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A GUIDE TO THE GRADING OF FISH AND SHELLFISH

A Collaborative Project between



Marine Fisheries Research Department (MFRD)
Southeast Asian Fisheries Development Center
Singapore

and



Fish Inspection and Quality Control Division (FIQD)
Department of Fisheries
Ministry of Agriculture and Co-operatives
Thailand

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER



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FOREWORD

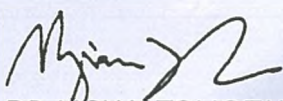
Fish remains the major source of protein for the people of Southeast Asia in spite of the shift to red meats with the increase in affluence in the region. In ensuring that fish sold in our markets are of good and acceptable quality, it is important to have a fish quality assessment method that is easy to use, rapid, accurate, low cost and most of all easily carried out in the field by fish inspectors, wholesalers, retailers and processors. Of the range of tests available : instrumental, chemical, biochemical, microbiological, and sensory; sensory analysis meets the requirements. Sensory analysis is the scientific discipline that evokes, measures, analyzes and interprets reactions to product characteristics through the senses of sight, smell, taste, touch and hearing.

As fish spoils, it goes through a sequence of changes that are readily detectable by the human senses. A trained person soon learns to recognize the pattern of changes and can readily assess the freshness of a sample.

This manual endeavours to guide fish wholesalers, retailers, processors, inspectors and technologists who are confronted with the need to use sensory tests to evaluate the quality of fish and shellfish under iced storage. It also aims to objectively reflect the sensory changes in fish and shellfish with the chemical, biochemical and microbiological indices. The manual has been made user friendly by organising the data as simply as possible and by providing many coloured plates of fish and shellfish at different stages of spoilage to serve as a basis for comparison.

I am sure that this publication will provide an objective and useful reference for fish wholesalers, retailers, processors, inspectors and technologists in the region. In this effort, the English edition published by the Marine Fisheries Research Department will be followed by the Thai edition to be published by the Department of Fisheries, Thailand.

I wish to congratulate the Department of Fisheries, Thailand, and the Marine Fisheries Research Department, SEAFDEC, Singapore, on this fine joint effort towards the improvement of fish quality in the ASEAN region.



DR. NGIAM TONG TAU
SEAFDEC COUNCIL DIRECTOR FOR SINGAPORE and
DIRECTOR, PRIMARY PRODUCTION DEPARTMENT,
MINISTRY OF NATIONAL DEVELOPMENT,
SINGAPORE

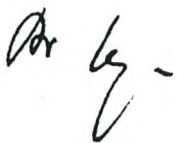
FOREWORD

Quality and safety of food is an important factor directly affecting consumer health. Seafood plays a vital role as a source of protein for people in Southeast Asian region. Prices of seafood could be high compared to other food products. Hence, fish processors need to realise the significance and pay more attention to proper handling techniques. Processors should select good quality raw materials for further processing into finished products that meet requirements and standards of buyers or importing countries.

Sensory evaluation is a method used for assessing the quality of both raw materials and finished products. Sensory evaluation is recognised worldwide as the most important test for quality. It remains the most widely applicable, rapid, inexpensive and effective procedure. Reliability can be acquired through extensive and regular trainings.

This publication has been established to serve as a reference and guideline for fish processors, researchers and interested persons to objectively and accurately assess quality of fish and shellfish. Fish and shellfish selected to appear in this manual are commercially important and representatives of major species traded in this region. It is also determined to be used as a training manual especially for quality control personnel. Raw materials possessing high and uniform quality should, in turn, produce good and acceptable quality finished products. This would subsequently lead to the improvement of the fish industry as a whole.

I hope that this publication “A Guide to the Grading of Fish and Shellfish” will assist the fish industry in Southeast Asia to develop and improve inspection and quality control system to achieve internationally acceptable standards. This could also contribute to the minimising and eliminating of detention problems issued by importing countries due to sub-standard quality. As a result, the processors should be able to substantially reduce economic losses and also maintain the sustainability and growth of fishery trade and industry in the ASEAN region.



MR. MONTRI KLITSANEEPHAIBOON
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We are sincerely grateful to the Thai Department of Fisheries and Japan International Cooperation Agency's (JICA) project on Quality Development of Fisheries Products (Thailand) for funding the research part conducted in Thailand as well as the publishing of an up-coming Thai version.

Special thanks to MFRD and FIQD staff for their cooperation, hard work and effort.

EXPLANATORY NOTES

This manual is expected to be a comprehensive guide to quality assessment of seafood. Illustrations with explanation on sensory characteristics provide readers a clearer picture of how quality of iced stored fish and shellfish deteriorates. The information on sensory characteristics, chemical and microbiological results in this manual was based specifically on experiments carried out under this project. The fish and shellfish obtained for this study were of the best quality obtainable from commercial fishing boats, fish farms and wholesale markets in Thailand and Singapore. The fish and shellfish studied were stored in ice as ice storage is the most common means of keeping the freshness of fish in Southeast Asia.

Though sensory analysis is recognised as rapid, effective and suitable for field work, a combination of sensory, chemical and microbiological analyses as used in this manual would allow for a more accurate judgment. It should be kept in mind that this manual serves only as a guideline and reference for quality assessment. Spoilage patterns of fish including sensory, chemical and microbiological properties may vary due to many factors such as size, sex, age, seasons, sources, catching methods, feeding habits, storage conditions, handling practices, etc.

This manual is intended for use by quality control personnel, researchers, fish traders and interested persons. However certain technical terms found in this book may not be familiar to all. The following are definitions of important keywords :

Carapace Dorsal and lateral shield-like plate covering the cephalothorax of decapods and certain other crustaceans.

Histamine Histamine is indicative of decomposition mostly found in fish of the families Scombridae and Scomberesocidae. Histamine forms postmortem by bacterial action on the amino acid, L-histidine. Histamine is heat-stable and survives thermal processing. Tuna and mackerel are most frequently involved in instances of histamine poisoning or widely known as “Scombroid Poisoning”. The most common symptoms are nausea, vomiting, abdominal cramps and diarrhoea, facial swelling and flushing. The presence of 50 ppm (5 mg/100g) or more histamine indicates decomposition.

K-value An index to measure the enzymatic freshness of fish. Immediately after death, ATP (adenosine triphosphate) and related compounds are broken down by endogenous enzymes. A typical schematic breakdown can be represented as :-



ADP	=	adenosine diphosphate
AMP	=	adenosine monophosphate
IMP	=	inosine monophosphate
HxR	=	inosine or hypoxanthine riboside
Hx	=	hypoxanthine

The K value is defined as

$$K \% = \frac{[HxR] + [Hx]}{[ATP] + [ADP] + [AMP] + [IMP] + [HxR] + [Hx]} \times 100$$

Nape odour	Odour perceived by sniffing at the cut-through flesh of fish at nape, located between head and body of fish on the dorsal.
Operculum	Gill cover, a flaplike outer protective covering for the gills of fish.
Total length (of fish)	Measured from the tip of the jaw to the tip of the upper lobe of caudal fin.

Sensory characteristics in this manual were observed and recorded by 2 - 5 sensory specialists. Chemical analyses of K-value, pH and moisture content were performed according to Laboratory Manual on Analytical Methods and Procedures for Fish and Fish Products (Miwa and Low, 1992). The method used for determination of histamine is specified in A.O.A.C. (1990). The method used for determination of Total Plate Count is specified in Bacteriological Analytical Manual, 6th edition (1984).

**ILLUSTRATION, SENSORY, CHEMICAL
AND
MICROBIOLOGICAL GUIDELINES**

FOUR-FINGERED THREADFIN

SCIENTIFIC NAME:

Eleutheronema tetradactylum

UTILIZATION:

Food dishes

ABOUT THE EXPERIMENT

Culture area:

Kukup island, Malaysia

Before arrival at MFRD Laboratory:

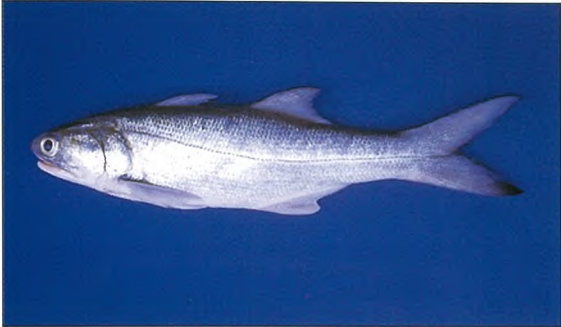







Cold shocked at pond, one night transfer in ice

Ice storage condition:

Fish: Ice = 1:2, ice changed daily



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
A	0 - 4		
B	4 - 9		
C	9 - 17		
D (Reject)	> 17		

FOUR-FINGERED THREADFIN

Characteristics					
Eyes	Body surface	Gills	Viscera	Flesh	Belly flap
Bright, clear, protruding, intact	Silver grey, bright and shiny, intact scales, slight seaweedy to neutral odour	Liver red colour, seaweedy or neutral odour, slight slime	Firm and intact, normal gut odour	White, opaque colour, firm and resilient texture, sweet or neutral odour	White colour, no bile stain present
Slightly sunken, cloudy, intact	Slight faded grey, slight opalescent sheen, no slime, some loose scales, neutral odour, firm and resilient texture	Deep dark, dull red to brown colour, neutral to slight salted fish odour, slight slime	Soft but intact, normal gut odour	White, opaque colour, firm and resilient texture, sweet or neutral odour	Pinkish with blood stain, bile stain present
Sunken to badly sunken, cloudy, opaque eyeballs and bloody cornea	Faded grey, slightly dull, no slime, many loose scales, strong fishy and slight amine odour, slightly firm and resilient texture	Dull red to brown, fishy to slight salted fish odour, moderate slime	Soft but intact, slightly fishy	Whitish pink, neutral to slightly fishy odour, slightly soft and resilient	Pinkish white with blood stain, bile stain present
Badly sunken, cloudy and opaque eyeballs, bloody cornea	Dull, faded grey, blood stain on operculum, no slime, many loose scales, strong putrid and nauseating odour, soft and non-resilient texture	Dull red to brown, fruity, putrid and nauseating odour, moderate slime	Soft and digested, strong salted fish odour to rancid, putrid	Pinkish white, blood stain present, salted fish odour, soft, gaping	Pinkish white with blood stain, soft belly wall, belly burn

SENSORY QUALITY CHANGES IN FOUR-FINGERED THREADFIN

	Grade	A	B	C	D(Reject)																		
Eyes	Sunken	Protruding	Slightly sunken	Sunken	Badly sunken																		
	Transparency	Bright, clear, intact	Cloudy, intact	Cloudy, slightly bloody	Cloudy, opaque, slightly bloody	Cloudy, opaque, bloody																	
Body surface	Colour	Silver grey, yellow tinge at lateral line	Slightly faded grey	Slightly pinkish along lateral line towards tail	Dull, faded grey																		
	Shine	Bright, opalescent sheen	Slightly opalescent sheen	Slightly dull	Slightly yellowish, blood stain on operculum																		
	Slime	Slimy	Slight watery slime	No slime																			
	Scales	Intact		Some loose scales	Many loose scales																		
	Odour	Sl. sea-weedy	Neutral		Slightly fishy to slight salted fish odour	Strong fishy, slight amine	Strong putrid, nauseating																
	Texture	Firm and resilient			Slightly firm and slightly resilient	Soft and resilient																	
Gills	Colour	Liver red		Deep dark/dull red	Dull red to dark brown	Dull red to brown																	
	Odour	Seaweedy	Neutral	Neutral to slight amine	Neutral to slight salted fish odour	Fishy, salted fish odour	Strong fishy and salted fish odour	Fruity, putrid, nauseating															
	Slime	None to slight slime				Moderate slime																	
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

		Grade		A	B	C	D(Reject)																
Viscera	Texture	Firm and intact	Slightly soft, intact	Soft, intact			Soft and digested																
	Odour	Normal gut odour		Normal gut odour to slight fishy	Slight fishy odour	Salted fish odour	Strong salted fish odour, rancid																
Flesh	Colour	White, opaque		Slightly yellow	Whitish pink to pink		Pinkish																
	Odour	Sweet, neutral			Neutral to slightly fishy		Salted fish odour																
	Texture	Firm and resilient		Soft and resilient			Soft and non-resilient slightly gaping																
Belly flap	Colour	White	Pinkish white with blood stain																				
	Bile stain	Absent	Present																				
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR FOUR-FINGERED THREADFIN

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
A	0 - 4	76 - 80	6.2 - 6.4	0 - 13	< 50	50-3x10 ³	< 50-1x10 ³
B	4 - 9	76 - 80	6.2 - 6.5	12 - 24	< 50-1x10 ²	50-9x10 ³	< 50-9x10 ³
C	9 - 17	78 - 80	6.3 - 6.5	22 - 37	< 50-3x10 ⁵	2x10 ² -3x10 ⁵	4x10 ² -9x10 ³
D (Reject)	> 17	> 79	>6.4	> 34	> 4x10 ⁴	>2x10 ⁴	>5x10 ²

Remarks * Should be considered as a possible trend only, not to be used as major criteria for grading

RED SNAPPER

SCIENTIFIC NAME:

Lutjanus altifrontalis

UTILIZATION:

Food dishes, frozen whole/fillet

ABOUT THE EXPERIMENT

Culture area:

Northern part of Singapore

Before arrival at MFRD Laboratory:




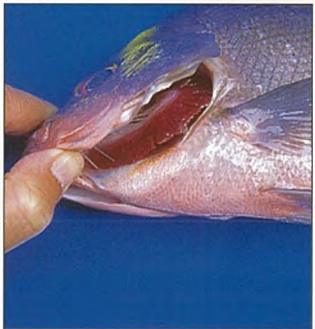


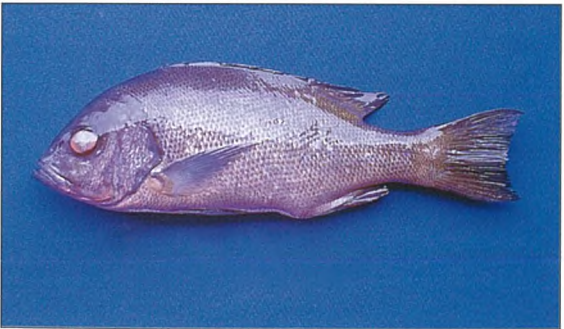

Cold shocked at pond, arrived in two hours in ice

Ice storage condition:

Fish: Ice = 1:2, ice changed daily



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
A	0 - 4		
B	4 - 8		
C	8 - 12		
D (Reject)	> 12		

RED SNAPPER

Characteristics					
Eyes	Body surface	Gills	Viscera	Flesh	Belly flap
Protruding, black, bright cornea and clear (could be reddish), intact	Dark brown on dorsal, reddish orange on ventral (colour may vary according to culture areas), bright and shiny, slimy, intact scale, seaweedy odour, firm and resilient texture	Bright red, seaweedy odour, none to slight slime	Firm and intact, normal gut odour	Pinkish white along lateral line, pinkish green along dorsal, neutral odour, firm and resilient to slightly soft texture	Shiny white, no bile stain present
Slightly sunken, slightly cloudy, bloody cornea, intact	Same colour and shine as A, intact scale, neutral to slight fishy odour, slightly firm and resilient texture	Liver red colour, strong fishy odour, copious slime	Firm and intact, normal gut odour to strong fishy	Pinkish white along lateral line, pinkish green along dorsal, neutral to slightly fishy odour, soft and non-resilient texture	Slightly pinkish white, bile stain present
Sunken, slightly cloudy, bloody cornea, intact	Dark brown, slightly reddish, slightly shiny, slightly watery slime, some loose scales, fishy odour, soft and resilient texture	Deep dark red, salted fish odour to slight putrid odour, copious slime	Firm and intact, normal gut odour to slight putrid	Same colour as A, neutral to slightly fishy odour, very soft and gaping	Slightly pinkish white, bile stain present
Badly sunken to swollen, cloudy, opaque, dull and bloody, damaged	Dull brown dorsal, dull to faded red ventral, dull surface, slight to no slime, many loose scales, strong fishy odour to putrid soft and non-resilient texture	Dull red or pale brown / bleached, slightly to strong putrid, fruity, nauseating, copious slime	Soft and digested, strong fishy, fruity, putrid	Pinkish white flesh to dark brown / bleached, fishy, putrid, sour or nauseating, very soft and non-resilient, extensive gaping	Pinkish white, bile stain present or burn

SENSORY QUALITY CHANGES IN RED SNAPPER

Grade		A	B	C	D(Reject)																				
Eyes	Sunken	Protruding	Slightly sunken	Sunken	Badly sunken	Swollen																			
	Transparency	Bright, clear, intact	Slightly cloudy, reddish		Cloudy, opaque	Cloudy, opaque bloody																			
Body surface	Colour	Dark brown on dorsal, reddish orange on ventral		Dark brown, light reddish	Dull brown, dull red	Dull brown, faded pink																			
	Shine	Bright, opalescent sheen		Slightly shiny	Dull, no shine																				
	Slime	Slimy		Slight watery slime	None to slight slime																				
	Slime	No slime				No slime																			
	Scales	Intact		Some loose scales	Many loose scales																				
	Odour	Seaweedy	Neutral to slight fishy	Fishy	Strong fishy	Strong fishy and strong putrid	Very strong putrid, nauseating																		
Texture	Firm, resilient	Slightly firm	Soft, resilient	Soft, non-resilient																					
Gills	Colour	Bright red	Liver red	Dull red	Dull red, faded brown	Pale brown, bleached																			
	Colour					Bleached																			
	Odour	Seaweedy	Strong fishy	Salted fish odour to slight putrid	Slightly fruity, putrid	Strong putrid	Strong nauseating, strong putrid																		
	Slime	Slight slime	Copious slime																						
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

Grade		A	B	C	D(Reject)																				
Viscera	Texture	Firm and intact		Soft and digested																					
	Odour	Normal gut odour	Strong fishy, slight putrid		Slight fruity, putrid	Putrid, nauseating																			
Flesh	Colour	Pinkish white and yellowish meat, greenish along dorsal		Pinkish meat, greenish along dorsal		Pinkish white, dark brown meat, bleached																			
	Odour	Neutral		Slight fishy	Slight fishy and putrid	Putrid and slight sour	Sour, nauseating																		
	Texture	Firm and resilient	Soft and non-resilient	Very soft and non-resilient																					
Belly flap	Colour	Shiny white	Slightly pinkish white			Yellowish																			
	Bile stain	Absent	Present																						
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR RED SNAPPER

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
A	0 - 4	74 - 77	6.0 - 6.3	0 - 12	< 50-2x10 ³	<50-3x10 ⁴	<50-3x10 ²
B	4 - 8	74 - 78	6.0 - 6.3	7 - 18	<50-3x10 ⁴	3x10 ² -7x10 ⁴	<50-3x10 ²
C	8 - 12	75 - 78	6.1 - 6.3	17 - 27	1x10 ⁴ -3x10 ⁴	7x10 ³ -7x10 ⁴	<50-4x10 ²
D (Reject)	> 12	> 75	>6.1	> 20	> 1x10 ⁴	>3x10 ²	>50

Remarks * Should be considered as a possible trend only, not to be used as major criteria for grading

SEABASS

SCIENTIFIC NAME:

Lates calcarifer

OTHER COMMON NAMES:

Giant seaperch

Cock-up

Barramundi

UTILIZATION:

Food dishes, frozen whole/fillet

ABOUT THE EXPERIMENT**Culture area:**

Chachengsao province, Thailand

Before arrival at FIQD Laboratory:









Cold shocked at pond, arrived in two hours in ice

Ice storage condition:

Fish: Ice = 1:2, ice changed daily



SENSORY GUIDELINES

Grade	Approximate day (s) in ice	Illustration	
A	0 - 4		
B	4 - 11		
C	11 - 17		
D (Reject)	> 17		

FOR SEABASS

Characteristics					
Eyes	Body surface	Gills	Viscera	Flesh	Belly flap
Bright, clear, protruding, intact	Bright silver grey, bright and shiny, copious slime, intact scales, neutral odour, firm and resilient texture	Bright liver red, neutral or slight seaweedy odour, none to slight slime	Firm and intact, normal gut odour	Grey, whitish, neutral odour, firm and resilient texture	Shiny white, no bile stain present
Slightly sunken, slightly cloudy eyeballs, slightly bloody cornea	Silver grey, opalescent sheen, no slime, intact scales, neutral odour, firm and resilient texture	Deep dark red, neutral odour, moderate slime	Firm and intact, normal gut odour	Pinkish, neutral to slightly sweet odour, firm and resilient texture	Pinkish, bile stain present
Sunken or slightly swollen, opaque eyeballs, bloody cornea	Slightly bleached, opalescent sheen, dry surface, many loose scales, slightly fishy odour, slightly firm and resilient texture	Bleached, brown, slight fishy and slight rancid odour, copious slime	Firm and intact, slight fishy odour	Pinkish, neutral to slightly sweet odour, firm and resilient texture	Pinkish and yellowish, bile stain present
Badly sunken or very swollen, opaque eyeballs, very bloody cornea	Extremely bleached, dull, dry surface, many loose scales, fishy, putrid and nauseating odour, soft and non-resilient texture	Very bleached, pale brown, rancid and putrid odour, copious slime	Soft and digested, fishy and rancid odour	Slightly green, fishy and putrid odour, soft and non-resilient texture	Yellowish, belly burn

SENSORY QUALITY CHANGES IN SEABASS

Grade		A	B	C	D(Reject)																							
Eyes	Sunken	Protruding	Slightly sunken	Sunken	Badly sunken	Swollen	Very swollen																					
	Transparency	Bright, golden, clear, intact	Slightly cloudy, slightly bloody	Cloudy, bloody	Opaque, bloody		Very bloody																					
Body surface	Colour	Bright silver grey		Faded blue grey	Slightly bleached	Extremely bleached																						
	Shine	Bright, shiny		Opalescent sheen		Dull, no shine																						
	Slime	Copious slime	No slime	Dry surface																								
	Scales	Intact		Many loose scales																								
	Odour	Neutral			Slightly fishy		Strong fishy, slightly putrid	Strong fishy, putrid, nauseating																				
	Texture	Firm, resilient				Soft, resilient		Soft, non-resilient																				
Gills	Colour	Bright liver red		Deep dark red		Bleached, brown																						
	Odour	Neutral, slight seaweedy			Slight fishy, slight rancid	Rancid putrid	Strong putrid																					
	Slime	None to slight slime	Moderate slime	Copious slime																								
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Viscera

Grade	A	B	C	D(Reject)
Texture	Firm and intact			Soft, intact Soft and digested
Odour	Normal gut odour		slight fishy	Slight putrid Fishy, strong putrid

Flesh

Colour	Grey white	Slightly pink		Slightly green
Odour	Neutral	Neutral, slight sweet odour		Fishy, slight putrid Strong putrid
Texture	Firm, resilient			Soft, resilient Soft, non-resilient Soft, gaping

Belly flap

Colour	Shiny white	Pinkish	Pinkish and yellowish	Yellowish
Bile stain	Absent	Present		Belly burn

Day(s) in ice 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR SEABASS

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
A	0 - 4	76 - 78	6.1 - 6.7	0 - 25	< 50	$7 \times 10^2 - 7 \times 10^3$	$5 \times 10^2 - 3 \times 10^3$
B	4 - 11	76 - 78	6.1 - 6.6	23 - 34	< 50	$4 \times 10^2 - 1 \times 10^4$	$2 \times 10^2 - 2 \times 10^3$
C	11 - 17	78 - 80	6.3 - 6.6	33 - 48	$4 \times 10^2 - 6 \times 10^5$	$1 \times 10^3 - 6 \times 10^5$	$1 \times 10^3 - 2 \times 10^4$
D (Reject)	> 17	> 77	> 6.3	> 45	$> 1 \times 10^5$	$> 7 \times 10^4$	$> 1 \times 10^3$

Remarks * Should be considered as a possible trend only, not to be used as major criteria for grading

EASTERN LITTLE TUNA

SCIENTIFIC NAME:

Euthynnus affinis

UTILIZATION:

Canned products

ABOUT THE EXPERIMENT**Catch area:**

South China Sea, landed in Pattani province, Thailand

Before arrival at FIQD Laboratory:

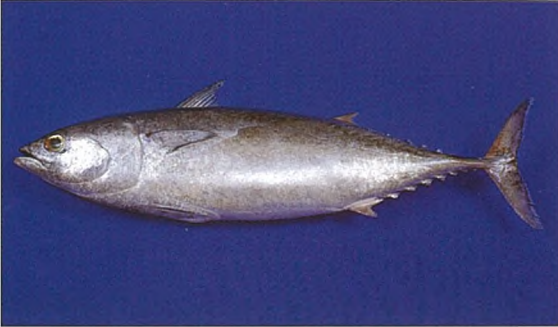
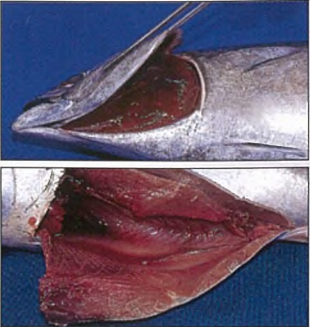

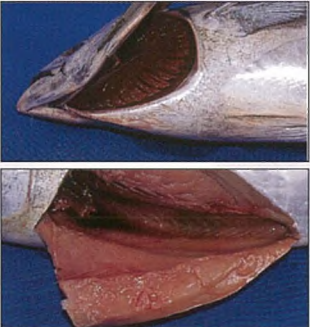

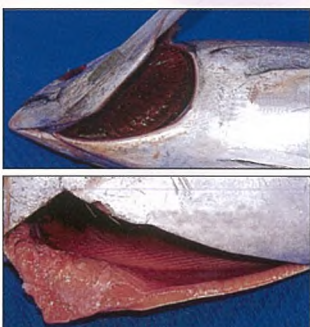

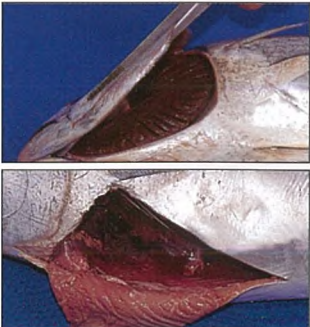
One night on fishing boat, one night transfer in ice

Ice storage condition:

Fish: Ice = 1:3, ice changed every alternate day



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
A	0 - 4		
B	4 - 8		
C	8 - 15		
D (Reject)	> 15		

EASTERN LITTLE TUNA

Characteristics					
Eyes	Body surface	Gills	Viscera	Flesh	Belly flap
Bright, clear, protruding, intact	Bright silver, grey, bright and shiny, neutral odour, firm and resilient texture	Deep dark red, neutral odour	Firm and intact, normal gut odour	Brown, reddish, neutral to fishy or bloody flesh odour (characteristic odour), neutral nape odour, firm to slightly soft and resilient texture, iridescent cut surface	Bright and shiny, pink and yellowish, smooth belly wall, none to slight bile stain present
Slightly sunken, slightly cloudy eyeballs	Silver grey, opalescent sheen, slight fishy odour, firm and resilient texture	Red, neutral to slight fishy odour	Firm and intact, normal gut odour	Brown, reddish, neutral to fishy or bloody flesh odour (characteristic odour), neutral nape odour, firm to slightly soft and resilient texture, iridescent cut surface	Brown, yellowish, smooth belly wall, slight bile stain present
Slightly sunken or slightly swollen, cloudy eyeballs, bloody cornea	Slightly bleached, opalescent sheen, fishy and slight rancid odour, soft and resilient texture	Brown red to pale brown, slight fishy, slight rancid and slight putrid odour	Firm and intact, normal gut odour	Slight brown, characteristic flesh odour, neutral nape odour, firm to slightly soft and resilient texture, iridescent cut surface	Brown, yellowish, slightly rough belly wall, slightly protruding bones, burn belly wall
Badly sunken or swollen, opaque eyeballs, very bloody cornea	Bleached, yellowish, brown, dull, rancid and putrid odour, soft and mushy texture	Dark brown, putrid odour	Soft and digested, putrid odour	Greenish, fishy, rancid and putrid flesh odour, stale nape odour, soft and mushy texture, gaping, non-iridescent cut surface	Discoloured (greenish, brownish), >10% protruding bones, belly burn

SENSORY QUALITY CHANGES IN EASTERN LITTLE TUNA

Grade		A	B	C	D(Reject)																		
Eyes	Sunken	Not sunken		Slightly sunken or slightly swollen																			
	Transparency	Bright, clear, intact	Slightly cloudy	Cloudy, bloody	Opaque, very bloody																		
Body surface	Colour	Bright silver-grey		Slightly bleached	Brown, yellowish																		
	Shine	Bright, shiny		Opalescent sheen	Dull no shine																		
	Slime	No slime																					
	Odour	Neutral	Slight fishy	Fishy	Slight rancid																		
	Texture	Firm, resilient		soft, resilient	Soft, non-resilient																		
Gills	Colour	Deep dark red		Brown red to pale brown																			
	Odour	Neutral slight fishy	Slight fishy, slight rancid	Slight putrid	Strong putrid																		
	Slime	None to slight slime																					
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

Grade		A	B	C	D(Reject)
Viscera	Texture	Firm and intact			Soft and digested intact
	Odour	Normal			Slight fishy
Flesh	Colour	Brown, reddish	Slight brown		Greenish
	Odour	Fishy, bloody odour			Fishy, slight rancid
	Nape odour	Neutral			Slightly stale
	Texture	Firm to slightly soft, resilient			Soft, non-resilient gaping
	Shine (cut surface)	Iridescent			Non-iridescent
Belly flap	Colour	Bright, shiny, pink, yellowish	Brown, yellowish		Greenish
	Smoothness	Smooth	Slightly rough, slightly protruding bones		Breakdown, > 10 % protruding bones
	Bile stain	Tinge		Burn	

Day(s) in ice 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

CHEMICAL AND MICROBIOLOGICAL GUIDELINES EASTERN LITTLE TUNA

Grade	Approximate storage time (days)	Chemical values				Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	Histamine (ppm)	5°C	20°C	35°C
A	0 - 4	73 - 75	5.8 - 6.0	0 - 40	0 - 2	< 50-8x10 ²	5x10 ² -1x10 ⁴	5x10 ² -1x10 ⁴
B	4 - 8	73 - 76	5.8 - 6.0	34 - 52	2 - 5	3x10 ² -1x10 ⁵	1x10 ³ -2x10 ⁵	1x10 ² -6x10 ³
C	8 - 15	73 - 77	5.8 - 6.1	46 - 65	2 - 8	3x10 ⁴ -3x10 ⁶	2x10 ⁴ -3x10 ⁶	1x10 ² -9x10 ⁴
D (Reject)	> 15	> 73	>5.8	> 62	> 2	> 3x10 ⁵	>1x10 ⁵	>1x10 ⁴

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

LONG TAIL TUNA

SCIENTIFIC NAME:

Thunnus tonggol

UTILIZATION:

Canned products

ABOUT THE EXPERIMENT

Catch area:

South China Sea, landed in Pattani province, Thailand

Before arrival at FIQD Laboratory:


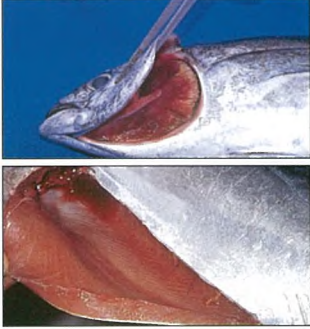

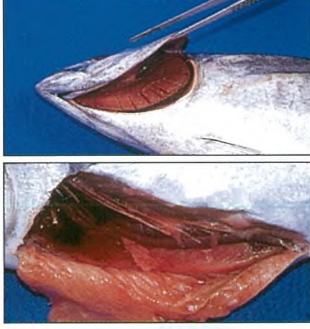

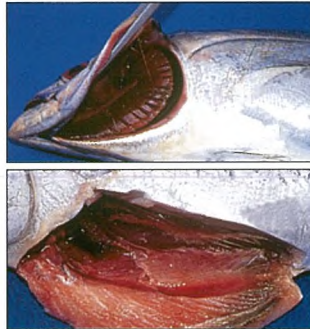

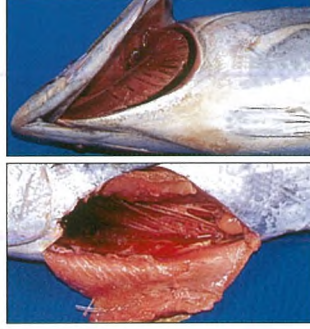
One night on fishing boat, one night transfer in ice

Ice storage condition:

Fish: Ice = 1:2, ice changed every alternate day



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
A	0 - 4		
B	4 - 8		
C	8 - 15		
D (Reject)	> 15		

LONG TAIL TUNA

Characteristics					
Eyes	Body surface	Gills	Viscera	Flesh	Belly flap
Bright, clear, protruding, intact	Bright silver grey, bright and shiny, neutral odour, firm to slightly soft and resilient texture	Deep dark red, neutral odour	Firm to slightly soft and intact, normal gut odour	Grey-pink, neutral flesh and nape odour; firm to slightly soft and resilient texture, iridescent cut surface	Bright, pink, yellowish, smooth to slightly rough belly wall, none to slight bile stain present
Bright, clear, protruding, intact	Bright silver grey, bright and shiny, neutral odour, firm to slightly soft and resilient texture	Brown red to pale brown, slight fishy odour	Slightly soft, slight fishy odour	Grey-pink, neutral flesh and nape odour; firm to slightly soft and resilient texture, iridescent cut surface	Bright, pink, yellowish, smooth to slightly rough belly wall, none to slight bile stain present
Slightly sunken, slightly cloudy eyeballs, slightly bloody cornea	Slightly bleached, opalescent sheen, slight fishy odour, soft and non-resilient texture	Brown red to pale brown, slight salted fish odour	Soft and digested, fishy to slight putrid odour	Yellowish, brownish, slight fishy flesh and nape odour; soft and non-resilient texture, non-iridescent cut surface	Pink, yellowish, slightly rough belly wall, slightly protruding bones, belly burn
Badly sunken, opaque eyeballs, damaged and very bloody cornea	Yellowish, greenish, dull, fishy, rancid and putrid odour, soft and mushy texture	Dark brown, putrid odour	Soft and digested / liquified, musty and putrid odour	Greenish, fishy, rancid and putrid flesh odour, slight stale and slight putrid nape odour; mushy texture, non-iridescent cut surface	Discoloured (greenish, pale), >10% protruding bones, belly burn

SENSORY QUALITY CHANGES IN LONG TAIL TUNA

Grade		A	B	C	D(Reject)																		
Eyes	Sunken	Not sunken		Slightly sunken	Sunken																		
	Transparency	Bright, clear, intact		Slightly cloudy slightly bloody	Opaque, very bloody	Opaque, damaged, very bloody																	
Body surface	Colour	Bright silver-grey		Slightly bleached	Bleached	Yellowish, greenish																	
	Shine	Bright, shiny sheen		Opalescent sheen	Dull, no shine																		
	Slime	No slime																					
	Odour	Neutral		Neutral to Slight fishy	Slight fishy, slight rancid	Strong fishy, putrid																	
	Texture	Firm to slightly soft, resilient		Soft, non-resilient																			
Gills	Colour	Deep dark red	Brown red to pale brown	Dark brown																			
	Odour	Neutral	Slight fishy,	Slight salted fish odour	Putrid	Strong putrid																	
	Slime	None to slight slime																					
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

		Grade		A	B	C	D(Reject)																
Viscera	Texture	Firm to slightly soft, intact		Slightly soft and slightly digested		Soft and digested		Very soft, liquified															
	Odour	Normal		Fishy, slight putrid				Musty, putrid Strong putrid															
Flesh	Colour	Grey, pink				Yellowish, brownish	Greenish																
	Odour	Neutral		Slightly fishy		Slight fishy, slight rancid		Fishy, slight rancid															
	Nape odour	Neutral				Slight fishy	Slight stale	Slightly putrid															
	Texture	Firm to slightly soft, resilient		Soft, non-resilient				Very mushy															
	Shine (cut surface)	Iridescent				Non-iridescent																	
Belly flap	Colour	Bright, pink-yellowish				Greenish		Greenish, pale															
	Smoothness	Smooth to slightly rough		Slightly rough, slightly protruding bones				Slightly digested, > 10 % protruding bones															
	Bile stain	None to slightly present		Burn																			
Day(s) in ice		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

CHEMICAL AND MICROBIOLOGICAL GUIDELINES LONG TAIL TUNA

Grade	Approximate storage time (days)	Chemical values				Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	Histamine (ppm)	5°C	20°C	35°C
A	0 - 4	75 - 76	5.9 - 6.1	0 - 41	0 - 2	$< 50 \times 10^3$	$1 \times 10^3 - 3 \times 10^4$	$1 \times 10^3 - 3 \times 10^4$
B	4 - 8	75 - 76	5.9 - 6.1	31 - 48	1 - 5	$4 \times 10^2 - 2 \times 10^4$	$1 \times 10^3 - 1 \times 10^4$	$2 \times 10^2 - 4 \times 10^3$
C	8 - 15	75 - 76	5.9 - 6.1	31 - 56	1 - 7	$5 \times 10^3 - 8 \times 10^5$	$2 \times 10^3 - 5 \times 10^5$	$2 \times 10^2 - 6 \times 10^4$
D (Reject)	> 15	> 76	> 5.9	> 54	> 2	$> 5 \times 10^5$	$> 4 \times 10^5$	$> 7 \times 10^3$

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

BLACK TIGER

PRAWN

SCIENTIFIC NAME:

Penaeus monodon

UTILIZATION:

Food dishes, frozen products

ABOUT THE EXPERIMENT

Culture area:

Off Paula Ubin, Singapore

Before arrival at MFRD Laboratory:







Arrived alive, cold shocked at laboratory

Ice storage condition:

Prawn: Ice = 1:2, ice changed daily



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
Acceptable	0 - 4		
Borderline Acceptable	4 - 7		
Reject	> 7		

BLACK TIGER PRAWN

Characteristics					
Head	Head/body attachment	Body	Odour	Texture	Black spots
Bluish grey to slightly faded carapace	Intact to slightly loose	Bluish green, dark blue or brownish green to slightly faded, translucent	Seaweed, neutral, fresh odour or characteristic odour	Firm, elastic, hard shell	Not present
Black	Very loose	Faded, slightly yellowish along dorsal line	Neutral to slight stale odour	Firm	Present in head
Completely black	Very loose to detached	Faded, slightly greenish or yellowish along dorsal, reddish (cooked appearance), opaque meat, black tail	Fishy, stale, musty, sour, putrid, ammoniacal, faecal	Slightly firm to soft or mushy, soft shell	Some on body and/or tail

SENSORY QUALITY CHANGES IN BLACK TIGER PRAWN

Grade	Acceptable	Borderline acceptable		Reject						
Head colour	Bluish grey	Bluish grey, faded carapace	Extensively black heads	Completely black heads						
Body colour	Bluish green or brownish green	Slightly faded	Faded, some yellowish along dorsal line	Faded, slightly greenish, yellow along dorsal						
Head/body attachment	Intact	Intact to slightly loose	Very loose	Very loose to dropping						
Odour	Seaweedly or neutral	Neutral	Neutral to slightly stale	Slightly fishy, stale, slightly sour						
Texture	Firm and elastic, hard shell		Firm	Slightly firm						
Black spots (body)	Not present			Few black spots on body						
Day(s) in ice	0	1	2	3	4	5	6	7	8	9

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR BLACK TIGER PRAWN

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
Acceptable	0 - 4	76 - 80	6.9 - 8.0	0 - 27	$1 \times 10^2 - 2 \times 10^4$	$1 \times 10^2 - 2 \times 10^4$	$1 \times 10^2 - 3 \times 10^3$
Borderline acceptable	4 - 7	79 - 81	7.8 - 8.2	25 - 43	$9 \times 10^3 - 2 \times 10^5$	$8 \times 10^3 - 2 \times 10^5$	$1 \times 10^2 - 6 \times 10^3$
Reject	> 7	> 80	> 8.0	> 40	$> 2 \times 10^5$	$> 2 \times 10^5$	$> 2 \times 10^3$

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

BANANA PRAWN

SCIENTIFIC NAME:

Penaeus merguensis

UTILIZATION:

Food dishes, frozen products

ABOUT THE EXPERIMENT

Culture area:

The Gulf of Thailand, landed in Chantaburi province

Before arrival at FIQD Laboratory:







One night on fishing boat, one night transfer in ice

Ice storage condition:

Prawn: Ice = 1:4, ice changed every alternate day



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
Acceptable	0 - 5		
Borderline Acceptable	5 - 10		
Reject	> 10		

BANANA PRAWN

Characteristics					
Head	Head/body attachment	Body	Odour	Texture	Black spots
Pink to slightly dark top, yellowish carapace	Intact to slightly drooping	Transparent, pinkish, yellowish	Neutral, slight seawater (characteristic odour)	Firm and resilient	Not present
Black head, orange carapace, bleached	Very loose	Bleached, more purple dots	Slight fishy, slight musty, slight ammoniacal	Firm to slightly soft	Present in head
Black head, orange carapace, very bleached	Detached	Bleached, black tail	Putrid, ammoniacal, musty, sour	Soft, mushy	Some on body and / or tail

SENSORY QUALITY CHANGES IN BANANA PRAWN

Grade	Acceptable		Borderline acceptable			Reject							
Head colour	Pink top, yellowish carapace	Slightly dark top, yellowish carapace, slightly bleached		Black head, orange carapace, bleached		Very bleached							
Body colour	Transparent, pinkish, yellowish	Slightly bleached	More purple dots, bleached		Bleached, black tails								
Head/body attachment	Slightly drooping	Drooping	Very loose		Almost detached	Completely detached							
Odour	Neutral, slightly sea water		Slightly fishy	Slight musty slight ammoniacal	Musty, slight putrid, ammoniacal	Musty, putrid, sour							
Texture	Firm, resilient		Less firm	Slightly soft		Soft, mushy							
Black spots (body)	Not present					Some on body and tail							
Day(s) in ice	0	1	2	3	4	5	6	7	8	9	10	11	12

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR BANANA PRAWN

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
Acceptable	0 - 5	75 - 89	7.2 - 7.6	0 - 36	$9 \times 10^3 - 9 \times 10^4$	$2 \times 10^4 - 2 \times 10^5$	$1 \times 10^4 - 4 \times 10^4$
Borderline acceptable	5 - 10	80 - 89	7.5 - 7.8	33 - 48	$6 \times 10^4 - 6 \times 10^7$	$8 \times 10^4 - 5 \times 10^7$	$2 \times 10^4 - 2 \times 10^6$
Reject	> 10	> 83	> 7.7	> 46	$> 3 \times 10^7$	$> 1 \times 10^7$	$> 2 \times 10^5$

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

SAND VELVET SHRIMP

SCIENTIFIC NAME:

Metapenaeopsis barbata

UTILIZATION:

Canned products

ABOUT THE EXPERIMENT**Catch area:**

South China Sea, landed in Songklah province

Before arrival at FIQD Laboratory:




Two night on fishing boat, one night transfer in ice

Ice storage condition:

Shrimp: Ice = 1:4, ice changed every alternate day



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration
Acceptable	0 - 10	
Borderline Acceptable	10 - 12	
Reject	> 12	

SAND VELVET SHRIMP

Characteristics					
Head	Head/body attachment	Body	Odour	Texture	Black spots
Slightly grey top, slightly yellowish carapace	Intact to loose	White, transparent, slightly purple and yellow stripes	Neutral to slight fishy	Firm (hard shell)	Not present
Dark green top, yellowish carapace, black gills, bleached	Very loose	Bleached	Fishy, slight musty, slight sour	Less firm	Not present
Dark green top, yellowish carapace, black gills, very bleached	Very loose to detached	Very bleached	Musty, putrid, sour	Soft	Some on body and / or tail

SENSORY QUALITY CHANGES IN SAND VELVET SHRIMP

Grade	Acceptable	Borderline acceptable	Reject		
Head colour	Slightly grey top, slightly yellowish carapace	Yellow carapace, green gills	Dark green top, yellowish carapace, black gills, bleached	Dark green top, yellow carapace; black gills, bleached	Very bleached
Body colour	White, transparent, slightly purple and yellow stripe	Bleached, pale purple			Very bleached, very pale purple
Head/body attachment	Intact to slightly drooping	Loose		Very loose	
Odour	Neutral to slightly fishy		Fishy, slightly musty, slightly sour	Musty, slightly putrid	Putrid, musty, sour
Texture	Firm, hard shell		Less firm	Soft, shrink, dehydrated	
Black spots (body)	Not present				Some on body and tail
Day(s) in ice	<div style="display: flex; justify-content: space-between; width: 100%;"> 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 </div>				

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR SAND VELVET SHRIMP

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
Acceptable	0 - 10	77 - 87	7.8 - 8.5	0 - 52	$1 \times 10^4 - 4 \times 10^7$	$1 \times 10^4 - 3 \times 10^7$	$1 \times 10^4 - 1 \times 10^7$
Borderline acceptable	10 - 12	83 - 88	8.3 - 8.5	50 - 55	$3 \times 10^7 - 1 \times 10^8$	$2 \times 10^7 - 6 \times 10^7$	$2 \times 10^6 - 1 \times 10^7$
Reject	> 12	> 83	> 8.2	> 52	$> 3 \times 10^7$	$> 9 \times 10^6$	$> 2 \times 10^6$

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

SOFT CUTTLEFISH

SCIENTIFIC NAME:

Sepistenthis lessoniana

OTHER COMMON NAME:

Bigfin reef squid

UTILIZATION:

Food dishes

ABOUT THE EXPERIMENT

Catch area:

The Gulf of Thailand, landed in Chantaburi province

Before arrival at FIQD Laboratory:









One night on fishing boat, one night transfer in ice

Ice storage condition:

Squid: Ice = 1:3, ice changed every alternate day



SENSORY GUIDELINES FOR

Grade	Approximate day (s) in ice	Illustration	
A	0 - 5		
B	5 - 10		
C	10 - 14		
D (Reject)	> 14		

SOFT CUTTLEFISH

Characteristics						
General appearance	Body surface (Front)	Body colour (Back)	Flesh odour	Texture	Gut colour	Gut odour
Intact, transparent, bright shiny, moving pigments	White with slight purple spots	Slightly orange, greenish, slightly purple	Neutral, characteristic odour	Firm to hard	Bright, greenish to slightly milky	Neutral to slight fishy (characteristic odour)
Yellowish especially on fins, slightly peeling, opaque, slightly dull	More purple spots, milky	Dark purple, orange tinge	Slight fishy to slight sour	Less firm	Very milky	Slight fishy, slight sour (characteristic ink odour)
Yellowish especially on fins, slightly peeling, opaque, dull	Dark purple spots, milky	Very dark purple, slight orange tinge	Fishy, slight sour	Soft	Very milky	Slight fishy, slight sour (characteristic ink odour)
Peeling, very opaque, dull	Very dark purple, very milky	Extremely dark purple	Sour, musty, putrid	Very soft	Milky, blue	Sour, musty, putrid

SENSORY QUALITY CHANGES IN SOFT CUTTLEFISH

Grade	A	B	C	D (Reject)														
General appearance	Intact, transparent, bright, shiny, moving pigments	Intact; yellowish slightly dull	Slightly peeling, opaque, dull	Peeling, very opaque, dull														
Body colour (front)	White with slight purple spots	More purple spots, milky	Dark purple spots, milky	Very dark purple spots, very milky														
Body colour (back)	Slightly orange, greenish	Purple, orange tinge	Dark purple, orange tinge	Very dark purple, slightly orange tinge	Extensively dark purple													
Fresh odour	Neutral, characteristic odour	Slightly fishy	Fishy, slightly sour	Sour, putrid, musty														
Texture	Firm	Less firm	Soft	Very soft														
Gut colour	Bright, greenish	Slightly milky	Very milky	Milky, blue														
Gut odour	Neutral to slightly fishy, (characteristic odour)	Slightly fishy, slightly sour (characteristic odour)		Musty, sour, putrid														
Day(s) in ice	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

CHEMICAL AND MICROBIOLOGICAL GUIDELINES FOR SOFT CUTTLEFISH

Grade	Approximate storage time (days)	Chemical values			Total Plate Count (cfu/g)		
		Moisture * (%)	pH *	K-value (%)	5°C	20°C	35°C
A	0 - 5	71 - 90	6.6 - 6.9	0 - 57	$3 \times 10^3 - 3 \times 10^4$	$6 \times 10^3 - 4 \times 10^4$	$9 \times 10^2 - 2 \times 10^4$
B	5 - 10	78 - 90	6.6 - 6.9	53 - 61	$1 \times 10^4 - 2 \times 10^6$	$2 \times 10^4 - 5 \times 10^7$	$9 \times 10^2 - 6 \times 10^4$
C	10 - 14	78 - 91	6.6 - 6.9	57 - 74	$6 \times 10^5 - 7 \times 10^7$	$3 \times 10^6 - 6 \times 10^7$	$5 \times 10^3 - 7 \times 10^4$
D (Reject)	> 14	> 79	> 6.6	> 72	$> 3 \times 10^7$	$> 4 \times 10^6$	$> 5 \times 10^4$

Remarks* Should be considered as a possible trend only, not to be used as major criteria for grading

APPENDIX

Chemical and Microbiological Results from the Experiments

FOUR-FINGERED THREADFIN (*Eleutheronema tetradactylum*)

Size : Total length = 31.8 ± 1.0 cm
 Weight = 316.9 ± 24.8 g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	77.34 ± 0.76	6.29 ± 0.06	4.04 ± 0.80	< 50	$1.2 \times 10^3 \pm 1.5 \times 10^3$	$6.7 \times 10^2 \pm 4.9 \times 10^2$
2	78.16 ± 1.59	6.32 ± 0.04	8.86 ± 0.91	< 50	$1.7 \times 10^2 \pm 1.6 \times 10^2$	$3.3 \times 10^2 \pm 2.8 \times 10^2$
4	77.66 ± 2.09	6.31 ± 0.09	12.51 ± 0.61	< 50	$1.2 \times 10^2 \pm 76$	< 50
7	78.00 ± 0.90	6.35 ± 0.06	20.17 ± 0.48	50 ± 50	$1.4 \times 10^3 \pm 1.1 \times 10^3$	$6.7 \times 10^2 \pm 6.7 \times 10^2$
9	77.94 ± 0.44	6.44 ± 0.04	22.61 ± 1.07	< 50	$3.9 \times 10^3 \pm 4.8 \times 10^3$	$3.8 \times 10^3 \pm 4.7 \times 10^3$
14	78.93 ± 1.17	6.39 ± 0.09	30.57 ± 3.14	$4.7 \times 10^2 \pm 2.4 \times 10^2$	$9.0 \times 10^2 \pm 7.1 \times 10^2$	$1.8 \times 10^2 \pm 1.9 \times 10^2$
17	79.73 ± 0.63	6.42 ± 0.03	35.26 ± 1.59	$1.7 \times 10^5 \pm 1.3 \times 10^5$	$1.3 \times 10^5 \pm 1.4 \times 10^5$	$9.2 \times 10^3 \pm 1.1 \times 10^4$
21	79.68 ± 1.04	6.49 ± 0.05	39.25 ± 2.82	$5.6 \times 10^5 \pm 3.9 \times 10^5$	$2.3 \times 10^5 \pm 1.2 \times 10^5$	$6.9 \times 10^3 \pm 6.3 \times 10^3$

Remarks All values are presented in Average \pm Standard Deviation.
 Three fish were drawn on every analysis day. Analysis on skinless fish muscle of each fish was conducted in duplicate.

RED SNAPPER (*Lutjanus altifrontalis*)Size : Total Length = 35.7 ± 3.8 cmWeight = 863.5 ± 249.0 g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	75.81 ± 0.36	6.28 ± 0.19	4.34 ± 0.35	< 50	< 50	< 50
4	75.86 ± 1.45	6.02 ± 0.02	9.22 ± 2.24	$1.0 \times 10^3 \pm 1.1 \times 10^3$	$1.6 \times 10^3 \pm 1.4 \times 10^3$	$1.7 \times 10^2 \pm 1.2 \times 10^2$
8	76.35 ± 1.19	6.23 ± 0.10	17.75 ± 0.51	$1.8 \times 10^4 \pm 7.7 \times 10^3$	$2.9 \times 10^4 \pm 3.6 \times 10^4$	$1.0 \times 10^2 \pm 1.0 \times 10^2$
12	77.26 ± 0.22	6.18 ± 0.04	23.12 ± 3.59	$1.7 \times 10^4 \pm 4.4 \times 10^3$	$1.9 \times 10^4 \pm 6.6 \times 10^3$	$3.2 \times 10^2 \pm 76$
16	76.28 ± 1.41	6.20 ± 0.13	31.84 ± 4.24	$7.5 \times 10^3 \pm 1.2 \times 10^4$	$6.5 \times 10^2 \pm 3.5 \times 10^2$	$4.0 \times 10^2 \pm 4.4 \times 10^2$
19	77.94 ± 0.68	6.34 ± 0.08	44.01 ± 5.03	$3.2 \times 10^6 \pm 2.6 \times 10^5$	TNTC*	$8.5 \times 10^3 \pm 3.3 \times 10^3$
23	78.51 ± 1.82	6.42 ± 0.05	67.92 ± 4.47	$1.1 \times 10^6 \pm 1.4 \times 10^6$	$8.9 \times 10^5 \pm 8.6 \times 10^5$	$1.8 \times 10^2 \pm 2.5 \times 10^2$

Remarks All values are presented in Average \pm Standard Deviation

Three fish were drawn on every analysis day. Analysis on skinless fish muscle of each fish was conducted in duplicate.

*TNTC = Too numerous too count

SEABASS (*Lates calcarifer*)

Size : Total Length = 35.7 ± 2.0 cm

Weight = 616.3 ± 93.9 g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	77.86 ± 0.21	6.57 ± 0.11	7.44 ± 2.85	< 50	$9.6 \times 10^2 \pm 2.7 \times 10^2$	$6.5 \times 10^2 \pm 1.1 \times 10^2$
4	77.29 ± 0.86	6.30 ± 0.18	24.09 ± 0.73	< 50	$4.1 \times 10^3 \pm 2.8 \times 10^3$	$2.4 \times 10^3 \pm 9.5 \times 10^2$
7	77.11 ± 1.26	6.41 ± 0.03	27.53 ± 1.09	$2.1 \times 10^2 \pm 97$	$5.1 \times 10^3 \pm 8.2 \times 10^3$	$1.0 \times 10^3 \pm 7.8 \times 10^2$
11	78.09 ± 0.21	6.42 ± 0.09	33.41 ± 0.47	$4.5 \times 10^3 \pm 5.5 \times 10^3$	$5.1 \times 10^3 \pm 5.5 \times 10^3$	$1.2 \times 10^3 \pm 2.1 \times 10^2$
14	77.59 ± 0.24	6.55 ± 0.08	41.94 ± 1.96	$2.3 \times 10^4 \pm 4.2 \times 10^3$	$3.1 \times 10^4 \pm 4.5 \times 10^3$	$4.3 \times 10^3 \pm 2.0 \times 10^3$
17	78.72 ± 0.56	6.56 ± 0.03	46.18 ± 1.61	$3.6 \times 10^5 \pm 2.2 \times 10^5$	$3.1 \times 10^5 \pm 2.4 \times 10^5$	$1.2 \times 10^4 \pm 1.1 \times 10^4$
19	79.42 ± 0.89	6.46 ± 0.13	52.42 ± 1.31	$5.2 \times 10^5 \pm 1.1 \times 10^5$	$6.8 \times 10^5 \pm 4.7 \times 10^5$	$1.3 \times 10^4 \pm 3.5 \times 10^3$
21	78.89 ± 1.84	6.66 ± 0.03	49.17 ± 4.24	$8.7 \times 10^5 \pm 9.0 \times 10^4$	$1.1 \times 10^6 \pm 1.3 \times 10^5$	$1.0 \times 10^4 \pm 4.4 \times 10^3$
24	78.83 ± 0.59	6.61 ± 0.03	52.01 ± 0.76	$5.5 \times 10^6 \pm 2.5 \times 10^6$	$5.6 \times 10^6 \pm 3.2 \times 10^6$	$3.4 \times 10^4 \pm 2.2 \times 10^4$
26	78.22 ± 0.84	6.67 ± 0.06	61.73 ± 3.59	$3.4 \times 10^6 \pm 7.9 \times 10^5$	$2.7 \times 10^6 \pm 5.1 \times 10^5$	$9.0 \times 10^4 \pm 1.2 \times 10^5$

Remarks All values are presented in Average \pm Standard Deviation
Three fish were drawn on every analysis day. Analysis on skinless fish muscle of each fish was conducted in duplicate.

EASTERN LITTLE TUNA (*Euthynnus affinis*)

Size : Total Length = 44.3 ± 1.5 cm
Weight = $1,094.6 \pm 86.3$ g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Histamine (ppm)	Total Plate Count (cfu/g)		
					5°C	20°C	37°C
0	73.94 ± 0.74	5.94 ± 0.07	27.72 ± 1.68	0	< 50	$6.0 \times 10^3 \pm 5.5 \times 10^3$	$5.5 \times 10^3 \pm 4.9 \times 10^3$
4	74.29 ± 0.64	5.88 ± 0.06	36.76 ± 2.72	2.00 ± 0	$5.3 \times 10^2 \pm 2.7 \times 10^2$	$6.2 \times 10^3 \pm 5.0 \times 10^3$	$2.8 \times 10^3 \pm 2.8 \times 10^3$
8	74.76 ± 1.26	5.94 ± 0.08	49.44 ± 2.81	3.61 ± 1.48	$6.7 \times 10^4 \pm 3.5 \times 10^4$	$8.7 \times 10^4 \pm 8.8 \times 10^4$	$1.2 \times 10^3 \pm 1.2 \times 10^3$
12	74.66 ± 0.89	5.88 ± 0.07	57.95 ± 0.75	4.46 ± 1.97	$2.1 \times 10^5 \pm 1.3 \times 10^5$	$2.4 \times 10^5 \pm 2.1 \times 10^5$	$1.7 \times 10^4 \pm 1.3 \times 10^4$
15	75.11 ± 1.83	5.93 ± 0.12	63.57 ± 1.23	4.71 ± 3.04	$1.5 \times 10^6 \pm 1.2 \times 10^6$	$1.4 \times 10^6 \pm 1.3 \times 10^6$	$4.4 \times 10^4 \pm 4.5 \times 10^4$
18	75.44 ± 1.67	5.89 ± 0.05	68.13 ± 0.25	3.03 ± 1.10	$1.9 \times 10^6 \pm 6.3 \times 10^5$	$1.6 \times 10^6 \pm 5.1 \times 10^5$	$2.0 \times 10^4 \pm 8.5 \times 10^3$
21	75.59 ± 0.63	5.90 ± 0.08	69.74 ± 0.68	10.61 ± 3.48	$1.1 \times 10^7 \pm 5.5 \times 10^6$	$1.0 \times 10^7 \pm 5.3 \times 10^6$	$2.1 \times 10^5 \pm 7.5 \times 10^4$

Remarks All values are presented in Average \pm Standard Deviation.
Three fish were drawn on every analysis day. Analysis on skinless fish muscle of each fish was conducted in duplicate .

LONGTAIL TUNA (*Thunnus tonggol*)

Size : Total Length = 41.2 ± 2.3 cm
Weight = 901.8 ± 133.0 g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Histamine (ppm)	Total Plate Count (cfu/g)		
					5°C	20°C	37°C
0	74.75 ± 1.72	6.00 ± 0.05	13.03 ± 6.69	0	< 50	$2.8 \times 10^4 \pm 2.9 \times 10^3$	$2.6 \times 10^4 \pm 4.9 \times 10^3$
4	74.22 ± 0.84	6.05 ± 0.05	36.20 ± 4.57	2.00 ± 0.00	$7.5 \times 10^2 \pm 3.6 \times 10^2$	$7.6 \times 10^3 \pm 6.2 \times 10^3$	$2.6 \times 10^3 \pm 1.4 \times 10^3$
8	74.59 ± 0.52	5.95 ± 0.09	39.19 ± 8.55	3.62 ± 1.50	$1.2 \times 10^4 \pm 6.7 \times 10^3$	$7.1 \times 10^3 \pm 5.1 \times 10^3$	$6.2 \times 10^2 \pm 3.9 \times 10^2$
12	74.96 ± 0.46	5.96 ± 0.08	50.36 ± 0.68	3.50 ± 2.23	$3.0 \times 10^5 \pm 4.8 \times 10^4$	$2.2 \times 10^5 \pm 9.8 \times 10^4$	$1.1 \times 10^4 \pm 4.8 \times 10^3$
15	75.78 ± 0.43	5.94 ± 0.07	55.61 ± 0.73	4.04 ± 2.56	$6.3 \times 10^5 \pm 1.4 \times 10^5$	$4.4 \times 10^5 \pm 8.0 \times 10^4$	$3.4 \times 10^4 \pm 2.7 \times 10^4$
18	75.90 ± 0.83	6.04 ± 0.04	57.11 ± 3.35	4.04 ± 2.02	$5.0 \times 10^6 \pm 2.9 \times 10^6$	$2.0 \times 10^7 \pm 1.2 \times 10^7$	$1.7 \times 10^5 \pm 9.9 \times 10^4$
21	75.99 ± 0.41	6.01 ± 0.06	65.01 ± 1.38	6.30 ± 1.50	$1.1 \times 10^7 \pm 1.3 \times 10^6$	$9.1 \times 10^6 \pm 2.2 \times 10^6$	$3.2 \times 10^5 \pm 1.7 \times 10^5$

Remarks All values are presented in Average \pm Standard Deviation.
Three fish were drawn on every analysis day. Analysis on skinless fish muscle of each fish was conducted in duplicate .

BLACK TIGER PRAWN (*Penaeus monodon*)

Size : Weight = 45 - 55 prawns / kg

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	76.27 ± 0.76	7.09 ± 0.19	4.21 ± 2.09	1.3×10 ² ± 29	2.6×10 ³ ± 1.4×10 ³	1.9×10 ² ± 32
2	77.96 ± 0.05	7.77 ± 0.05	16.15 ± 1.11	9.1×10 ³ ± 1.2×10 ³	1.1×10 ⁴ ± 2.8×10 ³	2.2×10 ³ ± 5.1×10 ²
4	79.60 ± 0.39	7.91 ± 0.10	26.23 ± 0.80	1.3×10 ⁴ ± 3.6×10 ³	1.3×10 ⁴ ± 4.7×10 ³	7.7×10 ² ± 6.4×10 ²
7	80.64 ± 0.19	8.06 ± 0.11	41.57 ± 1.12	1.6×10 ⁵ ± 1.0×10 ⁴	2.1×10 ⁵ ± 3.5×10 ⁴	4.2×10 ³ ± 2.3×10 ³
9	81.81 ± 0.35	8.12 ± 0.04	49.60 ± 3.20	4.9×10 ⁵ ± 1.4×10 ⁵	8.5×10 ⁵ ± 3.7×10 ⁵	6.1×10 ³ ± 4.0×10 ³

Remarks All values are presented in Average ± Standard Deviation
Three samples were drawn on every analysis day. One sample consisted of ten prawns. Analysis on headless, peeled prawn was conducted in duplicate.

BANANA PRAWN (*Penaeus merguensis*)

Size : Weight = 50 - 55 prawns / kg

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	83.97 ± 4.67	7.19 ± 0.04	14.80 ± 1.65	1.5×10 ⁴ ± 5.7×10 ³	3.7×10 ⁴ ± 9.0×10 ³	2.7×10 ⁴ ± 5.5×10 ³
3	81.11 ± 7.03	7.48 ± 0.08	24.64 ± 5.38	4.0×10 ⁴ ± 2.3×10 ⁴	4.5×10 ⁴ ± 2.1×10 ⁴	1.2×10 ⁴ ± 1.7×10 ³
5	82.51 ± 1.57	7.50 ± 0.01	34.71 ± 1.39	7.1×10 ⁴ ± 1.6×10 ⁴	1.3×10 ⁵ ± 5.4×10 ⁴	2.8×10 ⁴ ± 6.8×10 ³
7	84.12 ± 0.84	7.57 ± 0.04	43.22 ± 0.72	1.0×10 ⁶ ± 2.3×10 ⁵	7.4×10 ⁵ ± 1.2×10 ⁵	1.9×10 ⁵ ± 4.5×10 ⁴
10	83.68 ± 1.16	7.77 ± 0.03	47.01 ± 0.83	4.5×10 ⁷ ± 1.1×10 ⁷	3.8×10 ⁷ ± 1.6×10 ⁷	1.5×10 ⁶ ± 5.8×10 ⁵
12	84.78 ± 0.89	7.97 ± 0.07	53.34 ± 1.12	4.8×10 ⁷ ± 7.3×10 ⁶	2.4×10 ⁷ ± 1.3×10 ⁷	7.7×10 ⁵ ± 5.5×10 ⁵

Remarks All values are presented in Average ± Standard Deviation.
Three samples were drawn on every analysis day. One sample consisted of ten prawn. Analysis on headless, peeled prawn was conducted in duplicate.

SAND VELVET SHRIMP (*Metapenaeopsis barbata*)

Size : Weight = 350 - 400 shrimps / kg

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	80.21 ± 2.93	7.84 ± 0.03	27.24 ± 3.40	4.1×10 ³ ± 2.7×10 ³	1.9×10 ⁴ ± 7.8×10 ³	1.4×10 ⁴ ± 4.1×10 ³
3	79.75 ± 3.21	8.02 ± 0.02	39.45 ± 0.69	2.3×10 ⁴ ± 7.9×10 ³	7.1×10 ⁴ ± 2.1×10 ⁴	4.5×10 ⁴ ± 6.4×10 ³
5	85.16 ± 1.41	8.14 ± 0.02	43.85 ± 2.12	6.1×10 ⁵ ± 3.1×10 ⁵	6.1×10 ⁵ ± 2.4×10 ⁵	3.0×10 ⁵ ± 1.3×10 ⁵
7	85.55 ± 1.61	8.41 ± 0.05	48.60 ± 0.58	1.8×10 ⁶ ± 8.4×10 ⁵	1.4×10 ⁶ ± 9.6×10 ⁵	9.2×10 ⁵ ± 7.5×10 ⁵
10	86.74 ± 0.14	8.45 ± 0.04	51.17 ± 0.99	3.3×10 ⁷ ± 6.7×10 ⁶	2.8×10 ⁷ ± 5.1×10 ⁶	9.0×10 ⁶ ± 3.8×10 ⁶
12	85.52 ± 2.55	8.39 ± 0.07	53.67 ± 1.01	8.1×10 ⁷ ± 5.1×10 ⁷	3.8×10 ⁷ ± 1.7×10 ⁷	7.4×10 ⁶ ± 5.6×10 ⁶
14	87.13 ± 0.26	8.18 ± 0.02	55.85 ± 3.98	1.8×10 ⁸ ± 1.4×10 ⁸	1.1×10 ⁸ ± 1.1×10 ⁸	8.1×10 ⁶ ± 6.2×10 ⁶

Remarks All values are presented in Average ± Standard Deviation.
 Three samples were drawn on every analysis day. One sample consisted of approximately 200 g shrimp. Analysis on headless shell-on shrimp was conducted in duplicate.

SOFT CUTTLEFISH (*Sepistenthis lessoniana*)

Size : Body Length = 14.6 ± 1.6 cm
 Weight = 252.5 ± 70.7 g

Storage day (s) in ice	Moisture (%)	pH	K-value (%)	Total Plate Count (cfu/g)		
				5°C	20°C	37°C
0	80.11 ± 4.81	6.76 ± 0.12	38.58 ± 0.75	3.7×10 ³ ± 7.6×10 ²	2.0×10 ⁴ ± 3.4×10 ³	1.1×10 ⁴ ± 5.4×10 ³
3	77.86 ± 7.54	6.64 ± 0.09	51.77 ± 1.88	3.9×10 ³ ± 1.4×10 ³	9.7×10 ³ ± 3.4×10 ³	5.6×10 ³ ± 1.8×10 ³
5	85.62 ± 3.47	6.68 ± 0.10	54.99 ± 2.17	1.9×10 ⁴ ± 6.4×10 ³	2.8×10 ⁴ ± 1.2×10 ⁴	5.2×10 ³ ± 4.3×10 ³
7	87.62 ± 0.51	6.74 ± 0.05	56.14 ± 1.63	1.0×10 ⁵ ± 5.4×10 ⁴	7.8×10 ⁴ ± 3.3×10 ⁴	9.2×10 ³ ± 6.1×10 ³
10	84.96 ± 0.52	6.71 ± 0.06	58.67 ± 1.92	1.4×10 ⁶ ± 8.2×10 ⁵	3.8×10 ⁷ ± 1.6×10 ⁷	3.2×10 ⁴ ± 2.7×10 ⁴
12	80.84 ± 3.29	6.74 ± 0.02	63.95 ± 0.67	9.6×10 ⁶ ± 1.2×10 ⁶	4.4×10 ⁶ ± 1.2×10 ⁶	1.6×10 ⁴ ± 9.0×10 ³
14	88.44 ± 3.04	6.74 ± 0.17	72.92 ± 1.00	5.4×10 ⁷ ± 1.9×10 ⁷	4.9×10 ⁷ ± 1.3×10 ⁷	5.7×10 ⁴ ± 7.7×10 ³
17	84.38 ± 5.49	6.71 ± 0.03	74.31 ± 1.59	2.6×10 ⁷ ± 4.0×10 ⁵	1.1×10 ⁷ ± 7.0×10 ⁶	1.5×10 ⁵ ± 1.9×10 ⁴

Remarks All values are presented in Average ± Standard Deviation.
 Three squids were drawn on every analysis day. Analysis on squid muscle of each fish was conducted in duplicate .

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