Chapter 6

ANTI-DIABETES PLANTS OF SOUTHERN ASSAM WITH SPECIAL REFERENCE TO BIOLOGICAL SCREENING

RESULT AND DISCUSSION
RESULT AND DISCUSSION

A total of fifty eight (58) Ethnomedicinal plants have been collected from Southern Assam. The Ethnomedicinal aspect of Chorei, Reangs and Hmars in the treatment and management of Diabetes has bee thoroughly studied for the first time. Intensive field work for a period of two and a half years (April 2006 to Sep 2008) were carried out in villages in Southern Assam so as to obtain detailed information on each and every plant species used by the tribe in management of diabetes in their traditional way of treatment. A large number of medicine men and informers were consulted and repeated queries for authenticity of the information have been made. The data on Indian Medicinal plants have been systematically compiled in number of illustrations books viz., Directory of Economic Plants by Watt (1898); Indian Medicinal Plants by Kirtikar and Basu (1933); Medicinal Plants of India and Pakistan by Dastur (1952); Glossary of Indian Medicinal Plants by Chopra et al., (1956); Medicinal Plants by Jain (1985); Economic Plant by Nayer et al., (1969); Jain (1963, 1964a, 1965a, 1965b, 1967, 1985, 1987, 1989, 1991); Jain & Barthakur (1980); Jain & Dam (1979); Gogoi et al. (1984); Gopal et al. (1985) recorded useful information on medicinal plants and laid pioneering work in the field of ethnobotany in India. Gongalvez (1980) recorded the medicinal plants of Colombia.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Botanical Name of the Ethnomedicinal Plant</th>
<th>Family</th>
<th>Vernacular Name</th>
<th>Parts Used</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Adhatoda vasica</em> Ness.</td>
<td>ACANTHACEAE</td>
<td>Vasak Pata” (C &amp; B).</td>
<td>Root, leaf, flower</td>
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<td>2</td>
<td><em>Albizia procera</em> (Roxb.)</td>
<td>MIMOSACEAE</td>
<td>Koroi” (B), “Gurar, Kurha, Safed Siris” (H).</td>
<td>Leaf, Flower, Bark</td>
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<td>4</td>
<td><em>Alstonia scholaris</em> (Linn.)</td>
<td>APOCYNACEAE</td>
<td>“Saptaparnah” (S), “Chatkim, Chatwan” (B); “Catium, Saitan-Ka-jhad” (H).</td>
<td>Whole plant</td>
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<tr>
<td>5</td>
<td><em>Ananas comosus</em> (L)</td>
<td>BROMELIACEAE</td>
<td>“Amatoi” (R), “Ananash” (B), “Ananas” (H), “Anamnasam, Bahunetraphalam” (S).</td>
<td>Whole plant</td>
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<tr>
<td>Whole plant</td>
<td>Petiole</td>
<td>Leaf</td>
<td>Nuts</td>
<td>Leaks</td>
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<td>Kalmegh (B) Thikhama (B), &quot;Kairata&quot; (R)</td>
<td>Tree fern (E)</td>
<td>&quot;Sitaphalam, Gandhimagathra, Shubha, Seethaphal, Sharifa&quot; (H).</td>
<td>&quot;Supari&quot; (B), &quot;Tamul&quot; (A)</td>
<td>&quot;Kathal&quot; (B &amp; H)</td>
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<td>Common Names Description</td>
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<td>13</td>
<td><em>Canna indica</em> Linn.</td>
<td>CANNACEAE</td>
<td>“Devakuli” (S), “Sarbajaya” (B), “Sabbajaya” (H).</td>
<td>Leaf, aerial parts</td>
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<td>14</td>
<td><em>Cannabis sativa</em> L.</td>
<td>CANNABINACEAE</td>
<td>Bhang (B,H) Ganja (B)</td>
<td>Flowers, Leaves, resins</td>
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<td>16</td>
<td><em>Cassia fistula</em> Linn.</td>
<td>CAESALPINACEAE</td>
<td>“Aragvdha, Suvarnaka” (S), “Amultas, Bandarlathi” (B), “Amaltas, Bandarlauri, girimalah” (H).</td>
<td>Flower, seed, stem bark</td>
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<td>17</td>
<td><em>Cassia occidentalis</em> L.</td>
<td>CAESALPINACEAE</td>
<td>Kalkashundu (B) “Moitharbi” (C).</td>
<td>Leaves, seeds</td>
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<td>18</td>
<td><em>Cassia sophora</em> L.</td>
<td>CAESALPINACEAE</td>
<td>“Molteribu” (C), “Kalkasunda” (B); “Chakwar, Kasundari, Kesundi” (H).</td>
<td>Seeds &amp; stem bark</td>
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<td>No.</td>
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<td>Common Names</td>
<td>Part</td>
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<td>19</td>
<td>Cassia tora L.</td>
<td>CAESALPINIACEAE</td>
<td>“Moitarni” (C), “Panevar” (B), “Chakunda, Panevar, Pawad, Chakavat” (H).</td>
<td>Seeds</td>
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<td></td>
<td>Catharanthus roseus G.Don.</td>
<td>APOCYNACEAE</td>
<td>“Khumbiraghi” (R). “Gulferinghi, Nayantara” (B); “Sadabahar, Sadasuhagan” (H).</td>
<td>Leaf</td>
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<td>21</td>
<td>Centella asiatica (L.) Urban.</td>
<td>APIACEAE, UMBELLIFERAE</td>
<td>“Parup” (C). Thankuni, Tholkuri (B); Brahmi, Kulakudi (H).</td>
<td>Whole plant.</td>
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<td>22</td>
<td>Cicca acida (Linn) Meer</td>
<td>EUPHORBIACEAE</td>
<td>Harboroi/Laboir (B)</td>
<td>Leafs</td>
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<td>23</td>
<td>Cinnamomum tamala (Buch-Ham.) Nees.</td>
<td>LAURACEAE</td>
<td>Tejjatt (H) “Khespa” (R), “Tamaka” (S) “Tejpata” (H) &amp; (B), “Tamalapatram” (San).</td>
<td>Stem, bark &amp; root</td>
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<tr>
<td>24</td>
<td>Citrus aurantium Linn.,</td>
<td>RUTACEAE</td>
<td>“Khatta” (H).</td>
<td>Fruit</td>
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<tr>
<td>25</td>
<td>Citrus reticulate</td>
<td>RUTACEAE</td>
<td>&quot;Kamala&quot; (R).</td>
<td>Roots, fruits</td>
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<td>26</td>
<td>Clerodendrum viscosum Vent.</td>
<td>VERBENACEAE</td>
<td>&quot;Bhandirah&quot; (S). &quot;Basavanapada, Ibbane&quot; (B &amp; H).</td>
<td>Whole plant</td>
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<tr>
<td>27</td>
<td>Cocos nucifera L.</td>
<td>ARECACEAE, PALMAE</td>
<td>&quot;Narikelavrksah&quot; (S), &quot;Dab, Narikel&quot; (B); &quot;Nariyal, Nariyal-Ka-ped&quot; (H).</td>
<td>Fruit &amp; flower</td>
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<tr>
<td>28</td>
<td>Cordia dichotoma</td>
<td>BORAGINACEAE</td>
<td>Bahubara &quot;Shleshmanthaka, Bahuvaraka&quot; (S), &quot;Lasora, Chota Lasora&quot; (H)</td>
<td>Leaf and fruits</td>
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<tr>
<td>29</td>
<td>Curcuma domestica</td>
<td>ZINGIBERACEAE</td>
<td>&quot;Karma&quot; (R) &quot;Haridra&quot; (S) &quot;Haldi&quot; (H) and (B)</td>
<td>Leaf, rhizome</td>
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<td>30</td>
<td>Cynodon dactylon (Linn.)</td>
<td>POACEAE</td>
<td>&quot;Durba, Dubh&quot; (B), &quot;Dub, Durba&quot; (H), &quot;Durva, Niladurva&quot; (S).</td>
<td>Whole plant</td>
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<tr>
<td>31</td>
<td>Cyperus iria Linn</td>
<td>CYPERACEAE</td>
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<td>Whole plant</td>
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<td>No.</td>
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<td>Family</td>
<td>Common Names</td>
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<td>32</td>
<td>Dioscorea alata Linn</td>
<td>DIOSCOREACEAE</td>
<td>&quot;Guranialu, Katalu&quot; (A), &quot;Chupri alu&quot; (B).</td>
<td>Rhizome</td>
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<tr>
<td>33</td>
<td>Dioscorea bulbifera Linn</td>
<td>DIOSCOREACEAE</td>
<td>Banalu, Kukulalu, Gaichalu&quot; (B), &quot;Ratalu, Suaralu, Pitaalu&quot; (H).</td>
<td>Leafs and twigs</td>
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<td>34</td>
<td>Euphorbia hirta L. Syn.: E.pilulifera sensu Hook.f. non L.</td>
<td>EUPHORBIACEAE</td>
<td>&quot;Hektuk&quot; (C). &quot;Barokheruie&quot; (B), &quot;Dudhi&quot; (H).</td>
<td>Whole plant</td>
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<tr>
<td>35</td>
<td>Ficus benghalensis Linn</td>
<td>MORACEAE</td>
<td>&quot;Bar, Bot&quot;. (B.) &quot;Bar, Barged Bhor&quot;(H), &quot;Vata, Bahupada&quot;(S)</td>
<td>Stem bark, sap</td>
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<tr>
<td>36</td>
<td>Ficus hispida</td>
<td>MORACEAE</td>
<td>&quot;Thaichuwathia&quot; (R), &quot;Kakadumbura&quot; (S), &quot;Dumoor, Kakodumar&quot; (B); &quot;Dadurin, Golba. Kagsha, Katgularia&quot; (H). Oneadumur&quot;, &quot;Kakdumur&quot; (B).</td>
<td>Hypanthodium (fruits)</td>
</tr>
<tr>
<td>37</td>
<td>Ficus racemosa Linn</td>
<td>MORACEAE</td>
<td>Thaikat (C) &quot;Dumur, Jagyadumur,</td>
<td>Fruit</td>
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<td></td>
<td>Anti-Diabetes Plants of Southern Assam with Special Reference to Biological Screening</td>
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<tr>
<td>38</td>
<td><strong>MORACEAE</strong></td>
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<td>Ficus religiosa L.</td>
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<tr>
<td>39</td>
<td><strong>LILIACEAE</strong></td>
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<tr>
<td></td>
<td>Gloriosa superba Linn.</td>
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<td><strong>VERBENACEAE</strong></td>
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<td></td>
<td>Gmelia arborea Roxb.</td>
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**Table:**

<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Part Used</th>
<th>Family</th>
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<tbody>
<tr>
<td>Yagnadumur&quot; (B), &quot;Dimere, Gular, Leleka, Parao, Umbar, Umrai&quot; (H), &quot;Udumbhara, Sadaphala&quot; (S)</td>
<td>Rootbark and root</td>
<td><strong>MORACEAE</strong></td>
</tr>
<tr>
<td>&quot;Churmulihaang&quot; (C), &quot;Aswatha, Asvat, Asvattha, Pipal (H)</td>
<td>Whole plant</td>
<td><strong>LILIACEAE</strong></td>
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<tr>
<td>&quot;Langali, Agrisikha&quot; (S), &quot;Bishalanguli, Ulatchandali, Languli, Karbhar, Karadhikaminagade, Nangulika&quot; (H)</td>
<td>Leaf stem and fruit</td>
<td><strong>VERBENACEAE</strong></td>
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<tr>
<td>&quot;Gamir Gach&quot; (C), &quot;Gamari, Gumbar, Kumbhar&quot; (B), &quot;Gambio, Gambhari, Kasamari, Shripa, Bhadrapi&quot; (S)</td>
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<table>
<thead>
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<th>No.</th>
<th>Species</th>
<th>Family</th>
<th>Common Names</th>
<th>Part Used</th>
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<tr>
<td>41</td>
<td><em>Heliotropium indicum</em> Linn.</td>
<td>BORAGINACEAE</td>
<td>“Hatishur” (B).</td>
<td>Aerial parts</td>
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<td>43</td>
<td><em>Hydrolea zeylanica</em> (Linn.)</td>
<td>HYDROPHYLLACEAE</td>
<td>“Isha-langula, Kasschra” (B), “Langali” (S).</td>
<td>Leaf and twigs</td>
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<tr>
<td>44</td>
<td><em>Imperata cylindrica</em> (Linn.)</td>
<td>POACEAE</td>
<td>“Ooloo, Ulu” (B), “Dabh, Smi” (H), “Darbha” (S).</td>
<td>Root</td>
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<td>45</td>
<td><em>Ipomoea aquatica</em> Forsk.</td>
<td>CONVOLVULACEAE</td>
<td>“Kalmisak” (B).</td>
<td>Leaf and twigs</td>
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<td>46</td>
<td><em>Jatropha curcas</em> Linn.</td>
<td>EUPHORBIACEAE</td>
<td>“Lalbherenda” (B), “Nikumba” (S), “Verenda, Bherenda” (H).</td>
<td>Leaf and twigs</td>
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<tr>
<td>No.</td>
<td>Plant Name</td>
<td>Family</td>
<td>Common Names</td>
<td>Part Used</td>
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<tr>
<td>48</td>
<td><em>Mangifera indica</em> L.</td>
<td>ANACARDIACEAE</td>
<td>&quot;Am, Amba; Gharam&quot; (A); &quot;Am&quot; (B); &quot;Aam, Amra, Amba&quot; (H), &quot;Amrah, chutah&quot; (S).</td>
<td>Tender leaves</td>
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<td>49</td>
<td><em>Mimosa pudica</em> L.</td>
<td>MIMOSACEAE</td>
<td>&quot;Lajjabati&quot; (B), &quot;Choitaymora&quot; (C&amp;B), &quot;Lajjalu, Namaskari&quot; (S) &quot;Sensitive plant&quot; (E).</td>
<td>Whole plant</td>
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<tr>
<td>50</td>
<td><em>Momordica charantia</em> Linn</td>
<td>CUCURBITACEAE</td>
<td>&quot;Korola&quot; (B) &quot;Kangla&quot; (R.)</td>
<td>Leaf</td>
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<td>51</td>
<td><em>Musa Paradisica</em></td>
<td>MUSACEAE</td>
<td>&quot;Kela, Kal&quot; (A) &quot;Haili&quot; (R), &quot;Kadali, vanalakshmi&quot; (S), &quot;Kach, Kula, Kala, Keli&quot; (B); &quot;Kela, Marit, Kach kula&quot; (H).</td>
<td>Flower and fruits</td>
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<td>52</td>
<td><em>Nyctanthes arbortristis</em> Linn.</td>
<td>OLEACEAE</td>
<td>&quot;Shiwli, Sewali Phul&quot; (B).</td>
<td>Leaf</td>
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<td>53</td>
<td><em>Oxalis corniculata</em> L.</td>
<td>OXALIDACEAE</td>
<td>Amrul (B &amp; H) &quot;Cangeri&quot; (S)</td>
<td>Leaf</td>
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<td>Plant Name</td>
<td>Family</td>
<td>Common Names</td>
<td>Parts Used</td>
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<td>54</td>
<td>Phyllanthus emblica Linn.</td>
<td>(EUPHORBIACEAE)</td>
<td>&quot;Amloli&quot; Amla&quot; (B), &quot;Amla, Amlika&quot; (H), &quot;Amlaki&quot; (S).</td>
<td>Seeds</td>
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<tr>
<td>55</td>
<td>Streblus asper Lour</td>
<td>MORACEAE</td>
<td>Doi Shang (Reang) Rupashi (B), Sheora (B)</td>
<td>Bark</td>
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<td>56</td>
<td>Syzygium cumini (Linn.) Skeels.</td>
<td>MYRTACEAE</td>
<td>&quot;Chambu&quot; (R), &quot;Yambu&quot; (S.), &quot;Yamun&quot; (H) &quot;Jam&quot; (B) &quot;Jambuh&quot; (S). &quot;Jam, kalajam&quot; (B); &quot;Jamun, Jabava&quot; (H);</td>
<td>Bark, fruit and seeds</td>
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<td>57</td>
<td>Terminalia chebula Retz.</td>
<td>COMBRETACEAE</td>
<td>&quot;Baukhla&quot; (R); &quot;Harit&quot; (H); &quot;Haritaki&quot; (S) &amp; (B). Sanskrit: &quot;Haritaki, Harra, Harada, Abhaya&quot; (S), &quot;Hilikha&quot; (As); &quot;Haritaki&quot; (B); &quot;Har, Harara, Harra&quot; (H).</td>
<td>Seeds</td>
</tr>
<tr>
<td>58</td>
<td>Tinospora cordifolia (Wild.) Hook.f. &amp; Th.</td>
<td>MENISPERMACEAE</td>
<td>Vanrui (C) Golancha (B)</td>
<td>Leaf and Bark</td>
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</table>

Table 4. shows the collected anti-diabetes plants of Southern Assam used in treatment and management of diabetes. Of the collected plants dicotyledons showed higher percentage of use as compared to monocot and pteridophytes (Fig. 4). Among the plant parts used, leaf is highly used followed by bark, root, whole plant, fruit, seeds, roots, flowers, rhizome, sap and nuts (Fig. 5). This data shows that leaf is the main source of anti-diabetic crude drugs used by various tribes of Southern Assam. Among all the plant species collected, *Streblus asper* and *Cicca acida* are widely used among the tribes and thus considered for bioactivity evaluation.

Fig 4. The Pteridophyte, Dicot and Monocot ratio of the anti-diabetes plants of Southern Assam
In the present investigation, the anti diabetes activity of two Ethnomedicinal plants *Cicca acida* and *Streblus asper* have been studied. The biochemical parameters like blood glucose level, cholesterol level and triglycerides level were measured in STZ induced diabetes in mice.

Streptozotocin (STZ) is known to induce diabetes. It is a potent methylating agent for DNA and acts as nitric oxide donor in pancreatic cells, resulting in the generation of free radicals. The biochemical parameters measured showed significant results. All statistical analysis was performed in R Language and environment (R Development Core Team, 2009). All treatment groups were compared along with control group using one-way Analysis of Variance (ANOVA). The groups showing significant differences were compared with Tukey multiple comparison of means test (Zar, 2009).
Table 5. Glucose level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE Tukey multiple comparison of means (p<0.05 level of significance).

<table>
<thead>
<tr>
<th>Treatment Types</th>
<th>Glucose (mg/dl)</th>
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<tbody>
<tr>
<td>Control</td>
<td>42.924 ± 16.61</td>
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<tr>
<td>With STZ</td>
<td>207.104 ± 23.56</td>
</tr>
<tr>
<td>Metformine</td>
<td>68.120 ± 13.12</td>
</tr>
<tr>
<td><em>Cicca acida</em></td>
<td>25.250 ± 13.09</td>
</tr>
<tr>
<td><em>Streblus asper</em></td>
<td>139.520 ± 16.90</td>
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Table 6: Tukey multiple comparisons of means for Glucose

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<th>P value</th>
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<td>1.</td>
<td>With STZ- Control</td>
<td>0.0000000 *</td>
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<td>2.</td>
<td>Metformine – Control</td>
<td>0.1761710</td>
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<tr>
<td>3.</td>
<td><em>Cicca acida</em> – Control</td>
<td>0.4931641</td>
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<td>4.</td>
<td><em>Streblus asper</em> – Control</td>
<td>0.0000002 *</td>
</tr>
<tr>
<td>5.</td>
<td>Metformine - With STZ</td>
<td>0.0000000 *</td>
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<tr>
<td>6.</td>
<td><em>Cicca acida</em> - With STZ</td>
<td>0.0000000 *</td>
</tr>
<tr>
<td>7.</td>
<td><em>Streblus asper</em> - With STZ</td>
<td>0.0000373 *</td>
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<tr>
<td>8.</td>
<td><em>Cicca acida</em> - Metformine</td>
<td>0.0060662 *</td>
</tr>
<tr>
<td>9.</td>
<td><em>Streblus asper</em> - Metformine</td>
<td>0.0000177 *</td>
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<tr>
<td>10.</td>
<td><em>Streblus asper</em> - <em>Cicca acida</em></td>
<td>0.0000000 *</td>
</tr>
</tbody>
</table>
Fig. 6. Glucose level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p<0.05 level of significance as compared to control.

Fig. 7. Glucose level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p≤0.05 level of significance as compared to those treated with STZ.
Fig. 8. Glucose level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p<0.05 level of significance as compared to those treated with metformine.

Upon STZ treatment the blood glucose level increased significantly by 382% as compared to control (p = 0.0000000) (Table 5, 6 & Fig. 6,7,8). In this case *Streblus asper* shows significant reduction of blood glucose level by 32.63% (p = 0.0000373) when compared with STZ induced hyperglycemic mice. Though the study revealed that *Cicca acida* and the standard drug Metformine are very significant. (p=0.0000000 in both the cases) to reduced the glucose level when compared to STZ induced diabetic mice, till the effect of *Cicca acida* and the standard drug Metformine differ significantly to reduce the blood glucose level. (p = 0.0060662). In this case the standard drug Metformine reduces 67%, whereas *Cicca acida* reduces about 87% of blood
glucose level. Thus *Cicca acida* may be more effective to reduce blood glucose level than the standard drug Metformine. *Streblus asper* differ significantly when compared with the standard drug Metformine and *Cicca acida* do not differ significantly when compared with control (p = 0.1761710 & p = 0.4931641 respectively).

The study demonstrated that ethanolic extract of both the plants induced hypoglycemic property. Many earlier reports stated that administration of plant extracts do not produce appreciable differences in blood sugar level (Sagrawat *et al.*, 2006). Djomeni *et al.* (2006) showed that ethanolic extracts of *Ceiba pentandra* shows hypoglycemic effects on rats, Shirwaikar *et al.* (2001) reported active constituents from *Annona squamosa* to have hypoglycemic action on STZ induced diabetic rats. In addition to this, Olusola *et al.* (2003); Sharma *et al.* (1997) reported the hypoglycemic activity of *Ceiba pentandra* and *Cesalpinia boubinduella* seeds respectively. Kamtchouing *et al.* (1998); Sokeng *et al.* (2001) showed the protective role of *Anacardium occidentals* extract against STZ induced diabetes in rats. Kochhar *et al.* (2005) showed some effects of traditional medicinal plants on Non Insulin Dependant Diabetes Mellitus (NIDDM) patients. Ali *et al.* (1993) showed the hypoglycemic activity of fruit pulp of *Momordica charantia*. Ethanolic extract of both *Cicca aceda* and *Streblus asper* not only reduces the blood glucose level but also showed significant activity in controlling triglyceride and cholesterol level. The standard drug metformine though provided protection against
diabetes in the test animals, the effect of *Cicca acida* and *Streblus asper* is much more significant.

Table 7: Tukey multiple comparison of means for Cholesterol

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Comparisons</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>With STZ- Control</td>
<td>0.0000072 *</td>
</tr>
<tr>
<td>2.</td>
<td>Metformine - Control</td>
<td>0.7155293</td>
</tr>
<tr>
<td>3.</td>
<td><em>Cicca acida</em> - Control</td>
<td>0.0007321 *</td>
</tr>
<tr>
<td>4.</td>
<td><em>Streblus asper</em> - Control</td>
<td>0.0367928 *</td>
</tr>
<tr>
<td>5.</td>
<td>Metformine - With STZ</td>
<td>0.0001050 *</td>
</tr>
<tr>
<td>6.</td>
<td><em>Cicca acida</em> - With STZ</td>
<td>0.2443393</td>
</tr>
<tr>
<td>7.</td>
<td><em>Streblus asper</em> - With STZ</td>
<td>0.0070680 *</td>
</tr>
<tr>
<td>8.</td>
<td><em>Cicca acida</em> - Metformine</td>
<td>0.0125390 *</td>
</tr>
<tr>
<td>9.</td>
<td><em>Streblus asper</em> - Metformine</td>
<td>0.3605722</td>
</tr>
<tr>
<td>10.</td>
<td><em>Streblus asper</em> - <em>Cicca acida</em></td>
<td>0.4207311</td>
</tr>
</tbody>
</table>
Table 8. Cholesterol level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE Tukey multiple comparison of means (p<0.05 level of significance).

<table>
<thead>
<tr>
<th>Treatment Types</th>
<th>Cholesterol (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>64.726 ± 13.76</td>
</tr>
<tr>
<td>With STZ</td>
<td>211.30 ± 57.55 a</td>
</tr>
<tr>
<td>Metformine</td>
<td>90.032 ± 28.89 b,c</td>
</tr>
<tr>
<td><em>Cicca acida</em></td>
<td>166.836 ± 27.90 a</td>
</tr>
<tr>
<td><em>Streblus asper</em></td>
<td>130.120 ± 17.46 a,b</td>
</tr>
</tbody>
</table>

(a, b and c represents p≤ 0.05 level of significance as compared to control, STZ treatment and metformine treatment)

Fig. 9. Cholesterol level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p≤0.05 level of significance as compared to control.
Fig. 10. Cholesterol level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p≤0.05 level of significance as compared to those treated with STZ.

After STZ treatment the blood Cholesterol level increased significantly about 226% (p = 0.0000072) as compared to control, (Table 7, 8 & Fig. 9, 10 ). Here *Streblus asper* shows significant reduction in blood Cholesterol level by 38.42%, when compared with STZ induced hyperglycemic mice, (p = 0.0070680). In this case the standard drug Metformine shows significant reduction in blood Cholesterol level about 57.39%, when compared with STZ induced hyperglycemic mice, (p = 0.0001050). *Streblus asper* and the standard drug Metformine do not show the significant difference (p = 0.3605722). Thus it can be inferred that both of them has similar effect to reduce Cholesterol level to hyperglycemic mice. *Cicca acida* and *Streblus asper* shows significant difference when compared with control (p = 0.0007321 & p = 0.0367928 respectively). *Cicca acida* do not show significance with STZ induced mice (p =
Cicca acida do not show significance when compared with Streblus asper (p = 0.4207311).

Table 9: Tukey multiple comparisons of means for Triglyceride

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Comparisons</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>With STZ- Control</td>
<td>0.0000000 *</td>
</tr>
<tr>
<td>2.</td>
<td>Metformine - Control</td>
<td>0.0034142 *</td>
</tr>
<tr>
<td>3.</td>
<td>Cicca acida - Control</td>
<td>0.0001524 *</td>
</tr>
<tr>
<td>4.</td>
<td>Streblus asper - Control</td>
<td>0.0000000 *</td>
</tr>
<tr>
<td>5.</td>
<td>Metformine - With STZ</td>
<td>0.0000001 *</td>
</tr>
<tr>
<td>6.</td>
<td>Cicca acida - With STZ</td>
<td>0.0000017 *</td>
</tr>
<tr>
<td>7.</td>
<td>Streblus asper - With STZ</td>
<td>0.0167149 *</td>
</tr>
<tr>
<td>8.</td>
<td>Cicca acida - Metformine</td>
<td>0.6443167</td>
</tr>
<tr>
<td>9.</td>
<td>Streblus asper - Metformine</td>
<td>0.0001390 *</td>
</tr>
<tr>
<td>10.</td>
<td>Streblus asper - Cicca acida</td>
<td>0.0031059 *</td>
</tr>
</tbody>
</table>

Table 10. Triglycerides level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE Tukey multiple comparison of means (p<0.05 level of significance).

<table>
<thead>
<tr>
<th>Treatment Types</th>
<th>Triglycerides (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>70.548 ±13.94</td>
</tr>
<tr>
<td>With STZ</td>
<td>232.07 ±16.99</td>
</tr>
<tr>
<td>Metformine</td>
<td>121.52 ±23.48</td>
</tr>
<tr>
<td>Cicca acida</td>
<td>138.23 ±4.82</td>
</tr>
<tr>
<td>Streblus asper</td>
<td>189.70 ±27.65</td>
</tr>
</tbody>
</table>
Fig. 11. Triglyceride level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p<0.05 level of significance as compared to control.

Fig. 12. Triglyceride level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p<0.05 level of significance as compared to those treated with STZ.
Fig. 13. Triglyceride level in STZ induced diabetic mice and respective treatments with metformine and plant extracts after 14 days. Data presented are mean of five replicates ± SE. The asterisk (*) represent the p<0.05 level of significance as compared to those treated with metformine.

Upon STZ treatment the blood Triglycerides levels of the mice is also increased significantly about 228.95%, when compared with control, (p = 0.0000000). In this case Cicca acida shows most significant result after the standard drug Metformine. Cicca acida and Metformine shows 40.44% & 47.63% of reduction of Triglycerides respectively, when compared with STZ induced hyperglycemic mice (p = 0.0000017 & p = 0.0000001 respectively). Streblus asper also shows significance to reduce Triglycerides levels up to 18.26%, when compared with STZ induced hyperglycemic mice (p = 0.0167149). The standard drug Metformine, Cicca acida and Streblus asper showed significant differences when compared with respective controls (p = 0.0034142, p = 0.0001524 & p = 0.0000000 respectively). Streblus asper showed significance when compared to metformine (p = 0.0001390). Streblus asper also
showed significance with *Cicca acida* (p=0.0031059). Here, *Cicca acida* do not differ significantly when compared with the standard drug Metformine (p=0.6443167). Thus, it can be inferred that both *Cicca acida* & the standard drug Metformine are similar in effect to control triglycerides in blood of STZ induced hyperglycemic mice.

![Graph showing cholesterol, glucose, and triglyceride levels](image)

**Fig. 14.** The changes in cholesterol, glucose and triglyceride level in STZ induced diabetes in mice and subsequent treatment with metformine and plant extracts after 14d of induction of diabetes. The data presented are means of five replicates, ± SE.

Thus, the present study indicates that the treatment with ethanolic extract of *Streblus asper* and *Cicca acida* has favourable effect instantly on blood glucose but also in the lipid profile. The findings coincide with those of many earlier studies where medicinal and herbal remedies provided significant and valuable protection against diabetes. This points out the promising effect of *Cicca acida* and *Streblus asper* being a useful anti diabetes agent and its abilily to control diabetes related cardiovascular changes. In addition to this further
detail studies are desirable in order to identify and prioritize these two plants for drug development. Over past few decades Ethnobotany has emerged as a new or more appropriately revived interdisciplinary approach to drug discovery.
Swiss Albino Mice used in the experiments
Streblus asper Lour (MORACEAE)

Cicca acida (Linn.) Meer (EUPHORBIACEAE)

The Plants used for Biological Screening
Chapter 7

ANTI-DIABETES PLANTS OF SOUTHERN ASSAM WITH SPECIAL REFERENCE TO BIOLOGICAL SCREENING

SUMMARY AND CONCLUSION
SUMMARY AND CONCLUSION

1. The traditional aspects of common villagers and tribal people specially Chorei, Reangs and Hmar tribe of Southern Assam has been thoroughly studied. The geographical features and the climate of the area under investigation have been provided.

2. Intensive field work has been done for a period of two and a half years from April 2006 to September 2008 in the different tribal inhabitant areas of Southern Assam so as to obtain detail information on each and every plant species used by them for treatment of diabetes in their traditional system of medicine. A large number of local informers and medicine man were consulted and repeated queries for authenticity of the information have been made.

3. The plants have been collected from the area and after proper tagging preserved properly. Detailed morphological studies have been made for the collected specimens and identified with the help of available literature and confirmed the identity by matching the herbarium sheets found preserved in the Departmental Herbarium of Life Science, Assam University Silchar and Kanjilal Herbarium, Shillong.

4. A brief description of the collected plants species has been provided for easy identification, followed by phonological data of collection, ecological adaptation, nature of distribution etc. the usage of plants in medicine along with the established report of utilization has been provided separately.
5. All together fifty eight numbers of plants have been collected from Southern Assam. Of the collected plants Dicotyledons shows higher percentage of use as compared to monocot and pteridophytes. Among the plant parts used, leaf is highly used followed by bark, root, whole plant, fruit, seeds, roots, flowers, rhizome, sap and nuts. The observation shows that leaf is the main source of anti-diabetic crude drugs used by various tribes of Southern Assam.

6. Among all the plant species collected, *Streblus asper* and *Cicca acida* are widely used among the tribes and thus considered for bioactivity evaluation. The study demonstrated that ethanolic extract of the both the plants induced hypoglycemic property.

7. The effect of *Cicca acida* and *Streblus asper* is much more significant to reduce glucose level in blood than the standard drug metformine. *Streblus asper* shows significant reduction of blood glucose level by 32.63% \( (p = 0.0000373) \) when compared with STZ induced hyperglycemic mice. The standard drug Metformine reduces 67%, whereas *Cicca acida* reduces about 87% of blood glucose level. Thus *Cicca acida* may be more effective to reduce blood glucose level than the standard drug Metformine.

8. *Streblus asper* shows significant reduction in blood Cholesterol level by 38.42%, when compared with STZ induced hyperglycemic mice, \( (p = 0.0070680) \). The standard drug Metformine shows significant reduction in blood Cholesterol level about 57.39%, when compared with STZ induced hyperglycemic mice, \( (p = 0.0001050) \). *Streblus asper* and the standard drug
Metformine do not show the significant difference ($p = 0.3605722$). Thus it can be inferred that both of them has similar effect to reduce Cholesterol level to hyperglycemic mice.

9. *Cicca acida* and Metformine shows 40.44% & 47.63% of reduction of Triglycerides respectively, when compared with STZ induced hyperglycemic mice ($p = 0.0000017$ & $p = 0.0000001$ respectively). *Streblus asper* also shows significance to reduce Triglycerides levels up to 18.26%, when compared with STZ induced hyperglycemic mice ($p = 0.0167149$). Both *Cicca acida* & the standard drug Metformine are similar in effect to control triglycerides in blood of STZ induced hyperglycemic mice.

The time has come for the society to awake to the reality of diabetes in childhood and adolescence and do everything possible to reduce its prevalence for the healthcare provided to appreciate its heterogeneity and offer correspondingly different approaches to treatment and for all to ensure that each tender bud blooms to its full potential, without missing out on the joys and excitement of this important phase of life. Thus the present study indicates that the treatment with ethanolic extract of *Streblus asper* and *Cicca acida* has favorable effect instantly on blood glucose but also in the lipid profile. Further detail studies are desirable in order to identify and prioritize these two plants for drug development.