Research Article

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

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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.

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.

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].

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).

<table>
<thead>
<tr>
<th></th>
<th>Certified value</th>
<th>Measured value</th>
<th>Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fe</td>
<td>219.8</td>
<td>211</td>
<td>97.0</td>
</tr>
<tr>
<td>Ni</td>
<td>0.689</td>
<td>0.81</td>
<td>117</td>
</tr>
</tbody>
</table>

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(0.17-2.03mg/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.

**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.

<table>
<thead>
<tr>
<th>No.</th>
<th>Sampling sites</th>
<th>Sampling dates</th>
<th>Site description</th>
<th>DW (μg/kg)</th>
<th>WW (μg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sikamat-1 Seremban</td>
<td>11-Feb-18</td>
<td>Farming area</td>
<td>20.3</td>
<td>360</td>
</tr>
<tr>
<td>2</td>
<td>Sikamat-2, Seremban</td>
<td>Sep-13</td>
<td>Farming area</td>
<td>1.01</td>
<td>355</td>
</tr>
<tr>
<td>3</td>
<td>Kg Sitiawan Manjung, Perak</td>
<td>9-Nov-16</td>
<td>Farming area</td>
<td>1.71</td>
<td>232</td>
</tr>
<tr>
<td>4</td>
<td>Logi KLIA</td>
<td>Feb 1, 2006</td>
<td>Drainage</td>
<td>2.21</td>
<td>184</td>
</tr>
<tr>
<td>5</td>
<td>Bandar Baru Salak Tinggi</td>
<td>Feb 12, 2006</td>
<td>Drainage</td>
<td>2.00</td>
<td>617</td>
</tr>
<tr>
<td>6</td>
<td>KFC Factory</td>
<td>Feb 12, 2006</td>
<td>Drainage</td>
<td>3.50</td>
<td>409</td>
</tr>
<tr>
<td>7</td>
<td>Furniture Factory Sg. Pelek</td>
<td>Sept 3, 2005</td>
<td>Drainage</td>
<td>16.70</td>
<td>663</td>
</tr>
<tr>
<td>8</td>
<td>Kg Banghuris, Sepang</td>
<td>Ogos 27, 2005</td>
<td>Drainage</td>
<td>12.20</td>
<td>694</td>
</tr>
<tr>
<td>9</td>
<td>Kg Labu Lanjut</td>
<td>Feb 1, 2006</td>
<td>Drainage</td>
<td>12.40</td>
<td>775</td>
</tr>
<tr>
<td>10</td>
<td>Market KLIA</td>
<td>April 13, 2006</td>
<td>Cultivated soils</td>
<td>11.70</td>
<td>158</td>
</tr>
<tr>
<td>11</td>
<td>Market, Pasar Tani Salak</td>
<td>April 16, 2006</td>
<td>Cultivated soils</td>
<td>8.58</td>
<td>182</td>
</tr>
</tbody>
</table>

**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.

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

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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References


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