Peertechz

Annals of Environmental Science and Toxicology

LIFE SCIENCES GROUP

ISSN: 2641-2969 DOI: https://dx.doi.org/10.17352/aest

Research Article

Health risks of essential Ni and Fe via consumption of water spinach *Ipomoea aquatica* collected from Peninsular Malaysia

Chee Kong Yap[1]*, Wan Hee Cheng[2], Koe Wei Wong[1], Aziran Yaacob[1], Rozilah Razalai[1], Chee Seng Leow[3], Shih Hao Tony Peng[4], Mohamad Saupi Ismail[5], Chee Wah Yap[6], Yuhai He[7], Moslem Sharifinia[8], Alireza Riyahi Bakhtiari[9] and Salman Abdo Al-Shami[10]

[1]Department of Biology, Faculty of Science, University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia

[2]Inti International University, Persiaran Perdana BBN, Nilai, Negeri Sembilan, Malaysia

[3]Humanology Sdn Bhd, 73-3 Amber Business Plaza, Jalan Jelawat 1, 56000 Kuala Lumpur, Malaysia

[4]All Cosmos Bio-Tech Holding Corporation, PLO650, Jalan Keluli, Pasir Gudang Industrial Estate, 81700 Pasir Gudang, Johor, Malaysia

[5]Fisheries Research Institute, Batu Maung, 11960 Pulau Pinang, Malaysia

[6]MES Solutions, 22C-1, Jalan BK 5A/2A, Bandar Kinrara, 47100 Puchong, Selangor, Malaysia

[7]Orioner, 4810-2-42, CBD Perdana 2, Persiaran Flora, 63000 Cyberjaya, Selangor, Malaysia

[8]Shrimp Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Bushehr, Iran

[9]Department of Environmental Sciences, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, Noor, Mazandaran, Iran

[10]Indian River Research and Education Center, IFAS, University of Florida, Fort Pierce, FL 34945, USA

Received: 19 December, 2019
Accepted: 22 January, 2020
Published: 23 January, 2020

***Corresponding author:** Chee Kong Yap, Department of Biology, Faculty of Science, University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia, E-mail: yapckong@hotmail.com ; yapchee@upm.edu.my

Keywords: THQ; Water spinach; Ni and Fe

https://www.peertechz.com

Check for updates

Abstract

The concentrations of Fe and Ni were analyzed in the water spinach *Ipomoea aquatica* collected from 11 sampling sites (Ara Kuda (2016), Setiawan (2016), Sikamat (2013-2018) and 8 sites in Sepang area (2005-2006)) from Peninsular Malaysia. The range of Fe (mg/kg dw) in the plant samples was 155-775(15.5-77.5mg/kg ww) while the range of Ni(mg/kg dw) was 1.71-20.3(0.17-2.03 mg/kg ww). In assessing the human health risk, the target hazard quotient values for Fe and Ni in Malaysian adults are <1.00. The current results showed no non-carcinogenic risks of Fe and Ni through the consumption of *I. aquatica* from the 11 sites. Considering the fact that most of the samples were collected from the wild and grown in the uncontrolled drainages, the heavy metal concentrations should be closely monitored in these vegetables.

Introduction

Heavy metal pollution in agricultural soil has been a worldwide issue where it may bring upon the bioaccumulation of the pollutants in crops such as vegetables [1]. Human activities such as mining, the use of agricultural pesticides, and untreated water irrigation contributed to a major part of metal contamination in soil and vegetables [2,3]. Metal-contaminated vegetables has been a major concern for consumers because it constitutes one of the main route of heavy metals into the

Citation: Yap CK, Cheng WH, Wong KW, Yaacob A, Razalai R, et al. (2020) Health risks of essential Ni and Fe via consumption of water spinach Ipomoea aquatica collected from Peninsular Malaysia. Ann Environ Sci Toxicol 4(1): 001-004. DOI: https://dx.doi.org/10.17352/aest.000018

biological system human being [4]. Heavy metals that are consumed are normally accumulated in the bones and fat tissues.

Iron and Ni are classified as essential and probable essential metals but they may pose hazardous toxic effects at elevated levels [3]. The negative impact includes masking the normal functions of essential metals/minerals and would contribute to a complication of diseases [5]. According to a review by [6], the cultivated and wild water spinach (*Ipomoea aquatica*) are ecologically abundant throughout the Southeast Asia (SEA) region and they are a common leafy vegetable in among the SEA populations.

A number of studies has been reported regarding the metal bioaccumulation in *I. aquatica*. For example, Kamari, et al., [7] studied metal accumulation in *I. aquatica* while Milla, et al., (2014) [8] investigated the phytotoxicity of *I. aquatica* grown hydroponically using treated and untreated wastewaters. Rai, et al., [9], reported that the leaves of *I. aquatica* accumulated significantly higher Cu levels.

Heavy metal levels in the edible *I. aquatica* have been widely reported in the literature including those from Thailand [6]. However, such reported studies are limited in Malaysia. The aims of the current study are to 1) determined the concentrations of Ni and Fe in *I. aquatica* collected from 11 sampling sites in Peninsular Malaysia, and 2) assess the human health risks of Ni and Fe of the above collected *I. aquatica* from Peninsular Malaysia.

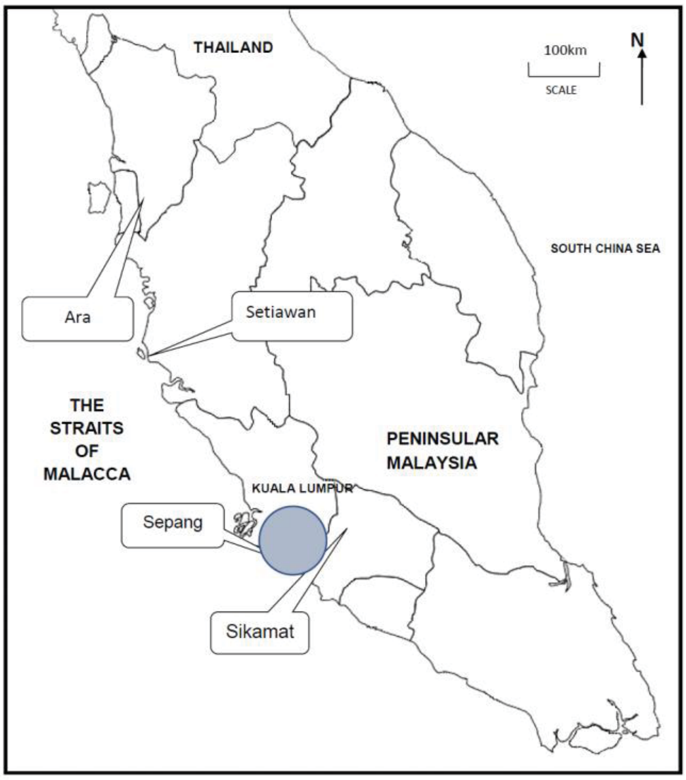

Figure 1: Sampling map of water spinach *Ipomoea aquatica* in Peninsular Malaysia. The specific sampling sites in Sepang area (in circle) is shown in Figure 2 [18].

Figure 2: Sampling sites in Sepang area [18].

Materials and methods

Samples of water spinach were collected from Kg Ara Kuda (Penang), and Kg Sitiawan Manjung (Perak) between September 2016 till to January 2017, while those from Sikamat-1 and Sikamat-2 (Seremban) were collected in February 2018 and September 2013, respectively (Figure 1). For those samples collected from Sepang area, the samplings were conducted between 2005-2006 (Figure 2). The samples were then stored in clean plastic bags until further analysis were conducted in laboratory.

In the laboratory, the plant samples were first washed with tap water and later on with distilled water before they cut into small pieces. The water spinach were dried at 80°c for three days. About 0.5g of the sample from each site balanced on the balancer before been put into the acid wash digestion tube. The heavy metals extraction were conducted based on acid digestion methods in which the samples were steeped into 10 ml of nitric acid in the digestion tubes. The digestion tube has were then heated at 40°c for the first hour before the temperature was raised to 140°c for the subsequent three more hours in a digestion block. Double distilled water were used to top up the digested samples to 40ml with before cooled down, as according to Yap, et al., [10]. Then, the samples were filtered (Whatman No1) and analysed for Fe and Ni by using the atomic absorption spectrophotometer (AAS) model Thermo Scientific iCE 3000 series at the Chemistry Department of Faculty of Science in UPM.

Table 1: The certified and measured values (mg/kg dry weight) of Fe and Ni based on Certified Reference Materials for Peach Leaves (NIST 1547).

	Certified value	Measured value	Recovery (%)
Fe	219.8	211	97.0
Ni	0.689	0.81	117

Note: NA=CRM values is not available.

Citation: Yap CK, Cheng WH, Wong KW, Yaacob A, Razalai R, et al. (2020) Health risks of essential Ni and Fe via consumption of water spinach Ipomoea aquatica collected from Peninsular Malaysia. Ann Environ Sci Toxicol 4(1): 001-004. DOI: https://dx.doi.org/10.17352/aest.000018

For quality control and quality assurance, the apparatus used was acid-washed with 10% diluted hydrochloric acid for at least 24 hours. The blank solution was treated and digested at the same time. To check for sample accuracy and data verification, certified reference materials (CRM) for Peach Leaf was used. The recoveries obtained from the CRM were Fe and Ni were 97 and 117%, respectively as shown in Table 1.

Human health risk assessment

The estimated daily intake is to calculate how much water spinach that is taken by an adult for one day. The conversion factor, 0.10, was utilized to convert the dry weight (dw) basis of the samples into wet weight (ww) as suggested by Aziran, et al., [11,12].

The mean concentrations of the samples are needed for the calculation of estimated daily intake of water spinach. The Estimated Daily Intake (EDI) (µg/kg/day) of water spinach that contains the heavy metal element of Cu and Zn were measured by using the following equation:

EDI= MC×CR/(BW)

MC represents the heavy metal concentration (µg/g wet weight) of collected water spinach. The body weight (BW; kg) for adults is 62kg and consumption rate (CR; g/person/day) for fruit vegetables is 34g, following the report for Selangor population [13].

As for human risk assessment of Fe and Ni, the Target Hazard Quotient (THQ) was utilized. According to Bogdanovic, et al., [14], a THQ value > 1.0 means the daily intake of water spinach would likely result in negative health effects during a lifetime of the consumer. The equation of THQ calculation was described as follow:

THQ= EDI/RfD

RfD represents the oral references dosage in µg/kg/day. The reference doses used for Fe and Ni are 700 and 20, respectively, as according to the USEPA's regional screening level [15].

Results and Discussion

From Table 2, the range of Ni (mg/kg dw) in the water spinach was 1.71–20.3(0.17–2.03mg/kg ww) while the range of Fe(mg/kg dw) in the water spinach was 155-775(15.5-77.5mg/kg ww). The current data is in line with those by Li, et al., [16], where they had reported that the range of Ni (mg/kg ww) in the leafy vegetables were 0.110-0.322 (mean: 0.195). A study conducted by Qureshi, et al., [17], had confirmed that leafy vegetables such as lettuce contributed to the highest Fe intake in consumers, which was about 10 folds higher compared to other vegetables.

Table 3 shows the the values of EDI and THQ of Fe and Ni in the water spinach collected from 11 sites from Peninsular Malaysia for the assessment of health risks. For Fe, the EDI values ranged from 8.50 to 42.54 while Ni ranged from 0.06 to 1.11. The THQ values of Fe ranged from 0.012 to 0.061 while those for Ni from 0.003 to 0.056. Therefore, the THQ values for Fe and Ni for all water spinach collected from all sampling sites in this study are <1.0 implicating that there are no non-carcinogenic risk of Fe and Ni from the consumption of water spinach collected from the sites of this study.

Table 2: Concentration (mg/kg dry weight) of Ni and Fe of *Ipomoea aquatica* collected from 11 sampling sites in Peninsular Malaysia.

				Ni	Fe	Ni	Fe
No.	Sampling sites	Sampling dates	Site description	DW	DW	WW	WW
1	Sikamat-1 Seremban	11-Feb-18	Farming area	20.3	360	2.03	36.0
	Sikamat-2, Seremban.	Sep-13	Farming area	1.01	355	0.10	35.5
2	Ara Kuda Penang	29-Sept-16	Farming area	1.77	155	0.18	15.5
3	Kg Sitiawan Manjung, Perak	9-Nov-16	Farming area	1.71	232	0.17	23.2
4 (S1)	Logi KLIA	Feb 1, 2006	Drainage	2.21	184	0.22	18.4
5 (S2)	Bandar Baru Salak Tinggi	Feb 12,2006	Drainage	2.00	617	0.20	61.7
6 (S3)	KFC Factory	Feb 12, 2006	Drainage	3.50	409	0.35	40.9
7 (S4)	Furniture Factory Sg. Pelek	Sept 3, 2005	Drainage	16.70	663	1.67	66.4
8 (S5)	Kg Banghuris, Sepang	Ogos 27, 2005	Drainage	12.20	694	1.22	69.5
9 (S6)	Kg Labu Lanjut	Feb 1, 2006	Drainage	12.40	775	1.24	77.6
10 (S7)	Market KLIA	April 13, 2006	Cultivated soils	11.70	158	1.17	15.8
11 (S8)	Market, Pasar Tani Salak	April 16, 2006	Cultivated soils	8.58	182	0.86	18.2

DW= Dry weight; WW= Wet weight.

Table 3: Values of estimated daily intake (EDI, µg/kg/day) and target hazard quotient (THQ) for Ni and Fe in *Ipomoea aquatica* collected from 11 sampling sites in Peninsular Malaysia.

	BW	CR	EDI	EDI	THQ	THQ
Sites			Ni	Fe	Ni	Fe
Sikamat-1 Seremban	62	34	1.11	19.74	0.056	0.028
Sikamat-2, Seremban.	62	34	0.06	19.47	0.003	0.028
Ara Kuda Penang	62	34	0.10	8.50	0.005	0.012
Kg Sitiawan Manjung, Perak	62	34	0.09	12.70	0.005	0.018
Logi KLIA	62	34	0.12	10.10	0.006	0.014
Bandar Baru Salak Tinggi	62	34	0.11	33.86	0.005	0.048
KFC Factory	62	34	0.19	22.45	0.010	0.032
Furniture Factory Sg. Pelek	62	34	0.92	36.39	0.046	0.052
Kg Banghuris, Sepang	62	34	0.67	38.09	0.033	0.054
Kg Labu Lanjut	62	34	0.68	42.54	0.034	0.061
Market KLIA	62	34	0.64	8.67	0.032	0.012
Pasar Tani Salak	62	34	0.47	9.99	0.024	0.014

Conclusion

Based on the current study, the THQ values for both metals in the water spinach from Peninsular Malaysia are all below 1.00. This indicated there were no non-carcinogenic risks of Fe and Ni from the consumption of water spinach from the present study. Regular monitoring studies for toxic chemical

Citation: Yap CK, Cheng WH, Wong KW, Yaacob A, Razalai R, et al. (2020) Health risks of essential Ni and Fe via consumption of water spinach Ipomoea aquatica collected from Peninsular Malaysia. Ann Environ Sci Toxicol 4(1): 001-004. DOI: https://dx.doi.org/10.17352/aest.000018

contamination in the commonly consumed water spinach from Malaysia are deemed necessary. This is due to the fact these leafy vegetables can be easily grown in polluted waterways such as rivers and drainages.

Acknowledgement

The authors wish to acknowledge the partial financial support provided through the Fundamental Research Grant Scheme (FRGS), No. Project: 02-10-10-954FR and vote no.: 5524953, by Ministry of Higher Education, Malaysia.

References

1. Tasrina RC, Rowshon A, Mustafizur AMR, Rafiqul I, Ali MP (2015) Heavy metals contamination in vegetables and its growing soil. J Environ Anal Chem 2: 142. Link: http://bit.ly/36hlnCU

2. Asdeo A, Loonker S (2011) A comparative analysis of trace metals in vegetables. Res J Environ Toxicol 5: 125-132. Link: http://bit.ly/3aqZu7A

3. Basha AM, Yasovardhan N, Satyanarayana SV, Subba Reddy GV, Kumar AV (2014) Trace metals in vegetables and fruits cultivated around the surroundings of Tummalapalle uranium mining site, Andhra Pradesh, India. Toxicol Rep 1: 505–512. Link: http://bit.ly/38qGTqz

4. Khan S, Cao Q, Zheng YM, Huang YZ, Zhu YG (2008) Health risks of heavy metals in contaminated soils and food crops irrigated with wastewater in Beijing, China. Environ Pollut 152: 686-692. Link: http://bit.ly/30KlogM

5. Jolly YN, Islam A, Akbar S (2013) Transfer of metals from soil to vegetables and possible health risk assessment. Springer Plus 2: 385. Link: http://bit.ly/2uiW3iX

6. Göthberg A, Greger M, Bengtsson BE (2002) Accumulation of heavy metals in water spinach (*Ipomoea aquatica*) cultivated in the Bangkok region, Thailand. Environ Toxicol Chem 21: 1934-1939. Link: http://bit.ly/3aufdCW

7. Kamari A, Yusoff SNM, Putra WP, Ishak CF, Hashim N, et al. (2015) The effects of application of agricultural wastes to firing range soil on metal accumulation in *Ipomoea aquatica* and soil metal bioavailability. Chem Ecol 31: 622-635. Link: http://bit.ly/3awWnLj

8. Milla OV, Rivera EB, Huang WJ (2014) Bioaccumulations of heavy metals in *Ipomoea aquatica* grown in bottom ash recycling wastewater. Wat Environ Res 86: 398-406. Link: http://bit.ly/2Rfj1Ag

9. Rai UN, Sinha S (2001) Distribution of metals in aquatic edible plants: Trapa natans (ROXB.) Makino and *Ipomoea aquatica* Forsk. Environ Monit Assess 70: 241-252. Link: http://bit.ly/2tJq0sr

10. Yap CK, Ismail A, Tan SG, Omar H (2002) Correlations between speciation of Cd, Cu, Pb and Zn in sediment and their concentrations in total soft tissue of green-lipped mussel Perna viridis from the West Coast of Peninsular Malaysia. Environ Int 28: 117-126. Link: http://bit.ly/2vdC99p

11. Yaacob A, Yap CK, Nulit R, Omar H, Abdo Al-Shami SA, et al. (2018) A comparative study of health risks of Fe and Ni in the vegetables collected from selected farming areas of Peninsular Malaysia. J Aquat Pollut Toxicol 2: 21. Link: http://bit.ly/2RL5DmO

12. Aziran Y, Yap CK, Nulit R, Omar H, Al-Shami SA, Bakhtiari AR (2018) Assessment of health risks of the toxic Cd and Pb between leafy and fruit vegetables collected from selected farming areas of Peninsular Malaysia. Integr Food Nutr Met 5: 1-9. Link: http://bit.ly/2RevYKO

13. Nurul Izzah A, Aminah A, Md Pauzi A, Lee YH, Wan Rozita WM et al. (2012) Patterns of fruits and vegetable consumption among adults of different ethnics in Selangor, Malaysia. *Int Food Res J 19: 1095-1107.* Link: http://bit.ly/2vcDa1u

14. Bogdanovic T, Ujevic I, Sedak M, Listes E, Simat V, et al. (2014) As, Cd, Hg and Pb in four edible shellfish species from breeding and harvesting areas along the eastern Adriatic Coast, Croatia. Food Chem 146: 197-203. Link: http://bit.ly/36hmZfW

15. USEPA (US Environmental Protection Agency) (2015) Human health risk assessment. Regional screening level (RSL)-summary table. Link: http://bit.ly/37cIVKF

16. Li Q, Chen Y, Fu H, Cui Z, Shi L, et al. (2012) Health risk of heavy metals in food crops grown on reclaimed tidal flat soil in the Pearl River Estuary, China. J Hazard Mater 227-228:148-154. Link: http://bit.ly/2RHBioP

17. Qureshi AS, Hussain MI, Ismail S, Khan QM (2016) Evaluating heavy metal accumulation and potential health risks in vegetables irrigated with treated wastewater. Chemosphere 163: 54-61. Link: http://bit.ly/2RHBAMr

18. Yap CK, Wong KW, Aziran Y, Rozilah R, Nulit N, et al. (2019) Health risks of essential Cu and Zn via consumption of water spinach *Ipomoea aquatica* collected from Peninsular Malaysia. EC Nutrition 14.12: 01-07. Link: http://bit.ly/37tjoNe

Citation: Yap CK, Cheng WH, Wong KW, Yaacob A, Razalai R, et al. (2020) Health risks of essential Ni and Fe via consumption of water spinach Ipomoea aquatica collected from Peninsular Malaysia. Ann Environ Sci Toxicol 4(1): 001-004. DOI: https://dx.doi.org/10.17352/aest.000018