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

Chee Kong Yap1*, Wan Hee Cheng2, Koe Wei Wong3, Aziran Yaacob1, Rozilah Razali1, Chee Seng Lew2, Shih Hao Tony Peng4, Mohamad Saupi Ismail5, Chee Wah Yap5, Yuhai He6, Moslem Sharifinia7, Alireeze Riyahi Bakhhtiari7 and Salman Abdo Al-Shami8

1Department of Biology, Faculty of Science, University Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia
2Inti International University, Persiaran Perdana BBN, Nilai, Negeri Sembilan, Malaysia
3Humanology Sdn Bhd, 73-3 Amber Business Plaza, Jalan Jelawat 1, 56000 Kuala Lumpur, Malaysia
4All Cosmos Bio-Tech Holding Corporation, PLO650, Jalan Keluli, Pasir Gudang Industrial Estate, 81700 Pasir Gudang, Johor, Malaysia
5Fisheries Research Institute, Batu Maung, 11960 Pulau Pinang, Malaysia
6MES Solutions, 22C-1, Jalan BK 5A/2A, Bandar Kinrara, 47100 Puchong, Selangor, Malaysia
7Orioner, 4810-2-42, CBD Perdana 2, Persiaran Flora, 63000 Cyberjaya, Selangor, Malaysia
8Shrimp Research Center, Iranian Fisheries Science Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Bushehr, Iran
9Department of Environmental Sciences, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, Noor, Mazandaran, Iran
10Indian River Research and Education Center, IFAS, University of Florida, Fort Pierce, FL 34945, USA

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*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

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**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 (15.5-77.5 mg/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.

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**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
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.

**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.
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 were 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:

\[
\text{EDI} = \frac{MC \times CR}{BW}
\]

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:

\[
\text{THQ} = \frac{\text{EDI}}{\text{RfD}}
\]

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 (0.17–2.03)mg/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 0.10–0.322 (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.

### 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

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

| 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 |
| 2   | Sikamat-2, Seremban.          | Sep-13         | Farming area     | 1.01 | 355 | 0.10 | 35.5 |
| 3   | Ara Kuda Penang               | 29-Sep-16      | Farming area     | 1.77 | 155 | 0.18 | 15.5 |
| 4   | Kg Sitiawan Manjung, Perak    | 9-Nov-16       | Farming area     | 1.71 | 232 | 0.17 | 23.2 |
| 5   | Bandar Baru Salak Tinggi      | Feb 12,2006    | Drainage         | 2.00 | 617 | 0.20 | 61.7 |
| 6   | KFC Factory                   | Feb 12, 2006   | Drainage         | 3.50 | 409 | 0.35 | 40.9 |
| 7   | Furniture Factory Sg. Pelek   | Sept 3, 2005   | Drainage         | 16.70 | 663 | 1.67 | 66.4 |
| 8   | Kg Banghuris, Sepang          | Ogos 27, 2005  | Drainage         | 12.20 | 694 | 1.22 | 69.5 |
| 9   | Kg Labu Lanjut               | Feb 1, 2006    | Drainage         | 12.40 | 775 | 1.24 | 77.6 |
| 10  | Market KLIA                   | April 13, 2006 | Cultivated soils | 11.70 | 158 | 1.17 | 15.8 |
| 11  | Market, Pasar Tani Salak     | April 16, 2006 | Cultivated soils | 8.58 | 182 | 0.86 | 18.2 |

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  | Ni  | Fe  | Ni  | Fe  | THQ  |
|-----|-----|-----|-----|-----|-----|------|
| 62  | 34  | 1.11 | 19.74 | 0.056 | 0.028 |
| 62  | 34  | 0.06 | 19.47 | 0.003 | 0.028 |
| 62  | 34  | 0.10 | 8.50  | 0.005 | 0.012 |
| 62  | 34  | 0.09 | 12.70 | 0.005 | 0.018 |
| 62  | 34  | 0.12 | 10.10 | 0.006 | 0.014 |
| 62  | 34  | 0.11 | 33.86 | 0.005 | 0.048 |
| 62  | 34  | 0.19 | 22.45 | 0.010 | 0.032 |
| 62  | 34  | 0.92 | 36.39 | 0.046 | 0.052 |
| 62  | 34  | 0.67 | 38.09 | 0.033 | 0.054 |
| 62  | 34  | 0.68 | 42.54 | 0.034 | 0.061 |
| 62  | 34  | 0.64 | 8.67  | 0.032 | 0.012 |
| 62  | 34  | 0.47 | 9.99  | 0.024 | 0.014 |

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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.

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