

**Review Article**

**THE WONDERS OF A MEDICINAL TREE: *HOLOPTELEA INTEGRIFOLIA* (ROXB.) PLANCH**

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**ABSTRACT**

In this busy era of herbal sciences, extensive study is being carried out on numerous plants to find novel drugs among which *Holoptelea integrifolia* Roxb. (Indian Elm) tree is just one of them. The age old knowledge ethnopharmacological significance, especially the stem, bark and leaves is well recognized in several Siddha, Ayurvedic, Unani literature. The plant parts are extensively used for its astringent, anti-inflammatory, digestive, carminative, laxative, depurative and diuretic properties. This plant is bestowed with a plethora of curative principles, namely antiviral, antimicrobial, antifungal, anti-arthritis, antioxidant, wound healing, anti-helminthic, anti-diabetic, anti-diarrheal, antiulcer, antitumor, adaptogenic, analgesic, hepatoprotective, larvicidal activities. Phytochemical investigation confirms the presence of signature chemical constituents such as terpenoids, alkaloids, glycosides, carbohydrates, steroids, sterols, saponins, tannins, proteins and flavonoids. The recent discovery of antibacterial nature of callus promises the discovery of callus derived novel antibiotics and unique drugs. The present review sheds light on current research trends in *Holoptelea integrifolia* with a serious look at its diverse ethnomedicinal uses as well as its prospect.

**Keywords:** *Holoptelea integrifolia*, Ethnomedicinal property, Anti-inflammatory, Antioxidant, Anti-adherent, Anti-biofilm

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**INTRODUCTION**

Plant-derived drugs are used as medicines for treating various diseases for decades. Today we still dependant on "Ayurveda" in about 75% of our medicines. The increasing prevalence of multi-drug resistant strains of the bacteria and the recent appearance of Ebola, Swine Flu, Bird Flu, HIV II and new strains with low susceptibility to antibiotics raises the specter of the untreatable bacterial infections and add urgency to the search for new infection-fighting strategies. Herbal medicines have recently drawn much attention as an alternative source of useful drugs for treating or preventing various diseases. *Holoptelea integrifolia* is a roadside tree possessing a wide range of biological activities. This medicinal plant is enriched with a variety of phytochemicals, which are widely applicable in curing diverse ailment in human and animals.

The plant species originated from Pacific Island [1]. It is distributed in temperate and tropical areas of northern hemispheres. In India, it is found in the outer Himalayan region up to 2000ft. It is a large deciduous tree with a height up to 30-35m. The bark is gray, exploiting in somewhat corky scales. Leaves alternate, elliptic-ovate, 5-13 cm long, acuminate, entire, sub-coreaceous pinnately veined. Flowers are greenish-yellow, usually male or hermaphrodite, monochlamydeous or rarely polygamous and flowering usually takes place in the month of January to February.

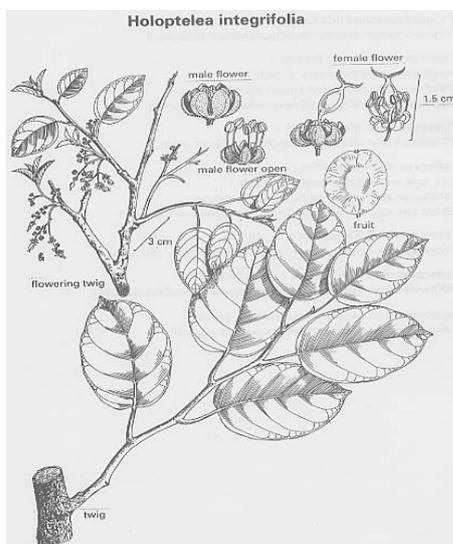
Fruits are sub orbicular samara with membranous wings and one small kidney shaped seed, usually seen during the month of April to May [2]. The review is based on the scientific articles published up to February 2016. The content of this review has been adopted from archiving services like Science Direct, Springer, Pubmed, Scopus, Elsevier. We also searched Google Scholar, EMBASE by using following keywords: phytochemicals, ayurvedic, antioxidant, antibacterial, antifungal, anti-arthritis, anti-convulsant, anti-cancer, wound healing.

**Phytochemical constituents**

The plant has been reported to possess various chemical constituents. Different plant parts like stem bark, heartwood, leaf, seed, pollen, root are the major sources of various medicinally important phytochemicals. Holoptelin-A and B [3, 4], 2-amino naphthoquinone, friedlin, epifriedlin,  $\beta$ -sitosterol,  $\beta$ -D-glucose,  $\beta$ -amyryn, betulin and betulonic acid are derived from stem bark [5]. 2,3-dihydroxyolean-12-en-28 oic acid, hederagenin are isolated from the heart wood [6] while hexacosanol, octacosanol, 1,4-naphthalenidione,  $\alpha$ -amyryn [7] and a newly invented phytosterol 17-(6-diethylamino) decan-3-yl)-10, 13-dimethyl-12, 13-dihydro-10H-cyclopenta[a] phenanthren-3-ol has been isolated from leaf [8]. Seeds are the major sources of fatty acids like palmitic acid, myristic, stearic, linoleic, linolenic acid and steroids like stigmasterol,  $\alpha$  and  $\beta$ -sitosterol,  $\beta$ -amyryn, friedel-1-en-3-one, lupeol,  $\beta$ -sitosterol-D-glucoside [9]. Histamine, 5-hydroxy tryptamine are derived from pollen grains [5]. 24-ethyl-cholest-22-en-3 $\alpha$ -ol is derived from roots [10].

**Ethnomedicinal uses**

The plant parts are harvested by tribal people for their curative properties. A list of ancient ayurvedic uses of plants parts has been given below:



**Fig. 1: A twig of *Holoptelea integrifolia* showing significant different plant parts. Courtesy:**

[http://www.ibin.gov.in/ibin/components/com\\_ibin/species\\_html/Holoptelea%20integrifolia3/Holoptelea%20integrifolia.htm#Taxonomic Details](http://www.ibin.gov.in/ibin/components/com_ibin/species_html/Holoptelea%20integrifolia3/Holoptelea%20integrifolia.htm#Taxonomic%20Details)

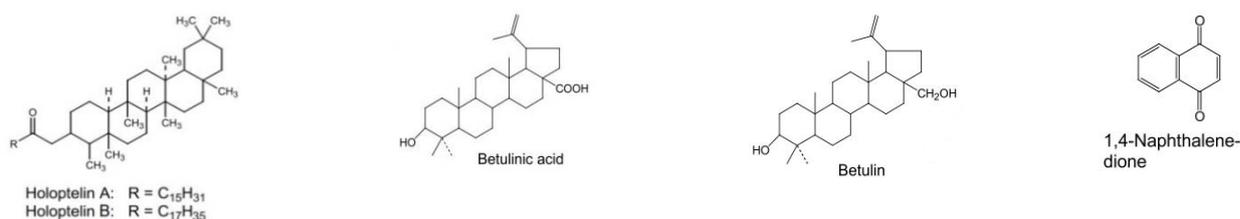


Fig. 2: Chemical structure of few metabolites. Courtesy: <http://dx.doi.org/10.1155/2014/401213>

Table 1: Ethnomedicinal profile of *Holoptelea integrifolia*

| Part used | Mode of application  | Disease  | Tribe/Area  | Reference                              |      |
|-----------|--|--|---|--|------|
| Bark      | Pest, used externally  | Headache   | Kharia  | [11]                                   |      |
|           | Powder   | Common fever, Herpes simplex infection,  | Sub-himalayan tract up to 1000m                           | [12]                                   |      |
|           | Juice of boiled bark   | Weakness, Inflammation of lymph glands, ringworm, scabies,                                   | Tharu, Bhoxa village of Udham Singh Nagar, Deharadun      | [13]                                   |      |
|           | Pounded and tied over the knee joint   | Chronic wound  | Bhil, Pawar, Vanjari, Tadavi, of Jalgaon                  | [14]                                   |      |
|           | Cut and tied on the arm  | Rheumatism   | Bayar, Bind, Charo, Kol, Musahar, Gond                    | [15]                                   |      |
|           | Bark is pounded with root of <i>Capparis zeyanica</i> , <i>Dichrostachys cinerea</i> and mixed with black pepper juice | Eczema   | Bayar, Bind, Charo, Kol, Musahar, Gond                    | [16]                                   |      |
|           |  | Joint Pain   | Koya  | [17]                                   |      |
|           |  | Malaria  | Koya  | [18]                                   |      |
|           |  | Facial Paralysis   | Tharu, Bhoxa village of Udham Singh Nagar, Deharadun      | [18]                                   |      |
|           | Leaf   | Pest   | Leucoderma  | Gond                                   | [20] |
|           |  | And decoction is made with root of <i>Plumabgo zeylanica</i> , fruit of <i>Carica papaya</i> | Inflammation  | Koya                                   | [21] |
|           |  | Boiled in water and given water bath   | Wound cleaner   | Koya                                   | [22] |
|           |  | Young leaf cut and tied on backbone  | Tumor, Alopecia   | Koya                                   | [23] |
|           |  | Decoction of leaf  | Termination of pregnancy                                  | Bayar, Bind, Charo, Kol, Musahar, Gond | [23] |
| Juice     |  | Leprosy, Inflammation, Skin disease, Scorpion sting  | Naugarh   | [24]                                   |      |
|           |  | Rickets  | Sub Himalayan tract up to 1000mt, Kol                     | [25]                                   |      |
|           |  | Ringworm, Eczema, Cutaneous disease  | Koya  | [26]                                   |      |
|           |  | Uncontrolled bleeding  |   |  |      |
|           |  | Nasal drop   |   |  |      |
| Fruit     | Dried  | Polyurea and other urinary problems  | Sub Himalayan forest of northeastern U. P                 | [27]                                   |      |
|           | Seeds are externally applied in the form of poultice on injured part   | Brain tonic and general debility   | Sub Himalayan tract                                       | [27]                                   |      |
|           | Seeds are crushed in water and given thrice a day  | Uncontrolled bleeding and Quick healing  | Up to 1000mt, Kol, Bayar, Bind, Charo, Kol, Musahar, Gond | [26]                                   |      |
|           |  | Diarrhea   |   | [21]                                   |      |
|           |  |  |   |  |      |

### Biological activity

Advantageous or adverse effects of any drug on living substances are known as its biological activity. Biological activity of a drug determines its uses in medicinal application. Activity is generally dose depended. *Holoptelea integrifolia* also possesses such biologically active compounds that lead this tree as a very popular ethnomedicinal plant since 'Ayurvedic' era. Incessant efforts of scientists and researchers, from decades, are able to reveal various biological activities as well as active principles of this plant. Such findings are based upon its ethnomedicinal properties which create a connection between ancient Ayurveda and modern medical science and technology.

### Anti inflammatory activity

Inflammation is an immuno-vascular response against detrimental stimuli. Anti-inflammatory is the property of a substance which reduces inflammation or swelling. Aqueous (@ 500 mg/kg) [28], ethanolic (@ 250, 500 mg/kg) [29] and methanolic (@ 100, 500 mg/kg) [30] leaf extract of *H. integrifolia* showed a significant inhibition of paw oedema formation in carrageenan-induced paw oedema test. It suggests the usefulness of the leaves of this tree in treating acute and chronic inflammations. It is recently reported that methanolic extract of fruit also possesses anti-inflammatory activity [31].

### Antibacterial activity

An antibacterial is a substance that destroys bacteria or inhibits their growth. The chloroform extract of stem bark [32] and leaves

[33] of *H. integrifolia* was found to be highly effective against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Citobacter freundii*, *Micrococcus luteus*, *P. aeruginosa* *P. fluorescens* respectively at diverse range of concentration. The diethyl ether extract (4 µg/ml) of leaves has revealed the maximum microbiocidal activity against β-lactam resistant strain and the active principle is found to be 1, 4-naphthalenedione which is characterized by GC-MS and FTIR spectroscopy [34]. Joshi et. al, 2013; demonstrated antibacterial and anti-tubercular activity of this plant against different Gram-positive and Gram-negative bacterial strain and *M. tuberculosis* H37RV strain [35].

### Antiviral activity

Antiviral substance either destroys a virus or represses its ability to replicate. Betulinic acid and betulin, isolated from the stem bark of *Holoptelea integrifolia* are responsible for antiviral properties against Herpes simplex type1, influenza FPV/Rostock and ECHO 6 viruses. Betulinic acid exerts potential inhibition on HIV-1 entry and HIV-protease or of reverse transcriptase activity [36].

### Antifungal activity

An antifungal drug refers to the chemical agent that is lethal to fungi or suppresses their reproduction or growth; effective against fungal infection. *Holoptelea integrifolia* has a broad anti-fungal effect [37]. Methanolic extract (MIC-152.2-1250 µg/ml) [37], petroleum ether extract (MIC-200 ppm) [38], ethylacetate leaf extract (MIC-39-625

µg/ml) [39] of *H. integrifolia* were examined for antifungal activity and found to be effective against *Candida tropicalis*, *Candida krusei*, *Candida albicans*, *Aspergillus niger*, *Saccharomyces cerevisiae*, *Alternaria* sp; *Colletotrichum capsici* and *Aspergillus parasiticus*, *Aspergillus nidulans*, *Trichoderma harzianum* respectively, using the agar well diffusion method and minimal inhibition concentration method. Methanolic extract of the stem also shows a promising antifungal effect against above mentioned fungal strain at a range of concentration (39-625 µg/ml) [37].

#### Antihelmintic activity

The drug that expels parasitic worms (helminths) from the body is an antihelmintic agent. The methanolic extract (@ 80 mg/ml) and aqueous extracts (@ 10, 20, 50 and 100 mg/ml) of stem bark of *H. integrifolia* were found to possess significant antihelmintic activity against *Pheretima posthuma* by showing shortest time of paralysis and death [40]. In the same manner, ethanolic extract of stem bark at 100 mg/ml was found to be lethal against *Eisenia foetida* worm [41].

#### Antioxidant activity

The oxidation is an essential process for the biological systems. However, uncontrolled oxidation can cause oxidative damage to DNA, proteins, lipids and oxidative stress related various diseases. Antioxidants are substances that can prevent or delay such oxidative damages caused by the ROS. The *in vitro* antioxidant activity of ethanolic stem bark extract [42], and methanolic [38] as well as aqueous [43] extract of stem bark of *H. integrifolia* were evaluated in various method like Ferric thiocyanate (FTC), Thiobarbituric acid (TBA) method and by measuring inhibition activity of DPPH, nitric oxide, superoxide radicle and its reducing power ability assay respectively. Interestingly, there is a relationship in between the total phenolic compound and the neutralizing free radical, quenching singlet, triplet oxygen to terminate the radical chain reaction and acting as an antioxidant. The antioxidant activity of petroleum ether extract (PEHI) at doses of 20-200 mg/ml and methanolic extract (MHI) of leaves at doses of 20-100 mg/ml) was evaluated using hydroxyl radical scavenging activity and total reduction capability models where PEHI is found to be more potent antioxidant than that of MHI [44].

#### Anticancer activity

Cancer is uncontrolled cell growth with loss of differentiation and potentiality of metastasis. Anticancer or anti-neoplastic, drugs are used to treat malignancies. Ethanolic extract of the leaves of *H. integrifolia* extract at concentrations of 250, 500 mg/kg could prolong the lifespan, restored hematological parameters, restored the mean survival time, decrease tumor volume count in treated mice in dose-dependent manner [45]. The ethanolic extract of bark of administrated orally at doses of 250, 500 mg/kg body weight showed significant ( $P < 0.05$ ,  $0.01$ ) dose-dependent inhibition of breast cancer formation [46]. Another experiment showed that the hexane and ethyl acetate extract of bark had significant cytotoxic effects on breast and prostate cancer cells. Hexane extract was selective over approx 2-fold more active against prostate cancer cells, 2.5-folds on colon cancer cells and 5-folds in breast cancer cells [47].

#### Antiulcer activity

Peptic ulcer disease (PUD) is associated with a rupture in the lining of the stomach, first part of the small intestine, or occasionally the lower esophagus. It has been reported that methanolic leaf extract of *H. integrifolia* at 500 mg/kg per oral dose, significantly ( $P < 0.01$ ) reduced the ulcer in rats [48].

#### Antidiabetic activity

Diabetes mellitus is a group of metabolic disorder which is due to either insufficient insulin production or the inefficiency of cells in responding properly to insulin and thereby causing high blood sugar levels over a prolonged period. The study of the antidiabetic effect of *H. integrifolia* leaves extract indicated that ethanolic, chloroform, aqueous extract had significant ( $P < 0.01$ ) antidiabetic activity in acute and prolong treatment on rat [49]. In another experiment, methanolic extract (at 200 mg/kg) and petroleum ether extract (at

100, 200 mg/kg) of leaves both showed significant antidiabetic activity [50]. Recently, it has been revealed that 5% aqueous extract (@ 300 mg/kg), petroleum ether extract (@ 100, 200 mg/kg) of stem bark also exert antidiabetic effect on blood glucose level, body weight and lipid profile at dose dependent manner [51].

#### Antidiarrheal activity

Diarrhea is the condition of abnormal liquid bowel movements each day, leading to dehydration. The most common cause is an intestinal infection due to a virus, bacteria, or parasite. The ethanolic leaf extract of *H. integrifolia* at doses of 250, 500 mg/kg showed significant ( $P < 0.01$  in both cases) antidiarrheal activity in experimental diarrhea induced by castor oil (0.5 ml) and magnesium sulphate (2 mg/kg) in mice. The extract also reduces the intestinal transit ( $P < 0.01$ ) in charcoal meal test in mice [52].

#### Wound healing activity

Wound healing is a complex tissue repairing mechanism of damage skin or tissue after trauma. The methanolic extracts of both stem bark and leaves at a concentration of 50 mg/550 mm<sup>2</sup> of wound area were found to possess wound healing potential on albino rats in incision and excision wound model (>90% wound healing recorded) [37].

#### Adaptogenic activity

Adaptogens are a new class of metabolic regulators which increases the assists any organism to adapt to its environmental factors. The ethanolic extract of stem bark of *H. integrifolia* revealed adaptogenic activity at doses of 250 and 500 mg/kg on albino Wistar rats. This effect is due to the presence of tannins, saponins, alkaloids, flavonoids, in the stem bark [53].

#### Analgesic activity

An analgesic or painkiller refers to any drug used to relieve pain. Ethanol extract of *H. integrifolia* leaf at a dose of 500 mg/kg per oral exhibits significant ( $P < 0.05$ ) analgesic activity while ethyl acetate extract showed moderate activity. Aqueous and n-butanol extract of the plant showed mild analgesic effects. The maximum effect was shown at 150 min, after consuming the drug [54].

#### Hypolipidemic activity

Hypolipidemic agents are lipid-lowering drugs, used in treating hyperlipidemia. The methanolic extract of leaf and bark of *H. integrifolia* exert hypolipidemic effect by markedly lowering body weight, serum lipid, HMGR activity and apo-B as well as increasing high-density-lipoprotein-cholesterol and apo-A1 concentration. The faecal analysis indicates the ability of the extract to prevent intestinal fat absorption. Extract possesses a compound 3-(7-ethoxy-4-methyl-2-oxo-2H-chromen-3-yl) propanoate (Cl) which might have inhibited HMGR activity, thus blocked intestinal fat absorption [55].

#### Hepatoprotective activity

Hepatotoxicity implies chemical mediated liver damage. Hepatoprotection is the ability to prevent damages to the liver. Methanolic leaf extract of *H. integrifolia* at a dose of 500 mg/kg against CCl<sub>4</sub> induced hepatotoxicity on rats altered the levels of serum marker enzymes Alanine Transaminase (ALT), Aspartate Transaminase (AST), Alkaline Phosphatase (ALP) and Total Bilirubin (TB). These observations were supported by histopathological changes such as steatosis (fatty change, fatty degeneration or adipose degeneration), inflammatory infiltrations and perivascular fibrosis [56].

#### Antiemetic activity

An antiemetic is a drug that prevents vomiting and nausea. Ethnolic leaf extract of *H. integrifolia* at doses of 250, 500 mg/kg shows the promising effect on cisplatin-induced nausea on rat [57].

#### Larvicidal activity

A larvicide is an insecticide that kills the larval stage of an insect. Acetone extract of leaves of *H. integrifolia* at various concentrations,

revealed the effect on larval mortality of *Culex vishnui* after 24, 48, 72h exposures. The study showed the significantly higher mortality rate ( $P < 0.05$ ) of all larval instars at 0.5% concentration. The highest mortality was observed at 400 ppm concentration and 72h exposure of acetone extract [58].

#### CNS depressant activity

CNS depression refers to physiological depression of the central nervous system owing to decreased breathing rate, heart rate, and loss of consciousness leading to coma or death. Methanolic leaf extract of *H. integrifolia* at a daily dose of 250 mg/kg revealed the Central Nervous System (CNS) depressant activity in Swiss albino mice by reducing exploratory behavior pattern and muscle relaxant of those animals in head dip test and traction test respectively [59].

#### Anti arthritic activity

Rheumatoid arthritis is an autoimmune disease, affecting the synovial joints and leads to joint destruction. The anti-arthritic activity of petroleum ether and methanolic leaf extract of *H. integrifolia* was evaluated by measuring paw volume displacement, radiographic analysis and secondary lesions changes as a mark of antiarthritic activity in Complete Freund's Adjuven (CFA) model of rat. Petroleum ether extract at doses of 100, 300 mg/kg was found to be more effective than methanolic extract [60].

#### Anticonvulsant activity

Anticonvulsants are the group of drugs that retard the rapid and excessive neurological disorder during seizures. The petroleum ether extract (at doses of 100, 300 mg/kg) and methanolic extract (300 mg/kg) of leaf delayed onset of convulsion and also prolonged the onset of tonic convulsion in mice. The result supports the ethnomedicinal application of the plant as an anticonvulsant agent [61].

#### Antiadherence and antibiofilm activity

Bacterial biofilm is a bacterial cell community, enclosed by the polymeric matrix and adherent to an inert or living surface. Thereby protects growth and allows survival in a hostile environment. Aqueous, methanol extracts both at a concentration of 15-30 mg/ml and acetone leaf extract at 15 mg/ml of this tree exert promising anti-adherent and anti-biofilm activity against *Staphylococcus aureus* biofilm formation [62].

#### Novel area of research

*Holoptelea integrifolia* shows a new dimension on controlling over metabolic syndrome by ameliorating a number of biomarker molecules associated with diseased state. According to Adult Treatment Panel III of the National Cholesterol Education Program in 2001 five criteria viz. abdominal obesity, impaired fasting glucose, high triglycerides (TG), low HDL-cholesterol (HDL-C) concentration and increased blood pressure had been included in metabolic syndrome. Metabolic Syndrome is diagnosed if any three of these criteria are found in an individual. 60% methanolic leaf extract of *Holoptelea integrifolia* exert up and down regulation of biomarker proteins in 3T3-L1 adipocytes in a dose dependent manner. Several phytochemicals like trigonelline, myo-inositol, piperidine-2-carboxylic acid, uracil, adenine, frideline and  $\alpha$ -amyrine have been isolated and characterized from different plant parts. These phytochemicals are assumed to be the active principles responsible for such regulation and can be used alone or optionally combined with nutraceutical, pharmaceutical or dietetically acceptable carrier molecules for preventing diseases associated with metabolic syndrome [63].

#### CONCLUSION

Recent research findings of the forest trees of Indian subcontinent indicate that few of these species (*Shorea robusta*, *Buchanania lanzan*, *Terminalia arjuna*, *Azardirchata indica*, *Saraca asoca*, *Santalum album*, *Terminalia chebula*) really hold promise to become rich source rare phytomedicines. *Holoptelea integrifolia* is such a tree with a plethora of biologically active compounds which need to be isolated and clinically correlated for their unknown medicinal

properties. In this review, we have tried to portray an updated account of *Holoptelea integrifolia* with emphasis on its phytomedicines and their clinical studies. As of now, thorough and critical research is being conducted globally to discover novel drugs from unexplored plants, especially from the tropics and sub-tropics. With recurrence of virulent pathogens and their new aggressive mutants, such unique drugs could be the answer to dreadful diseases like malaria, Ebola, flues, AIDS and cancer.

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#### CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding this publication.

#### REFERENCES

- Singh A. Exotic floristic diversity of Varanasi district of Uttar Pradesh, India. *Indian J Plant Sci* 2012;1:73-85.
- Padmaja V, Srisailam K, Reddy VM. Pharmacognostic and preliminary phytochemical investigations on *Holoptelea integrifolia*. *Pharmacogn J* 2009;1:71-4.
- Rastogi PR, Melhotra BM. Compendium of Indian Medicinal Plants. New Delhi National Institute of Science Communication; 1985-89. p. 375-83.
- Mondal DN, Barik BR, Dey AK, Patra A, Kundu AB. Holoptelin A and B, two new triterpenoid fatty acids esters from *Holoptelea integrifolia*. *Indian Drugs* 1993;31:69-72.
- Ahmed M, Rizwani GH, Mohammed EV, Mahmood I, Ahmed VU, Mahmud S. A Triterpenoid Antioxidant Agents found in *Holoptelea integrifolia* (Roxb) Planch. *Int J Pharm Chem Biol Sci* 2013;3:63-7.
- Misra G, Bhatnagar SC, Nigam SK. 2a, 3a-Dihydroxyolean-12-en-28-oic acid from *Holoptelea integrifolia* heartwood. *Planta Med* 1975;27:290-7.
- Misra G, Bhatnagar SC, Nigam SK. Constituents of *Holoptelea integrifolia* heartwood. *Planta Med* 1977;31:232-4.
- Sutar RC, Kasture SB, Kalaichelvan VK. Isolation and identification of a new phytosterol from *Holoptelea integrifolia* (Roxb) planch leaves. *Int J Pharm Pharm Sci* 2014;6:354-7.
- Biswas KM, Mallik H. Chemical investigation of *Holoptelea integrifolia* and *Cassia fistula*. *J Indian Chem Soc* 1986;63:448-9.
- Jain R, Alam S, Jain S. 24-ethyl-cholest-22-en-3 alpha-ol and other constituents from the roots of *Holoptelea integrifolia*. *Indian J Chem* 1998;37:190-1.
- Mishra DK, Somanta G, Mishra TK. Ethnomedicine of tribe Kharia of Midnapore district, West Bengal. *Ethnobotany in South Asia*. JK Mahalakshmi. Ed. Scientific Publishers, Jodhpur, India; 1996.
- Singh VK, Ali ZA. Folk medicines in primary health care: common plants used for the treatment of fevers in India. *Fitoterapia* 1994;65:68-74.
- Parinitham M, Harish GU, Vivek NC, Mahesh T, Shivanna MB. Ethnobotanical wealth of Bhadra wild life sanctuary in Karnataka. *Indian J Traditional Knowledge* 2004;3:37-50.
- Kare MA, Dhabe AS, Bhuktar AS. Studies on crude drug Bark-*Holoptelea integrifolia* (Roxb.) Planch *J Exp Sci* 2011;2:9-11.
- Pawar S, Patil DA. Ethnomedicinal uses of barks in Jalgaon district. *Indian J Nat Prod Resour* 2007;6:341-6.
- Nandkani KM. *Indian Materia Medica*, Popular Prakashan Pvt. Ltd, Mumbai, India; 1976. p. 652.
- Harsha VH, Hebbar SS, Shripathi V, GR Hegde. Ethnomedicobotany of Uttara Kannada district in Karnataka, India plants in treatment of skin diseases. *J Ethnopharmacol* 2003;84:37-40.
- Bhuvad Sushama B, Nishteswar K. Ayurvedic and ethnobotanical perspective of chirabilva (*Holoptelea integrifolia* Planch). *Int Ayurvedic Med J* 2013;1:1-8.
- Mahishi P, Srinivasa BH, Shivanna MB. Medicinal plant wealth of local communities in some villages in Shimoga district of Karnataka, India. *J Ethnopharma* 2005;98:307-12.

20. Singh H. Medicinal plants and their local uses in sub-himalayan tract of uttaranchal. Medicinal Plants: Ethnobotanical Approach. Agrobios. Ed. PC Trivedi. Jodhpur, India; 2006.
21. Khanna KK, Mudgal V, Shukla G, Shrivastav PK. Unreported ethnomedicinal uses of plants from Mirzapurdistrict, Uttar Pradesh. Ethnobot in South Asia. JK Mahalakshmi. Ed. Scientific Publishers, Jodhpur, India; 1996.
22. Sharma V, Hem K, Mishra A, Murya SK. Time tested remedies for wound care from Ayurveda science. Innov J Ayurvedic Sci 2016;4:9-11.
23. Koppula Hemadri. A Treatise on Tribal Medicine. Koppula Hemadri's House of Tribal Medicine, Vijayawada; 2011. p. 2, 4, 11, 13-4, 27, 35-7, 42, 44-5.
24. Singh KK, Prakash A. Observation on ethnobotany of Kol tribe of Varanasi district, Uttar Pradesh. Ethnobot in South Asia. JK Mahalakshmi. Ed. Scientific Publishers, Jodhpur, India; 1996.
25. Benjamin JKP, Christopher PKS. Preliminary phytochemical and pharmacognostic studies of *Holoptelea integrifolia* Roxb. Ethnobotanical Leaflets 2009;13:1222-31.
26. Beg MJ, Beg MZ, Ali SJ. Ethnomedicinal studies on sub-himalayan forest of North Eastern Uttar Pradesh. Medicinal Plants: Ethnobot Approach. Agrobios. Ed. PC Trivedi. Jodhpur, India; 2006.
27. Khare CP. Indian Medicinal Plants an illustrated Dictionary. Spinger Science; 2007. p. 313.
28. Sharma S, Lakshmi K, Patidar A, Chaudhary A, Dhaker S. Studies on anti-inflammatory effect of aqueous extract of leaves of *Holoptelea integrifolia* Planch. in rats. Indian J Pharm 2009;41:87-8.
29. Kalpana, Upadhyay A. Anti-inflammatory evaluation of ethanolic extract of leaves of *Holoptelea integrifolia* planch. Scholars Res Library 2010;1:185-95.
30. Sharma S, Rai V, Kapoor B, Sarkar Bapi Rai. Phytochemical screening and evaluation of anti-inflammatory activity of leaves extract of *Holoptelea integrifolia* (Roxb). Int J Res Pharm Sci 2011;1:76-87.
31. Affan Z, Ghazala H Rizwani, Zahid H. Anti-nociceptive and anti-inflammatory activities of *Holoptelea integrifolia* (Roxb). Planch fruit extract on laboratory animals. Afr J Pharm Pharmacol 2015;9:886-92.
32. Padmaa P, Durga N. Antibacterial activity of different extracts of stem bark of *Holoptelea integrifolia*. Int Res J Pharm 2011;2:111-3.
33. Ahmad S, Sharma R, Mahajan S, Agnihotri R, Gupta A. Antibacterial evaluation and preliminary phytochemical analysis of the leaf extract of *Holoptelea integrifolia*. J Pharm Res 2012;5:3823-5.
34. Vinod NV, Haridas M, Sadasivan C. Isolation of 1,4-naphthalenedione, an antibacterial principle from the leaves of *Holoptelea integrifolia* and its activity against  $\beta$ -lactame resistant *Staphylococcus aureus*. Indian J Biochem Biophy 2010;47:53-5.
35. Joshi SD, Hallikeri CS, Kulkarni VH. Evaluation of antibacterial and antitubercular activities of *Holoptelea integrifolia* (Roxb) Planch bark. Univ J Pharm 2013;2:87-90.
36. Rajbhandari M, Wegner U, Julich M, Schopke T, Mentel T. Screening of nepalese medicinal plants for antiviral activity. J Ethnopharmacol 2001;74:251-5.
37. Reddy BS, Reddy RKK, Naidu VGM. Evaluation of antimicrobial, antioxidant and wound-healing potentials of *Holoptelea integrifolia*. J Ethnopharmacol 2008;115:249-56.
38. Sahoo KK, Yadav VK, Saxena AR. Antifungal properties of *Holoptelea integrifolia* (Roxb.) Planch. Ann Plant Protection Sci 2010;18:438-42.
39. Ishnava KB, Chauhan KH, Bhatt CA. Screening of antifungal activity of various plant leaves extracts from Indian plants. Arch Phytopathol Plant Prot 2012;45:152-60.
40. Nadella N, Paarakh PM. Evaluation of anthelmintic activity of *Holoptelea integrifolia* (Roxb.) planch. Int J Res Ayurveda Pharm 2011;1:637-41.
41. Kaur S, Kumar B, Puri S, Tiwari P, Divakar K. Comparative study of anthelmintic activity of aqueous and ethanolic extract of bark of *Holoptelea integrifolia*. Int J Drug Dev Res 2010;2:758-63.
42. Saraswathy A, Nandini DS, Ramasamy D. Antioxidant, heavy metals and elemental analysis of *Holoptelea integrifolia* Planch. Indian J Pharm Sci 2008;70:683-6.
43. Srivastava J, Dwivedi KN, Pandey HP. Antioxidant activity of methanolic extract from stem bark of the *Holoptelea integrifolia* planch. Int J Pharm Sci Rev Res 2014;24:104-9.
44. Sutar RC, Kalaichelvan VK. Evaluation of antioxidant activity of leaf extract of *Holoptelea integrifolia* (Roxb) Planch. Int J Appl Pharm 2014;6:6-8.
45. Lakshmi KS, Sharma SS, Rajesh T, Chitra V. Antitumour activity of ethanolic extract of leaves of *Holoptelea integrifolia* on Dalton's ascitic lymphoma in Swiss albino mice. Int J Green Pharm 2010;4:44-7.
46. Soujanya J, Silambuajanaki P, Leela Krishna V. Anticancer efficacy of *Holoptelea integrifolia*, planch. against 7, 12-dimethyl benz(a)anthracene induced breast carcinoma in experimental rats. Int J Pharm Pharm Sci 2011;3:103-6.
47. Guo H, Wang DS, Rizwani GH. Antineoplastic activity of *Holoptelea integrifolia* (Roxb.) planch bark extracts (*in vitro*). Pak J Pharm Sci 2013;26:1151-6.
48. Hemamalini K, Suvidha S, Bhargav A, Vasireddy U. Evaluation of anti-ulcer activity of methanolic extracts of *Kigelia africana*, *Sophara interrupta* and *Holoptelea integrifolia* leaves in experimental rats. Int J Curr Pharm Res 2012;4:61-6.
49. Mamatha MK. Phytochemical investigation and antidiabetic activity of *Holoptelea integrifolia* planch [M. S. thesis], KLE University, Karnataka, India; 2009.
50. Sharma S, Khatri P, Pandey A, Jakheta V, Chaturvedi L, Dwivedi N. Anti-diabetic screening of leaves extract of *Holoptelea integrifolia* roxb. Int J Pharm Res Dev 2010;2:66-71.
51. Sharma J, Sharma SC, Sarangdevot YS, Vyas B. Study of antidiabetic activity of the stem bark extract of *Holoptelea integrifolia* (Roxb.). Res J Pharmacol Pharm 2012;4:181-4.
52. Shrinivas S, Lakshmi KS, Rajesh T. Evaluation of anti-diarrhoeal potentials of ethanolic extract of leaves of *Holoptelea integrifolia* in mice model. Int J Pharm Res 2009;1:832-6.
53. Kumar B, Puri S, Debnath J, Salhan M, kaur M, Mittal A. Comparative pharmacological evaluation of adaptogenic activity of *Holoptelea integrifolia* and *Withania somnifera*. Int J Drug Dev Res 2011;3:84-98.
54. Rizwani GH, Mahmud S, Shareef H, Perveen R, Ahmed M. Analgesic activity of various extracts of *Holopteleaintegrifolia* (Roxb) planch leaves. Pak J Pharm Sci 2012;25:629-32.
55. Subhash AK, Augustine A. Hypolipidaemic effects of methanolic extract of *Holoptelea integrifolia* (Roxb.) planchon bark in diet-induced obese rats. Appl Biochem Biotechnol 2013;169:546-53.
56. Hemamalini K, Sathya SB. Hepatoprotective activity of *Sophara interrupta* and *Holoptelea integrifolia* against carbon-tetrachloride induced hepatotoxicity in rats. Int J Biol Pharm Allied Sci 2013;2:80-9.
57. Shrinivas S, Ravindra K, Aradhana M, Kailash B. Ethanolic leaf extract of *Holoptelea integrifolia* Planch decreases cisplatin-induced pica in rats. J Pharmacogn 2008;7:293-7.
58. Singha S, Adhikari U, Ghosh A, Chandra G. Mosquito larvicidal potentiality of *Holoptelea integrifolia* leaf extract against Japanese Encephalitis Vector, *Culex vishuni*. J Mosque Res 2012;2:25-31.
59. Hemamalini K, Soujanya LG, Vasireedy U, Pavani P. CNS activity of the methanolic leaf extracts of *Sophora interrupta* Bedd, *Kigelia pinnata* Dc, *Holoptelea integrifolia* plants in experimental animal models. Int J Pharm Technol 2011;3:3785-91.
60. Sutar RC, Kasture SB, Kalaichelvan VK. Screening of leaf extracts of *Holoptelea integrifolia* (Roxb.) planch for its antiarthritic activity in experimental animals. Int J Pharm Res 2014;6:1526-32.
61. Sutar RC, Kasture SB, Kalaichelvan VK. Evaluation of anticonvulsant activity of leaf extract of *Holoptelea integrifolia* (Roxb) planch in experimental animals. Int J Pharm Pharm Sci 2014;6:308-11.

62. Shah K, Burange P, Singh S. Phytochemical, antimicrobial and anti adherent analysis of plant and ayurvedic extract. *Int J Appl Biol Pharm Technol* 2015;6:72-9.
63. Gokaraju RR, Ranga Raju Gokaraju VK, Golakoti T, Bhupathiraju K, Chirravuri VR, Chillara S. Agents derived from *Holoptelea integrifolia* for the control of metabolic

syndrome and associated disease. Publication no: US20120231095; 2010.

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