Mary Nona Kumarage

and

my loving wife

Mrs. K. Wathsala Indumathy

for their love, continued encouragement

and

tremendous support in every step that I make in my life.

DECLARATION

The work described in this thesis was carried out by me at the Department of Zoology and Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura under the supervision of Dr. D.C.T. Dissanayake, Senior Lecturer, Department of Zoology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Prof. Indira Wickramasinghe, Professor, Department of Food Science and Technology, Faculty of Applied Sciences, University of Sri Jayewardenepura, Dr. D.V.P. Prasada, Senior Lecturer, Department of Agricultural Economics and Business Management, Faculty of Agriculture, University of Peradeniya and Dr. M.D.S.T. de Croos, Senior Lecturer, Department of Aquaculture and Fisheries, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka. A report on this work has not been submitted in whole or in part to any University or any institution for another degree/diploma.

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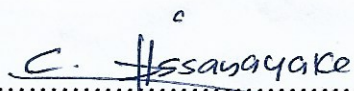
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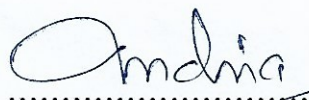
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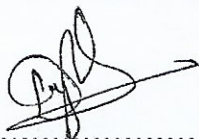
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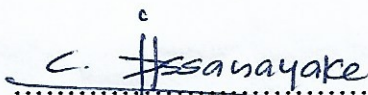
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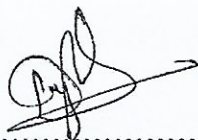
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LIST OF ABBREVIATIONS

ANOVA	-	Analysis of variance
AOAC	-	Association of Official Analytical Chemists
AR	-	Analytical reagent
CPUE	-	Catch per unit effort
DFAR	-	Department of Fisheries and Aquatic Resources
FAME	-	Fatty Acid Methyl Esters
FAO	-	Food and Agriculture Organization
GC/MS	-	Gas Chromatography/Mass Spectrometry
HP	-	Horsepower
HPLC	-	High-Performance Liquid Chromatography
ITI	-	Industrial Technology Institute of Sri Lanka
LDPE	-	Low-density polyethylene
MUFA	-	Monounsaturated fatty acids
NAQDA	-	National Aquaculture Development Authority
NARA	-	National Aquatic Resources Research and Development Agency
PUFA	-	Polyunsaturated fatty acids
SCUBA	-	Self-contained underwater breathing apparatus
SD	-	Standard Deviation
SFA	-	Saturated fatty acids
SLSI	-	Sri Lanka Standards Institution
SWOT	-	Strengths, Weaknesses, Threats and Opportunities
USDA	-	United States Department of Agriculture
UVC	-	Underwater Visual Census

Management of Sea Cucumber Fishery in Sri Lanka, Sustainable Utilization and Value Addition

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ABSTRACT

Sea cucumbers belonging to class Holothuroidea of the phylum Echinodermata are soft-bodied, elongated, worm-like marine organisms. The sea cucumber fishery was introduced to Sri Lanka by the Chinese and *bêche-de-mer* is one of the major commodities taken to China for centuries. Due to poor catch rates as well as poor postharvest practices, both fishers and processors lose their income considerably. Therefore, this study was carried out to evaluate the status of sea cucumber fishery and processing processes in Sri Lanka in order to propose suitable measures for sustainable utilization and value addition.

To achieve this objective, sea cucumber fishing pattern and the socio-economic characteristics of the fisher communities in the north, northwest and northeast regions of Sri Lanka were assessed using the data collected from November 2015 to January 2017. As entire sea cucumber harvest is exported after processing as *bêche-de-mer*, major steps involved in the processing of seven sea cucumber species; *Bohadschia marmorata*, *Stichopus chloronotus*, *Holothuria spinifera*, *Thelenota anax*, *Holothuria scabra*, *Bohadschia vitiensis* and *Bohadschia* sp. 1 were studied through questionnaires and direct observations of processing activities carried out by both industrial and domestic level processors. Strengths, weaknesses, opportunities and threats of current processing methods were identified and impacts of processing on proximate composition and fatty acid profile of these species were investigated. An attempt was made to develop species-specific processing practices using 3 model species, *S. naso*, *H. spinifera* and *B. vitiensis*, subjecting them to different processing practices by interchanging major processing steps. To further increase the value and sustainable utilization of sea cucumber harvests, a ready to drink soup mix was prepared using highly abundant low-value *B. vitiensis*. The best

composition of soup mix was selected based on the sensory test and the initial chemical and microbial qualities were analysed. The best packaging material was selected based on shelf-life studies.

A total of 9 sea cucumber species harvested in these areas using 4 fishing methods; SCUBA diving, breath-hold diving, gleaning and surrounding nets. SCUBA diving is the dominant fishing method and SCUBA divers do both day and night fishing reporting the highest catch rates (CPUE \pm SD in numbers/person/day) and income levels than the other fishers ($p < 0.05$; ANOVA). The current sea cucumber fishery mainly depends on low-value species and *B. vitiensis* made the highest percentage contribution (61.3%) to the total sea cucumber landings during the study period. This updated information on fishery will be useful for sea cucumber management authorities of Sri Lanka to implement suitable management measures to avoid further depletion of these valuable resources.

Domestically processed *bêche-de-mer* always reported a higher percentage of moisture, crude ash, crude fat and a lower percentage of crude protein than industrially processed ($p < 0.05$; ANOVA). Although processing resulted in a significant reduction of total SFA and MUFA in fresh individuals of most of the species, total PUFA increased significantly in processed individuals excluding *Bohadschia* species. The most suitable processing steps for *S. naso*, *H. spinifera* and *B. vitiensis* were identified and major processing steps found to be varied with species. The organoleptically best soup mix contains high protein ($21.43 \pm 1.21\%$) and low fat ($4.98 \pm 0.23\%$) and it is safe for human consumption. The Polyester-Aluminum-PE was selected as the best packaging material with 6 weeks shelf life at room temperature. This study provides a detailed insight into the sea cucumber fishery in Sri Lanka and some potential mechanisms for management, sustainable utilization and value addition.

Keywords: Sea cucumbers, Fishery, Sustainable utilization, Processing, Value-addition