IJPSR (2020), Volume 11, Issue 2 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 23 April 2019; received in revised form, 08 August 2019; accepted, 01 September 2019; published 01 February 2020

COMPREHENSIVE ETHNOPHARMACOLOGICAL REVIEW OF *RUDANTI* (*CAPPARIS MOONII* WIGHT)

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Keywords:

Rudanti, *Capparis moonii*, Insulinomimetic, Anti-bacterial, Anti-ulcer, Hepato protective

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Abstract: *Capparis moonii* wight is a large woody climber or shrub (locally known as *Rudanti*) having Rasayana (rejuvenating) actions and it is being used in respiratory diseases like cough, bronchial asthma and pulmonary tuberculosis by ayurvedic physicians. It is one of the drugs which have references for its use from centuries but still not much explored in this contemporary era. The review aims to provide a critical and comprehensive evaluation, from the ancient times to our days, of the ethnological, botanical, chemical and pharmacological aspects of *Capparis moonii*, with a vision for promoting further pharmaceutical research to explore its complete potential as a therapeutic agent. This study was performed by reviewing in extensive details the studies on historical significance and ethnopharmacological applications of *Capparis moonii* by using classical ayurvedic texts, international scientific databases, books, *etc*. In addition, the plant taxonomy was validated using certified databases such as Medicinal Plant Names Services (MPNS) and the plant list. A detailed comparative analysis of the available sources for *Capparis moonii* wight confirmed that fruits of *Capparis moonii* are absolutely safe with rich source of biologically active components like rutin and quercitin with no toxicity. It has hepatoprotective, insulinomimetic, anti-ulcer, anti-bacterial and anti-fungal activities. Moreover immunomodulatory and antioxidant properties make it highly beneficial to use this herb in under nutrition and emaciating patients. We believe that this review will help lay the foundation for promoting exhaustive clinical studies to validate its reported activities.

INTRODUCTION: Herbal medicines have a strong traditional and conceptual base and the potential to be useful as drugs in terms of safety and efficacy leads to treating different diseases.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.11(2).556-62

The article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.11(2).556-62

World Health Organization has made an attempt to identify all medicinal plants used globally and listed more than 20,000 species [1].

In the present era of drug development and discovery of newer drug molecules many plant products are evaluated on the basis of their traditional uses. Still, there are many herbs which are time tested and have references for its use from centuries but still not much explored in this contemporary era. *Rudanti* is such a drug which has Rasayana (antioxidant and rejuvenating) properties

and it is being used in respiratory diseases like cough, bronchial asthma and pulmonary tuberculosis by ayurvedic physicians. There is controversy regarding the genuine source of *Rudanti*, primarily four different plant species which are taken as botanical source. P. V. Sharma accepts *Capparis moonii* as a source plant for *Rudanti* [2], whereas Vaidya Bapa Lal accepts *Cressa cretica* as *Rudanti* [3]. In market dried fruits of *Capparis moonii* are being sold by the name of *Rudanti*. In this article comprehensive review of *Capparis moonii* as a source plant of *Rudanti* is being done covering its various domains.

Approach to Systematic Review: A detailed review was done from the major ayurvedic classical texts and nighantus (Ayurvedic materia medica) and online literature search was performed on PubMed, Web of Science, Google Scholar and Embase databases for the keywords of *Rudanti*, *Capparis moonii*, with a time limit of papers published from 1950 up to Feb 2019 in accordance to PRISMA guidelines. Phytochemical studies, *In-vitro in-vivo* analysis, experimental trials, clinical studies as well as articles related to its controversy in botanical source were included in the review to search out the different therapeutic potential of Ayurveda herb. Only research articles published in English language were considered. Total 10 articles were selected for review.

Classical References: The drug *Rudanti* is not mentioned in Vedas and brihattrayi (three major texts of Ayurveda Charaka Samhita, Sushruta Samhita, and ashtanga hridya samhita). The earliest reference of *Rudanti* was found in shodhala nighantu as vriddhapalitake [4]. In sharanga samhita *Rudanti* is mentioned as a Rasayana dravya and in its commentary, Adhamala described it as a vegetable (shaka dravya) and it is famous in western region [5]. Later a detailed description was described in raja nighantu [6]. Sravattoya (Dripping of water or any liquid), sanjeevani (which might be either a magical plant or impart infinite life to others, life giving), amritsrava (from which elixir drips or gives life to other plants through its secretion), romachika (species of small shrub or thrilling with joy or terror), mahamansi (deep root system), chanakpatri (leaves resembling that of chickpea), sudhasrava (secretion of sudha-beverage of god, nectar, good drink).

Rudanti is also mentioned in shankara nighantu, shaligrama nighantu and adarsha nighantu. All these nighantu's transcript references are from Raja nighantu. There is another reference found in Raja Nighantu in a group of panchsiddhaaushadi dravyas in mishrakadi varga [7]. Rudanti is also important in Ras Shastra preparations (mineral formulations). *Rudanti* is mentioned to have best parada bandhan and Abhraka jaran properties. It was taken as a constituent and also as Bhavna Dravya in many medicinal preparations like Trailokyevijaya rasa (Thailam), Kushthadi rasayan, *etc*. Also, came in reference to Ratnadruti. *Rudanti* was used by saints in alchemy i.e. preparing gold from Parad [8].

Controversy Related to Rudanti: There is controversy related to its correct identity. Today four species of plants are taken as the source of *Rudanti- Cressa cretica*, *Capparis moonii*, astragalus species, and cicer species. In Uttarakhand botanical source of Rudanti is primarily taken as *Astragalus candolleanus*. In states like Gujarat and Rajasthan especially in the region of Kachchh, *Cressa cretica* is taken as source plant of *Rudanti*. Vaidya Bapalal has accepted *Cressa cretica* as a source plant of *Rudanti*, whereas P. V. Sharma has accepted *Capparis moonii* instead of *Cressa cretica* as a botanical source of *Rudanti*. In market fruits of *Capparis moonii* are sold under the name *Rudanti* and same is used by the ayurvedic physicians for treating respiratory ailments.

Geographical Distribution: *Capparis moonii* Wight is distributed in tropical and sub-tropical India frequently found in the Konkan region and grows vigorously in hot semi-arid conditions. Its worldwide distribution is restricted to only Indian subcontinent *i.e*. southern India, Sri Lanka exhibiting its endemism.

Morphological Characters: *Capparis moonii* Wight commonly known as Waghati in Marathi and *Rudanti* in Sanskrit. It has the largest flower among all capers. It is a large woody climber or shrub, 3 - 5 m high. It has thick erect stems with trailing glabrous branches and recurved thorns. Leaves 7 - 10 cm long oblong obtuse or subacute with a callous tip, glabrous above, pale beneath. Flowers appear in corymbs at the end of branches. Flowers are large, 10 - 12 cm across, white and

fragrant. Numerous white stamens 5 - 8 cm long are prominent on the flower. The fruit is round, 5 - 10 cm in diameter across green-grey to red in color. Seeds are many reniform in shape and size of a large bean.

TABLE 1: BOTANICAL SOURCES OF *RUDANTI* AS PER DIFFERENT TEXTS

S. no.	Book	Hindi or Regional name	Botanical Source
1	The wealth of India	*Rudanti*	*Capparis moonii*
2	Pharmacographia indica	Rudravanti/Rudranti	*Cressa cretica*
3	Indian Materia Medica	Rudravanti	*Cressa cretica*
4	Uttarakhand ki vanaushadhiyan	Rudravanti	*Astragalus candolleanus*
5	Medicinal plants used in Ayurveda	*Rudanti* Pratinidhi – Rudravanti – *Rudanti* Pratinidhi – *Rudanti*	*Astragalus candolleanus*. *Capparis moonii*. *Cicer soongaricum* (marked it as doubtful)
6	Sharangdhar Samhita ki vanaspatiyan	*Rudanti*	Astragalus species and *Capparis moonii* Wight
7	Dravyaguna Vigyan	*Rudanti*	*Capparis moonii*
8	Ladakh ki sanskriti evam paramparagat tibeti chikitsa pranali (Traditional Tibbetan system of medicine & culture of Ladakh)	Sadnak, *Rudanti*- Rudravanti (Ladakhi/Baalati)- Thak-chut-kar- Sarigamo, Marmukhni –	*Astragalus candolleanus*, *Cicer songaricum.*
9	Nighantu Adarsh	*Rudanti*.	*Cressa cretica*
10	Some controversial drugs in Indian medicine	*Rudanti*.	*Cressa cretica*
11	Ayurveda ki jaan vanaushadhivigyan	*Rudanti*	*Capparis moonii*
12	Medicinal flora of Garhwal Himalayas	Rudravanti	*Astragalus leucocephalus, Astragalus candolleanus* and *Astragalus himalayanus*
13	Uttarakhand Himalaya ki vanaushadhi evam khanij	*Rudanti* Rudravanti –	*Astragalus leucocephalus* Grah. and *Astragalus chlorostachys* Lindl *Astragalus candolleanus*
14	Dravyaguna Sutramala	*Rudanti*	*Capparis moonii*
15	A report on medicinal plant of Kachchh (Gujarat)	*Rudanti*	*Cressa cretica*

TABLE 2: TAXONOMICAL CLASSIFICATION

Kingdom	Plantae
Class	Dicotyledons
Subclass	Polypetalae
Series	Thalamiflorae
Order	Parietales
Family	Capparaceae
Genus	Capparis
Species	*Moonii*

Phytochemical Studies: The total ash value, acid insoluble ash, water extractive value, ethanol extractive value, total solid content and loss on drying for CM fruits extracts were found to be 6.4, 0.5, 26.5, 9.4, 26.6 and 15.4% w/v respectively. CM fruits extracts were found to be present positive for flavonoids, steroids, alkaloids, saponins, glycoside, tannins and phenolic compounds, fats and oils [9]. Different extracts of stem and leaves of *Capparis moonii* showed different metabolites in preliminary phytochemical investigations like glycosides were found in chloroform, ethyl acetate, and methanol. Steroids and alkaloids were present in hexane, chloroform, ethyl acetate extracts. Methanolic and aqueous extracts showed presence of Proteins and Tannins. Saponins were present only in aqueous extracts. Carbohydrates were found in chloroform, methanol, and aqueous extracts. The maximum amount of phenolic content was found in hexane extract of stem (16.19 mg TAE/g dry wt.) followed by chloroform leaves extract (15.57 mg TAE/g dry wt.) whereas chloroform extract of leaves had maximum flavonoid content (2.52 mg rutin equivalents/g dry wt.) [10].

Two new hydrolyzable gallotannins, (1 and 2) from the fruits of *Capparis moonii* were isolated using bioassay-guided fractionation technique and characterized using IR, MS, 1D, and 2D NMR spectroscopic techniques [11]. β-sitosterol, [1] stachyhydrin and rutin were isolated from fruits of *Capparis moonii* [12]. The total phenolic and flavonoid content of MECM, HMECM, and

AQCM fruits extracts were found to be 0.20, 0.11 and 0.47 mg of gallic acid/g and 78.3, 18.8 and 64.4 mg of rutin/g respectively. Rutin and quercetin were confirmed by HPTLC and HPLC showing well-resolved peaks [9].

TLC: Mobile phases of methanol/chloroform/ glacial acetic acid (1.5:2.5:1) and methanol/glacial acetic acid/formic acid/water (3:1.5:0.9:0.5) were used for identification of rutin and quercetin respectively in methanolic (MECM), hydro-methanolic (HMECM) and aqueous (AQCM) extracts of fruits of *Capparis moonii*. Before spotting on the plates, standard and extract samples were dissolved in the methanol (10 mg in 1 ml) and filtered through Whatman filter paper no.1. Plates were exposed to ammonia and visualized under UV lamp. R_f values were found to be 0.79 (MECM), 0.77 (HMECM) and 0.74 (AQCM) in comparison to the standard rutin having 0.79. Quercetin was found to have R_f values of 0.63 (MECM), 0.66 (HMECM) and 0.66 (AQCM) in comparison to the standard 0.64 for CM fruits extracts [9].

Pharmacological Properties: *Rudanti* is kashaya, tikta in rasa (taste), laghu tikshna guna, katu vipaka and ushna virya [2]. Raj nighantu had mentioned *Rudanti* as Rasayani (nourishes each and every cell of the body). It is useful in diseased conditions of shaya (undernutrition and emaciating conditions), krimi (Vermifuge, anthelmintic), kasa (Cough), shwasa (Asthma), raktapitta (Hemorrhagic conditions), meha (urinary disease, excessive flow of urine, diabetes) [6]. Signs of aging (Jara Vinashnam) are delayed by use of *rudanti* and P.V. Sharma has mentioned that it is also useful in diseases which are having devastating effects on all the systems of the body (Rajyakshma Shasyate) [2].

Acute Toxicity Studies: CM fruits extracts were reported therapeutically safe up to 2000 mg/kg b.w. and all rats had gained body weight by day 14 as compared to day 09.

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Anti-Bacterial and Anti- Fungal Activity: Antibacterial activity of ten different size silver nanoparticles of *Capparis moonii* against S.A (*Staphylococcus aureus*), P.A (*Pseudomonas aurginosa*), *E. coli* (*Escherichia coli*) and V.C (*Vibrio cholera*) was done and these are compared with standard values of Amoxicillin. In this S.A of AgNp-5 shows a higher anti-bacterial activity at 5 mm concentration and shows a lower activity at AgNp-10 and P.A of AgNp-5 shows a higher anti-bacterial and lower anti-bacterial activity at AgNp-10, P.A of AgNp-5 have anti-bacterial activity near to standard value of Amoxicillin and it is favorable. Similarly, AgNp-5 shows higher antibacterial activity on *E. coli* and low at AgNp-10 (Higher pH).

Similarly AgNp-5 shows a higher anti-bacterial activity on V. C. it is near to standard value and low anti-bacterial activity at AgNp-10. Bacterial growth was reduced with an increase in AgNP concentration. Further increasing concentration of AgNP caused absence of bacterial growth. The shape of silver nanoparticles may have significant effect on antibacterial activity along with the size of nanoparticles. Factors like bacterial concentration, microbial strains, and composition of culture media influence the bacterial activity. Moreover the size, shape, crystallinity, surface chemistry and capping reagent of silver nanoparticles is likely to play an important role and may cause variation in the anti-bacterial effect. Results showed that the anti-bacterial potential of AgNPs was greatly enhanced as their size was reduced.

Anti-fungal activity of silver nanoparticles and its synergistic activity against A.N (*Asperigillus*

niger), C.A (*Candida albicans*), P.C (*Penicillin chrysogeum)* and C.O (*Cladosporium oxysporum*) was done and these are compared with standard values of flucanazole. In this study A.N of AgNp-5 (higher concentration) shows highest anti-fungal activity and low anti-fungal activity at AgNp-10(higher pH). Similarly, AgNp-5 shows higher antifungal activity in C.A and low or negligible activity at AgNp-8, AgNp-9, Ag Np-10. In case of P.C higher anti-fungal activity at AgNp-5 and negligible or zero antifungal activity at AgNP-8, AgNp-9, AgNp-10 and finally in case of C.O AgNp-5 shows higher anti-fungal activity and low at AgNp-9, Ag Np- 10[13].

Hepatoprotective Activity against Carbon Tetrachloride – Induced Hepatotoxicity: Hepato-protective activity of ethanol extract of *Capparis moonii* Hook. f. Thomas. (Capparidaceae) fruit was studied in carbon tetrachloride (CCl_4)-induced hepatotoxicity in rats. A mixture of CCl_4 in olive oil (1:1 v/v) at the dose of 1 ml/kg subcutaneously was used to induce hepatotoxicity in rats on day 7. The ethanol extract of *C. moonii* (200 mg/kg) and the standard drug silymarin (25 mg/kg) were given orally from day 1 to day 9. The extract of *C. moonii* significantly ($p < 0.001$) reduced the elevated Serum glutamic oxaloacetic transaminase (SGOT), Serum glutamic pyruvate transaminase (SGPT), alkaline phosphatase (ALP), and increase in depleted total protein took place when compared with the toxic control. The results were comparable with the standard drug silymarin [14].

Antioxidant Activity:

DPPH: *Capparis moonii* fruits methanolic (MECM), hydromethanolic (HMECM) and aqueous (AQCM) extracts (0.2ml) was diluted with methanol and 2 ml of DPPH (1-Diphenyl-2-picrylhydrazyl) solution (0.5mM) were added. Absorbance was measured at 517 nm after 30 min. A graph of percent inhibition *v/s* concentration was plotted. CM fruits extract showed IC_{50} value of MECM (0.338), HMECM (0.905) and AQCM (2.122) as compared to standard (Ashwagandha powder) (0.132) [9]. Another study was done with leaves and stem of *Capparis moonii*. Hexane, chloroform, ethyl acetate, methanol and aqueous crude extracts of leaves and stem of *Capparis moonii* were evaluated for their antioxidant activity by using DPPH, Phosphmolybdenum reduction, FRAP, reducing power assay and H_2O_2 radical scavenging assay. Butylated hydroxytoluene (BHT) and Ascorbic acid were used as standard antioxidants and results were compared. Phenolic and flavonoid content was correlated with antioxidant activity. Crude extracts were found to be more effective as compared to standard antioxidants like ascorbic acid and BHT [10].

Insulinomimetic Activity: Two new chebulinic acid derivatives were isolated by using Bioassay guided fractionation of the hydro-alcoholic extract of *Capparis moonii* fruits. Both compounds displayed significant glucose uptake effect of 223% and 219% over the control at the 10 ng/ml and 100 ng/ml concentration respectively. The increased glucose uptake effects of the compounds were associated with significant IR and IRS-1 phosphorylation, GLUT4 and PI3-kinase mRNA expression in the L6 cells [11].

***In-vitro* Immunomodulatory Activity:** Aqueous and ethanolic extract of dried fruits of *Capparis moonii* Wight were evaluated, for their *in-vitro* immunomodulatory activity, at various concentrations (832 µg/ml to 6.5 µg/ml) for the secretion of mediators like nitric oxide, superoxide, lysosomal enzyme, *etc*. of isolated murine peritoneal macrophages. Both the extracts showed significant results *in-vitro* phagocytic assay on NBT dye reduction, nitric oxide in peritoneal mouse macrophages, stimulation of lysosomal enzyme activity, and myeloperoxidase activity [15].

***In-vivo* Immunomodulatory Activity:**

Hemagglutination Antibody (HA) Titre: Immunization was induced in female rats by 0.1 ml of sheep RBCs suspension containing 0.5×10^9 cells intraperitoneally on day 0. Control (0.5% sodium CMC solution at 1 mg/kg), CM fruits methanolic (MECM), hydromethanolic (HMECM) and aqueous (AQCM) extracts and standard (Ashwagandha) were given orally for 7 days. On 7th day, blood samples were collected in micro-centrifuge tubes by retro-orbital puncturing technique, followed by centrifugation and the serum was pooled from each group. A two-fold serial dilution of pooled serum samples was made in 25 µl volumes of normal saline in microtitration plates and it was added to 25 µl of 1% suspension of sheep RBCs in saline. Incubation of the plates at

37 °C for 1 h was done and hemagglutination was observed under microscope. Reciprocal of the highest dilution of the test serum agglutination was treated as antibody result. CM fruits extracts at 200 mg/kg showed significant activity and no activity at 100 mg/kg as compared to the standard (Ashwagandha) [9].

Delayed-Type Hypersensitivity (Dth) Response: Right hind footpad of female rats was encountered with 0.5×10^9 Sheep RBCs cells. Foot thickness was monitored with Vernier calipers after 24 h and 48 h of treatment period. Control (0.5% sodium CMC solution at 1 mg/kg), CM fruits extracts methanolic (MECM), hydromethanolic (HMECM) and aqueous (AQCM) and standard (Ashwagandha) were administered from 0 to 7th day. The treated foot measurement was done on 7th (prior to injection), 8th and 9th day. Difference between prior and post-injection footpad thickness was noticed as DTH response. CM fruits extract showed dose-dependent decrease in paw edema after 48 h of challenge at 100 and 200 mg/kg when compared to control group [9].

Antiulcer Activity: Anti-ulcer activity of aqueous extracts of *Capparis moonii* was evaluated in experimentally induced gastric ulcer in rats by using aspirin, alcohol and pyloric ligation models. Parameters like volume of gastric secretion, PH, free acidity, total acidity, ulcer score, and ulcer index were taken to assess anti-ulcer activity.

Omeprazole (20 mg/kg) was used as positive control. Aqueous extract of *capparis moonii* significantly ($P<0.05$) decreases the volume of gastric acid secretion, PH, free acidity, total acidity, ulcer score and ulcer index with respect to control and comparable with Omeprazole [16].

***In-vitro* Screening of the Extracts Using Cell Lines:** The cell cultures and media consist of human colon cancer cell line HCT15, human breast cancer cell line MCF7 and standard drug adriamycin (Doxorubicin) CM fruit extracts were found to be unresponsive on selected cell lines at different concentrations studied as compared to standard drug adriamycin [9].

Potato Disc Assay Method on CM Fruits: CM fruits extract were found to be unresponsive on the selected assay method [9].

CONCLUSION: Rudanti (*Capparis moonii*) is a good source of traditional medicine used for the treatment of Kasa (Cough), shwasa (Asthma), raktapitta, (Hemorrhagic conditions), meha (urinary disease, excessive flow of urine, diabetes) and rajyakshma (Pulmonary tuberculosis). It has Rasayana properties (nourishes each and every cell of the body).

Although, many of the experimental studies validated its traditional medicinal uses, but still there are no experimental studies available on diseases like cough, asthma and tuberculosis, though it is being extensively used by ayurvedic physicians in the above-mentioned diseases. Efforts are therefore needed to establish and validate evidence regarding its judicious use in diseases of respiratory origin.

This study stretches the controversy related to its botanical source, history, morphology, physical and chemical nature, mechanism of action, traditional and medicinal use of drug. The outcome of these studies will further expand the existing therapeutic potential of *Capparis moonii* and provide convincing support to its future clinical use.

ACKNOWLEDGEMENT: The authors would like to acknowledge the support of Department of Dravyaguna, IMS, BHU, and UGC Non-NET Fellowship, Government of India for financial assistance to carry out the work.

CONFLICTS OF INTEREST: The authors declare no conflict of interest.

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How to cite this article:
Nagar L, Lamo R and Dwivedi KN: Comprehensive ethnopharmacological review of Rudanti (*Capparis moonii* wight). Int J Pharm Sci & Res 2020; 11(2): 556-62. doi: 10.13040/IJPSR.0975-8232.11(2).556-62.