Review on *Ruellia tuberosa* (Cracker plant)

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**INTRODUCTION**

*Ruellia tuberosa* Linn. belongs to family Acanthaceae, a native of Central America, introduced into Indian garden as ornament.[1] It is used medicinally in West Indies, Central America, Guiana and Peru.[2] *Ruellia tuberosa* has tuberous root to tide over dry season and an ingenious seed dispersal system that helps it spread. The ripe seed capsules of *Ruellia tuberosa* breaks open with force when drops of water fall on the capsule and seeds are dispersed away from the plant. This explosive behavior gave the plant local name in English ‘Cracker plant’.

**Taxonomical Profile**

- **Kingdom**: Plantae
- **Division**: Magnoliophyta
- **Class**: Magnoliopsida
- **Order**: Scrophulariales
- **Family**: Acanthaceae
- **Genus**: Ruellia
- **Species**: *Ruellia tuberosa*

**Synonyms**: *Ruellia picta, Ruellia clandestina*

**Common name**: Bluebell, Daniel’s great gun, large bell-flower, Minnie root, popping pod, sheep potato, snapdragon root, Duppy gun.[5]

**ABSTRACT**: *Ruellia tuberosa* Linn. (Acanthaceae), known as cracker plant is traditionally used as diuretic, anti-pyretic, analgesic, anti-hypertensive, anthelmintic, abortifacient, emetic, in bladder disease, kidney disorder, bronchitis, gonorrhoea and syphilis. Many phytoconstituents have been identified. It has been experimentally proved which possess anti-oxidant, anti-microbial, anti-cancer and gastroprotective activity and antiinociceptive and anti-inflammatory activity. Present review summarizes the traditional claims, phytochemistry and pharmacology of *Ruellia tuberosa* reported in scientific literature.

**Keywords**: Cracker plant, *Ruellia tuberosa*.

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**Vernacular names**

<table>
<thead>
<tr>
<th>Language</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hindi</td>
<td>Chatakani Phallis</td>
</tr>
<tr>
<td>Gujarati</td>
<td>Bandukadi</td>
</tr>
<tr>
<td>Tamil</td>
<td>Pottakanchi</td>
</tr>
<tr>
<td>French</td>
<td>Patate chandelier</td>
</tr>
<tr>
<td>English</td>
<td>Cracker plant</td>
</tr>
</tbody>
</table>

*Ruellia tuberosa* is an erect, sub-erect or diffuse perennial herb up to 60–70 cm tall herb with stout, 4-angled stems, swollen and purplish at the nodes, tender parts sparsely hairy. Roots are slender, elongated, fusiform tuberous and off white in colour. Leaves with up to 2 cm long petiole; lamina; oblong-obovate to oblanceolate, 5–9 x 2–4 cm, shining, basally cuneate to attenuate, entire to undulate, obtuse to somewhat acute. Flowers shortly pedicellate, blue-violet, showy, 5–5.5 cm long, solitary or in 1–3-flowered, terminal or axillary cymes; bracts and bracteoles linear-lanceolate, 5 mm long. Calyx lobes equal, linear, 1.3–2 cm long, ciliate, acute. Corolla pubescent outside, tube; 3.5 cm long, abruptly narrowed at base, limb 5–lobed, lobes equal, ovate, c. 1.5 cm long. Stamens with oblong-sagittate, c. 4 mm long, puberulous anthers. Ovary oblong, c. 4 mm long, glabrous; style 2.3–2.5 cm long. Capsule is subcylindrical, brownish black, 1.5 cm long, 24–28-seeded, minutely beaked at tip, seeds are flatten, orbicular; 2–2.5 mm in diameter. The plants are propagated by cutting tubes or through seeds produce in brownish black capsules explode on ripening and the seed disperse all around *Ruellia tuberosa* originates from tropical America, but is naturalized in Southeast Asia (Thailand, Peninsular Malaysia, Java) and elsewhere in the tropics (India, Sri Lanka, Africa), as an escape from cultivation and as an ornament.[6–13]

**Microscopical identification**

**Microscopy of Leaf:** It is a dorsiventral leaf.

**Lamina:** Upper epidermis and lower epidermis is single layered with polygonal cells covered outside with a thin walled cuticle having diacytic stomata, covering trichomes. Mesophyll is a differentiated into palisade and spongy parenchyma. Palisade tissue cells in two layers. Upper layered palisade cell larger than lower rows of palisade cell. Spongy parenchyma is a thin, 2 to 4 layers loosely arranged with intercellular space. Vascular strands are seen.

**Midrib:** Epidermal layers of lamina are in continuity with that of midrib. The dorsal surface of the midrib having central shallow depression and ventral surface is flat. A 2 to 4 layered collenchyma can be seen below the upper epidermis and above the lower epidermis. The rest of midrib is occupied by the cortical parenchyma with the are shaped collateral vascular bundle embedded in the middle.
**Microscopy of root**

Epidermis is a thin layer having thick walled epidermal cells and bearing dense root hairs. Hypodermis; Single layered immediately below the epidermis with thin walled cells. Cortex is wide, homogeneous with characteristic pattern of parenchyma cells, many layers having thick walled parenchymatous cells; they become smaller toward the periphery and smaller intercellular spaces. Brownish coloring matter present in cortex region. Cambium is formed external to the xylem mass. Vascular tissue; Phloem occupies larger area than xylem. Phloem seen around the xylem vessels. Xylem consists of vessels and lignified parenchyma. Pith consists of large parenchyma with intercellular spaces. Wide pith, within the vascular cylinder.

**Microscopy of stem**

T.S. of the stem is more or less circular. Following are the important tissues from the periphery to the centre.

Epidermis is single layered consisting of rectangular cells and shows the presence of thick cuticle. Cortex is heterogeneous having outer layers of colcheyma cells and inner layers of parenchyma cells wider than outer zone. Parenchyma cells are compactly arranged. A continuous zone of cambium occurs in between xylem and phloem. Vascular bundles; phloem elements are seen in small isolated groups around the xylem vessels. Xylem forms a continuous layer surround the pith, well developed, consists of tracheids and xylem parenchyma. Pith is large and is made of thin walled, big polygonal parenchyma with intercellular spaces.

**Physical constants of Ruellia tuberosa**

**TABLE: 1** Proximate analysis of leaf, root and stem of Ruellia tuberosa.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>*AVERAGE VALUES % w/w</th>
<th>LEAF</th>
<th>ROOT</th>
<th>STEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water soluble extractive value</td>
<td></td>
<td>28.0</td>
<td>19.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Alcohol soluble extractive value</td>
<td></td>
<td>13.5</td>
<td>33.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Total ash value</td>
<td></td>
<td>24.77</td>
<td>8.33</td>
<td>10.55</td>
</tr>
<tr>
<td>Water soluble ash value</td>
<td></td>
<td>8.0</td>
<td>3.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Acid insoluble ash value</td>
<td></td>
<td>11.5</td>
<td>5.3</td>
<td>0.48</td>
</tr>
<tr>
<td>Loss on drying</td>
<td></td>
<td>3</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>Foaming index</td>
<td></td>
<td>less than 100</td>
<td>less than 100</td>
<td>less than 100</td>
</tr>
</tbody>
</table>

*The values given here are expressed as percentage of air dried material. Each value is average of three determinations.*
Ethnobotanical uses

- In Siddha system of medicine, leaves are given with liquid copal as remedy for gonorrhoea and ear diseases.\textsuperscript{14} \textit{Ruellia tuberosa} used in stomach cancer.\textsuperscript{15-16}
- Dried and ground root in dose of two ounces cause abortion, also used in sore eyes.\textsuperscript{17}
- The herb also exhibits emetic activity and employed substitute of ipecac, also used in bladder stones and decoction of leaves used in treatment of Bronchitis.\textsuperscript{18}
- In Suriname’s traditional medicine system, it is used as an anthelmintic and also in management of joint pain and strained muscles. In folk medicine, it has been used as diuretic, anti-pyretic, anti-diabetic, antidotal, thirst-quenching agent, analgesic and anti-hypertensive activity.\textsuperscript{19-20}
- Paste of leaves applied on skin diseases, wounds, boils etc. Seeds employed in sexual debility, spermatorrhoea, leucorrhoea etc.\textsuperscript{21}
- Roots used for oestrous induction and as an anthelmintic.\textsuperscript{22}
- \textit{R. tuberosa} used as cooling in urinary problem, used in treatment of uterine fibroids.\textsuperscript{23-24}
- It has recently been incorporated as a component in an herbal drink in Taiwan.\textsuperscript{25}
- Whole plant is used to treat bladder diseases and frequent micturition; decoction with \textit{Petiveria alliacea} is drunk to “clean out” uterine tract (dilation and curettage) or as an abortifacient. Root infusion is used for kidney diseases; in a syrup for whooping cough; infusion or decoction for a diabetes remedy; tubers in a tea used for cleansing the blood. Root and leaf used in form of tea alleviates retention of urine and it is suggested as a remedy to weakness.\textsuperscript{26}
- Tuber powder (5–10gm) is given with milk for checking abdominal pain after delivery and stomach ache.\textsuperscript{27-28}

Phytochemistry

Flavonoids, steroids and triterpenoids: Chwan-Fwu Lin et al, isolated five flavonoids cirsimaritin (yellow prism; m.p. 255–256°C), cirsimarin (white prism; m.p. 158–160°C), cirsililol 4′-glucoside (yellow prisms; m.p. 214–216°C) sorbifolin (yellow solid; m.p. 274–275°C), and pedatin (yellow solid) along with betulin (white prisms; m.p. 255–256°C), vanillic acid (colorless solid; m.p. 212–213°C), and indole-3-carboxaldehyde (yellow solid) from the ethyl acetate extracts of \textit{Ruellia tuberosa}. Compounds cirsimarin and cirsililol 4′-glucoside showed cytotoxicity against KB cell line.\textsuperscript{29}

The leaves contained only traces of apigenin and luteolin, while flowers malvidin-3′,5′-diglucoside in appreciable quantity. The flowers buds contained the maximum proportion of flavonoids (3% apigenin-7-O-glucoronide and the other flavones were identified as apigenin 7-O-glucoside, apigenin-7-O-rutinoside and luteolin-7- O-glucoside.\textsuperscript{30} Seed oil yields myristic, capric and lauric acids.\textsuperscript{31}

The aerial part of \textit{Ruellia tuberosa} is reported to contain apigenin 7-β-D glucuronide\textsuperscript{32} and malvidin 3, 5-digitoxoside \textsuperscript{33} and some other natural products includes n-alkenes (C\textsubscript{11} –C\textsubscript{15}), esters and sterols– stigmasterol, B-sitosterol, campesterol, cholesterol.

A triterpenoid, 21-methylammonium-22-en-3β, 18, 27, triol reported from the aerial part of \textit{Ruellia tuberosa} (white crystal, m.p. 184–185°C).\textsuperscript{34}

The tubers of the plant are reported to contain n-alkanes, triterpenoids and phytosterols, lupeol. In which n-alkanes (C\textsubscript{23}-C\textsubscript{33}) with maximum occurrence of n-nonacosane (C\textsubscript{29}: 44.83%) and n-hentriacontane (26.52%), Sterol– stigmasterol, B-sitosterol, campesterol.\textsuperscript{35}

Alkaloid: Arun et al., isolated of Tylocrebrine, a phenanthrene alkaloid from aerial part of \textit{Ruellia tuberosa} through bioassay directed column chromatography and elucidating its anti-cancer and anti-inflammatory potential.\textsuperscript{36}

Pharmacological Activity

Antioxidant: The antioxidant activity of different extracts of stem of \textit{Ruellia tuberosa} L. was investigated by various \textit{In Vitro} methods like 2, 2-diphenyl-1- Picryl-hydrazyl (DPPH) free radical-scavenging assays and the hydrogen peroxide induced luminol chemiluminescence assay. The methanolic extract (ME) and its four fractions of water (WtF), ethyl acetate (EaF), chloroform (CfF), and n-hexane (HxF) were evaluated for antioxidant activity. The results of revealed that \textit{R. tuberosa} possesses potent antioxidant activity. The antioxidant activities of the different fractions tested decreased in the order of EaF > CfF > ME > WtF > HxF according to the hydrogen peroxide-induced luminol chemiluminescence assay, and results were the same with the exception of the rank order of HxF and WtF according to the DPPH free radical-scavenging assay. The results provide useful information on the pharmacological activities associated with free radicals of this traditional folk remedy.\textsuperscript{37}

Gastroprotective activity: Aqueous extract of \textit{R. tuberosa} roots showed a strong and dose-dependent gastro protective activity in alcohol induced gastric lesion model of rats (in terms of reduction in length
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The extract also had a mild erythropoietic and moderate analgesic activity and was well tolerated even with subchronic treatment.[38]

**Antimicrobial activity:** The antibacterial activities of hexane, dichloromethane, ethyl acetate and methanol extracted fractions of *R. tuberosa* were investigated against Gram positive and Gram negative bacteria. The ethyl acetate and methanol fractions exhibited the highest rates of antibacterial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa*.[39]

**Anticancer activity:** Methanol extract of aerial part of herb *R. tuberosa* possessed cytotoxicity. The minimum inhibitory concentration (IC₅₀) for methanol extract was found to be 3.5 and 1.9 μg/m l in H460 and MDA-MB231 cancer cells respectively. Tylocrebrine was isolated from *Ruellia tuberosa* through bioassay directed column chromatography and elucidating its anti-cancer and anti-inflammatory potential.[40]

**Antinociceptive and anti-inflammatory activity:** The ethanol extract of *R. tuberosa* L. was evaluated for

<table>
<thead>
<tr>
<th>NAME OF FLAVONOIDS</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
</tr>
</thead>
<tbody>
<tr>
<td>cirsimaritin</td>
<td>CH₃</td>
<td>CH₃</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>cirsimarin</td>
<td>CH₃</td>
<td>CH₃</td>
<td>H</td>
<td>Glc</td>
</tr>
<tr>
<td>cirsimarin 4′-glucoside</td>
<td>CH₃</td>
<td>CH₃</td>
<td>OH</td>
<td>Glc</td>
</tr>
<tr>
<td>sorbilin</td>
<td>H</td>
<td>CH₃</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>pedalitin</td>
<td>H</td>
<td>CH₃</td>
<td>OH</td>
<td>H</td>
</tr>
</tbody>
</table>

**FIGURE 5:** Chemical constituents of *R. tuberosa*.
its antinociceptive and anti-inflammatory properties in experimental mice and/or rat models. In the hot-plate test, the group that received a dose of 300 mg/kg showed maximum time needed for the response against thermal stimuli and maximum possible analgesia was similar to that of diclofenac sodium. The extract at 500 and 250 mg/kg doses showed significant reduction in acetic acid-induced writhing in mice, which was similar to diclofenac sodium. The extract also demonstrated significant inhibition in serotonin and egg albumin-induced hind paw edema in rats at the doses 100, 200 and 300 mg/kg. The anti-inflammatory properties exhibited by the extract were comparable to that of indomethacin at a dose of 5 mg/kg.\[41\]

**CONCLUSION**

Herbal medicine is the oldest form of healthcare known to mankind. Herbs had been used by all cultures throughout history. It was an integral part of the development of modern civilization. *Ruellia tuberosa* has been used traditionally in the treatment of various ailments. The literature review showed that the presence of alkaloid, flavonoids and phenolic compounds in various parts of the plant. The pharmacological review suggested that *Ruellia tuberosa* (cracker plant) has reported antioxidant, gastroprotective, antinociceptive, anti-inflammatory, antimicrobial, and anticancer. Further pharmacological and phytochemical exploration is required for systematic investigation of this plant.

**REFERENCES**

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