Iodine Content of Some Commonly Consumed Freshwater and Marine Fishes and Prawns in Myanmar

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In Myanmar, fish is an irreplaceable animal-source food in the diet, both in terms of quality and quantity. Fish is an economical source of animal protein and other essential nutrients including iodine in developing countries. Iodine is an essential trace element for nutrition. The element is an essential part of the thyroid hormones triiodothyronine (T3) and thyroxine (T4), which are required for growth and development. Seawater fish and other marine food are natural sources of dietary iodine. The iodine content of marine fishes varies depending on the species. In addition, different individuals of the same species show variation in iodine concentration. Therefore, this study was aimed to determine the iodine content of some commonly consumed fishes and prawns in Myanmar. A total of 18 freshwater fish and prawn (from Yangon Region) and 30 marine fish and prawn (from Rakhine and Mon States) were analyzed for iodine content with spectrophotometric method. The mean and standard deviation (SD) of iodine content of freshwater fish and marine fish were 8.32±9.32 µg /100 g and 27.38±15.82 µg/100 g, respectively. The mean and SD of iodine content of freshwater prawn and marine prawn were 8.03±5.93 µg /100g and 264.03±18.73 µg/100g respectively. The mean iodine content of freshwater fish and prawn were significantly lower than those of marine fish and prawn (p values <0.001 and <0.05, respectively). The mean and SD of iodine content of marine fish and prawn from Rakhine State were 28.38±16.32 µg/100 g and 267.19±20.58 µg/100g and those from Mon State were 26.37±13.95 µg/100 g and 260.87±20.6 µg/100g. The mean iodine content of marine fish and prawn from the Bay of Bengal (Rakhine State) was higher than those of fish and prawn from Andaman Sea (Mon State) but not statistically significant. In conclusion, the mean iodine content of marine fish and prawn were significantly higher than those of freshwater fish and prawn. The mean iodine content of marine fish and prawn from Rakhine State was higher than those of fish and prawn from Mon State. These results can be applied in formulating dietary guidelines and nutrition education to population.

Key words: Iodine content, Fish, Prawn, Sea water, Freshwater

INTRODUCTION

Iodine plays a critical role in regulating the body's metabolism. Iodine deficiency can lead to changes in metabolism and in turn reduced growth and cognitive decline.[1, 2] Iodine is an essential trace element in nutrition. The element is necessary for thyroid hormone synthesis. Iodine deficiency is one of the most widespread deficient in theworld.[3] In Myanmar, the National Goiter

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Survey in 2000-2001 indicated that iodine deficiency disorders (IDD) was a public health problem especially in coastal areas and hilly regions. Due to the IDD elimination program, the consumption of adequately iodized salt increased from 65% in 2002 and 73% in 2005.[4] However, according to a 2013 Ministry of Health report, adequately iodized salt coverage decreased dramatically from 73% in 2005 to 47% in 2008. It indicated that iodine deficiency may be an issue in parts of the country.[5] A cross-sectional descriptive study in coastal areas of Mon State in 2013 showed that iodine nutritional status of pregnant women in that area is insufficient.[6] Fish contains more iodine content than all other food on a normal diet. The main iodine supply occurs via nutrition and marine seafood is the only natural source containing relatively large amounts of iodine.[7] However, the iodine content of marine fish varies considerably according to the species.[8] There is also a great variation between different individuals of the same species.[9] Therefore, this study was aimed to explore the iodine contents of fish and prawn from freshwater in Yangon and seawater in two different coastal regions.

MATERIALS AND METHODS

Sample collection and preparation

A descriptive study was conducted to explore the iodine content of freshwater and seawater fish and prawn from January 2019 to January 2020. A total of 16 commonly consumed freshwater fishes and 2 freshwater prawns, 24 seawater fishes and 6 seawater prawns were collected. Freshwater fishes and prawns were purchased from local markets, Insein and Kyee Myin Taing Markets, in Yangon Region. Seawater fishes and prawns imported from Rakhine State (Bay of Bengal) and Mon State (Andaman Sea) were bought from Insein and Pa Zun Taung jetties, Yangon. The samples were collected in a plastic bag with an ice box and transported to the laboratory. Biochemical analysis was carried out at laboratory of the Nutrition Research Division, Department of Medical Research.

Determination of iodine concentration

Duplicates of each selected sample were analyzed by the method based on catalytic destruction of thiocyanate by nitrite in the presence of iodine[10, 11]. Alkaline dry ashing was used to remove organic matter and to convert the organic form of iodine contained in fish to inorganic form of iodine during the process of ashing. Since seawater contain higher salt content than freshwater, approximately 1gram of seawater fish/prawn or 10grams of freshwater fish/prawn were placed in a clean dry crucible. Then 1 milliliter of 30% potassium carbonate solution and 1 milliliter of 10% zinc sulphate solution were added. The slurry mixture was made with a glass rod and any residue left on the rod was washed back into the crucible and placed in a drying oven at 95°C until dry overnight. The crucible was covered with a lid and placed in a muffle furnace at 100°C.

Then, the temperature was gradually increased evenly to 550°C for approximately 90 minutes and maintained for one hour. The crucible was removed and it was allowed to cool to room temperature. Then 1 milliliter of zinc sulphate solution was added to the charred residue. The drying process was repeated as before. Next, the cooled ash was transferred to a centrifuge tube with 40±0.5 milliliter of distilled water and then the tube was spined at 1500 rpm for 15 minutes. The solution was stored in the tube covered with parafilm and the tube was placed in the refrigerator. Four milliliters of each working standard solution, sample and blank solution were pipetted into test tubes, respectively.

Then, 1 milliliter of distilled water, 1.5 milliliter of potassium thiocyanate solution and 2 milliliters of ferric ammonium sulphate reagents were added to each tube. The orange solution in the tube was mixed well. Then the tubes were placed in a water-bath and kept at 37°C for 15 minutes. Then, 1 milliliter of sodium nitrite solution (freshly prepared) was added to each tube at 1-minute intervals using a stop watch and the tube was thoroughly mixed. The sample was analyzed by a UV/Vis Spectrophotometer (APEL

PD-303 S, Japan) at a wavelength of 450 nm exactly 15 minutes after the addition of sodium nitrite, at 1-minute intervals. All solutions were maintained at the same temperature.

Statistical analysis

Data entry and statistical analysis were done by computer using Microsoft Excel 2010. Quantitative data were expressed as mean± standard deviation (SD). The iodine contents in the samples were presented in microgram per 100 grams. The statistical test, Mann-Whitney U Test was used to get a p-value because of the small sample size and a non-normal distribution. A 'p' value of <0.05 was considered as statistically significant.

RESULTS

A total of 18 freshwater fish and prawn from Yangon and 30 of marine fish and prawn from Rakhine and Mon States (Table 1 & 2) were analyzed for iodine content using the spectrophotometric method.

Table 1. Iodine content of fishes and prawns from freshwater

No.	Name (Myanmar Language)	Common name	Scientific name	Iodine concentration (µg/100g) (Mean±SD)
1	Nga-khoo (ငါးခူ)	Common catfish	*Clarias batrachus*	3.77±0.12
2	Nga-yant (ငါးရံ့)	Snake head fish	*Channa striatus*	10.89±4.09
3	Nga-myit-chin (ငါးမြစ်ချင်း)	Common carp	*Labeo rohita*	4.09±1.03
4	Nga-phe (ငါးဖယ်ခြစ်)	Father back	*Notopterus notopterus*	3.44±0.11
5	Nga-Patte (ငါးပတ်)	Great white sheatfish	*Wallagonia attu*	4.88±0.57
6	Te-lar-pee-yar (တီလားဦးယား)	Three-spot gourami	*Trichogaster trichopterus*	3.92±0.34
7	Nga-tha-lauk (ငါးသလောက်)	Herring	*Hilsa ilisha*	8.20±0.40
8	Nga-bya-ma (ငါးပြေမ)	Climbing perch	*Anabas testudineus*	4.24±1.70
9	Nga-thale-doe (ငါးသလဲတိုး)	Loach	*Lepidocephalus*	33.92±0.91
10	Nga-gyin (ငါးကြင်း)	Hamilton's carp	*Cirrhina mrigala*	4.96±0.23
11	Nga-bae (ငါးဘဲ)	Silver hued barb	*Amblypharyngodon mola*	5.44±0.23
12	Nga-zin-yine (ငါးဇင်ရိုင်း)	Truncated estuarine catfish	*Arius truncatus*	5.20±0.34
13	Nga-than-gake (ငါးသံကျိတ်)	Glass sheatfish	*Kryptopterus bicirrhis*	29.12±0.45
14	Nga-phe (ငါးဖယ်)	Father back	*Notopterus notopterus*	4.72±0.11
15	Nga-gin (ငါးကျည်း)	Stinging catfish	*Heteropneustes fossilis*	2.00±0.11
16	Nga-pona (ငါးပုဇွန်း)	Thread-fin	*Polynemus paradiseus*	4.40±0.11
17	Pa-zun-douk (ပုစွန်ထုတ်)	Prawn	*Macrobrachium rosenbergii*	3.84±0.45
18	Pa-zun-zeik (ပုစွန်ဆိတ်)	River shrimp	*Metupenaus*	12.22±0.54

Table 1 shows the mean iodine content of fishes and prawns from freshwater. Among freshwater fish, stinging catfish (ငါးကျည်း) (Fig. 1a) had lowest iodine content (2.0±0.11 µg/100g) and loach fish (ငါးသလဲထိုး) (Fig. 1b) had highest iodine content (33.92± 0.91 µg/ 100g). In freshwater, prawn (ပုစွန်ထုတ်) (Fig. 2a) had lower iodine content (3.84±0.45 µg/100g) than river shrimp (ပုစွန်ဆိတ်) (Fig. 2b) (12.22 ±0.54 µg/100 g). Table 2 shows the mean iodine content of marine fishes and prawns from Rakhine and Mon States. Among marine fish, slender shad fish (ငါးဇင်းပြား) (Fig. 1c) had lowest iodine content (13.56±1.13 µg/100 g) and flat fish (ငါးခွေးလျှာ) (Fig. 1d) had highest iodine content (74.7±1.09 µg /100g). Among marine prawns, white prawn (ပုစွန်ဖြူ) (Fig. 2c) from both Rakhine (252.3 ± 4.52 µg/ 100 g) and Mon (245.88± 4.52 µg/100 g) States had lowest iodine content; and flower tiger prawn (ပုစွန်ကြား) (Fig. 2d)

Table 2. Iodine content of marine fish and prawn from Rakhine and Mon States

No.	Name (Myanmar anguage)	Common name	Scientific name	Iodine concentration (µg/100g)(Mean±SD)	
				Rakhine	Mon
1	Pa-lar-too (ပလာတူး)	Mackerel	*Rastrelliger kanagurta*	27.94±1.13	24.77±1.13
2	Nga-mok (ငါးမုတ်)	Silver pomfret	*Pampus argenteus*	19.96±1.13	16.75±1.13
3	Nga-tha-lauk (ငါးသလောက်)	Hilsa shad	*Tenulosa Ilisha*	27.96±1.13	24.74±1.13
4	Nga-tha-lauk-yout-pha (ငါးသလောက်ယောက်ဖ)	Toli sha	*Tenulosa toli*	26.36±1.13	24.75±1.13
5	Nga- pa-lway (ငါးပုလွေ)	Whiting	*Sillago domina*	22.35±2.26	22.38±0.00
6	Nga-zin-pya (ငါးဇင်းပြား)	Slender shad	*Ilisha sp*	13.56±1.13	13.57±1.13
7	Nga-kun-sha (ငါးကွင်းရှဉ်)	Spanish mackerel	*Cybium commersoni*	34.33±1.13	31.16±1.13
8	Nga-thin-war (ငါးသင်းဝါ)	Yellow Croaker	*Chrysochir aureus*	34.36±1.13	32.12±2.56
9	Nga-khwe-sha (ငါးခွေးလျှာ)	Flat fish	*Plagusia marmoratus*	75.88±1.13	73.52±2.26
10	Nga-shwe (ငါးရွှေ)	Indian pike conger	*Muraenesox telabonoides*	16.33±0.49	15.98±2.26
11	Nga-hnut (ငါးဟောက်)	Bombay duck	*Harpodon nehereus*	18.37±1.13	16.78±1.13
12	Nga-poke-ma (ငါးပုတ်မ)	Pama croacker	*Scieanadea pama*	23.17±1.13	19.97±1.13
13	Pa-zun-gyar (ပုစွန်ကြား)	Flower tiger prawn	*Penaeus mondon*	290.68±4.31	284.32±4.52
14	Pa-zun (ပုစွန်ပန်းရောင်)	Pink prawn	*Metapenaus affinis*	258.61±4.52	252.40±4.52
15	Pa-zun (ပုစွန်ဖြူ)	White prawn	*Penaeus indicus*	252.3±4.52	245.88±4.52

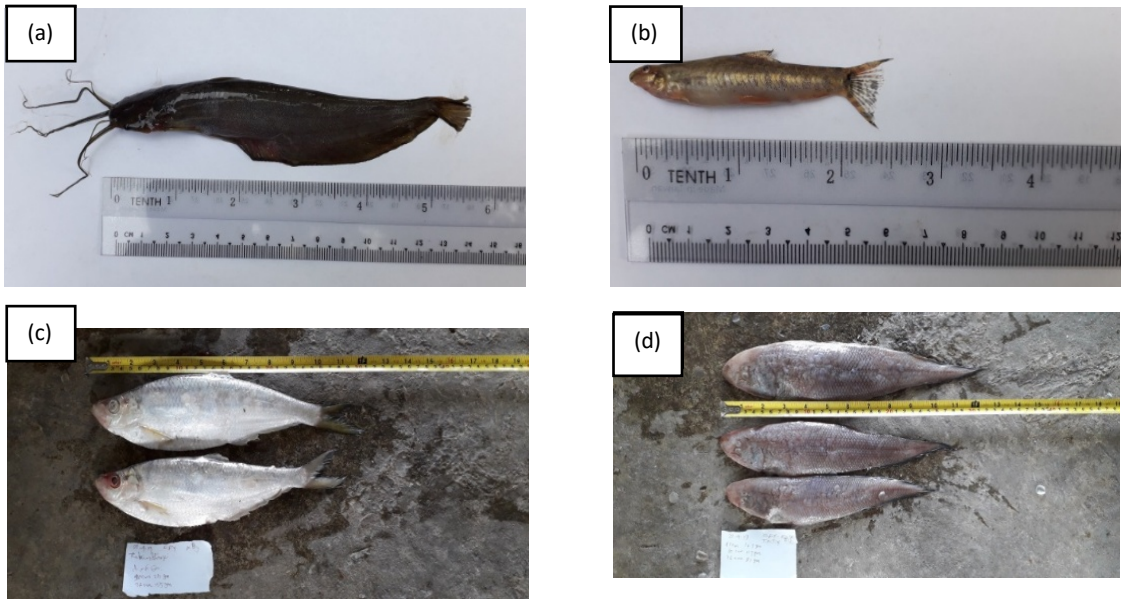

Fig 1. Freshwater fish (a) Stinging catfish (Nga-gye, ငါးကျည်း) (*Heteropneustes fossilis*); (b) Loach (Nga-thale-doe, ငါးသလဲတိုး) (*Lepidocephalus*). Seawater fish (c) Slender shad (Nga-zin-pya, ငါးဇင်းပြား) (*Ilisha sp*); (d) Flat fish (Nga-khwe-sha, ငါးခွေးလျှာ) (*Plagusia marmoratus*)

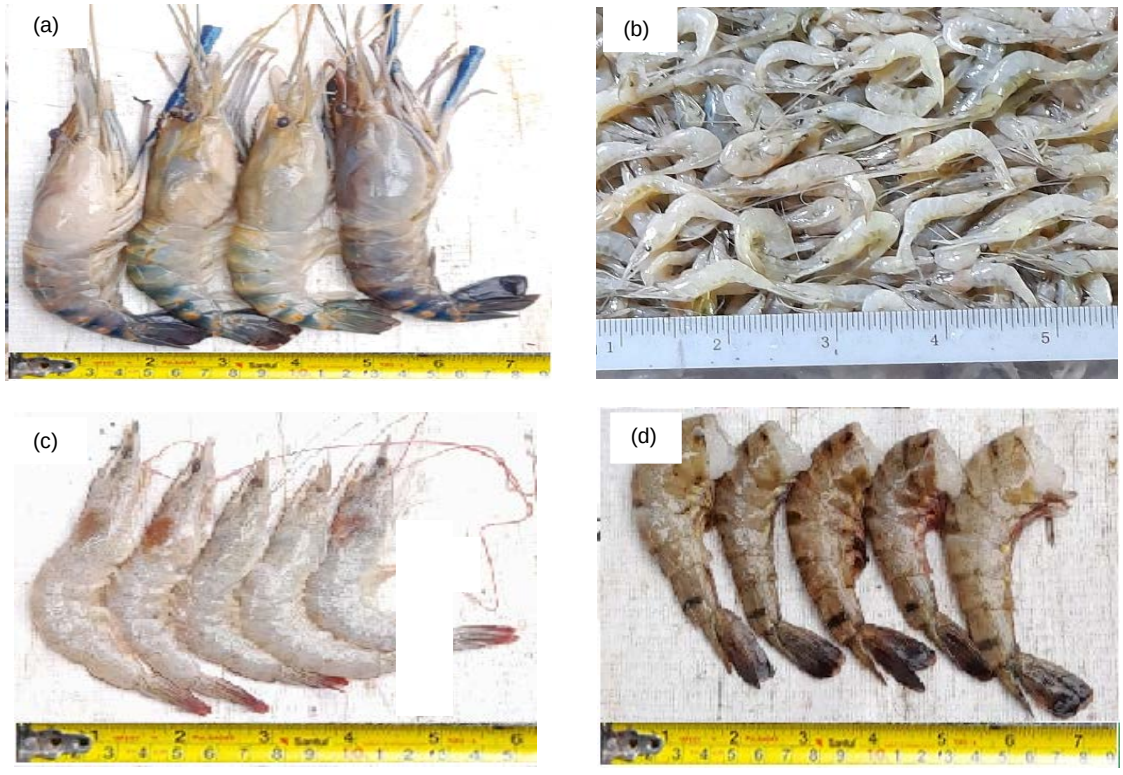

Fig. 2. Freshwater prawn (a) Prawn (Pa-zun-douk, ပုစွန်ထုတ်) (*Macrobrachium rosenbergii*); (b) River shrimp (Pa-zun-zeik, ပုစွန်ဆိတ်) (*Metapenaus*). Seawater prawn (c) White Prawn (Pa-zun, ပုစွန်ဖြူ) (*Penaeus indicus*); (d) Flower tiger prawn (Pa-zun-gyar, ပုစွန်ကြား) (*Penaeus mondon*)

Table 3. Comparison of mean iodine content in fresh and seawater fishes and prawns

Common name	Iodine concentration (µg /100g) (Mean±SD)		P value
	Freshwater	Seawater	
Fishes	8.32±9.32	27.38±15.82	<0.001*
Prawns	8.03±5.93	264.03±18.73	0.046*

*Statistically significant ($p<0.05$)

from both Rakhine (290.68±4.31 µg/100g) and Mon (284.32± 4.52 µg/100g) States had highest iodine content. The mean and standard deviation (SD)of iodine content of fresh-water fish (8.32± 9.32 µg/100 g) was signi-ficantly lower than those of marine fish (27.38±15.82 µg/100g) ($p<0.001$). The mean and SD of iodine content of freshwater prawn (8.03±5.93 µg /100g) was signifi-cantly lower than those of marine prawn (264.03±18.73 µg/100 g) ($p<0.05$) (Table 3). The mean iodine content of marine fish and prawn from the Bay of Bengal (Rakhine State) was higher than those of fish and prawn from Andaman Sea (Mon State).

DISCUSSION

The only natural source of iodine supply via nutrition is marine seafood and the iodine content of marine fish depends on the species and individuals considerably.[7-9] Freshwater prawn and fishes namely Pa-zun-zeik (River shrimp), Nga-than-gake (Glass sheatfish) and Nga-thale-doe (Loach) would benefit for their iodine content more than 10 µg of iodine in 100 g. According to the findings of the present study, among

freshwater fishes, stinging catfish (ငါးကျည်း) had the lowest iodine content and loach fish (ငါးသလဲထိုး) had the highest iodine content. Among freshwater prawn, prawn (ပုစွန်ထုတ်) had lower iodine content than river shrimp (ပုစွန်ဆိတ်).

Among marine fish, slender shad fish (ငါးဇင်းပြား) had the lowest iodine content and flat fish (ငါးခွေးလျှာ) had the highest iodine content. Among marine prawns, white prawn (ပုစွန်ဖြူ) from both Rakhine and Mon States had the lowest iodine contents; and flower tiger prawn (ပုစွန်ကြား) from both Rakhine and Mon States had the highest iodine contents. The iodine concentrations varied between and within fish species.[8] The acquisition of iodine from different aquatic resources varies species to species according to the nature of species.[10]

In this study, mean iodine concentration of seafoods from salt water is 3 to 30 times higher than those from freshwater ($p<0.05$) (Table 3). In the study of *Eckhoff and Maage*, fillet of salt water fish contained 5 to 10 times higher iodine content than those of freshwater fish, with the highest value of 920 µg iodine kg^{-1} wet weight.[11] The iodine content of freshwater fish and prawn were significantly lower than those of marine fish and prawn (p values <0.001 and <0.05). The high concentrations of iodine in seafood of salt water origin were consistent with the results reported by Thri Myint Oo, 1996.[12]

The location-dependent (salt-water and fresh-water) iodine variability in seafoods was also occurred in Bayelsa State, Nigeria.[13] This may be due to the different iodine content of the plants that the fishes and prawn rely on.[14] Moreover, Azmat R, *et al.*[3] suggested that day-by-day pollution of sea might induce the low concentration of iodine in marine water fish, and could cause health hazards in human who consume marine fish. The iodine content of fishes and prawns from Rakhine State has higher iodine concentrations than those from Mon State. A study by Moh Moh Hlaing *et al.*[6], in 2021 indicated that pregnant women in Mon State have insufficient iodine status.

The findings could help the iodine insufficient people in that region to choose the type of fishes and prawns with high iodine content as food and adjust the consumption amount of them in daily requirement.

Conclusion

This study showed a large variation in iodine content between freshwater and seawater food. The variation was also found within and between species, as well as between locations. The iodine content of freshwater fish is lower than that of marine fish. Seawater fish in the diet can be regarded as a really good iodine source. The iodine content of marine fish and prawn from the Bay of Bangal (Rakhine State) is higher than that of fish and prawn from Andaman Sea (Mon State). The mean iodine content of marine prawn is much higher than other products.

The data could be used for iodine contents in commonly consumed fish, prawn and their products and provision of hard data in formulating dietary guidelines and nutritional education. The findings would also support the choice of food type in iodine deficiency pregnant women in the local area.

Competing interests

The authors declare that they have no competing interests.

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