Concentration of Surfactants and Levoglucosan from Biomass Burning during Haze Episodes in Tin Mine Lake Area

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Introduction: Air pollution from biomass burning contains a large and diverse number of trace gases and particulate matter to the troposphere. Biomass burning was also reported as one of the largest source of organic carbons in the atmosphere, many of which have been associated with adverse health impacts (Aghamohammadi et al., 2011; Hennigan et al., 2010; Simoneit et al., 2002; Streets et al., 2003). Surfactants are a group of organic compounds which could be contributed by biomass burning and vegetation (Latif et al., 2011; Latif et al., 2012; Wahid et al., 2013). The released surfactants could act as cloud condensation nuclei (CNN) and significantly influence the formation of the cloud as well as the global climate (Halim et al., 2010). To determine the amount of biomass burning activities in the environment, levoglucosan was introduced and increasingly employed as a biomass burning indicator (Fraser and Lakshmanan, 2000; Kim Oanh et al., 2011; Latif et al., 2011; Latif et al., 2012; Simoneit, 1999; Zhang et al., 2008;).

This research aims to determine the amount of surfactants and levoglucosan that can be produced from three plants named as Cinnamomum Iners Gliricidia Sepium and Hopea Odorata, which are located around the tin mine lake areas and to investigate the impact of haze related to biomass burning on the composition of surfactants and levoglucosan. Besides, interactions and relationships between surfactants and levoglucosan which derived from the vegetation will be analysed.

Methods: Samples of vegetation around the tin mine lakes were collected at different sampling points which situated between 0.1 m to 1.0 m away from the lake side at the center of UTAR Perak Campus, Kampar, Malaysia. Vegetation samples used for the surfactants and biomass burning analysis were cut into two parts which were leaves and stems. Samples were then burnt in furnace at a temperature of 300°C for 3 hours and then sieved (0.6 mm) to remove coarse particles after 24 hours cooling period (Latif et al., 2011 and Latif et al., 2012). All vegetation samples were taken in twelve days during Jan to March 2014, the traditional dry season in Southeast Asia.

In this study, the determination of levoglucosan from the plant extractions was conducted using anthrone-sulphuric colorimetric method. This method was based on the formation of coloured ion-association complexes as used by Laurentin and Edwards (2003), Fartas et al., (2009), Latif et al., (2011) and Latif et al., (2012).

Determination of anionic surfactants such as methylene blue active substances (MBAS) and
cationic surfactants like disulphine blue active substances (DBAS) has been widely used and is described in the Standard Method for the Examination of Water and Wastewater (APHA, 1992). The principal of this methodology is based on the formation of a chloroform extractable ion-association complex between the anionic or cationic surfactants and cationic (disulphine blue) or anionic (methylene blue) dyes, followed by a spectrophotometric measurement of the intensity of the extracted coloured complex as applied by many researchers such as Chitikela (1995), Hanif et al. (2009), and Latif et al., (2011).

In the MBAS analysis, sodium dodecyl sulphate (SDS) was used as a standard compound to plot the standard curve at a concentration range of 0.05 μM to 2 μM. The concentrations of cationic surfactants as DBAS were measured at the concentration ranging from 0.04 to 2 μM using Zephiramine for the standard solutions.

**Results:** The concentration range of surfactants (MBAS and DBAS) and levoglucosan in different types of plants was presented in Table 1.

**Table 1: Concentration ranges of surfactants and levoglucosan for different plants during Jan to March 2014.**

<table>
<thead>
<tr>
<th>Sample</th>
<th>MBAS (μg/g)</th>
<th>DBAS (μg/g)</th>
<th>Levoglucosan (mg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Cinnamomum Iners</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Leaf)</td>
<td>28.28~148.91</td>
<td>UD~48.13</td>
<td>9.10~43.40</td>
</tr>
<tr>
<td>(Stem)</td>
<td>23.35~71.39</td>
<td>UD~30.99</td>
<td>8.32~32.14</td>
</tr>
<tr>
<td><em>Gliricidia Sepium</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Leaf)</td>
<td>35.24~112.05</td>
<td>UD~37.22</td>
<td>6.75~41.58</td>
</tr>
<tr>
<td>(Stem)</td>
<td>19.31~53.55</td>
<td>UD~30.47</td>
<td>2.78~28.07</td>
</tr>
<tr>
<td><em>Hopea Odorata</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Leaf)</td>
<td>33.10~106.11</td>
<td>UD~33.33</td>
<td>4.20~25.24</td>
</tr>
<tr>
<td>(Stem)</td>
<td>18.12~46.42</td>
<td>UD~25.79</td>
<td>UD~21.41</td>
</tr>
</tbody>
</table>

During the two month sampling period, highest average concentration of MBAS falls into the *Cinnamomum Iners* leaves followed by the *Gliricidia Sepium* leaves and *Hopea Odorata* leaves. The concentration of MBAS in stems is lower than the concentration in leaves for all of the three plants. On the other hand, the concentrations of DBAS for both leaves and stems from all plants showed a lower range of concentrations compared to the MBAS. Some days concentrations of DBAS from the vegetation around the tin mine lakes ecosystem were found to be undetected. Similar as surfactants, the average concentrations of levoglucosan after burning were found to be higher in plant leaves than in stems for all of the three plants in this research, which agreed with the result by Latif et al. (2012) for plant *Asystasia nemonum* and *Cocos nucifera*.

Besides, according to weather records during sampling period, higher concentrations of both surfactants and levoglucosan were detected during the smoke-haze phenomenon on 6th Jan, 17th March and 24th March 2014. The correlations between surfactants such as MBAS and DBAS for each section of the plants with levoglucosan after burning were shown in Figure 1 and Figure 2.
Figure 1: Correlation between DBAS and Levoglucosan in Leaves and Stems

Figure 1 showed a positive correlation between MBAS and levoglucosan for both the leaves and the stems. However, in Figure 2, no good correlation was found between DBAS and levoglucosan in the section of leaves but there was a weak positive correlation in the stems for all plants under study.

Conclusions: This study illustrated that the concentrations of levoglucosan and surfactants in vegetation were dominated in the plants leaves. Activities such as burning of decayed leaves or occurrence of natural forest fires which conducted in tin mine lake area were the contributions to the high level of levoglucosan and surfactants in the vegetation. Moreover, the positively significant correlation was found between anionic surfactants and levoglucosan. This proved that the biomass burning activities indicated by levoglucosan in Kampar area could contribute to a large amount of polar group molecules which mainly behave like anionic surfactants in the plants.

References:


