Luffa echinata Roxb.—A review on its ethanomedicinal, phytochemical and pharmacological perspective

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ABSTRACT

Luffa echinata Roxb. (Cucurbitaceae) is a spreading climbing herb of tremendous medicinal importance, distributed throughout Pakistan, India, Bangladesh and Northern Tropical Africa. Traditionally various parts of the plant are being used for the treatment of different ailments such as jaundice, intestinal colic, enlargement of liver and spleen, leprosy, diabetes, bronchitis, nephritis, rheumatism, cirrhosis, dropsy, anthelmintic, stomach ache, snake bite, dog bite, fever, diarrhea and hemorrhoid disorder. The plant also possesses antioxidant, analgesic, anti-inflammatory, antidepressant, anxiolytic, antiepileptic, hepatoprotective, antibacterial, antifungal, antiallergic and anticancer activity. Research has been carried out using different techniques to support most of these claims. This review is an attempt to compile an up-to-date data on its ethanomedicinal, phytochemical and pharmacological perspective.

KEYWORDS

Luffa echinata, Cucurbitaceae, Cucurbitacin, Chrysirol, Hepatoprotective

1. Introduction

Ayurveda is the most ancient traditional system of medicine in India with sound philosophical, experiential and experimental basis, which is used to treat the human disease[1]. Due to increased side effects, high cost of new drugs, lack of curative treatment at root level and development of new disease, people not only in developing countries but also in developed countries rely on herbal medicines[2]. India has 2.4% of world’s area with 8% of global biodiversity; more than 1.5 million practitioners are using herbs or herbal formulations based on 25 000 medicinally important plants, for the effective management and treatment of human diseases[3]. Though scientific studies have been carried out by scientists on many Indian botanicals, but still numerous drugs have entered the international market through the exploration of ethanopharmacology and traditional medicine[4].

Luffa echinata (L. echinata) belongs to family Cucurbitaceae which includes about 130 different genera and about 800 species of medicinally important plants[5,6]. Few plants from this family posses ribosomal inactivation proteins (such as MAP30, Luffin A and B) and triterpenes with immunomodulator, antiretroviral, anti-HIV activities besides other pharmacological action such as antidiabetic, antihyperlipidemic, anticancer and free
radical scavenging[7]. The genus *Luffa* comprises more than eight species, three of which are found in India viz. *Luffa acutangula* Roxb., *Luffa aegytiaca* Mill. and *L. echinata* Roxb[8]. *L. echinata* is a spreading climber herb, with bifid bristly or smooth tendrils and extremely bitter taste, grows widely in Pakistan, India, Bangladesh and Northern Tropical Africa. In India, it is mainly found in Gujarat, Bihar, Rajasthan and Madhya Pradesh. It is known by various names viz. English: Bristly Luffa; Sanskrit: Koshataki; and in Hindi: Bindaal, Bidali, Kukurlata, Ghagerbel. Infusion of the fruit is given orally in biliary and intestinal colic while applied to the body in case of putrid fever. Roots of the plant are used for the treatment of bronchitis, piles, jaundice, vaginal discharge, laxative and analgesic. Apart from that, entire herb is used as stoma in Hindi: Bindaal, Bidali, Kukurlata, Ghagerbel. Infusion of the fruit is given orally in biliary and intestinal colic while seeds have anthelmintic activity[17]. Therefore, an attempt has been made to compile the data of pharmacological perspective.

2. Ethnomedical uses

2.1. Traditional uses

*L. echinata* is a well known ethnomedical plant used in Ayurveda. Its uses in the Indian traditional medicine are well documented. The uses of different parts of *L. echinata* in traditional system of medicine are given in Table 1.

2.2. Alternative and complementary medicinal uses

Among various species of *Luffa*, *L. echinata* is used extensively throughout the world. Its polyherbal formulation containing *Acacia catechu*, *Andrographis paniculata*, *Azadirachta indica*, *Boerhavia diffusa*, *Curcuma longa*, *Eclipta elba*, *Emblica officinalis*, *Picrorrhiza kurroa* and *Phyllanthus amarus* showed significant (*P*<0.05) prophylactic and curative effect against carbon tetrachloride (CCl4) and paracetamol induced hepatic damage[27]. *L. echinata* fruits have been incorporated in Hepia-10, a polyherbal hepatoprotective formulation[28].

3. Morphology of *L. echinata*

3.1. Fruits

Fruits are ashy, oblong, ovoid having 2–5 cm length and densely covered with 4–7 mm long bristles. Seeds are ovate, black 4–5 mm long, 3–5 mm broad and 2 mm thick[9,10].

3.2. Stems

Stem pieces are slender, yellowish–brown to blackish–brown in color, longitudinally furrowed, glabrous, measuring 1.5–1.7 cm in length and 5–8 mm diameter[20].

3.3. Flowers

Flowers are white, stalked, about 2.5 cm wide. Male flowers are borne in 5–12 flowered raceme having length up to 15 cm long. Sepal tube is about 5.6 mm long and hairy. Sepals are lance shaped while petals are ovate, 1.0–1.2 cm long, blunt and hairy at the base[20].

Table 1

<table>
<thead>
<tr>
<th>Part</th>
<th>Disease/ Uses</th>
<th>Method of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits and stems</td>
<td>Biliary and intestinal colic, jaundice, fever enlarged liver or spleen, cirrhosis, ascites</td>
<td>Tincture (1 in 20) or hot/cold infusion (10–20 mins) taken internally or applied externally to the body[10]. Fruits are used as snuff for the treatment of jaundice in Garwhal hills in Uttar Pradesh[18].</td>
</tr>
<tr>
<td>Fruits</td>
<td>Diabetes</td>
<td>Fruits are crushed into a fine powder and one teaspoon full of it is given with water twice a day to a diabetic patient[19,20].</td>
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<tr>
<td></td>
<td>Diabetic</td>
<td>Hot infusion (1 in 80) in a dose of 1–2 ounce three times in a day has powerful effect against dropsy. In combination with nitrohydrochloric acid acts as potent diuretic[10].</td>
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<td></td>
<td>Purgative</td>
<td>Decoction of fruits has been used as enema for the elimination of toxins[21,22].</td>
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<tr>
<td></td>
<td>Anestrus</td>
<td>Fruits has been given to animals along with thick rota (flat bread) twice a day for 7–8 d[23].</td>
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<td></td>
<td>Dog bite</td>
<td>Fine powder of mature fruits with ‘Bael’ (<em>Aegle marmelos</em>) leaves and Betle (<em>Piper betle</em>) leaves is given in case of dog bite once a week for three weeks[19].</td>
</tr>
<tr>
<td>Root</td>
<td>Hemorrhoid</td>
<td>Mature sponge of fruit is soaked in a glass of water for 5–10 min and squeezed properly. The extract obtained is given to dog bite victim in the morning with empty stomach[24].</td>
</tr>
<tr>
<td>Leprosy</td>
<td></td>
<td>Roots powder is given orally daily in the morning[25].</td>
</tr>
<tr>
<td>Leaves</td>
<td>Blood Purifier</td>
<td>Root paste fried in mustard oil is applied externally on body surface[26].</td>
</tr>
<tr>
<td></td>
<td>Rheumatism</td>
<td>Juice of the fresh leaves[19].</td>
</tr>
<tr>
<td></td>
<td>Fever</td>
<td>Decoction is applied externally to treat rheumatism[26].</td>
</tr>
</tbody>
</table>

Table 1: Ethnomedical uses of different parts of *L. echinata*. 

*L. echinata* is a well known ethanomedicinal plant used in Ayurveda. Its uses in the Indian traditional medicine are well documented. The uses of different parts of *L. echinata* in traditional system of medicine are given in Table 1.
3.4. Leaves

Leaves are kidney-shaped, round, shallowly or deeply 5-lobed. Tip is rounded or rarely pointed, bristly on both surfaces, margin is minutely toothed and leaf stalk is stout, bristly, up to 12 cm long[10].

4. Phytochemistry of L. echinata

Phytochemical analysis of aerial parts of L. echinata revealed the presence of alkaloid, glycoside, carbohydrate, proteins and flavonoids in ethanolic extract; while that of the roots revealed sterols, triterpenes, reducing sugars, glycosides, flavones and tannins[30,31].


Two other flavonoids, luteolin–7–glucoside and chrysoeriol–7–glucoside have been isolated from flowers and leaves of L. echinata. Chemical structures of these compounds have been confirmed by comparing the Rf values of these compounds with standards such as luteolin, chrysoeriol, apigenin, etc.

5. Pharmacological activities of L. echinata

5.1. Antioxidant activity

Free radical scavenging activity of hydro alcoholic (50:50) extract of L. echinata fruits has been evaluated using in vitro methods viz. 1, 1-diphenyl–2-pircyl hydrayl free radical (DPPH), hydroxyl radical and inhibition of lipid peroxidation effect. Extract showed concentration dependent activity and maximum protection was found at 1000 µg/mL which was 84.05%, 73.07% and 59.83% respectively[12]. In another study, free radical scavenging effect of hydro–methanolic (20:80) extract of fruits has been evaluated using different in vitro methods viz. DPPH, ORAC and TEAC. IC50 value was found to be 188.00±0.87 µg/mL, 253.7 µmol TE/g and 0.34 mmol/g respectively. It is suggested that free radical scavenging activity and inhibition of lipid peroxidation might be due to presence of flavonoids[38].

Free radical scavenging effect of methanolic extract of

![Chemical structures of phytoconstituents present in various parts of L. echinata Roxb.](image)

Figure 1. Chemical structures of phytoconstituents present in various parts of L. echinata Roxb.

<table>
<thead>
<tr>
<th>Parts of plants</th>
<th>Phytoconstituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>Luteolin–7–glucoside, Chrysoeriol–7–glucoside[36]</td>
</tr>
<tr>
<td>Fruit</td>
<td>Luteolin–7–glucoside, chrysoeriol–7–glucoside[38]</td>
</tr>
<tr>
<td>Flowers</td>
<td>Luteolin–7–glucoside, chrysoeriol–7–glucoside[38]</td>
</tr>
<tr>
<td>Seeds</td>
<td>Cucurbitacin–B, triterpene, fatty acid, saponin containing oleanolic acid as sapogenin[14,29]</td>
</tr>
</tbody>
</table>
5.2. Analgesic and anti-inflammatory activity

Methanolic extract (50, 100, 200 mg/kg, p.o.) of \textit{L. echinata} seeds has been evaluated for analgesic and anti-inflammatory activity. Analgesic effect has been evaluated by eddy’s hot plate and tail immersion methods using diclofenac sodium (10 mg/kg, p.o.) as standard. Treatment with extract showed significant \(P<0.05\) dose dependent increase in basal reaction time i.e. licking response (7.47, 7.75 and 8.31 seconds) or tail flicking (10.13, 11.70 and 15.17 seconds) as compared to normal control (3.39 and 3.55 seconds) as well as positive control (9.45 and 17.10 seconds) respectively. Anti-inflammatory effect has been evaluated by using carrageenan (0.1% w/v, 1 mL/kg) and extent of oedema was measured by plethysmograph as positive response. Treatment with extract showed significant \(P<0.05\) dose dependent decrease in paw oedema (60.57%) induced by carrageenan as compared to normal control and positive control (70.16%)\cite{13}.  

5.3. Antidepressant, anxiolytic and antiepileptic activity

Methanolic extract of \textit{L. echinata} (200 mg/kg, p.o.) fruits was evaluated for antidepressant, anxiolytic and antiepileptic activities. Antidepressant and anxiolytic effects were evaluated by behavior model viz. open field and elevated plus maze using diazepam (2 mg/kg, p.o.) as control. Treatment with extract significantly \(P<0.05\) reduced number of square crossed and number of rearing (antidepressant activity) while simultaneously increased the time spent in open arm (anxiolytic activity) as compared to control. Antiepileptic activity was evaluated using maximal electric shock model with phenytoin (25 mg/kg, p.o.) as a control. Treatment with the extract significantly \(P<0.05\) reduced extension, stupor and total recovery as compared to control\cite{40}.  

5.4. Antiulcer activity

Ethanolic extract of defatted aerial parts of \textit{L. echinata} (200 and 400 mg/kg, p.o.) showed significant protection \(P<0.001\) against pylorus ligation and diclofenac sodium induced gastric ulcer using ranitidine (20 mg/kg) as standard drug. The protection was found dose dependent in both models\cite{41}.  

5.5. Antibacterial and antifungal activity

\textit{L. echinata} fruits extract (dichloromethane:methanol; 1:1 v/v) has been evaluated for antibacterial and antifungal effect against number of microorganism by agar dilution streak method using ciprofloxacin (3 µg/mL) and amphotericin B (3 µg/mL) as positive control. At a dose of 500 µg/mL, extract showed complete inhibition of \textit{Bordetella bronchiseptica}, \textit{Streptococcus faecalis} and partial inhibition of \textit{Staphylococcus aureus} while a dose of 1000 µg/mL showed complete inhibition of \textit{Micrococcus luteus}, \textit{Staphylococcus aureus} and partial inhibition of \textit{Bacillus subtilis} and \textit{Aspergillus niger}. It did not show any effect on \textit{Bacillus cereus} var. mycoides, \textit{Bacillus pumilus}, \textit{Staphylococcus epidermidis}, \textit{Escherichia coli}, \textit{Klebsiella pneumonia}, \textit{Pseudomonas aeruginosa}, \textit{Candida albicans}, \textit{Saccharomyces cerevisiae} and \textit{Aspergillus niger}\cite{42}.  

5.6. Hepatoprotective activity

Prophylactic and curative effect of ether extract (cucurbitacin and elaterine–2–glycoside, 3 mg/kg, p.o.) and alcoholic extract (chrysoisol and β–chrysoeriol–7–aploglucoside, 10 mg/kg, p.o.) of \textit{L. echinata} have been evaluated against CCl\textsubscript{4} (0.25 mL/100 g, s.c.) induced liver damage in rats. Histopathological examination revealed that ether extract has more protective effect than ethanolic extract\cite{43}. \textit{L. echinata} fruits have been successively extracted with petroleum ether, acetone and methanol by cold percolation method and evaluated for protective effect at a dose of 250 mg/kg against CCl\textsubscript{4} (1:1 olive oil, 1 mL/kg, s.c.) induced liver damage using silymarin (10 mg/kg, p.o.) as positive control. Treatment with extracts significantly decreased serum glutamic oxalacetic transaminase, serum glutamic pyruvate transaminase, alkaline phosphatase, total protein and total albumin induced by CCl\textsubscript{4}. All the extracts contain some active principles (triterpenes); responsible for hepatoprotective activity\cite{34–46}. Methanolic extract of \textit{L. echinata} fruits (50, 100, 200, 400 and 800 µg/mL) did not show any significant effect on human hepatocellular liver carcinoma cell (HepG2)\cite{47}.  

In another study, acetone extract (250 mg/kg, p.o.) of \textit{L. echinata} root was evaluated for protective effect against CCl\textsubscript{4} (1:1 olive oil, 3 mL/kg, s.c.) induced liver damage using silymarin (25 mg/kg, p.o.) as standard. Treatment with the extract causes significant \(P<0.05\) decrease in serum enzyme level induced by CCl\textsubscript{4}. Histopathological examination of rat liver also supports the protecting effect of root extract. It is suggested that the protecting effect of roots might be due to the existence of flavonoids, tannins, steroids and terpenoids\cite{31}.  

5.7. Anti cancer effect

Methanolic extract of \textit{L. echinata} fruits (50, 100 and 200 µg/mL) has been evaluated for \textit{in vitro} anti-proliferative effect on human colon cancer cell (HT29). Cell viability was determined at 6, 12, 24, 48 and 72 h using MTT assay. Extract showed dose and time dependent significant \(P<0.05, IC_{50}: 80.6\) µg/mL inhibition of HT29 cell proliferation. It is suggested that anti-proliferative effect was shown by inducing apoptotic cell death which caused cell arrest in G2/S phase. It also promoted reactive oxygen species generation (65.85%), loss of mitochondrial membrane integrity and increased the ratio of
apoptotic genes (Bcl–2 and Bax)[47].

6. Conclusion

Although herbal medicines have been used for thousands of years in human health care, but the safety of herbs is a myth. Number of people experience negative or adverse effects of these drugs due to various reasons including insufficient procedure for cultivation and collection, lack of quality assurance and control in manufacturing, inadequate practices to study the drug safety, and concomitant administration of the medicine from different systems[48]. Increased use of herbal therapies demands scientifically sound evidence for principles behind therapies and for effectiveness of medicine[49]. Progress in genomics and proteomics has opened a new gateway in therapeutics and drug discovery. This development has also helped in better understanding of human genomes and scientific variation in human beings[3]. Traditional Indian system of medicine can be benefited enormously by selective amalgamation of traditional Indian system of medicine with modern science and modern medicine[50]. Basic research programmes need to develop comprehensive policies regarding legislation, regulation, quality control and safety regulation[51]. Without all these measures, it is impossible to realize the dream to become “a global leader in herbal drug industry” despite having golden mines of well documented and well practiced traditional herbal medicines. L. echinata appears to have a broad spectrum of activity on several ailments. Various parts of the plant have been explored for antioxidant, analgesic, anti-inflammatory, antidepressant, anxiolytic, antiepileptic, hepatoprotective, antibacterial, antifungal, antiulcer and anticancer activity. Ethanomedicinal uses and pharmacological studies reported in this review confirm the therapeutic value of L. echinata. However, very less information is available regarding the clinical toxicity and phytoanalytical properties of this plant. Several phytochemical studies have been reported but still for better insight of phytochemical analysis, modern tools are required. Availability of information on ethanomedicinal uses, active phytochemicals present and pharmacological perspectives will help to explore it on scientific basis as well as to establish and validate the quality and practice of this herbal medicine in current scenario.

Conflict of interest statement

We declare that we have no conflict of interest.

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References


