INTRODUCTION
Meghalaya one of the states of Northeast India has been blessed with unique floral and faunal varieties spread out in diversified agro climatic areas viz. tropical and sub-tropical to temperate or near temperate conditions. In West Garo Hills of Meghalaya, many species of honey bees are found but four species mainly Rock bee (Apis dorsata, locally known as Bija Nokma), Little bee (Apis florea, locally known as Kalmik), Indian bee or common bee (Apis cerena indica, locally known as Bija kol) and Stingless bee (Trigona, locally known as Mengkari) are commonly found. There are scattered reports of occurrence of other species, which resembles the rock bee but it could also be European bee or Italian bee (Apis mellifera) as reported by some local beekeepers. Of all the species found locally in West Garo Hills, Indian bee or Bija kol and the stingless bee or Mengkari is most widely reared in captivity for commercial production of honey. They also serve an ornamental purpose being hived in earthen pots.

Honey contains a complex mixture of carbohydrates, mainly glucose and fructose; other sugars are present as traces, depending on floral origin. It also contains small quantities of organic acids, lactones, amino acids, minerals, vitamins, enzymes, phenolic compounds, volatile compounds, pollen, wax and pigments (Crane, 1980). The contents of these components in honey are the most important criteria and are important determining the quality of the honey (Sahinler and Gul, 2004). The variation in the composition of honey constituents is due to various physiological factors such as climate, soil, flora, bee species, etc. Such variation in composition directly or indirectly affects both the local price and difference in preferences which in turn affect prices and the export earnings of the country.

The Codex Alimentarius Standard for honey quality includes several chemical and physical parameters, comprising moisture content, mineral content, acidity, hydroxyl-methyl-furfural (HMF)
content, diastase activity, apparent sugar content, and water insoluble solids content. These criteria help the food analyst to determine the “chemical” quality of the honeys analyzed (Cantarelli et al, 2008).

Stingless bees are small just few mm in length. The resident species nest among boulders, old walls, dead trees and tree cavities and are widely distributed in tropical and sub temperate region of the world (Kumar et al, 2012). In rural West Garo Hills, the tribal (Garos) people have learnt about the occurrence and behaviour of the local bee species over the years from their ancestors. The beekeepers of this region collect the bees (colonies) from undisturbed branches of trees or crevices found naturally in forests and hive the colonies in the wooden boxes or earthen pots. Therefore, the study was initiated to analyse the nutrient contents in the honey produced by stingless bees in West Garo Hills of Meghalaya, India.

MATERIALS AND METHODS

Study Area

The study was conducted from January to December, 2013 in the West Garo Hills district located in Meghalaya which is situated at North-eastern part of India. The area experience a warm climatic which encourages great bio-diversity giving great potential for human manipulation and management. The rainy season extends from April to September with highest rainfall usually recorded in August. The mean annual rainfall is 4851.48 mm. with average maximum and minimum temperatures of 24.53 °C and 19.57° C, respectively. The area is between 90 to 1418 m above sea level.

Sample Collection and Preparation

Twenty samples of locally produced raw honey (200g each) were collected from local honey producer (HS-1 to HS-20). The collected samples were analyzed at the Food Processing and Preservation Department, Polytechnique Institute, Tura, Meghalaya.

Moisture Content, pH, TSS and Acidity

The moisture content of the honey samples was estimated by the oven drying method and the pH of honey was determined by using Microprocessor pH. The Total Soluble Solid Content (TSS) of the honey samples was estimated by the Abbe’s refractrometer method and the acidity of the honey was determined by using titrimetric method.

Hydroxyl- Methyl-Furfural (HMF) and Ash Content

The Hydroxyl-Methyl-Furfural content of the honey samples was estimated by the spectrometer method and the ash content of honey was determined by using Gravimetric method.

Water Insoluble Solids Content and Conductivity

The water insoluble solid content of honey sample was estimated by Gravimetric method and the conductivity content of honey was determined by using conductometry method.

RESULTS AND DISCUSSION

The results of moisture, pH, acidity, ash, estimation of HMF and water insoluble solids, total soluble sugar and conductivity content of locally produced honey were presented in Table 1.

Moisture content

The data revealed that the moisture content of the honey was between 18.8 to 19.3 per cent. Gairola et al (2013) reported or moisture content of Apis Cerana- indica honey from Uttarkashi district of Uttarkhand, India to be between 19 to 25 per cent. Generally, the Indian honey has significantly higher moisture content which ranges between 20 – 25 per cent compared to western honey (12 to 15%) (Singh and Bath,1998). The mean value of moisture content of the honey samples in the study of Mohmoudi et al (2012) was in the limits of international standards of acceptability a moisture content of 20%. Similarly, moisture content of honey of different origins showed varietal differences and varied between 13 to 29 per cent (Saxena et al, 2010). The control of the water content is an important requirement of proposed Codex Alimentarius Commission Standards for honey (2001), which sets an upper limit for moisture of 21.0 per cent for honey in general.
Quality Evaluation of Honey from Stingless Bee

Table 1. Comparison of honey quality in the study area compared to national and international standards.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameter</th>
<th>Study Area Test Result (Average)</th>
<th>Indian Standards</th>
<th>World Honey Standards*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Moisture content %</td>
<td>18.80 - 19.30</td>
<td>Not &gt; 25 % by mass</td>
<td>18-23</td>
</tr>
<tr>
<td>2</td>
<td>Ash %</td>
<td>0.003 - 0.005</td>
<td>Not &gt; 0.5 % by mass</td>
<td>0.25-1.0</td>
</tr>
<tr>
<td>3</td>
<td>Water Insoluble Solid %</td>
<td>1.97- 2.40</td>
<td>-</td>
<td>A0.1</td>
</tr>
<tr>
<td>4</td>
<td>pH</td>
<td>4.43-4.49 at 21°C</td>
<td>-</td>
<td>3.2-4.5</td>
</tr>
<tr>
<td>5</td>
<td>TSS %</td>
<td>76.85 – 76.99</td>
<td>Not &lt; 65 % by mass</td>
<td>60-70</td>
</tr>
<tr>
<td>6</td>
<td>Conductivity µS/cm</td>
<td>3.21 – 3.22</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Acidity %</td>
<td>0.87 – 1.30</td>
<td>Not &gt; 0.2% by mass</td>
<td>Å50</td>
</tr>
<tr>
<td>8</td>
<td>Hydroxymethyl furfural mg/kg</td>
<td>-</td>
<td>Not &gt; 80 mg/kg</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: 1. Indian Standards- Food Safety and Standards Authority of India, 2010. Ministry of Health & Family Welfare, Govt. of India

**pH and TSS Value**

The pH value of the Edirine, Turkey honey samples varied between 4.43-4.49 at 21 °C. The pH value of the honey samples used ranged between 3.70 – 5.90 with an average of 3.87 ± 0.33 (Elif Sari and Nusret Ayyildiz, 2012). The low pH of honey inhibits the presence and growth of micro-organisms and makes honey compatible with many food products in terms of pH and acidity. This parameter is of great importance for the storage as it influences the texture, stability and shelf life of honey.

Similarly, in all honey samples, monosaccharide glucose and fructose predominate. These are defined as total soluble sugar (TSS). The results of the analysis showed that the TSS content of honey was 76.85 – 76.99 per cent for the tested samples, which was more than World Honey Standard. TSS of the Zambia, African, honey ranged from 85.7 to 83.6 per cent (Nyau et al, 2013). As per Alimentarius Commission Standards (2001), a minimum TSS content of 65 per cent is required.

**Acidity and Total ash**

The acidity of the tested honey samples ranged between 0.87 – 1.30 per cent. Variation in free acidity among different honey depends on nearby floral origin and the harvesting season. When the acidity becomes high, the honey becomes sour. Certain nitrogen compounds, minerals, vitamins, pigments and aromatic substances contribute to the ash content of honey. The ash content of locally produced tested honey samples ranged from 0.003 - 0.005 per cent which was within the Indian standard limits. Nyau et al (2013) reported ash content of Zambia, African honey samples to be within the range of 0.27 to 0.19 per cent. The ash content of locally produced honey in Gomma Woreda, South Western Ethiopia, ranged between 0.20 – 0.25 per cent which was within the standard limits (Kinati et al, 2011). Similarly, Aloisi (2010) evaluated the Argentina honey samples and the ash content ranged from 0.00 to 0.54 per cent. The result indicates that if ash contents were less than the standard limit which means beneficial substances were also less concentrated in that honey.

**HMF values**

The HMF values of Uttarkhand, Indian honey were recorded between 13.80 to 36.86 mg/ kg (Gairola et al, 2013). The HMF contents of locally produced honeys ranged between 0.05 and 17.70 mg/ kg. Hence, all of the samples met the HMF standard for quality. Previously, Jose et al (2009) analysed the honey samples and found the HMF content ranged from 0.9 to 22.8 mg/kg. Similarly, Duthil (1983) also reported that mean HMF content of different Cuban honey samples ranged from 5.47 to 5.95 mg/kg. Significant differences were observed in ash, water insoluble solid content and TSS of honey samples in the tested samples but no significance difference was observed in other parameters.

**CONCLUSION**

Honey bees are primarily distinguished by the production of honey. Nearly all the samples were found to be in acceptable range of national as well
as world standards for all of the tested parameters except for ash content materials which was below the standard limit. These samples were marked to be safe for human consumption. Usually the honey of stingless bees is used for home consumption by the Garo tribe. The results shows the potential of the honey of this area is very high for export. The range of ash content material could easily be brought within the standard range by changing month and season of harvesting. Hence, it can be concluded that with some small intervention from the technical experts as well as the Government, the honey of the region has a tremendous potential to catch the export market leading to better earning of the local tribes as well as improving their livelihood.

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