Characterization of Sterculia setigera gum (gum karaya) in Sudan

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Abstract

This study aimed to characterize Sterculia setigera gum (gum karaya) obtained from different locations in Sudan. Gum samples were collected from El Nour forest, East Eldamazin City in the Blue Nile State, and from Rashad area (Gabal Alahmer and Um-Abdalla forest) in South Kordofan State during April, May and June 2004. The physiochemical analysis of gum was carried out, and the estimated values of Blue Nile and Kordofan samples, respectively, were: moisture (12.5; 13)%; ash (7.1; 7.0)%, pH (4.8; 4.7), nitrogen (0.08; 0.08), protein (0.56; 0.56)%, optical rotation (+3; +3), viscosity (720; 690) ml/gm, equivalent weight (680; 655) and uronic acid (27.3; 29.6)%. Cationic composition was also determined. Mineral composition of gum from Blue Nile State showed calcium to be the highest followed, in descending order, by magnesium, potassium, sodium, iron, manganese, cobalt, zinc and copper, whereas cationic concentration of gum samples from Kordofan State was in decreasing order; calcium, potassium, magnesium, sodium, iron, cobalt, manganese, zinc and copper. Both Kordofan and Blue Nile gums gave identical FTIR spectra indicating that their detailed molecular structures are similar.

The study suggests that more research work to be carried out on management of Sterculia setigera tree and on gum production technologies to enhance gum karaya production in Sudan.

Key Words: Forest trees, Sterculia spp, growth and development

Introduction

Gum karaya, Sterculia gum, is the dried exudates obtained from the stem and branches of Sterculia tree, family Sterculiaceae. The gum is collected after tapping or blazing the tree or as natural exudates. It is widely used in pharmaceutical and dental adhesives preparations. It is also used in food
industry as a stabilizer and emulsifier, in textile industry as a thickener and in pulp and paper making as a binder. *Sterculia setigera* is universally accepted as one of the main contributing sources of the world’s commercial gum karaya. *Sterculia setigera* is widespread deciduous species of savanna woodland of Sudan. It is found in southern part of Blue Nile, southern Kordofan, Nuba Mountains, Bahr el Ghazal and Red Sea Hills regions (El Amin, 1990).

Sudan has the potential to supply much large quantities of gum karaya (Coppen, 1995). There is a considerable scope for the development of *Sterculia setigera*.

Sudan is directed to gum Arabic. Very limited data is available on gum karaya as a tree crop in Sudan (Anderson et al., 1982). Most of the research on gum in and research studies are needed to explore the potential of this valuable gum in Sudan. Accordingly the objective of this study was to characterize the gum of *Sterculia setigera* (gum karaya) obtained from different locations in Sudan through determining and comparing their physiochemical properties.

**Materials and methods**

Samples of gum karaya were collected from El Nour forest, East Eldamazin City in the Blue Nile State (Lat. 11°49′ N, long. 34°29′ E) and from Rashad area (Gabal Alahmer and Umabdalla forest) in South Kordofan State during April, May and June 2004. Several *Sterculia setigera* trees were tapped by making incisions using an axe. Gum samples were dried at room temperature and cleaned by hand to remove foreign particles and adhering bark. The samples were then ground using a mortar and piston, sieved through sieve No. 4 and kept in glass containers. Moisture and ash content were determined according to FAO (1990). The pH was determined on 1% aqueous solution of gum using Berkman Zeromatic IV pH meter at room temperature. Nitrogen content was determined following the semi-micro kjeldahl method (AOAC, 1984). Protein content was derived by multiplying nitrogen content by 6.25. The observed optical rotation was determined for 0.5% aqueous gum solution.
using a Bellingham and Stanely polarimeter. Viscosity was determined on 0.5% gum solution using Ubbehode viscometer (B2 USA) immersed in a constant temperature water bath set at 25°C. Apparent equivalent weight was determined according to the Encyclopedia of Chemical Technology (1966). Uronic acid% was determined by multiplying the molecular weight of uronic acid (194) by 100 and dividing by the apparent equivalent weight of gum sample. The cationic composition was determined according to the dry ashing method (Perkin Elmer, 1994) using Perkin Elmer 3110 Atomic Absorption spectrometer. The Fourier Transform Infra-red (FTIR) spectra of gum samples were obtained on a Thermo-Nicolet-IR300 spectrophotometer using potassium bromide (KBr) pellets.

Results and discussion

Data obtained on the physiochemical properties of gum karaya are presented in Table 1. The moisture content of gum karaya from Blue Nile (12.5)% and Kordofan (13.2)% are higher than the values of 9.5% and 9.0% reported by Hussein (2006), and less than the value of 15.8% reported by Anderson et al., (1982), but agree with the value of 12.8% given by Taher (1998). The results are in line with the Sudanese Standards which stated not more than 20% moisture content for Sterculia setigera gum in Sudan (Osman and Hassan, 2004).
Table 1: The physiochemical properties of gum karaya from Blue Nile and Kordofan regions

<table>
<thead>
<tr>
<th>source</th>
<th>M.C.%</th>
<th>Ash %</th>
<th>pH</th>
<th>Nitrogen%</th>
<th>Protein%</th>
<th>Specific rotation (degree)</th>
<th>Intrinsic viscosity ml/g</th>
<th>Equivalent weight</th>
<th>Uronic acid%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Nile</td>
<td>12.73</td>
<td>7.14</td>
<td>4.8</td>
<td>0.08</td>
<td>0.56</td>
<td>+ 3.0</td>
<td>720</td>
<td>680</td>
<td>27.3</td>
</tr>
<tr>
<td>Kordofan</td>
<td>12.25</td>
<td>7.70</td>
<td>4.7</td>
<td>0.09</td>
<td>0.56</td>
<td>+ 3.0</td>
<td>690</td>
<td>655</td>
<td>29.6</td>
</tr>
</tbody>
</table>
Table 2: Mineral composition of gum karaya (µg/g) from Blue Nile and Kordofan regions

<table>
<thead>
<tr>
<th>source</th>
<th>Na</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Co</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Nile</td>
<td>50</td>
<td>940</td>
<td>3275</td>
<td>1370</td>
<td>40</td>
<td>1</td>
<td>30</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Kordofan</td>
<td>40</td>
<td>940</td>
<td>4300</td>
<td>1200</td>
<td>40</td>
<td>1</td>
<td>10</td>
<td>40</td>
<td>4</td>
</tr>
</tbody>
</table>

Ash content of Blue Nile (7.1%) and Kordofan gum (7.0%) agree with the values of 7.8% and 7.5% reported by Taher (1998). Hussein (2006) gave less value of 6.1% and 4.4% for Blue Nile and Kordofan gums. The results are also in close agreement with the 7.0% value reported for international commercial karaya gum (Anderson et al., 1982) and matches with the Sudanese specifications for gum karaya, which stated a standard of not more than 8% as ash content (Osman and Hassan, 2004). The pH of aqueous solution indicated the acidity of gum karaya and agree with the figures reported in the literature (Anderson et al., 1982; Taher, 1998; Hussein, 2006). Compared to gum arabic, the results obtained shows that the pH of gum karaya is higher than the value (4.4) reported for Acacia senegal gum (Siddig, 2003). Nitrogen and protein content obtained for Blue Nile and Kordofan gum were found to be similar, with nitrogen as 0.08% and protein as 0.56%. These results are comparable to the values of 0.15% and 0.19% nitrogen and 0.95% and 1.20% protein reported by Hussien (2006) for Blue Nile and Kordofan gums respectively. The results agree with Anderson et al.,(1982). Compared to gum arabic, gum karaya has less nitrogen content than the 0.29% reported for Acacia Senegal gum (Anderson, 1978). The aqueous solutions of gum obtained from Blue Nile and Kordofan regions were both found to be optically active (dextrorotatory) with similar specific optical rotation of +3. These results are comparable to the value of +1.5 given by Taher, (1998) and disagree with the values of +57 and + 47 reported by Anderson et. al. (1982) and Khristova et. al. (1982), respectively. The intrinsic viscosity of gum karaya agree with the values of 753 and 725 ml/gm reported by Hussien (2006) for Blue Nile and Kordofan gum, respectively, but are lower than the value of 810 ml/g reported by Anderson et. al.(1982). Both the equivalent
weight and uronic acid obtained agree with Anderson et al. (1982) who reported uronic acid content of gum karaya as 32%.

**Cationic composition**

Results on mineral composition of gum karaya obtained from *Sterculia setigera* grown in Blue Nile and Kordofan States (Table 2) showed calcium to be the highest followed, in descending order, by magnesium, potassium, sodium, iron, manganese, cobalt, zinc and copper, whereas cationic concentration of Kordofan gum was in decreasing order; calcium, magnesium, potassium, sodium, iron, cobalt, manganese, zinc and copper. Mineral composition was observed to be, more or less similar for both regions, however, variations observed in calcium and magnesium could probably be related to differences in soil types.

**Infrared spectroscopy (FTIR)**

The infrared spectra (Fig. 1 and 2.) are identical, indicating similarities in the chemical structure of gums from both regions. The results agree with the finding of Hussien (2006). The study indicated that the physiochemical properties of gum karaya produced in Sudan from *Sterculia setigera* trees grown in Blue Nile and South Kordofan agree with the international specifications for commercial gum karaya. More research work is needed to increase gum karaya production in Sudan.
Fig. 1. FTIR spectrum of gum karaya from Blue Nile
Fig. 2. FTIR spectrum of gum karaya from Kordofan
References


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