Coastal vegetation—An underexplored source of anticancer drugs

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Received 21 April 2005; Accepted 24 November 2005

Abstract
Some plants found in coastal region have been discussed as possible source of anticancer drugs, based on traditional uses and preliminary scientific works. Further investigation for various other medicinal properties of coastal vegetation is required to explore these natural resources.

Keywords: Coastal plants, Anticancer drugs, Mangroves, Salt-marsh, Sand-dune.

IPC code; Int. cl.7 — A61K 35/78, A61P 35/00

Introduction

Being a dreadful human disease, cancer kills annually about 3500 per million population around the world. Constituting 47% of all cancers in the Indian sub-continent, oral cancer is a major cause of morbidity and mortality1. A large number of chemo-preventive agents are used to cure cancers, but they produce toxic side effects that prevent their extensive usage. Although more than 1500 anticancer drugs are in active development with over 500 of the drugs under clinical trials, there is an urgent need to develop much effective and less toxic therapies2. In India, there are only limited research studies on curing cancers using herbal extracts which are largely confined to tomato, garlic and neem. Such type of work on coastal plants is largely ignored.

Coastal vegetation is categorized into three major divisions — Mangroves, Salt-marshes and Sand-dunes based on occurrence and adaptations. The mangrove forests constitute mostly trees or shrubs, predominantly occurring in muddy soil substrates of inter-tidal areas, lagoons, estuaries and backwaters in tropical and sub-tropical countries. The salt-marshes are plant communities of grasses, herbs or shrubs, which grow in wet soil substrates that are alternately inundated and drained by tidal action. The sand-dune vegetation occupies dry sandy area of coast3. All the vegetation thrives under extreme coastal environment by virtue of synthesizing stress-induced metabolites belonging to chemical groups such as, steroids, triterpenoids, saponins, flavonoids, alkaloids and tannins4. These coastal plant-derived chemicals are mostly unexplored for anticancer property. Based on traditional knowledge and scientific works, we have identified 16 coastal plant species for their possible potential as sources of anticancer drugs (Table 1).

Traditional knowledge

Coastal vegetation has been traditionally used in fisher-folk medicine4,5. The mangrove species used to cure cancer and tumours are: Avicennia africana

P. Beauv., A. nitida. Jacq., Bruguiera exaristata Ding Hou, B. parviflora (Roxb.) Wight & Arn. ex Griff., and B. sexangula (Lour.) Poir. Other mangrove associated species which are known for anticancer treatments include Caesalpinia bonduc (Linn.) Roxb. emend. Dandy & Exell syn. C. bonducella (Linn.) Flem. and Pongamia pinnata Pierre. However, till date, these plant species have not been tested scientifically to validate their traditional medicinal uses.

Scientific reports

Government of India under ‘Drug from the sea’ programme have been making efforts to brought out (i) antiviral sphingosine from a green alga Ulva fasciata Delile and (ii) anti-vibrio compounds from marine bacteria and marine algae. However, there is no specific programme for the coastal vegetation. Only a few reports are available from our laboratory on the antiviral activities.

Our research team has been working on antiviral substances from coastal vegetation in the last 20 years. Coastal plant extracts have been tested against viruses that cause human and animal diseases, such as human immunodeficiency virus (HIV), Newcastle disease virus, Vaccinia virus, Semiliki
forest virus, Encephalomyocarditis virus, and Hepatitis-B-virus. A few of the mangrove plants belonging to family — Rhizophoraceae are most effective against the viruses tested. Bioactive compounds present in the mangrove plants are acid polysaccharides which composed of galactose, galactosamine, glucose and arabinose having potent anti-HIV activity. Further, lignins extracted from the mangroves significantly protect mice from lethal infection of Escherichia coli. This antibacterial activity is due to antioxidant property of the lignins. This property is believed to kill cancer cells.

Bark extract of Bruguiera sexangula, is active against two tumours, Sarcoma 180 and Lewis Lung Carcinoma. This activity is due to tannins, an unidentified alkaloid, tropine and its acetic acid ester (brugine) present in the extract (Fig. 1A). Ribose derivatives of benzoxazoline extracted from Acanthus ilicifolius Linn. is reported to be active against cancer.

A few other plants found in coastal region are also known for medicinal property. Pongamia pinnata is used as source of crude drug for treatment of tumours, piles, skin diseases, wounds, ulcers and these activities are related to flavonoids (chalcone) present in the plant (Fig. 1B). Pandanus odoratissimus Linn. f. is rich in phenols, lignins and a benzofuran derivative; and, these compounds exhibit antioxidant activity. Morinda citrifolia Linn. rich in polysaccharides shows anticancer and analgesic activities.

Coastal animal species form an excellent source of drugs. An ascidian (Ecteinascidia turbinata) that grows in the submerged aerial roots of

Fig.1 (A-C) : Anticancer Compounds from Coastal Plants
**Rhizophora mucronata** Linn. syn. *R. mangle* Roxb. produces compounds that show strong activity against a variety of carcinomas, melanomas, and lymphomas. The giant African snail fed on the leaves of a mangrove associated species, *Calophyllum inophyllum* Linn. has yielded inophyllums and calophyllolides (Fig. 1C). A xanthone derivative compound of the snail showed intensive inhibitory effect against topoisomerases I and II. The xanthones are claimed to be promising lead compounds for anticancer drugs¹⁹.

### Table 1: Coastal plants with anticancer activities

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Botanical and Family name</th>
<th>Anticancer reports</th>
<th>Chemical compounds identified</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Abrus precatorius</em> Linn. <em>Fabaceae</em></td>
<td>Anti-tumour activity against <em>Yoshida ascites</em> sarcoma</td>
<td>Methyl ester of N, N-dimethyl tryptophan metho-cation and picatorine</td>
<td>24, 25</td>
</tr>
<tr>
<td>2</td>
<td><em>Acanthus ilicifolius</em> Linn. <em>Acanthaceae</em></td>
<td>Active against cancer</td>
<td>Ribose derivatives of benzoxazoline</td>
<td>12-14</td>
</tr>
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<td>3</td>
<td><em>Alstonia macrophylla</em> Wall. ex A. DC. <em>Apocynaceae</em></td>
<td>Cytotoxic activities towards human cancer cell and antineoplastic activity</td>
<td>Polyphenols, protein, tannins</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td><em>Avicennia alba</em> Blume <em>Avicenniaceae</em></td>
<td>–</td>
<td>Naphthoquinolines and their analogue, named avicequinone A, B, C</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td><em>A. africana</em> P. Beauv.*</td>
<td>–</td>
<td>Naphthoquinones, Phytoalexins</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td><em>A. nitida</em> Jacq.*</td>
<td>–</td>
<td>–</td>
<td>4</td>
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<tr>
<td>7</td>
<td><em>Bruguiera exaristata</em> Ding Hou <em>Rhizophoraceae</em></td>
<td>–</td>
<td>Alkaloids, inositos</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td><em>B. parviflora</em> (Roxb.) Wight &amp; Arn. ex Griff.</td>
<td>–</td>
<td>Tannins, phenolic compounds</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td><em>B. sexangula</em> (Lour.) Poir.</td>
<td>–</td>
<td>Antitumour activity of bark extracts was associated with tannin-free aqueous residue containing an alkaloid, brugine as well as tropine and its acetic acid ester</td>
<td>10</td>
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<td>S.No.</td>
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<tr>
<td>10</td>
<td><em>Caesalpinia bonduc</em> (Linn.) Roxb. emend. Dandy &amp; Exell*&lt;sup&gt;1&lt;/sup&gt; <em>Caesalpiniaceae</em></td>
<td>–</td>
<td>Caesalpines</td>
<td>22</td>
</tr>
<tr>
<td>11</td>
<td><em>Calophyllum inophyllum</em> Linn. <em>Clusiaceae</em></td>
<td>Anticancer, antitumour, and lipid peroxidation</td>
<td>Xanthone, biflavonoids, benzophenones, neoflavanoids and coumarin derivatives</td>
<td>19, 21</td>
</tr>
<tr>
<td>12</td>
<td><em>Excoecaria agallocha</em> Linn. <em>Euphorbiaceae</em></td>
<td>Methanolic extracts showed antitumour activity based on three assays: (i) DPPH radical scavenging assay, (ii) linoleic acid oxidation assay, and (iii) Oxidative cell death assay.</td>
<td>Diterpenes exhibited remarkable antitumour promoting activity <em>in vivo</em> on a two-stage carcinogenesis test of mouse tumour</td>
<td>23</td>
</tr>
<tr>
<td>13</td>
<td><em>Morinda citrifolia</em> Linn. <em>Moraceae</em></td>
<td>Fruit juice has antitumour activity against syngenic LLC tumour and antineoplastic effects</td>
<td>Polysaccharide-rich substances in fruits</td>
<td>18</td>
</tr>
<tr>
<td>14</td>
<td><em>Pandanus odoratissimus</em> Linn. f. <em>Pandanaceae</em></td>
<td>Antioxidative activity</td>
<td>Phenolic and lignin compounds and a benzofuran derivative</td>
<td>17</td>
</tr>
<tr>
<td>15</td>
<td><em>Pongamia pinnata</em> Pierre*&lt;sup&gt;1&lt;/sup&gt; <em>Fabaceae</em></td>
<td>–</td>
<td>Flavonoid and related compounds, polyhydroxylated chalcones</td>
<td>15</td>
</tr>
<tr>
<td>16</td>
<td><em>Terminalia catappa</em> Linn. <em>Combretaceae</em></td>
<td>Methanolic extracts showed antitumour activity based on three assays: (i) DPPH radical scavenging assay, (ii) linoleic acid oxidation assay, and (iii) oxidative cell death assay.</td>
<td>Tannins</td>
<td>23</td>
</tr>
</tbody>
</table>

*Traditionally used for anticancer activity
– No scientific report
Conclusion

A broad based screening of a large number of organisms is necessary in order to identify anticancer compounds. This is because of the fact that only less than 2% of the organisms screened so far have shown anticancer activity\textsuperscript{20}. Our research team has done a pioneering work on the value of coastal floral species for their antiviral, antimicrobial and antioxidant properties. There is a great scope for deriving novel anticancer drugs from the coastal vegetation, which deserves a thorough investigation.

References


