Although the antioxidants suppressed the activity of SOD, APX and GR, they had a promoting effect on peroxidase. Both benzoquinone and α-tocopherol enhanced peroxidase activity in the cotyledons exposed or unexposed to UV-B. This observation needs further experimentation.

Status, utility, threats and conservation options for rattan resources in Manipur

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RATTANs, prickly climbing palms or canes with solid stem, form a group of 600 species distributed throughout South-East Asia and the neighbouring areas and are principal non-timber forest products1. They are highly valued and have social and economic importance because of their unique characteristics such as strength, durability, looks and bending ability; they are regarded as ‘green gold’1. In 1996, about 80% of the rattans at the international market originated from Indonesia and in 1999, the export volume was 590,021 tons and a value of US $ 1.147 billion7. Cane and bamboo craft is traditional and symbolic of north-eastern India. The role of bamboo in the socio-economy of the people of Manipur has been studied7. Rattans are produced in the evergreen tropical and moist deciduous forests of northeastern India, Kerala, Karnataka and Tamil Nadu1 for the manufacture of furniture and other articles in India.}

Nestled in a valley among the hills of eastern Himalayas, far above the sea level with nature’s pristine glory, Manipur’s mythological concept of creation is revealed in her famous folk dances and crafts8. Cane handicraft has an


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important role in the Manipuri society. Beautiful pieces of cane and bamboo furniture and other products are gaining increasing aesthetic appeal. Cane and bamboo products are an integral part of the people of Manipur because of their multipurpose economic uses and association with legends.

'Mahal' is a well-defined area from where certain types of forest products are collected and sold from all parts of Manipur. Cane is officially extracted through mahals. The royalty thus generated goes to the state government. Besides, the local villagers also unofficially harvest a large quantity of canes from the surrounding forest. The main cane growing areas of Manipur are the western state boundary along the Jiri–Barak region (Figure 1).

Manipur houses more than 13 species of rattans under three genera as against 23 species under five genera from northeastern India. In India totally 51 species under five genera occur out of the 600 species under 13 genera from the world as a whole. The common species of canes available in Manipur are listed in Table 1. For commercial purposes, canes can be classified into three classes, namely A, B and C based on their quality (A > B > C). The uses of canes range from household construction to craft items and ornaments to food, etc. (Table 2). Revenue generated from major and minor forest products, including bamboo and rattans in Manipur during 1994–2000 is presented in Table 3. Rattans contributed 0.3 to 2.1% of the total minor forest products, while the contribution was from 0.1 to 1.4% of the total forest products during 1994–2000 (Table 3). According to the records of the State Forest Department, the highest rattan extraction was recorded during 1987–88, where about 185,000 running metre of cane was extracted (Figure 2) and a revenue of Rs 740,000 was generated during 1992–93, which declined to just Rs 30,000 during 2000–01 (Figure 2). This period coincided with ethnic clashes between Naga and Kuki tribes and the result was less extraction pressure on the canes. It has been estimated that an extraction pressure of 6.8 m²/km² during 2000–01 was recorded against 149 m²/km² during 1987–88 (Figure 3). Unofficial extraction of rattans also took place. As most of the villagers have no fixed income for survival, exploitation of forest products both major and minor for commercial purposes has increased directly with the increase in population. Since rattans have great demand and price in the market, villagers opt to

![Figure 1](image1.png)

Figure 1. Satellite imagery map of Manipur showing important cane-growing areas.

![Figure 2](image2.png)

Figure 2. Quantity of canes extracted and revenue generated from it in Manipur during 1980–2001.

![Figure 3](image3.png)

Figure 3. Extraction pressure of canes in Manipur during 1980–2001.

<table>
<thead>
<tr>
<th>Table 1. Diversity of rattans in different regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
</tr>
<tr>
<td>Manipur*</td>
</tr>
<tr>
<td>Northeast India</td>
</tr>
<tr>
<td>India</td>
</tr>
<tr>
<td>World</td>
</tr>
</tbody>
</table>

*Present study area.
harvest canes in a large scale. A survey of the cane-growing areas of Manipur has revealed that around 50% of natural canes are grown along the west-facing slopes (Table 4). Generally, rattans grow under moist conditions intermingled with other trees of the forests. As the structure of the forest has changed rapidly, the growth of rattans is also being affected. Canes are highly habitat-specific\(^\text{7}\). The uses of rattans extend from simple home needs to early developments in aviation and as carbonized fibre in electric bulbs\(^\text{8}\). The International Network of Bamboos and Rattans has identified and prioritized seven species of rattans for international action on the basis of commercialization potential, environmental rehabilitation and usefulness in rural industries\(^\text{9}\). Among these three species, viz. *C. caesius*, *C. anadamicus* and *C. nagbellae* occur in India. Calamus oil extracted from the roots contains palmic acid, iso-eugenol, calamine, calamol, etc. and is used in perfumery and for flavouring liquors\(^\text{10}\). In Manipur, the ripe

### Table 2. Common cane species available in Manipur and their economic uses

<table>
<thead>
<tr>
<th>Species</th>
<th>Vernacular names</th>
<th>Stem diameter (mm)</th>
<th>Commercial class</th>
<th>Economic use</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Calamus acanthospathus</em> Griff.</td>
<td>Lee-ting'chang</td>
<td>20–25</td>
<td>B</td>
<td>Craft and twine for house</td>
</tr>
<tr>
<td><em>C. arboreces</em> Griff.</td>
<td>Lee-jao</td>
<td>35–45</td>
<td>B</td>
<td>Knife handle, rope, basket</td>
</tr>
<tr>
<td><em>C. collina</em> Linn.</td>
<td>Lee-phat</td>
<td>20–25</td>
<td>B</td>
<td>Craft items, wall-hangings</td>
</tr>
<tr>
<td><em>C. erectus</em> Roxb.</td>
<td>Lee-tangjaobi</td>
<td>30–40</td>
<td>B</td>
<td>Tender shoot edible; used for stomach ulcer and muscular sprain. Also used as spices</td>
</tr>
<tr>
<td><em>C. flagellum</em> Griff.</td>
<td>Lee-khet</td>
<td>15–20</td>
<td>B</td>
<td>Basket, rope</td>
</tr>
<tr>
<td><em>C. floribundus</em> Griff.</td>
<td>Lee-ree</td>
<td>20–30</td>
<td>A</td>
<td>Fruit edible and dyspepsiac, twine for house, polo stick and javelin, fruit used for religious purposes, electric lamp shades, shoot edible</td>
</tr>
<tr>
<td><em>C. guauda</em> Bach-Ham.</td>
<td>Lee</td>
<td>15–20</td>
<td>B</td>
<td>Craft items</td>
</tr>
<tr>
<td><em>C. inermis</em> T. Andersons.</td>
<td>Lee-nan</td>
<td>15–20</td>
<td>A</td>
<td>Craft items</td>
</tr>
<tr>
<td><em>C. latifolius</em> Roxb.</td>
<td>Lee-ren</td>
<td>15–25</td>
<td>A</td>
<td>Furniture, rope, walking stick, craft items, religious purposes, fruit edible, umbrella handle, hat, bows, tender shoot edible</td>
</tr>
<tr>
<td><em>C. leptospadix</em> Griff.</td>
<td>Yair-e-mabi</td>
<td>10–18</td>
<td>B</td>
<td>Furniture, fruit edible, tender leaf paste applied for poisonous bries</td>
</tr>
<tr>
<td><em>C. tenuis</em> Roxb.</td>
<td>Yai-ree</td>
<td>6–12</td>
<td>A</td>
<td>Furniture, rope, fruit edible, twine for house, necklace and ear ring, shoot edible</td>
</tr>
<tr>
<td><em>Daemonorops jenkinsianus</em> (Griff) Matt</td>
<td>Lee-phop</td>
<td>45–60</td>
<td>C</td>
<td>Craft items</td>
</tr>
<tr>
<td><em>Plectocomia bractealis</em> Becc.</td>
<td>Lee-phop</td>
<td>70–120</td>
<td>C</td>
<td>Craft items</td>
</tr>
</tbody>
</table>

### Table 3. Revenue (rupees) from major and minor forest products, including bamboo and rattans in Manipur

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Major products</td>
<td>6,065,600</td>
<td>15,560,500</td>
<td>14,517,800</td>
<td>738,400</td>
<td>2,496,600</td>
<td>1,820,700</td>
</tr>
<tr>
<td>Minor products</td>
<td>13,258,300</td>
<td>6,276,600</td>
<td>12,890,100</td>
<td>28,225,000</td>
<td>4,387,500</td>
<td>6,708,300</td>
</tr>
<tr>
<td>Bamboo and rattans</td>
<td>586,000</td>
<td>541,100</td>
<td>323,300</td>
<td>372,100</td>
<td>314,500</td>
<td>416,100</td>
</tr>
<tr>
<td>Rattans</td>
<td>2,755,800</td>
<td>84,500</td>
<td>40,200</td>
<td>117,600</td>
<td>78,800</td>
<td>39,600</td>
</tr>
<tr>
<td>Total (major and minor)</td>
<td>19,323,900</td>
<td>21,837,100</td>
<td>27,407,900</td>
<td>28,963,400</td>
<td>6,884,100</td>
<td>8,528,900</td>
</tr>
<tr>
<td>Per cent of bamboo and rattans to minor products</td>
<td>4.4</td>
<td>8.6</td>
<td>2.5</td>
<td>1.3</td>
<td>7.2</td>
<td>6.2</td>
</tr>
<tr>
<td>Per cent of rattans to minor products</td>
<td>2.1</td>
<td>1.3</td>
<td>0.3</td>
<td>0.4</td>
<td>1.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Per cent of rattans to total products</td>
<td>1.4</td>
<td>0.4</td>
<td>0.1</td>
<td>0.4</td>
<td>1.1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

### Table 4. Slope aspects of ratan-growing habitat (no. of villages surveyed = 28)

<table>
<thead>
<tr>
<th>Slope aspect</th>
<th>Village location</th>
<th>Per cent of slope aspect</th>
</tr>
</thead>
<tbody>
<tr>
<td>West</td>
<td>Hanglep, Nahgang, Nuphou, Keneeilong, Shaichang, Sating, Thanlon, Loutung, Saangpakhmum, Tallion, Leijangphai, Tongkham, Hangship, Phaiotong, Aibulon, Sunviek, Savaipai, Buaimai,Saungsang, Tuantung, Pangon, Dailon.</td>
<td>48.8</td>
</tr>
<tr>
<td>South</td>
<td>Loinhai, Lailong, Lungchang, Singawal, Palkhuang, Mongon.</td>
<td>13.3</td>
</tr>
<tr>
<td>North</td>
<td>Vatungbhang, Sunpi, Khajang, Kailham.</td>
<td>8.8</td>
</tr>
<tr>
<td>East</td>
<td>Molchoiching, Mungang Dou, Saangpakhmum, Tallion, Laijangphai, Phekjuan, Chinsuqam, Aibulon, Sungpelon, Dzialhain, Singal, Pangol, Buaimai</td>
<td>28.8</td>
</tr>
</tbody>
</table>

92 CURRENT SCIENCE, VOL. 87, NO. 1, 10 JULY 2004
fruit pulp of *C. floribundus* is edible and is a dyspepsiac (Figure 4 a). The tender shoots of *C. erectus*, *C. floribundus* and *C. latifolius* (Figure 4 b) are eaten as vegetable and also as a cure for stomach ulcer and muscular sprain (Table 2).

Because of high demand for rattan products worldwide and its collection from wild habitat, rapid deforestation and land-use/land-cover change, there exists a considerable threat to the survivability of most of the species of rattans. Kerala, famous for its cane-craft, is facing a serious problem as the state’s resources are dwindling. Presently, Kerala has only 13 species of *Calamus*, including the best-known Malabar cane, *C. rheedi*1. In peninsular Malaysia, about 35% of the rattan species is threatened2. The rapid deforestation and alteration of vegetation structure in South East Asia has also become a serious concern for rattan survival. Countries like Indonesia and Philippines have banned the export of raw rattans because of the growing requirements of the industry and a decline in the local supply. However, in Manipur such restrictions are not exercised till date and raw materials and products are sold in the open local market (Figures 4 and 5). Presently in Manipur, the rattan-growing areas are located in the interior forests of high inaccessibility like steep slopes where no proper transport facilities are available.

Driven by a commitment to develop Manipuri craft as vibrant and self-sustaining, the Craft Society of Manipur strives to promote it as a social, cultural and economic force of significance. It has designed and produced a variety of good-looking cane furniture for the international market (Figure 5 c). Rattans in Manipur grow mostly in the wild and therefore in situ conservation should be adopted. Other measures are systematic harvesting, ban on collection of tender shoots for edible purpose from the wild, germplasm collection and maintenance in Botanic Gardens that may help in further in-depth research and for educational purposes. Regeneration of cane in the natural habitat is poor. Local demand is unable to meet supply from the wild resources. This has resulted in the shrinkage of wild rattan resources and put the gene pool diversity under threat. There have been no attempts at large-scale cultivation of canes in Manipur, except for a few instances of planting them around the vicinity of Kamjong and Kasom Khullen villages (Figure 1). This practice should be encouraged and promoted through community participation. Shoot production began in Thailand in 1999 and at least 3000 hectares of plantation has been planted experimentally with rattans11.

Species of *Calamus* are dioecious12 and chances of pollination are limited while the habitat of the plant is disturbed. Agro-techniques and micropropagation of rattans are not well worked out. Pioneering work on cane micropropagation has been done in Philippines and Malaysia. Complete plantlet regeneration through consistently reproducible protocols has been reported for *C. manillensis*13, *C. manan*14 and *C. rotang*15. Before fully understanding the micro-propagation techniques for various species, conservation of rattans will be best achieved by protecting them in their natural habitat as well as by restricted harvesting. Simple and inexpensive methods of preserving harvested raw materials susceptible to pests, microbes and fungi is required. Cultivation of canes can be summarized as (i) through seeds by removing the fruit coat, washing in lukewarm water to clean the pulp completely, followed by soaking in cold water, which is changed daily for seven–ten days; (ii) shoot plantation method, which provides little or no harvest in the first year but later appears to offer high income almost year round. Once harvesting begins, shoot production is rapid with an yield of one shoot per plant per month on average, although this may be an over-estimate1 and the report has to be confirmed, and (iii) as most of the natural canes (around 50%) in Manipur are grown in west-sloping hills, it is likely to be more successful to cultivate the canes in these regions.

After clearing a forest plot for jhum cultivation for one to two years, the fallow land can be planted with cane when the rotation is allowed to be repeated in 5 to 15 years; the farmers will first harvest cane for substantial income and clear the plot again for a new crop16. In Manipur,

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**Figure 4.** a. A bunch of ripe fruits of *Calamus floribundus*. b. Edible tender shoots of *Calamus latifolius* sold in the local market.
2035 km² area (9.1% of the state’s total geographical area) is currently under jhum cultivation that can be planned and developed scientifically for a large-scale cultivation and production for canes. This will definitely decrease its extraction pressure and would generate significant employment opportunities for artisans, entrepreneurs and farmers of the state, thus revolutionizing the socio-economic status of the rural community.


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