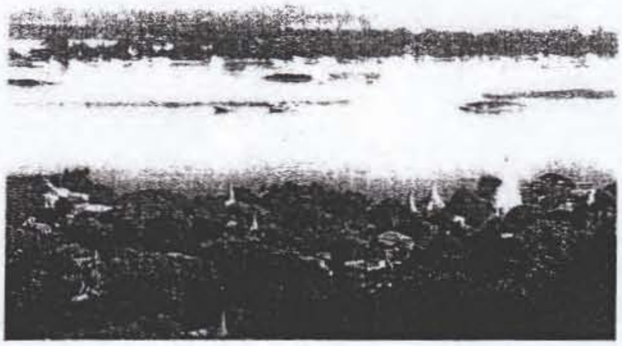
Southeast Asian Modernities

Frauke Kraas, Mi Mi Kyi, Win Maung (Eds.)

Sustainability in Myanmar



LIT

Southeast Asian Modernities

edited by

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Volume 15

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Cover photo: Nature and people: Ayeyarwady River during the monsoon season, the pagodas of Sagaing and shipping activities.
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Published with the support of:

German Alumni Association Myanmar

University of Cologne

The print was sponsored by the German Academic Exchange Service (DAAD).

DAAD Deutscher Akademischer Austausch Dienst German Academic Exchange Service

This book is printed on acid-free paper.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.d-nb.de.

ISBN 978-3-643-90536-9

A catalogue record for this book is available from the British Library

Klosbachstr. 107
CH-8032 Zürich
Tel. +41 (0) 44-251 75 05
E-Mail: zuerich@lit-verlag.ch http://www.lit-verlag.ch
Distribution:
In the UK: Global Book Marketing, e-mail: mo@centralbooks.com
In North America: International Specialized Book Services, e-mail: orders@isbs.com
In Germany: LIT Verlag Fresnostr. 2, D-48159 Münster
Tel. +49 (0) 2 51-620 32 22, Fax +49 (0) 2 51-922 60 99, e-mail: vertrieb@lit-verlag.de
In Austria: Medienlogistik Pichler-ÖBZ, e-mail: mlo@medien-logistik.at
e-books are available at www.litwebshop.de

Content

in: Frauke Kraas, Mi Mi Kyi, Win Maung (Eds.) (2016): Sustainability in Myanmar. Southeast Asian Modernities 15. Berlin: 113–131.

Chemical Analysis of Several Export Fish Species

Myat Myat Thaw, Khin Hla Phyu, Ni Ni Sein

Abstract

This research is concerned with chemical analysis of several export fish species. Some physicochemical properties, spoilage indicators and trace elements in several export fish (*Bombay duck, Gold spotted grenadier anchovy, Butter catfish, Tilapia, Cirrhinus mrigal* and *Labeo rohita*) were determined according to season. Fish is one of the main parts of our diet, as it includes nutritional elements such as protein, fat, ash, water, amino acids, several vitamins and minerals in sufficient amounts for healthy living. Freshwater fish (*Butter catfish, Tilapia, Cirrhinus mrigal* and *Labeo rohita*) were collected from the Ayeyarwady Region, and marine water fish (*Bombay duck* and *Gold spotted grenadier anchovy*) were collected from Rakhine State. In the *Bombay duck, Gold spotted grenadier anchovy, Butter catfish* and *Tilapia* species, crude protein and fat content were found to be higher in the hot season than those in the other two seasons. The water content of these fish was higher in the rainy season than in the other two seasons. Spoilage indicators (TVB-N, TMA-N and NH_3) were found to be higher in the hot season than in the rainy and cold seasons. Histamine, one of the biogenic amines for chemical hazards, was measured using the spectrophotometric method and found to be in the range of 0.05 ppm to 31.44 ppm in the hot season, 0.012 ppm to 30.98 ppm in the rainy season and 0.007 ppm to 15.35 ppm in the cold season. Concentrations of histamine in seawater fish (*Bombay duck* and *Gold spotted grenadier anchovy*) were observed to be higher than those in freshwater fish (*Tilapia* and *Butter catfish*) in all seasons. Concentrations of trace elements in these fish were determined using Atomic Absorption Spectroscopy. The concentrations were as follows: Cu (0.15–2.34 ppm), Pb (0.18–0.81 ppm), Zn (1.04–9.13 ppm), Cd (ND-0.57 ppm), As (13.32–18.69 ppm) and Fe (1.68–20.79 ppm) in the hot season, Cu (0.13–1.08 ppm), Pb (0.80–1.42 ppm), Zn (1.02–7.08 ppm), Cd (ND–0.37 ppm), As (10.15–18.71 ppm) and Fe (1.35–19.19 ppm) in the rainy season, and Cu (0.11–1.01 ppm), Pb (0.25–1.01 ppm), Zn (0.81–5.82 ppm), Cd (ND-0.41 ppm), Fe (0.55–19.01 ppm), As (7.9–17.13 ppm) in the cold season.

Keywords:
Gold spotted grenadier anchovy, tilapia, butter catfish, bombay duck, Cirrhinus mrigal, Labeo rohita, histamine, spoilage, indicators

1. Introduction

1.1 The Health Benefits of Eating Fish

Fish is widely consumed in many parts of the world by humans because it is an important part of a healthy diet. The health benefits of fish include the fact that it is high in protein, low in saturated fat, high in unsaturated fat, and high in omega oils, other nutrients and important elements of a healthy diet. Fish contain omega 3 polyunsaturated fatty acids which are reported to help prevent several human illnesses. Fish have beneficial effects on coronary heart diseases, arrhythmias, hypertension, inflammation, cancer and brain disorders (Numes et al. 1992).

1.2 The spoilage of fish

The spoilage of fish is caused by enzymatic, bacterial and chemical action. The activity of organisms can be controlled, reduced or even retarded by proper handling and immediate lowering of the temperature. The chilling of the fish immediately after catching, as well as storing the fish at 0°C using proper icing, will reduce the spoilage. The foods are usually classified as less perishable, moderately perishable or highly perishable. Cereals, nuts and grains are included in the less perishable and more stable category, while vegetables are classified as moderately perishable and seafoods as highly perishable food items. Seafoods are less stable because of their high moisture content and availability of nutrients for the growth of microorganisms. Ambient temperature plays a crucial role in altering the stability of a product. Highly perishable foods such as seafoods have low tolerance to ambient temperature, while moderately perishable items such as fruits and vegetables have increased tolerance, and non-perishable items are least affected.

1.3 Causative factors of spoilage

Spoilage and freshness are the two qualities that have to be clearly defined. A fresh product is defined as one whose original characters remain unchanged. Spoilage, therefore, is indicative of post-harvest change. Spoilage is usually accompanied by change in physical characteristics. Change in color, odor, texture, color of eyes, color of gills and softness of the muscle are some of the characteristics observed in spoiled fish. Spoilage is caused by the action of enzymes, bacteria and chemicals present in the fish. Factors contributing to the spoilage of fish include the high moisture content, high fat content, high protein content, weak muscle tissue, ambient temperature, and unhygienic handling (Hungerford 2010).

1.4 Process of spoilage

Fish is highly nutritive. It is tasty because of its constituents. The main components of fish are water, protein and fat. The spoilage of fish is a complicated process brought about by actions of enzymes, bacteria and chemical constituents. The spoilage process starts immediately after the death of the fish. The process involves three stages: rigor mortis. autolysis and bacterial invasion, and putrefaction.

1.5 Type of Fish

There are various types of fish, differing in their habits and characteristics. Some major types of fish include freshwater fish, tropical fish, marine fish, cold water fish, aquarium fish, etc.

Freshwater fish spend all or part of their lives in fresh water, such as rivers and lakes, with a salinity of less than 0.05%. These environments differ from marine conditions in many ways, the most obvious being the difference in levels of salinity. To survive fresh water, the fish need a range of physiological adaptations in order to keep the ion concentration of their bodies balanced.

Marine Fish are found in seawater. There are about 15,000 species of marine fish. Every species has its own appearance, characteristics, reproduction, environmental needs, nutritional requirements, survival adaptations and compatibility with other marine creatures. Most marine fish need a tropical climate.

Tilapia species are also a potential biological control for certain aquatic plant problems. In Kenya, tilapias were introduced to control the spread of malaria, because they consume mosquito larvae which consequently reduces the number of adult female mosquitoes, which are the vector of the disease. Tilapias do not generally accumulate contaminants in their tissues under natural conditions. In Myanmar, tilapia species can be found in the Ayeyarwady Region (Abimbola et al. 2010).

Tilapia (*Oreochromis*)

The complete classification of tilapia (*Oreochromis*) (Fig. 1) is as follows.

Class	:	Actinopterygii
Order	:	Perciformes

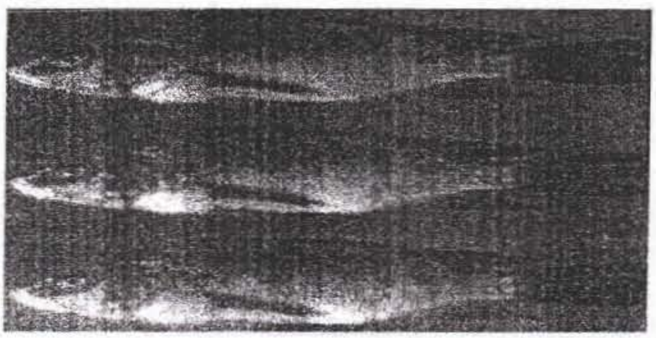

Fig. 1: Tilapia (Oreochromis)

Family	:	Cichlidae
Genus	:	*Oreochromis*
Scientific name	:	*Oreochromis. sp*
Common name	:	Tilapia
Local name	:	Tilapia
Occurrence	:	Africa, India and Myanmar

Butter Catfish (*Ompok bimaculatus*)

Ompok bimaculatus, popularly known as "butter catfish", is a freshwater fish species native to India, Bangladesh, Pakistan and Myanmar. Rivers are common habitats. Butter catfish has fine flesh with a soft meat texture, good taste and high nutritional value (Sobha et al. 2007). *Ompok bimaculatus* is a highly priced, delicious and nutritious catfish and well preferred fish because it contains relatively few bones. It has not received much attention in aquaculture mainly due to non-availability of information regarding its breeding and culture technique (Sarma et al. 2012).The complete classification of nga-nu-than (Ompok bimaculatus) (Fig. 2) is as follows.

Class	:	Actinopterygii
Order	:	Siluriformes
Family	:	Siluridae
Genus	:	*Ompok*
Species	:	*bimaculatus*
Scientific name	:	*Ompok bimaculatus*
Common name	:	Butter catfish
Local name	:	Nga-nu-than
Occurrence	:	Bangladesh, Myanmar and Pakistan

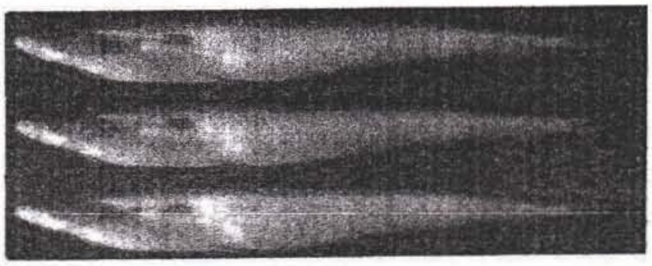

Fig. 2: Butter catfish (Ompok bimaculatus)

Mrigal (*Cirrhinus mrigala*)

The complete classification of Mrigal (*Cirrhinus mrigala*) (Fig. 3) is as follows:

Class	:	Antinopterygii
Order	:	Cypriniformes
Family	:	Cyprinidae
Genus	:	*Cirrhinus*

Species	:	*mrigala*
Scientific Name	:	*Cirrhinus mrigala*
Common Name	:	Mrigal
Local Name	:	Nga Kyinn Phyu

The mrigal is a freshwater fish species and is actually native to large river systems of India, Thailand and Myanmar. It is a very popular food in Iraq.

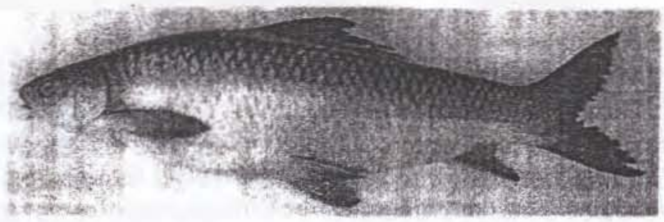

Fig. 3: Mrigal (Cirrhinus mrigala)

Rohu (*Labeo rohita*)

The complete classification of Rohu (*Labeo rohita*) samples (Fig. 4) is as follows:

Class	:	Actinopterygill
Order	:	Cypriniformes
Family	:	Cyprinidae
Genus	:	*Labeo*
Species	:	*rohita*
Scientific Name	:	*Labeo rohita*
Common Name	:	Rohu
Local Name	:	Nga-Myit-Chin

These fish are found in South and South-East Asia. In Myanmar, the fish occur in the Ayeyarwaddy and Bago Regions.

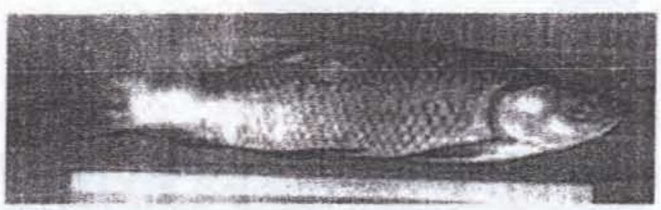

Fig. 4: Labeo rohita (Nga-Myit-Chin)

Gold spotted grenadier anchovy

The complete classification of mee-tan-thwe (*Coilia dussumieri*) (Fig. 5) is as follows.

Class	:	Actinopterygii
Order	:	Clupeiformes
Family	:	Engraulidae
Genus	:	*Coilia*
Species	:	*dussumieri*
Scientific name	:	*Coilia dussumieri*
Common name	:	Gold spotted grenadier anchovy
Local name	:	Mee-tan-thwe
Occurrence	:	Bangladesh, Brazil and Myanmar

Coilia dussumieri is popularly known as gold spotted grenadier anchovy in England. It is well known in the coastal districts of Bangladesh and is commonly found in the shallow coastal waters and estuaries. The gold spotted grenadier anchovy, *Coilia dussumieri*, is widely distributed in the Indian Ocean (coast of India, probably also Myanmar, Thailand and Malaysia) (Mohan 2012).

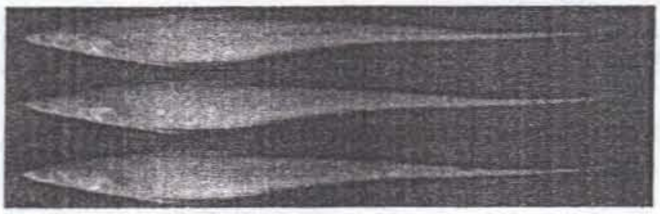

Fig. 5: Gold spotted grenadier anchovy (Coilia dussumieri)

Bombay duck (*Harpadon nehereus*)

The complete classification of Bombay duck (*Harpadon nehereus*) (Fig. 6) is as follows.

Class	:	Actinopterygii
Order	:	Aulopiformes
Family	:	Synodontidae
Genus	:	*Harpadon*
Species	:	*nehereus*
Scientific name	:	*Harpadon nehereus*
Common name	:	Bombay duck

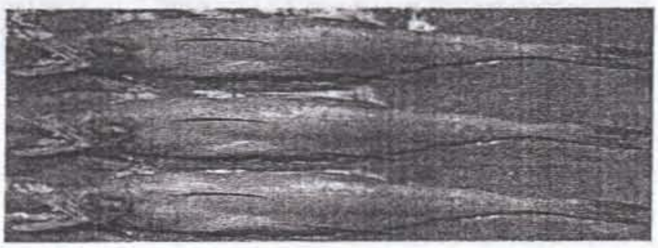

Fig. 6: Bombay duck (Harpadon nehereus)

Local name : Nga-hnat
Occurrence : China, India, Bangladesh and Myanmar

1.6 Chemical Compositions of Fish

The composition of food is very important in determining its nutritive value. This is particularly true of commodities such as fish, as there is large variation in the composition. Water, fat, protein and minerals are the main components of fish meat. The chemical composition of fish is closely related to feed intake, migratory swimming and sexual changes in connection with spawning.

Volatile Amines

Volatile amines are the characteristic molecules responsible for the fishy odor and flavor present in fish several days after the catch and together with the sensory parameters, they are the most common criteria for assessing the fish. The designation "volatile amines" regroups mostly three molocules, ammonia, dimethylamine (DMA) and trimethylamine (TMA). TVB is one of the most widely used parameters to evaluate fish quality. It represents the sum of ammonia, DMA, TMA and other basic nitrogenous compounds volatile under the analysis conditions.

1.7 Scombroid Fish and Non-scombroid Fish

The term "scombroid" is derived from the name of the family *Scombridae* which includes the fish species that were first implicated in histamine intoxication (i. e. tuna and mackerel). Non-scombroid fish are those which are not included in the Scombridae fish species family (Hungerford 2010).

Scombroid Fish Poisoning

The term "scombroid" is derived from the name of the family *Scombridae*, which includes the fish species that were first implicated in histamine intoxication (i. e. tuna and mackerel). Scombroid fish poisoning is a syndrome resembling an allergic reaction that occurs within a few hours of eating fish contaminated with histamine. These species of fish share high levels of free histidine in their muscle tissues. It is known that other non-scombroid fish species are also implicated in scombroid poisoning, such as mahi-mahi (*Coryphaena* spp.), sardines (*Sardinella* spp.), pilchards (*Sardina pilchardus*), anchovies (*Engraulis* spp.), herring (*Clupea* spp.), marlin (*Makaira* spp.), bluefish (*Pomatomus* spp.), Western Australian salmon (*Arripistruttaceus*), sockeye salmon (*Oncorhynchus nerka*), amberjack (*Seriola* spp.), Capeyellowtail (*Seriola lalandii*), and swordfish (*Xiphias gladius*). The scombroid fish poisoning symptoms include rash, urticaria, edema, localized inflammation, nausea, vomiting, diarrhea, abdominal cramps, headache, palpitation, flushing and severe respiratory distress (Marrow et al. 1991).

1.8 Toxicity levels of histamine

Histamine levels in illness-causing fish have been above 200 ppm, and often above 500 ppm. However, there is some evidence that other biogenic amines such as putrescine and cadaverine may also play a role in this type of poisoning. A hazardous level of histamine for human health has been suggested as 500 mg/kg although levels as low as 50 mg/kg (50 ppm) have been reported in histamine poisoning (FDA, 2001). Shalaby (1996) suggested the following guideline levels for histamine content of fish regarding health hazards: (i) < 5 mg/100 g (safe for consumption), (ii) 5–20 mg/100 g (possibly toxic), (iii) 20–100 mg/100 g (probably toxic), (iv) >100 mg/100 g (toxic and unsafe for human consumption) (Shalaby 1996).

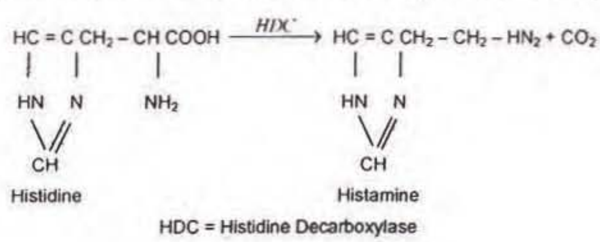

Fig. 7: Histamine

1.9 Aim and Objectives

The main aim of this research is to perform a chemical analysis of some export fish species from Myanmar waters. To fulfill this aim, the following objectives were carried out. Some of the chemical constituents such as the protein, ash, fat and water content in Bombay duck, Gold spotted grenadier anchovy, Tilapia and Butter catfish, Nga Kyinn Phyu (*Cirrhinus mrigala*) and *Labeo rohita* (Nga-Myit-Chin) were determined according to season. The elemental compositions in fish samples were measured using AAS (quantitative analysis). Spoilage indicators such as total volatile basic nitrogen (TVB-N), trimethylamine nitrogen (TMA-N) and ammonia content were monitored seasonally. The presence or absence of scombroid fish poisoning (histamine contents) in Bombay duck, Gold spotted grenadier anchovy, Butter catfish, Tilapia, Mrigale and *Labeo rohita* (Nga-Myit-Chin) fish samples were evaluated.

2. Materials and Methods

2.1 Collection of Samples

Fish samples studied in this work were the freshwater fish Butter Catfish, Nga Kyinn Phyu (*Cirrhinus mrigala*), *Labeo rohita* (Nga-Myit-Chin) and Tilapia, and the seawater fish Bombay Duck and Gold Spotted Grenadier Anchovy. Freshwater fish were collected from the Ayeyarwady Region, and the seawater fish were collected from Rakhine State.

2.2 Physicochemical Properties of Some Export Fish Species

The ash content was determined using the ashing method (Fish Nutrition of Practical Guide 1997). The pH of fish samples were determined by pH meter. Water content of the fish was determined using the Dean and Stark distillation method (Association of Official Analytical Chemists 2000). The fat content was determined using the Soxhlet extraction method (Fish Nutrition of Practical Guide 1997). Determination of protein was carried out using the biuret method, and protein standard (Bovine Serum Albumin from Nakarai chemical, Ltd., Kyoto, Japan) was used in this work.

2.3 Spoilage Indicators in Some Export Fish Species

Total volatile base nitrogen and trimethylamine nitrogen were determined using the Conway microdiffusion method (Association of Official Analytical Chemists, 2000). Ammonia content was determined using the spectrophotometric method "Nessler's method" (Association of Official Analytical Chemists 2000). Histamine analysis was carried out using the colorimetric method based on the method of Kawabata et al. (1960).

2.4 Determination of Trace Elements using atomic absorption spectroscopy (AAS)

The amounts of trace elements were determined using the Atomic Absorption Spectrophotometric method (Association of Official Analytical Chemists 2000). The ash (0.1 g) was digested for 30 min with 2 mL of concentrated hydrochloric acid. The resulting solution of ash sample was then evaporated to dryness and added to 5 mL of H_2O_2 (35%) was added. It was evaporated again to dryness and then dissolved in 6 mL of 25% hydrochloric acid solution. The solution was decanted and the clear solution was topped up to 100 mL with distilled water. Standard solutions were prepared using Analar chemicals and dilution was made using distilled water. The trace elements were determined using their specific hollow cathode lamps. The prepared solutions were now ready for analysis of trace elements using Atomic Absorption Spectrophotometric analysis.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Properties of Some Export Fish Species according to Season

The measurement of pH is an indicator of fish freshness. Figure 8 shows seasonal variation of pH values in these fish samples. It was found that the pH values in freshwater fish (Tilapia, Nga-Nu-Than, *Mrigal* and *labeo rohita)* were in the range of 6.85 to 7.35 in the hot season, 6.48 to 7.01 in the rainy season and 6.35 to 6.95 in the cold season. In seawater fish, pH values of Nga-Hnat and Mee-Tan-Thwe were found to be in the range of 6.98 to 7.09 in the hot season, 6.95 to 7.05 in the rainy season and 6.30 to 6.50 in the cold season. The investigation was conducted on fish samples from three seasons, and results may be due to the water temperature effect. Ash value is also one of the constituents present as a nutritional parameter in food. Figure 8 shows the seasonal variation of ash content in fish samples. In the present study, ash content in the fish samples analyzed – Nga-Hnat, Mee-Tan-Thwe, Nga-Nu-Than and Tilapia, *Mrigal* and *labeo rohita* – was found to be 1.84%, 1.50%, 1.42% and 1.34%, 1.95%, 2.10% in the hot season, 1.64%, 1.39%, 1.26% and 1.20%, 1.25%, 1.50% in the rainy season, and 1.75%, 1.38%, 1.40% and 1.30%, 1.18%, 1.11% in the cold season respectively. In the present investigation, it was found that ash content in *Mrigal* and *labeo rohita* fish samples was slightly higher than those for the other fish in all seasons.

The variation in fat content could be influenced by the variation of species, diet, temperature, salinity, selective mobilization and distribution. In the present investigation fat content was observed to be 10.72%, 9.64%, 7.72% and 7.36%, 4.48%, 4.18% in the hot season, 9.54%, 8.91%, 5.72% and 5.09%, 5.91%, 3.04% in the rainy season, and 9.81%, 9.27%, 5.90% and 6.81%, 8.25%, 5.40% in the cold season respectively. The fat content in the fish samples was found to be higher in the hot season than in the other two seasons. Water is the main component of fish flesh. In the present study, the water content was the highest in the samples collected in the rainy season. Figure 8 presents the seasonal variation of water

Fish Names	pH			Ash (%)			Fat (%)			Water (%)			Protein (%)		
	*h	**r	***c	*h	**r	***c	*h	**r	***c	*h	**r	***c	*h	**r	***c
1. Bombay duck	7.09	7.05	6.5	1.84	1.64	1.76	10.72	9.54	9.81	66.8	69.9	69.04	20.28	16.28	18.66
2. Butter Catfish	7.03	7.01	6.63	1.42	1.26	1.4	9.64	8.91	9.27	70.02	72.1	71.98	18.98	15.39	17.22
3. Gold Spotted Grena-dien anchovy	6.98	6.95	6.3	1.5	1.39	1.38	7.72	5.72	5.9	73.11	76.1	74.7	17.12	14.9	16.67
4. Tilapia	6.8	6.9	6.45	1.34	1.2	1.3	7.36	5.09	6.81	71.2	77.02	75.3	16.43	14.11	15.91
5. Mrigal	6.85	6.48	6.7	1.95	1.25	1.18	4.98	5.91	8.25	72.8	77.6	73.5	20.01	15.5	18.38
6. Labeo rohita	7.35	6.51	6.98	2.1	1.5	1.11	4.18	3.04	5.4	75.4	78.82	74.9	22.07	17.3	18.89

*h = hot

**r = rainy

***c = cold

Fig. 8: Physicochemical properties of some export fishes seasonally

content in fish samples. The water content of Nga-Hnat, Nga-Nu-Than, Mee-Tan-Thwe and Tilapia was found to be 66.80%, 70.02%, 73.16% and 71.20%, 72.8%, 75.4% in the hot season, 69.90%, 72.10%, 76.10% and 77.02%, 77.60%, 72.82% in the rainy season, and 69.04%, 71.98%, 74.70% and 75.30%, 73.50%, 74.90% in the cold season respectively. Water content was found to be highest in the rainy season in all species, which may be due to the higher humidity. For the determination of the concentrations of sample solution, Beer's law can still be used by constructing a calibration curve. Using Beer's law, a plot of absorbance vs. concentration was constructed. In this study, the different absorbance values were obtained for different protein concentrations using a visible spectrophotometer. It was found that the nature of the plot of absorbance vs. concentration of protein at 550nm was a straight line (R^2 = 0.996) passing through the origin, showing that Beer's law was obeyed. It was found that the protein content of fish samples were 20.28%, 18.98%, 17.12%, 16.43%, 20.01%, 21.07% in the hot season, 16.28%, 15.39%, 14.90%, 14.11%, 15.50%, 17.30% in the rainy season and 18.66%, 17.22%, 16.67%, 15.91%, 18.38%, 18.89%, in the cold season respectively. These fish are a good source of protein.

3.2 Determination of Spoilage Indicators in Some Export Fish Species according to Season

The TVB-N level in fish was also used to indicate spoilage and growth of microorganisms. The acceptable level of TVB-N in fish is 30mg/100g (Commission regulation (EC) No2074/2005). Figure 9 shows the seasonal variation of TVB-N contents in Nga-Hnat, Mee-Tan-Thwe, Nga-Nu-Than, Tilapia, *Mrigal* and *labeo rohita* samples. In this research, the contents of TVB-N in fish samples were found to be 17.11mg/100g, 13.43mg/100g, 13.11mg/100g, 10.05mg/100g, 8.10mg/100g, 3.36mg/100g in the hot season, 16.59mg/100g, 12.11mg/100g, 12.05mg/100g, 9.45mg/100g, 6.20mg/100g, 3.01mg/100g in the rainy season, and 13.29mg/100g,

Fish Names	TVB-N (mg/100g)			TMA-N (mg/100g)			NH_3 (mg/100g)		
	*h	**r	***c	*h	**r	***c	*h	**r	***c
1. Bombay duck	17.11	16.59	13.3	5.3	4.6	4	4.9	4.3	2.4
2. Gold Spotted Grenadien anchovy	13.43	12.11	10.1	4.7	4	3.4	4	3.8	1.3
3. Butter Catfish	13.11	12.05	10.1	3.4	2	1.3	3.2	2.3	1.1
4. Tilapia	10.1	9.45	8.12	1.3	1	1	0.7	0.6	1
5. Mrigal	8.1	6.2	7.05	0.1	0.1	0	2.3	1	0.9
6. Labeo rohita	3.36	3.01	2.28	1.3	0.7	0.1	2.2	1.8	0.8

*h = hot

**r = rainy

***c = cold

[illegible] Spoilage indicators of some export fishes seasonally

10.11mg/100g, 10.07mg/100g, 8.12mg/100g, 7.05mg/100g, 2.28mg/100g in the cold season respectively. None of these fish samples exceed the acceptable limit of FDA guidelines. The TVB-N content of fish samples was observed to be higher in the hot season than in the rainy and cold seasons. This could be explained by the fact that fish samples collected in hot season had a higher temperature and humidity (Mohd et al. 2010). Figure 9 shows the seasonal variation of TMA-N content in Nga-Hnat, Mee-Tan-Thwe, Nga-Nu-Than and Tilapia. In this research, the TMA-N contents in fish samples were found to be 5.31mg/100g, 4.70mg/100g, 3.36mg/100, 1.34mg/100g, 0.08mg/100g, 1.33mg/100g in hot, 4.64mg/100g, 4.03mg/100g, 2.01mg/100g, 1.01mg/100g, 0.05mg/100g, 0.67mg/100g in the rainy season, and 3.98mg/100g, 3.37mg/100g, 1.34mg/100g, 1.02mg/100g, 0.01mg/100g and 0.13mg/100g in the cold season respectively. The TMA-N content of fish samples proved to be higher in the hot season than in the other two seasons. It was noted that the TMA content of seawater fish was found to be higher than that of the freshwater fish. The Trimethylamine nitrogen content present in these fish was found to be within the limits of Commission regulation (EC) No2074/2005.

Before any spectrophotometric determination, a calibration curve must be constructed to check the validity of Beer's law. A calibration curve was prepared using different concentrations of standard ammonium sulphate solutions, and the absorbance values were determined at 420nm. The data were recorded (Fig. 9) and a plot of absorbance vs. wavelength was drawn. From this plot, it was seen that a straight line with $R^2 = 0.998$ passed through the origin, indicating that it obeyed Beer's law. Figure 9 shows the seasonal changes of ammonia content in Nga-Hnat, Mee-Tan-Thwe, Nga-Nu-Than, Tilapia, *Mrigal* and *labeo rohita* fish samples. The ammonia content in fish samples were found to be 4.92mg/100g, 4.01mg/100g, 3.21mg/100g, 1.02mg/100g, 2.28mg/100g, 2.23mg/100g in the hot season, 4.27mg/100g, 3.83mg/100g, 2.26mg/100g, 0.62mg/100g, 1.01mg/100g and 1.82mg/100g in the rainy season, and 2.38mg/100g, 1.28mg/100g, 1.13mg/100g, 0.95mg/100g, 0.90mg/100g, 0.82mg/100g in the cold season respectively. Commission regulation (EC) No2074/2005 requires the ammonia content in fish to be 3–8mg/100g for these fish not to be harmful for human consumption.

3.3 Chemical Hazards (Histamine) in Some Export Fish Species according to Season

For spectrophotometric determination of the histamine standard, a calibration curve should be constructed. In this work, a calibration curve was constructed using five different concentrations of histamine standard solutions ranging from 2 to 10ppm (Fig. 10). The plot of absorbance vs. histamine concentration was linear over the range of 2–10ppm histamine with a correlation coefficient of 0.997 (Fig. 11, 12, 13). The straight line passing through the origin indicated that Beer's law was obeyed. Figure 14 shows the seasonal variation of histamine

Concentration (ppm)	Absorbance at 500 nm
2	0.129
4	0.228
6	0.378
8	0.484
10	0.628

Fig. 10: Relationship between absorbance and concentration of standard histamine

content in *Nga-Hnat, Mee-Tan-Thwe, Nga-Nu-Than Tilapia, Mrigal* and *labeo rohita*. It was observed that the histamine content in fish samples was 31.44 ppm, 9.15 ppm, 7.43 ppm, 5.30 ppm, 0.08 ppm, 0.05 ppm in the hot season, 30.98 ppm, 8.76 ppm, 6.88 ppm, 4.16 ppm, 0.028 ppm and 0.012 ppm in the rainy season,

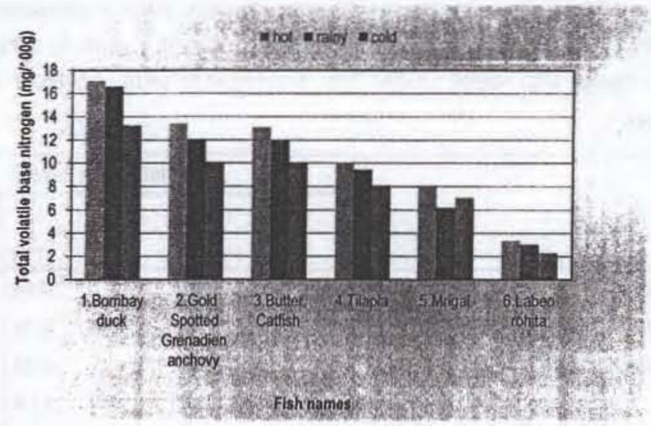

Fig 11: Total volatile base nitrogen (TVB-N) content in some fish seasonally

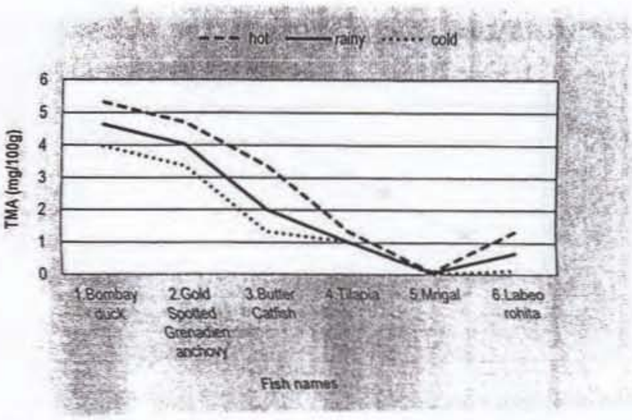

Fig 12: Trimethylamine (TMA) content in some fish seasonally

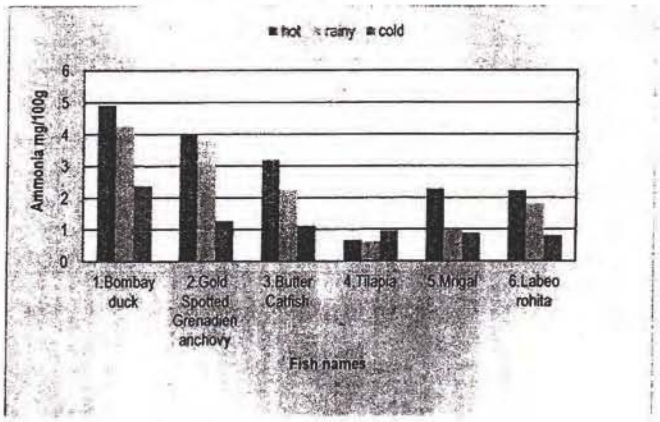

Fig 13: Ammonia content in some fish seasonally

and 15.35 ppm, 5.85 ppm, 4.51 ppm, 3.32 ppm, 0.004 ppm and 0.007 ppm in the cold season respectively. Possibly due to histamine forming bacteria, seawater fish were found to have a higher histamine content than freshwater fish in all seasons. The FDA guideline limit for histamine content in fish is 50 ppm. Histamine contents in these fish were under the acceptable limit, so they are suitable for consumption.

	Histamine (ppm)		
Fish Names	***S**	****R**	*****W**
1. Bombay duck	31.44	30.98	15.35
2. Gold Spotted Grenadien anchovy	9.15	8.76	5.85
3. Butter Catfish	7.43	6.88	4.51
4. Tilapia	5.3	4.16	3.32
5. Mrigal	0.08	0.028	0.004
6. Labeo rohita	0.05	0.012	0.007

Fig. 14: Chemical hazard (Histamine) in some export fishes seasonally

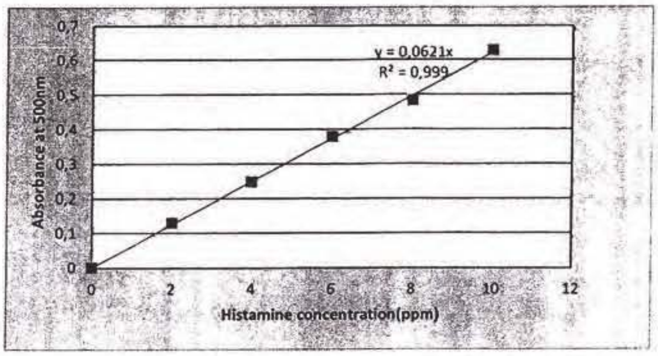

Fig 15: Histamine standard concentration Vs absorbance at 500 nm

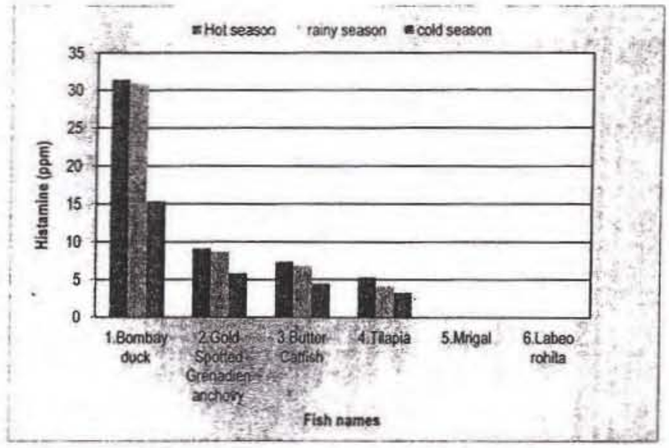

Fig 16: Histamine content in some fish seasonally

3.4 Quantitative determination of trace elements by AAS

Since fish come from the aquatic environment, they may accumulate metals from the water bodies in which they live. Water levels have increased due to domestic, industrial, mining and agricultural activities. In the determination of trace elements, Cu, Zn, Fe, Pb, Cd and As were measured using the dry ashing digestion method at 324.8 nm, 213.9 nm, 248.3 nm, 228.2 nm, 283.3 nm, 193.7 nm and 253.7 nm wavelengths respectively. In the present study, the concentration of trace elements in Nga-Hnat, Nga-Nu-Than, Tilapia and Mee-Tan-Thwe were Fe > As > Zn > Pb > Cu > Cd in the hot season, Fe > As > Zn > Pb > Cd > Cu in the rainy season, and As > Fe > Zn > Cd > Pb > Cu in the cold season. The concentration of *Mrigal* and *labeo rohita* fish samples were As > Zn > Fe> Cu > Pb in all three seasons. These concentrations of Cu, Zn, Fe, Pb, Cd and As in freshwater fish and seawater fish are shown in Table (Fig. 17).

4. Conclusion

This research work has attempted to analyze export fish. Physicochemical properties, spoilage indicators and quantitative determination of trace elements in several export fish species were monitored in this study. Six different species – Nga-hnat (*Harpadon nehereus*) and Mee-tan-thwe (*Coilia dussumieri*) collected from Rakhine State, and Tilapia (*Oreochromis*) Nga-nu-than (*Ompok bimaculatus*), Nga Kyinn Phyu (*Cirrhinus mrigala*) and *Labeo rohita* (*Nga-Myit-Chin*) collected from the Ayeyarwady Region – were studied in this investigation. From the experimental results of this investigation, the following inferences may be deduced. From the chemical compositions of the fish analyzed. The mean water content of these fish were found to be in the range of 66.80 to 75.40 % in hot

Trace ele-ments (ppm)	Bombay duck			Butter Cat-fish			Tilapia			Gold Spotted grenadien anchovy			Mrigal			Labeo rohita		
	*h	**r	***c	*h	**r	***c	*h	**r	***c	*h	**r	***c	*h	**r	***c	*h	**r	***c
Cu	0.63	0.2	0.11	0.35	0.28	0.16	0.42	0.21	0.44	0.25	0.18	0.15	2.34	1.08	1.01	0.15	0.13	0.11
Pb	0.71	1.04	0.25	0.18	1.25	0.28	0.59	1.42	0.22	0.81	1.4	0.72	0.73	0.8	0.55	1.17	1.08	1.01
Zn	2.34	1.62	0.81	2.37	1.79	1.14	2.82	2.21	1.84	2.53	2.11	1.01	9.13	7.08	5.82	1.04	1.02	0.83
Cd	0.41	0.25	0.23	0.44	0.4	0.25	0.54	0.5	0.41	0.57	0.37	0.28	ND	ND	ND	0.09	0.03	0.01
Fe	20.79	19.19	11.8	21.1	16.88	15.91	21.56	19.09	19.01	21.56	17.62	10.11	3.47	2.85	2.32	1.68	1.35	0.55
As	18.62	18.71	16.2	17.5	17.52	17.13	18.69	19.05	16.88	16.92	17.66	12.04	13.3	10.31	7.9	11.7	10.65	10.01

*h = hot

**r = rainy

***c = cold

Fig. 17: Some trace elements in export fishes seasonally

season, 69.90 to 78.82% in rainy season and 69.04 to 74.90% in cold season. It was found to be in the range of 6.85 to 7.35 in hot season, 6.48 to 7.05 in rainy season and 6.30 to 6.98 in cold season for these fish. It was observed that the water content in these fish was higher in the rainy season than the other two seasons. The pH values were found to be normal for all of these fish in all seasons: The ash per cent of these fish were found to be in the range of 1.34% to 2.10% in hot season, 1.20 to 1.64% in rainy season and 1.11 to 1.76% in cold season. A slightly higher ash content was found in Nga-hnat than in other fish in all seasons. The fat content observed in these fish were found to be in the range of 4.18 to 10.72% in hot season, 3.04 to 9.54% in rainy season, and 5.4 to 9.81% in cold season respectively. The protein content of these fish was observed to be in the range of 16.43% to 22.28% in hot season, 14.11 to 17.30% in rainy season, and 15.91 to 18.89% in cold season. It was noted that fat and protein contents were found to be higher in the hot season than in the other two seasons. All of these fish are good sources of protein. As fish plays a major role in human nutrition, the physicochemical properties, spoilage indicators and trace elements of fish analyzed in this research can contribute to information on human consumption. Total volatile base nitrogen (TVB-N) values of these fishes were in the range of 3.36 mg/100g to 17.11 mg/100g in hot season, 3.01 mg/100g to 16.59 mg/100g in rainy season, and 2.28 mg/100g to 13.29 mg/100g in cold season. In this research, the TMA-values in fish samples were found to be in the range of 0.08 mg/100g to 5.31 mg/100g in hot season, 0.67 mg/100g to 4.64 mg/100g in rainy season and 0.01 mg/100g to 3.98 mg/100g in cold season respectively. It was observed that the ammonia values in these fish were from 1.02 mg/100g to 4.92 mg/100g in hot season 1.01 mg/100g to 4.27 mg/100g in rainy season, and 0.82 mg/100g to 2.38 mg/100g in cold season respectively. None of these fish samples exceed the acceptable limit of FDA guidelines. TVB-N contents of fish samples were observed to be higher in the hot season than in the rainy and cold seasons. This could be explained by the fact that fish samples collected in the hot season had a higher temperature and humidity. In this research, the TMA-N contents in fish samples were found to be 5.31 mg/100g, 4.70 mg/100g, 3.36 mg/100g, 1.34 mg/100g, 0.08 mg/100g, 1.33 mg/100g in summer, 4.64 mg/100g, 4.03 mg/100g, 2.01 mg/100g, 1.01 mg/100g, 0.05 mg/100g, 0.67 mg/100g in the rainy season, and 3.98 mg/100g, 3.37 mg/100g, 1.34 mg/100g, 1.02 mg/100g, 0.01 mg/100g and 0.13 mg/100g in the winter season. The TMA-N content of fish samples was higher in the hot season than in the other two seasons. It was noted that TMA contents in seawater fish were found to be higher than that of the freshwater fish. The Trimethylamine nitrogen content present in these fish was found to be within the limits of FDA guidelines (FDA 2001). It was observed that the ammonia content in fish was 4.92 mg/100g, 4.01 mg/100g, 3.21 mg/100g, 1.02 mg/100g, 2.28 mg/100g, 2.23 mg/100g in the summer season, 4.27 mg/100g, 3.83 mg/100g, 2.26 mg/100g, 0.62 mg/100g, 1.01 mg/100g and 1.82 mg/100g in the rainy season, and 2.38 mg/100g, 1.28 mg/100g, 1.13 mg/100g, 0.95 mg/100g, 0.90 mg/100g, 0.82 mg/100g in the winter season.

In this work, histamine fish poisoning (HFP) was studied for a risk assessment of a significant public health and safety concern. Although it is generally associated with high levels of histamine (> 50 mg/100 g) in bacterially contaminated fish of particular species, the fish studied in this work are harmless when fresh. In this investigation the histamine levels of these fish were noted within the range of 0.05 ppm to 31.44 ppm in hot season, from 0.012 ppm to 30.98 ppm in rainy season, from 0.007 ppm to 15.35 ppm in cold season respectively. It was found that the values of histamine in sea water fish were found to be higher than these of fresh water fish. The FDA guideline of histamine in fish is 50 ppm. Therefore, it was found that the histamine content in these fish samples is within the range of FDA guidelines. Seasonal variation in the concentration of several trace elements – Cu, Pb, Zn, Cd Fe, and As – was determined in these fish. The concentrations were as follows: Cu (0.15–2.34 ppm), Pb (0.18–0.81 ppm), Zn (1.04–9.13 ppm), Cd (ND-0.57 ppm), As (13.32–18.69 ppm) and Fe (1.68–20.79 ppm) in the hot season, Cu (0.13–1.08 ppm), Pb (0.80–1.42 ppm), Zn (1.02–7.08 ppm), Cd (ND-0.37 ppm), As (10.15–18.71 ppm) and Fe (1.35–19.19 ppm) in the rainy season, and Cu (0.11–1.01 ppm), Pb (0.25–1.01 ppm), Zn (0.81–5.82 ppm), Cd (ND-0.41 ppm), Fe (0.55–19.01 ppm), As (7.9–17.13 ppm) in the cold season respectively. In all four fish species analyzed, the Cu, Pb, Zn, Cd, Fe and As content of *Nga-hnat, Nga-nu-than, Tilapia, Mee-tan-thwe, Mrigal* and *Labeo rohita* are under the acceptable level of FDA guidelines. This study shows that the concentration of some trace elements in these fish are within the acceptable limit of FDA guidelines.

5. Acknowledgements

The authors would like to acknowledge Rectors Dr. Tin Tun and Dr. Aung Thu and Pro-Rector Dr. Kyaw Naing, University of Yangon and Dr. Daw Hla Ngwe, Professor and Head, Department of Chemistry, University of Yangon, for their kind encouragements.

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