MEASUREMENTS OF IODINE CONTENTS IN SEAWEED (KALAMOAT SEIGH) (CATENELLA SP) FROM VARIOUS PLACES IN MON STATE

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Abstract

The purpose of this research work was to study the amount of iodine contents and intermolecular bond structure of seaweed from three locations (Waegali, Haigyii and Kyaikkhami) in Mon State. These samples were analysed by using Energy Dispersive X-Ray Fluorescence (EDXRF) and Fourier Transform Infra-Red (FTIR) techniques. From the EDXRF measurement, the result showed that iodine contents of seaweed from three locations (Waegali, Haigyii and Kyaikkhami) were 17.81%, 15.79% and 18.50% respectively. It was found that the iodine isotope as in treatment of diagnosis and diseases of the thyroid gland or thyroid cancers.

Keyword: *seaweed (Waegali, Haigyii and Kyaikkhami), EDXRF, FTIR*

Introduction

Iodine-131 is the commonly used radioactive isotope of Iodine. It is used in the diagnosis, treatment of disease and localization or tracer studies. To get an adequacy on Iodine levels, the amount of iodine contents in seaweeds were taken up for measuring, with EDXRF techniques by which the elemental contents of the samples were acquired. As it had been mentioned the main objective of this work is to get the iodine level, but it was not come of because instrumental requirements. In EDXRF spectrum of three seaweed samples from represented for iodine contents. To get over this task (FTIR Analysis) would be taken out FTIR Analysis which allows for the determination of specific bonds of molecules and to identify any phase of the elements in compound materials "Nicholas Tsoulfanidls (2009)".

By means of Vibrational spectroscopic method, it has been obtained frequency or wave number between potassium (K) and iodine (I) in single bond constituted in sample (1). According to this method it would be also carried out for Ca=I double bonds in samples (2) and (3).

From FTIR spectra and EDXRF results for these samples, the iodine concentration percentages could be figure out and these results can be confirmed by S-I_2 bonds because sulpha was assumed to be the largest constituents in the *seaweed* samples and potassium (or) calcium was the second behind.

Materials and Methods

Humans need sufficient iodine to make thyroid hormones which were produced by the thyroid gland. The deficiency of iodine was several important health consequences called IDD (Iodine Deficiency Disorders). Iodine is a mineral that is important for health. It is needed to make the thyroid hormones. These hormones are needed for many body processes including growth, regulating metabolism and for the development of a baby's brain during pregnancy and early life. In this research have been taken out FTIR Analysis which allows for the determination of specific bonds of molecules and identify any phase of the elements in compound materials.

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By means of Vibrational spectroscopic method, it has been obtained frequency or wave number between sulphur (S) and iodine (I) in double bonds constituted in sample 1, samples 2 and 3.

From EDXRF results for these samples, the iodine concentration percentages could be figured out and FTIR spectra results can be confirmed by S - I_2 bonds because sulphur was assumed to be the largest constituents in the seaweed samples and potassium (or) calcium were the second behind it.

Collection of Sample

Three samples of seaweed were collected from different locations, sample 1 from Waegali township, sample 2 from Haigyii township and sample 3 from Kyaikkhami township in Mon State in month of January to April. The seaweed were thoroughly cleaned with seawater and finally cleaned with running water to remove salt and foreign materials. The cleaned seaweed were dried and ground into fine powder and it was stored at room temperature and used for further analysis "Pereira, (2011)".

Sample Preparation

The samples were dried at room temperature for 34 days in the open air and blended. The dried sample were crushed and ground into powder by using grinding machine. The samples were fine dried and ground enough to meet the conditions for homogeneous dense material, and ensure reproducibility in measurement. And then, these powder sample were weighed with scientific balance to get about 5 grams. Then poured into a disc made of steel and pressed into pellets by using 3 ton weight of Hydraulic press, Cambridge Elective Industries. The diameter of each pellet is 2.5 cm and samples of seaweed were shown in Figure 1 and 2 "Pereira, (2011)".

(a) (b) (c)

Figure 1 Photograph of samples from (a) Waegali township (b) Haigyii township (c) Kyaikkhami township

(a) (b) (c)

Figure 2 Pallets Sample of seaweed from (a) Waegali Township (b) Haigyii Township (c) Kyaikkhami Township

Energy Dispersive X-Ray Fluorescence (EDXRF)

Energy Dispersive X-Ray Fluorescence Spectrometer (EDXRF) is an analytical method to determine the elemental composition of many types of materials. It can be used to determine the

thickness and composition of layers, coatings, and plating. It is fast, accurate and non-destructive and requires minimal sample preparation. Samples can be soil, liquid, powder. EDXRF spectrometer provides one of the simplest, most accurate and most economic analytical methods for the determination of the chemical composition. It can be used for a wide range of elements, from Sodium (11) to Uranium (92), and provides detection limits at the sub-ppm level; it can also measure concentrations of up to 100% easily and simultaneously "Raquel Salamo Clapera (2006)".

Measurement Condition of Rigaku NEX CG EDXRF Spectrometer

Cartesian Geometry Energy dispersive X-ray fluorescence (EDXRF) is a routinely used analytical technique for the qualitative and quantitative determination of major and minor atomic elements in a wide variety of sample types. The heart of its versatility stems from the ability to provide rapid, non-destructive, multi-element analyses – from low.

parts-per-million (ppm) levels to high weight percent (wt%) concentrations – for elements from sodium (^{11}Na) to uranium (^{92}U) "Raquel Salamo Clapera (2006)".

The versatile Rigaku NEX CG EDXRF spectrometer delivers routine elemental measurements across a diverse range of matrices – from homogeneous, low viscosity liquids – to solids, metals, slurries, powders and pastes. Especially well suited to the semi-quantitative determination of elemental content in complete unknowns, the superior analytical power, flexibility and ease-of-use of the NEX CG add to its broad appeal for research, industrial and in-plant monitoring applications. The schematic diagram of the Cartesian Geometry Energy Dispersive X-Ray Fluorescence Spectrometer (Rigaku NEX CG EDXRF) [Mawlamyine University, Department of Physics] as shown in Figure 3 "Raquel Salamo Clapera (2006)".

Figure 3 Energy Dispersive X-ray Fluorescence NEX CG EDXRF Spectrometer

Table 1 The Specification of Rigaku NEX CG EDXRF spectrometer

Excitation	X-ray tube with pd anode 50 W max power 50 W max voltage Four standard polarization and secondary targets depending on application for optimum excitation Optional fifth target for optional excitation of Na and Mg
Detector	High performance SDD Peltier electronic cooling Large active detection area Optimum balance of spectral resolution and high count rate

FTIR Spectroscopic Measurement

FTIR spectrometers have several prominent advantages.

(i) The signal-to-noise ratio of spectrum is significantly higher than the previous generation infrared spectrometers. (ii)The accuracy of wavenumber is high, the error is within the range of ±0 cm^{-1}. (iii)The scan time of all frequencies is short (approximately 1s). (iv) The resolution is extremely high (0.1–0.005 cm^{-1}). (v) The scan range is wide (10000–10 cm^{-1}). (vi) The interference from stray light is reduced.

The collected lines in the observed FTIR spectra indicate the vibrational characteristics of constituent molecules in the samples or it indicates the phase formation of the samples (with molecular vibration). Infrared (IR) refers to that part of the electromagnetic spectrum between the visible and microwave regions. The electromagnetic spectrum can be considered as a wave or particle traveling at the speed of light. These waves differ from each other in the length and frequency.

The obtained data (observed wavenumber) are found experimentally that the octahedral site molecular networks in the sample emitted frequencies with $\frac{1}{\lambda} = \bar{\nu}$ wavenumbers.

FTIR 8400 Spectrophotometer is combined with the IR solution- a 32 bit high performance FTIR software- to analyze samples easily and securely. Universities' Research Centre (URC), University of Yangon (YU) at room temperature.

Experimental conditions were as follows:

Measurement mode : %T

Wavenumber range : 400 cm^{-1} – 4000 cm^{-1}

Time of scan : 60 s

Method : KBr pellet

Vibrational Frequency from Spectroscopic Technique

Vibrational spectroscopic method or Fourier Transform Infrared (FTIR) spectroscopy is the analysis of the sample by using infrared radiation. Infrared radiation refers broadly to electromagnetic spectrum between the visible and microwave regions. When infrared radiation of wave number in the range from about 10000-100 cm^{-1} interacts with matter it can be absorbed, causing the chemical bonds in the material to vibrate. The presence of chemical bonds in a material is a necessary condition for infrared spectrum can provide quantitative information as well, such

as the concentration of a molecule in a sample. The relation between absorbance (A) and transmittance (T) is

$$A = \log_{10} \frac{1}{T}$$

The infrared bond gives information about the strength and nature of molecular interactions. Thus, an infrared spectrum provides a great deal of information about a sample. The frequency of absorptions depends on the relative mass of the atoms, the force constants of the bonds and the geometry of the atoms.

The following equation derived from Hooke's Law states the relationship between of oscillation atomic mass and force constant (F) of the bond. For single bond force constant is 5×10^5 dynes/cm.

$$\bar{\upsilon} = \frac{1}{2\pi c}\left[\frac{F}{\frac{M_x M_y}{M_x + M_y}}\right]^{1/2}$$

Where, $\bar{\upsilon}$ = the vibrational frequency or wave number

c = velocity of light = 3×10^{10} cms^{-1}

M_x = mass of carbon

M_y = mass of sulphur

According to the above equation vibrational frequency or wave number between carbon (C) and sulphur (S) is carried out[1].

Common Functional Group in Organic Compound

Any organic compound continuous chain of carbon atoms which has the various functional group. To get the di-iodoethane the basic structure is $-\overset{I}{\underset{I}{C}}-I$ and carbon constituted in chemical group of C S with C = S stretching mode. Modified wave number for two successive bond is 1017cm^{-1}. From this use, it can be deduce the conversion factors for iodine contents interms of sulphur in phenols and di-iodoethane organic compounds.

Results and Discussion

From EDX - NEXCG spectrometer, the results show the presence of different chemical elements in the seaweed as shown in Figure (4) to (6). The element contents of seaweed was listed in Table (2) and diagram of the iodine contents for three samples of seaweed in Figure (7). In this table, the iodine (I) constituents in these seaweed samples are 17.81 % in sample 1, 15.79 % in sample 2 and 18.50 % in sample 3 respectively. Among this iodine content in sample 3 is higher than that of samples 1 and sample 2.

The EDXRF spectroscopic analysis, the qualitative results were analyzed by $C_6H_{10}O_5$ constituted in seaweed is 12.500 mg cm^{-2} in total analyze 12.503 mg cm^{-2}. Iodine contents of three seaweed samples were 17.87 %, 15.79 % and 18.50 % of elemental concentration in Si-U analyzes.

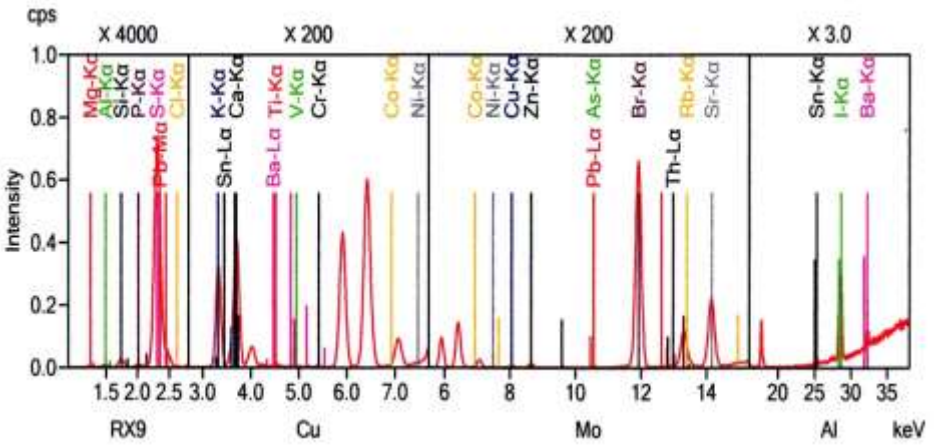

Figure 4 Spectrum of elemental concentration in seaweed from Waegali by NEXCG Spectrometer

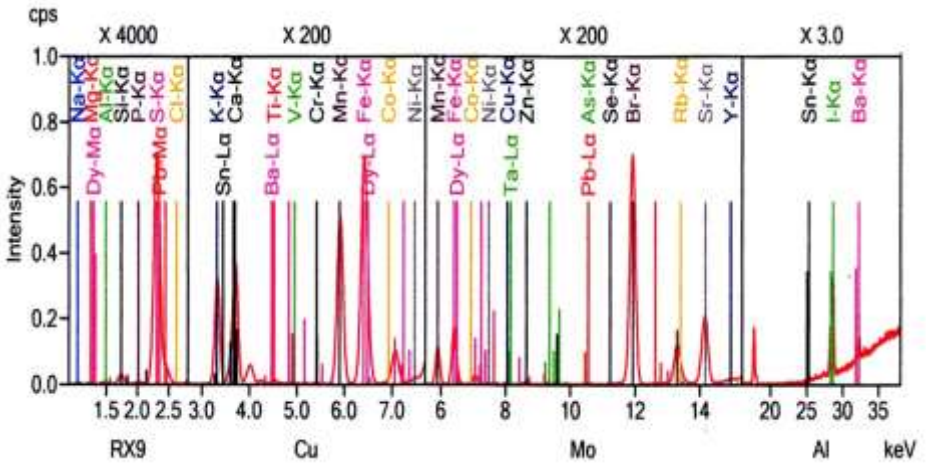

Figure 5 Spectrum of elemental concentration in seaweed from Haigyii by NEXCG Spectrometer

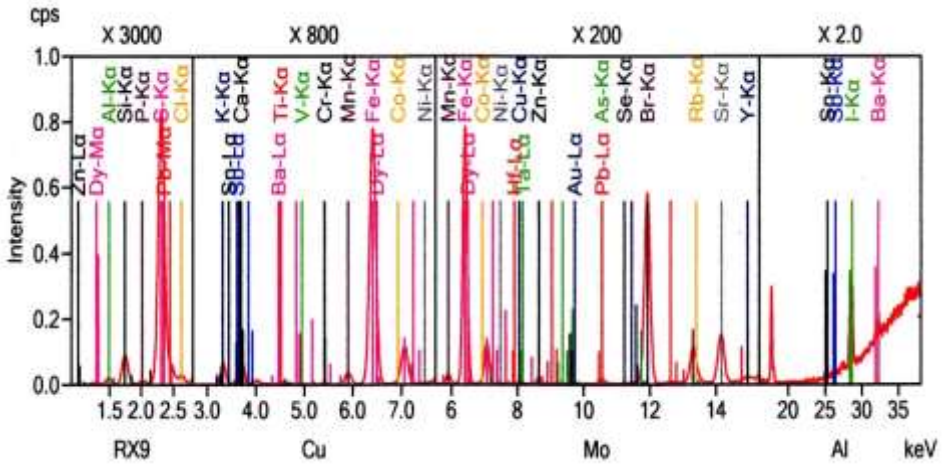

Figure 6 Spectrum of elemental concentration in seaweed from Kyaikkhami by NEXCG Spectrometer

Table 2 Element contents of seaweed (mass%)

No	Element	Smple1 Mass %	Sample 2 Mass %	Sample 3 Mass %
1	Na	-	-	0.44
2	Mg	0.21	-	0.70
3	Al	0.47	-	0.24
4	Si	4.80	4.13	1.21
5	P	1.00	4.30	-
6	S	40.05	42.69	36.32
7	Cl	1.47	2.10	0.02
8	K	16.72	17.42	21.80
9	Ca	15.90	14.80	13.62
10	Ti	0.43	-	-
11	Mn	-	0.51	-
12	Fe	2.40	6.10	5.35
13	Zn		0.17	0.15
14	As	-	-	0.17
15	Br	1.70	-	1.61
16	I	17.81	15.79	18.50
17	Sr	-	0.30	-
18	Cu	-	-	0.14

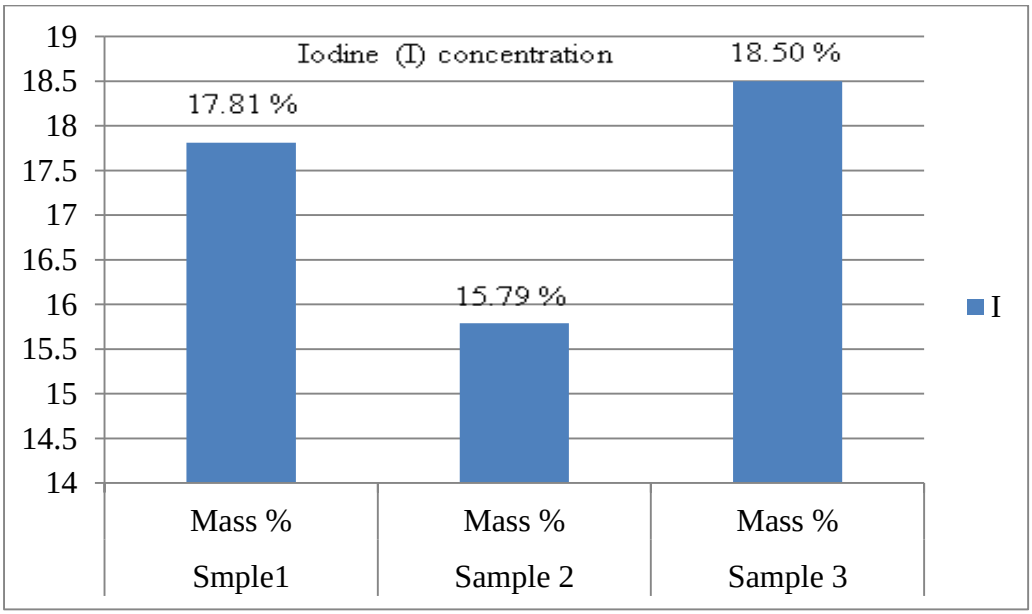

Figure 7 Diagram of the iodine contents for three samples of seaweed

FTIR Spectroscopic Study

According to molecular vibrational theory, in the present work, FTIR transmission spectrum of, sample 1 is C = S stretching mode and C S group in the wavenumber range of 1029 cm^{-1} region with KBr pellet method is shown in Fig 8, sample 2 is C = S stretching mode and C S group in the wavenumber range of 1003 cm^{-1} region with KBr pellet method is shown in Figure 9 and sample 3 is C = S stretching mode and C S group in the wavenumber range of

1017 cm^{-1} region with KBr pellet method is shown in Figure 10. The observed wavenumbers were assigned by using wavenumbers of free ions or molecules. Vibrational characteristics and corresponding mode assignments of molecules are tabulated in Table 3, 4 and 5.

Inclusive iodine results were determination of the iodine contents in seaweed by using vibrational spectroscopic method. In this research, the Fourier Transform Infrared FTIR were used for the vibrational analysis. The concentration of other constitutions are also expressed in modified content percentages.

From analysis the results, the calibrated iodine contents in the samples have to be verified by conventional volumetric method (WHO recommended). It has been known that the contents would be obtained in ppm (parts per million) by HATR (Horizontal Attenuated Total Reflectance) technique. The information and results of this research will contribute to our common goal of the elimination of iodine deficiency disorder (IDD).

Table 3 Intermolecular structure of sample-1 from FTIR spectrum

No.	wave number (cm^{-1})	Mode	Chemical group
1	3437.28	N - H stretching	Amino acid I
2	2926.11	C-H stretching	characteristic of aliphatic (- CH) groups
3	1643.41	C ≡ O stretching C = C stretching	Carbonyl groups
4	1535.38	N = N – O stretching	aromatic group
5	1384.94	N – O stretching	Nitro compound
6	1244.13	Vibration stretching	C - O group of ester
7	1028.09	C = S stretching	C S group
8	922.00	C - O H stretching	C - H groups
9	788.91	Vibration stretching	C-H out of plane deformation
10	528.51	K – I stretching	K-I single bond
11	466.79	C - OH_3 stretching	CO_2 groups

Table 4 Intermolecular structure of sample-2 from FTIR spectrum

No.	wave number (cm^{-1})	Mode	Chemical group
1	3685.49	N - H stretching	Amino acid I
2	2297.30	C ≡ N stretching	C N group
3	1523.82	N - H stretching	Amino acid II
4	1365.65	NO_2 symmetric stretching	Aromatic nitro compound
5	1003.02	C = S stretching	C S group
6	677.040	Ca = I stretching	Ca = I

Table 5 Intermolecular structure of sample-3 from FTIR spectrum

No.	wave number (cm^{-1})	Mode	Chemical group
1	3421.83	N - H stretching	Amino acid I
2	2926.11	C-H stretching	characteristic of aliphatic (- CH) groups
3	2303.08	C ≡ N stretching	C N group
4	1631.83	C = C stretching	Carbonyl groups
5	1531.53	N - H stretching	Amino acid II
6	1377.22	N – O stretching	Nitro compound
7	1016.52	C = S stretching	C S group
8	675.110	Ca = I stretching	Ca = I

Quantitative Analysis

In present research elemental concentrations in seaweed samples were obtained in two categories; exclusive iodine percentage and inclusive iodine percentage. Exclusive iodine elemental concentrations were determined by EDXRF spectrometer. The elemental concentrations in sample 1, 2 and 3 were determined as shown in table 2.

The estimation of quantity due to EDXRF spectrum in sample 1 and sulphur S concentration is 49.052% and from FTIR spectrum 1028.09 cm^{-1} absorbtion peak correspond to C = S bond. From this research the I_2 contents in di-iodoethane can be deduced as 49.052 % exclusive I_2 and 29.537% inclusive I_2.

The estimation of quantity due to EDXRF spectrum in sample 2 and sulphur S concentration is 50.706% and from FTIR spectrum 1003.02 cm^{-1} absorbtion peak correspond to C = S bond. From this research the I_2 contents in di-iodoethane can be deduced as 50.706% exclusive I_2 and 30.398 % inclusive I_2.

The estimation of quantity due to EDXRF spectrum in sample 3 and sulphur S concentration is 45.412 % and from FTIR spectrum 1006.52 cm^{-1} absorbtion peak correspond to C = S bond. From this research the I_2 contents in di-iodoethane can be deduced as 45.412% exclusive I_2 and 27.64 % inclusive I_2.

Conclusion

The present results showed the inclusive iodine contents in three samples from different location by EDX- NEXCG spectrometer. Among these iodine contents in sample 3 is (18.50 %) higher than that of other sample 1(17.81 %) and sample 2 (15.79 %). The iodine contents have been studied in seaweed for consumer levels.

From the result showed that iodine contents in three samples from different location by Rigaku NE**X** CG EDXRF spectrometer. Among these iodine contents in sample3 is (0.0085 %) higher than that of other sample 1 and sample 2 are (0.0065 %) and (0.0046 %) respectively.

The resultant contents should be recommended, the contents percentage are calibrated with each others resulted from two elements. In table 6 the contents of elements in two rows deduce from potassium and calcium row 1 and deduce from sulphur row 2 are roughly in same order.

From analysis the results, the calibrated iodine contents in the samples have to be verified by conventional volumetric method (WHO recommended). It has been known that the contents would be obtained in ppm (parts per million) by HATR (Horizontal Attenuated Total Reflectance)

technique. The information and results of this research will be hoped for contribution to our common goal of the elimination of iodine deficiency disorder (IDD).

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References

L.Pereira, (2011) "A Review of the nutrient composition of selected edible seaweeds," in Seaweed: Ecology, Nutrient Composition and Medicinal Uses, V.H. Pomin, Ed, pp.15-47, Science, New York, NY, USA.

Nicholas Tsoulfanidls (2009) "Measurement and Detection of Radiation Second Edition" (Washington, DC Taylor Francis)

Raquel Salamo Clapera (2006) "Energy Dispersive X-Ray Fluorescence: Measuring Elements in Solid and Liquid Matrices"

Topliss, D.J. and Eastman, C.J. (2004) "Diagnosis and management of hyperthyroidism and hypothyroidism". The Medical Journal of Australia, 180(4):186-193.

World Health Organization 2000 "Progress towards the Elimination of Iodine Deficiency Disorders" (Geneva: WHO)