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PHYTOCHEMISTRY AND PHARMACOLOGY OF *OXALIS CORNICULATA* LINN.: A REVIEW

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ABSTRACT

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Many herbal remedies have been employed in various medical systems for treatment and management of different diseases. The plant *Oxalis corniculata* Linn. has been used in different system of traditional medication for the treatment of diseases and ailments of human beings. β -sitosterol, betulin, 4-hydroxybenzoic acid, ethyl gallate, methoxyflavones, apigenin, and 7-O- β -D-glucopyranoside were previously isolated from the whole plant of *Oxalis corniculata*.linn. The review reveals that wide ranges of phytochemical constituents have been isolated from the plant like flavanoids, tannins, phytosterols, phenol, glycosides, fatty acids, galacto-glycerolipid and volatile oil. The leaves contain flavonoids, iso vitexine and vitexine-2''- O- beta – D- glucopyrunoside. It is rich source of essential fatty acids like palmitic acid, oleic, linoleic, linolenic and stearic acids. It has been reported that the plant contains anti-inflammatory, anxiolytic, anticonvulsant, antifungal, antiulcer, antinociceptive, anticancer, antidiabetic, hepatoprotective, hypolipedemic, abortifacient, antimicrobial and wound healing properties. The current study is therefore reviewed to provide requisite phytochemical and pharmacological detail about the plant.

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INTRODUCTION: There exists a plethora of knowledge and information and benefits of herbal drugs in our ancient literature of Ayurvedic and Unani medicine. One of the earliest treatises of Indian medicine, the Charaka Samhita (1000 B.C.) mentions the use of over 2000 herbs for medicinal purpose¹.

A large proportions of world's population depend on traditional medicine because of scarcity, high cost of orthodox medicine and unpleasant side effects². Exploration of the chemical constituents of the plants and pharmacological screening may provide us the basis for developing the leads for development of novel agents.

In addition, herbs have provided us some of the very important lifesaving drugs used in the armamentarium of modern medicine³.

There is a worldwide belief that herbal remedies are safer and less damaging to the human body than synthetic drugs. Therefore laboratories around the world are engaged in screening of plants for biological activities with therapeutics potential. One major criterion for the selection of plant for such a study is traditional healer's claim for its therapeutics usefulness. The traditional Indian medicinal system mentions herbal remedies for the treatment of variety of diseases.

Ayurveda has emphasized importance of food in the management of diseases. Even practitioner of modern system has realized the significance of dietary items, in the form of nutraceutical elements, in the treatment of chronic diseases⁴.

Oxalis corniculata Linn. (Family: Oxalidaceae) is a well-known in India and is one of the most versatile medicinal plants having a wide spectrum of biological activity. It is commonly known as creeping wood sorrel, an excellent plant in the nature having composition of all the essential constituents that are required for normal and good health of humans⁵. Herb is a good appetizer, removes kapha, vata, and piles; astringent cures dysentery and diarrhoeas, skin diseases and quarten fevers. An infusion of the small leaves is externally used to remove warts and opacities of cornea. The leaves are anti-inflammatory, refrigerant and antiscorbutic⁶.

The present review is dealing with medicinal importance of the *Oxalis corniculata*. Linn with reference to its Pharmacognosy, Phytochemistry and pharmacological activities.

Taxonomic Classification⁷:

Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Magnoliopsida
Order	: Oxalidales
Family	: Oxalidaceae
Genus	: Oxalis
Species	: <i>O. corniculata</i>

Vernacular Names⁷:

Sanskrit: Ambashta, Amlalonika, Amlapatrika, Amlika, Amlotaja, Cangeri

Hindi: Seh-patti, Tinpatiya, Anboti, Chuka tripati, Bhilmori, Khatari

English: Indian sorrel

Urdu: Khatt-i-buti

Assamese: Changeritenga, Saru tengesi

Bengali: Amrul-sak, Amrul shak, Amrul, Tandi chatom arak, Amrool

Kannada: Huli-hunice, Hulihunice, Pullam-purachisappu, Teltuppi

Tamil: Palaikiri, Puliyarail

Telugu: Ambotikura, Pulichintha, Pallachintha

Marathi: Ambali, Chicha

Malayalam: Poliyarala, Puliyaral, Puliyarala, Puliyarila, Pullampurachi

Marathi: Umbuti, Ambuti, Bhinsarpati, Aambootee, Ambata chukaa

Oriya: Sialthur, Siakthur, Ambo chingari

Arabic: Hememdab, Hemda, Homadmad

Distribution: It is a somewhat delicate-appearing, low-growing, herbaceous plant abundantly distributed in damp shady places, roadsides, plantations, lawns, nearly all regions throughout the warmer parts of India, especially in the Himalayas up to 8,000 ft-cosmopolitan⁷. It is also distributed in ballast about the eastern seaport town of the United States and becomes quite abundant in Texas and Ontario. These weeds are found throughout Florida. They are common in the southeastern United States; from Newfoundland to North Dakota; and southward to Mexico. *O. corniculata* is a cosmopolitan weed occurring in the Old World and in temperate and tropical regions of North, Central and South America and the West Indies⁸.

Morphology: They are tap rooted herbs, bushy or mat forming, and 0.1-0.5 m tall (**Figure 1**). Branching from the base and often rooted at the nodes, the upper portions are ascending or weakly erect smooth or hairy⁸.

a) **Stem:** The stem is slender, terete and pubescent, 0.4 to 1.5 cm long. The internodes vary from 4.5 to 8.5 cm in length. Acidic odour, taste sour when fresh⁹.

b) **Leaves:** The trifoliate leaves are alternate, with thin, heart-shaped, leaflet blades having a distinct

apical indentation. Leaflets 0.5 to 1 cm long with reticulate venation. The blades are smooth on the upper surface, slightly folded upward lengthwise along the major vein, and have a few appressed hairs along the veins on the lower surface and along the lower portion of the margins. The leaves are arranged alternately along the stems. A single long stalk arises from the axils of the leaf, from which extend three flower stalks, each with a single flower.

- c) **Flowers:** The flowers are 7-11 mm wide and have 5 yellow petals ⁸.
- d) **Fruit:** The fruit is a capsule, 1-1.5 cm long, cylindrical, pointed apically, and 5-ridged in cross section ⁸.
- e) **Seeds:** The seeds are oval in outline, apically rounded, basally pointed, flattened in cross section, light brown, and have a surface distinctly transversely ridged. *Oxalis corniculata* will have stolons ⁸.



FIG. 1: IMAGE OF *OXALIS CORNICULATA* LINN.

Ethnobotany: In Nepal village, *Oxalis corniculata*. Linn (Jujur saang) is used as medicinal herb ⁹. The plant is mixed in equal amount with the leaf bud of *Justicia adathoda* L. and *Maesa macrophylla* is pounded and the juice about 6 tea spoons 3 times a day is given in gastric troubles ¹⁰. The leaf decoction is used in fever and dysentery in some areas of Madhya Pradesh ¹¹. Maceration of the whole plant with leaves of *Sida acuta* is taken orally to treat gonorrhoea in Cameroon ¹². The herb juice is used as eye drop in conjunctivitis by Boro Tribals of Assam ¹³. The local inhabitants of Tehsil Chakwal (Pakistan) uses Plant sap to cure skin diseases, Leaves as cooling agent and refrigerant in stomach

disorders, fever and acute headache and also in snake bite. Plant pounded with cumin seeds are taken with water thrice a day for dysentery. It is also used for sensitive teeth ¹⁴.

Phytochemistry: Phytochemical investigations of *Oxalis corniculata* Linn. have revealed the presence of tannins, palmitic acid, a mixture of 8 oleic, linoleic, linolenic and stearic acids. Methanolic and ethanolic extracts of this plant show the presence of carbohydrate, glycosides, phytosterols, phenolic compounds, flavonoids, proteins (12.5%), amino acids and volatile oil. It also showed the presence of calcium, fiber and tannin. Leaves contain tartaric acid and citric acids, calcium oxalate, flavones (acacetin and 7,4'-diOMe apigenin), glycoflavones (4'-OMe vitexin, 4'-OMe iso-vitexin and 3',4'-diOMe orientin), flavonols (3',4'-diOMe quercetin) and phenolic acids such as p-hydroxybenzoic, vanillic and syringic acids. This herb is well known to have an acid taste due to the high content of oxalate in its leaves and stems. Study revealed the presence of three C-glycosylflavones in the leaves namely 6-C-glucosyl luteolin (isoorientin), 6-C-glucosylapigenin (isovitexin) and isovitexin 7-methylether (sertisin) (Figure 2).

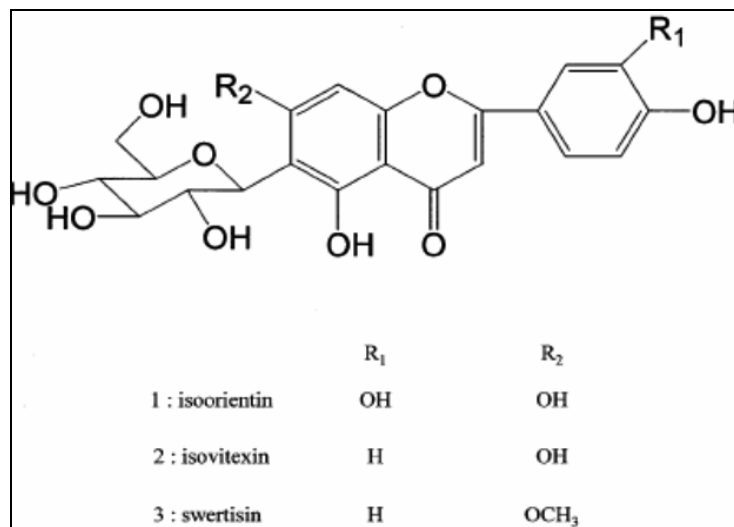


FIG. 2: THE STRUCTURES OF FLAVONOIDS [1: LUTEOLIN 6-C-GLUCOSIDE (ISOORIENTIN), 2: APIGENIN 6-C-GLUCOSIDE (ISOVITEXIN), 3: ISOVITEXIN 7-METHYLETHER (SWERTISIN)] ISOLATED FROM THE SHOOTS OF *O. CORNICULATA*

Ferritin was detected in the integumentary cells of the *Oxalis corniculata* ovule that was confirmed by an electron microscope x-ray microanalysis; it occurs in immature plastids & in amyloplasts in the form of paracrystalline aggregates which have round profiles or

which may be intended by the surrounding starch grains. Integumentary ferritin aggregates are regarded as an iron source for the embryo. The leaves contain about 86% water, 0.8% fat, 8.2% carbohydrate, 150mg calcium, 78 mg phosphorus, 8mg iron, 0.6mg niacin, 78mg vitamin C, 6050 microgram beta carotene and between 7-12% oxalate⁵.

During photosynthesis, an oxalic acid is produced by carbon dioxide fixation both in light and in darkness but the 2 rate of its photosynthetic formation is much higher in darkness. Identified several compounds that were characterized by nuclear magnetic resonance, infrared, and mass spectrometry as (i) Oc-1, a mixture

of saturated fatty acids C₂₄ to C₂₈; (ii) Oc-2, a mixture of long-chain alcohols C₁₈ to C₂₈; and (iii) Oc-3, a single compound that was a galacto-glycerolipid¹⁵.

β -sitosterol (1), betulin (2), 4-hydroxybenzoic acid (3), ethyl gallate (4), 5-hydroxy-7,8-dimethoxyflavone (5), 5-hydroxy-3', 4', 6, 7, 8-pentamethoxyflavone (6), 7, 5'-dimethoxy-3, 5, 2'-trihydroxyflavone (7), 5-hydroxy-3, 6, 7, 4'-tetramethoxyflavone (8), 4', 5-hydroxy-3, 6, 7-trimethoxyflavone (9), 5-hydroxy-3, 6, 7, 4'-tetramethoxyflavone (10), apigenin 7-O- β -D-glucoside (11) and 3, 3', 5, 7-trihydroxy-4'-methoxyflavone 7-O- β -D-glucopyranoside (12), has been recently isolated from the *Oxalis corniculata* (Figure 3)¹⁶.

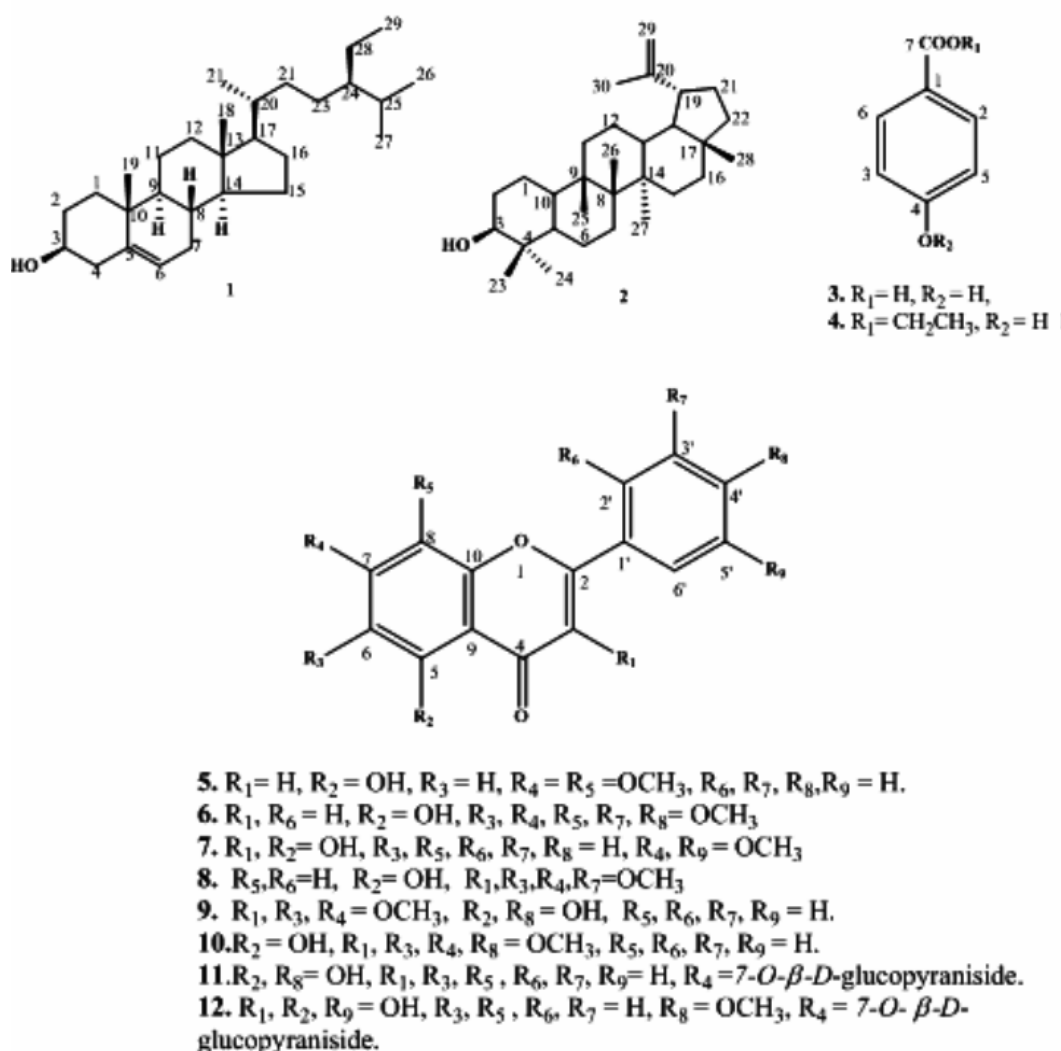


FIG. 3: STRUCTURES OF COMPOUNDS 1-12 ISOLATED FROM *OXALIS CORNICULATA* LINN.

Nutritional Value of *Oxalis Corniculata* Linn.: The leaves have been found to be rich in moisture, total carbohydrate, crude protein, crude lipid hence it can be alternative vegetable during emergency. The leaves of *Oxalis corniculata* linn. exhibit rich in mineral

contents like Sodium (1.12+0.02%), Potassium (2.17+0.31%), Calcium (2.51+0.08%), Nitrogen (3.56+10.70%) and Magnesium (0.25+0.03%), these mineral components are vital in regulating various metabolic pathways in human body¹⁷.

Pharmacological Activities of *Oxalis Corniculata* Linn.:

Oxalis corniculata Linn. plant is anthelmintic, anti-inflammatory, analgesic, astringent, depurative, diuretic, emmenagogue, febrifuge, relaxant, lithontriptic, stomachic and styptic. It is used in the treatment of influenza, fever, urinary tract infections, enteritis, diarrhoea, traumatic injuries, sprains and poisonous snake bites. An infusion can be used as a wash to rid children of hookworms. The plant is used as an antiscorbutic in the treatment of scurvy. The leaves are used as an antidote to poisoning by the seeds of *Datura*, arsenic and mercury. The leaf juice is applied to insect bites, burns and skin eruptions. It has an antibacterial activity. An infusion of leaves is used to remove opacities of the cornea and is dropped into the eyes for itching lids. A decoction of leaves is used as a gargle.

Wound Healing Activity: The alcoholic and petroleum ether extract of whole plant of *Oxalis corniculata* linn. has been evaluated for its wound healing activity by using excision, resutured incision and dead space wound models in rats. Both the extracts at the dose of 300 and 500 mg per kg p.o. showed significant wound healing activity by producing an increase in wound contraction rate, wound breaking and significant decreases in epithelization period. In this study both the extracts significantly increased the granuloma tissue breaking strength and hydroxyl proline content as compared to control¹⁸.

Anti-implantation and Abortifacient Activity:

Petroleum ether and ethanol extracts of the whole plant of *Oxalis corniculata* linn. were administered orally at the dose level of 100 and 200 mg/kg body weight from day 1 to 7 of pregnancy to evaluate the antiimplantation activity. Though all the treated groups showed significant antiimplantation activity when laparotomised on day 10, it was maximum (76.42%) with the high dose of petroleum ether extract. Upon withdrawal of the treatments the rats which retained the implantation continued pregnancy. The pregnant rats which received the treatment from day 8 to 14 of pregnancy showed abortifacient activity and it was maximum (78.55%) with high dose of petroleum ether extract¹⁹.

Anti-diabetic activity: The aqueous extract of the *Oxalis corniculata*. Linn plant has been tested for the

inhibitory potential against procaïne pancreatic amylase. At a concentration of 100µg/ml exhibited a maximum inhibition of 89.27% (IC₅₀ value 68.08±0.06). The organic extracts did not show any significant inhibition in this study which might suggest that the active principle possessing amylase inhibitory potential is extracted only in the aqueous extract²⁰.

Antiamoebic Activity: *Oxalis corniculata* Linn. identified several compounds that showed antiamoebic activity in axenic cultures of *E. histolytica*. These were characterized by nuclear magnetic resonance, infrared, and mass spectrometry as (i) Oc-1, a mixture of saturated fatty acids C₂₄ to C₂₈; (ii) Oc-2, a mixture of long-chain alcohols C₁₈ to C₂₈; and (iii) Oc-3, a single compound that was a galacto-glycerolipid (GGL). Of the different compounds that were obtained, the strongest antiamoebic activity was found in GGL¹⁵.

Anti-cancer Activity: Ethanolic extract of *Oxalis corniculata* Linn. evaluated for its anticancer activity in Ehrlich ascites carcinoma (EAC) induced in Swiss albino mice. Results conclude that the ethanolic extract of *Oxalis corniculata* Linn. was effective in inhibiting the tumor growth in ascitic and solid tumor models²¹.

Anti-nociceptive Activity: Ethanolic extract of *Oxalis corniculata* linn. at doses of 200 and 400mg/kg body weight evaluated for its antinociceptive activity in diabetic neuropathy rats. Diabetic rats were showed significant reduction in tail flick latency by 49% in hot water tail immersion test and decreased paw withdrawal by 40% in hot plate test by the end of 5th week²².

Antioxidant Activity: The study revealed that ethanolic extract of *Oxalis corniculata* linn. at different doses level showed significant antioxidant activity in mice²⁰. Methanolic extract of *Oxalis corniculata* linn showed potent antioxidant activity compare to reference standard ascorbic acid. The concentration of plant extract required for 50% inhibition of DPPH radical scavenging effect (IC₅₀) were recorded as 30 mg/ml and 37 mg/ml for MEOC and standard ascorbic acid. These results suggest that the MEOC possess antioxidant activity compared to ascorbic acid²³. The whole plant of *Oxalis corniculata* linn. in three different solvent systems was tested for antioxidant capacity by phosphomolybdate method. The radical

scavenging activity of plant extracts was studied by different standard in vitro methods. The quantitative estimation of major antioxidant constituents was carried out by standard method and contained total crude phenolics content (6.424 mg gallic acid eqvt./gm dry wt. of sample), phenolic acid (0.738 mg gallic acid eqvt./gm drywt.), total flavonoids (0.814 mg rutin eqvt./gm dry wt.) and glutathione (948.143 μ M/gm fresh wt.). The antioxidant vitamins of the plant were also estimated. The vitamin C content was found to be 0.414 mg/gm fresh wt. and vitamin E was found to be 137.36 mg/gm fresh wt.²⁴.

Antifungal activity: The aqueous extract of four various plants were evaluated for antifungal activity against various pathogens. All the four plants showed different activities against all the pathogenic fungi. Among them, *Oxalis corniculata* Linn. showed the significant antifungal activity against A. Niger by suppressing the fungal mycelial growth by 71 to 86% and moderately against P. these, R. Solani after three days of incubation²⁵.

Anti-diarrhoeal activity: The anti-diarrhoeal activity of aqueous and methanolic extracts of *Oxalis corniculata* Linn. was evaluated on castor oil induced diarrhoea in rats and on small muscle intestinal transit. At orally administered doses of 160,320 and 640 mg/kg of body weight. The two plant extracts significantly ($p < 0.05$) prolonged the time of onset of diarrhoea and inhibited the frequency of defecation. These extracts also reduced the wetness of faecal droppings in castor oil induced diarrhoea and decreased the propulsion of charcoal meal through the small intestine. At all doses the aqueous extract appeared to be more effective than the methanolic extract²⁶.

Antimicrobial activity: Methanolic and ethanolic extracts of *Oxalis corniculata* Linn. plant showed significant antibacterial activity against Xanthomonas and fourteen human pathogenic bacteria. Interestingly, among the extracts, Methanol extract showed highly significant activity as compared to K-cycline and Bact-805 against plant pathogenic bacteria. In case of human pathogenic bacteria methanol extract showed moderately significant antibacterial activity when compared with standard streptomycin²⁷.

Anti-epileptic activity: Methanolic extract of *Oxalis corniculata* Linn. leaves at doses of 200 and 400mg/kg body weight were screened for antiepileptic activity on Maximal Electroshock (MES) and Pentylene tetrazole (PTZ) induced seizures models in Albino Wistar rats. In MES model, MEOC showed significant reduction in duration of hind leg extension with 200 mg/kg dose and effect was dramatically reduced with 400mg/kg. Similar dose dependent results were obtained in PTZ model by delayed the onset of clonic convulsions. The complete protective effect against mortality was reported in both the tests. In conclusion, our present results indicate that *Oxalis corniculata* L. has antiepileptic effects on MES and PTZ induced convulsions and its mechanisms might relate to potentiation of the activity of GABA receptors and their signal transduction process²⁸.

A study was conducted to investigate the effect of methanolic extract of *Oxalis corniculata* linn. on antioxidant enzymes in rat brain after induction of seizures by MES and PTZ. The levels of antioxidant enzymes Superoxide dismutase, glutathione peroxidase, glutathione reductase and catalase was decreased in rat brain due to seizure and it was restored significantly by administration of ethanol extract of *Oxalis corniculata* Linn. treated rats. Similar dose dependent results were obtained in PTZ model also, Whereas MEOC significantly decreased lipid peroxidation in both models. The anticonvulsant activity of MEOC might be presents of antioxidant properties and it delays the generation of free radical in MES & PTZ induced epilepsy²⁹.

Anti-ulcer activity: The aqueous and ethanolic extract of *Oxalis corniculata* linn. leaves at a doses of 200 and 400mg/kg body weight were screened for anti-ulcer activity by using ethanol induced gastric mucosal ulcers and pylorus ligated ulcers. There was a decrease in gastric volume and reduction in free and total acidity treated with both extracts and the catalase and SOD levels was increased and lipid peroxide was decreased in both extracts³⁰.

Anti-inflammatory activity: Methanol extract of whole plant of *Oxalis corniculata* Linn. (Family: Oxalidaceae) was assessed for its antioxidant and anti-inflammatory activity by *in-vitro* methods. *In-vitro* anti-inflammatory activity was evaluated using albumin denaturation

assay, membrane stabilization assay and proteinase inhibitory activity at different concentrations. Aspirin was used as a standard drug for the study of anti-inflammatory activity. Linear regression analysis was used to calculate IC₅₀ value.

Results showed that, the extract exhibited significant DPPH and nitric oxide radical scavenging activity with IC₅₀ value of 302.93±4.17 and 73.07±8.28µg/ml respectively. Lipid peroxidation induced by the Fe²⁺, was inhibited by the extract with IC₅₀ value 58.71±2.55µg/ml. Total phenol content was estimated as 25.62±0.10mg of gallic acid equivalents of dry extract. Total flavonoids and flavonols were found to be 150.88±12.61 and 150.16±2.16 mg of rutin equivalents per gram of dry extract respectively. Extract also showed *in-vitro* anti-inflammatory activity by inhibiting the heat induced albumin denaturation and Red Blood Cells membrane stabilization with the IC₅₀ values of 288.04±2.78 and 467.14±9.56µg/ml respectively.

Proteinase activity was also significantly inhibited by the extract (IC₅₀=435.28±5.82µg/ml). From the results, it is concluded that flavonoids and related polyphenols present in the *O. corniculata* extract may be responsible for the activity³¹.

Anxiolytic activity: The anxiolytic effect of Ethanolic extract of *Oxalis corniculata* Linn. (100 and 300 mg/kg) produced a significant increase in the number of squares crossed (controls= 24.33±3.48), but significantly decreased both the immobility (controls = 47.17±4.29 sec) and fecal pellets (controls = 13.50±0.96 fecal pellets) when compared with control mice in the open-field test; they significantly increased the number of entries (controls = 53.00±2.67 sec) in the open arms, but decreased both the number of entries (controls = 29.33±1.05 entries) and time spent (controls = 166.7 ± 4.30 sec) when compared with the control mice in the closed arms of the elevated plus-maze test. Furthermore, ethanol extract of *Oxalis corniculata* (100 and 300 mg/kg) decreased the fighting episodes significantly (controls = 9.50±0.62 fighting episodes) when compared with control mice. In addition these results were found to be consistent with anxiolytic effect produced by diazepam³². The study is to evaluate anxiolytic effect of Ethanolic extract of *Oxalis corniculata* linn. (200mg/kg and 400mg/kg P.O)

on male mice using various paradigms of anxiety. In elevated plus maze, extract (200mg/kg and 400mg/kg) had shown a dose dependent increase in time spent and number of entries into open arm compared to control group. The number of central squares, peripheral squares crossed and rearings were stepped up significantly in open field paradigm. The treated groups had shown accession in time spent in light compartment, number of crossings, latency compared to control group in light dark exploration test. In Hole board model, number of head dips were minified in mice that received Ethanolic extract of *Oxalis corniculata* (200mg/kg and 400mg/kg)³³.

Hepatoprotective activity: The hepatoprotective activity of aqueous and ethanolic leaves extracts of *Oxalis corniculata* Linn. (200 and 400 mg/kg) were evaluated against thioacetamide-induced hepatotoxicity. Oral administration of *O. corniculata* aqueous and ethanolic leaves extract at 400 mg/kg resulted in a significant reduction in SGOT (146.42±2.54 and 136.75±1.37 IU/L respectively), SGPT (81.96±3.15 and 72.05±2.33 IU/L respectively), GGTP (16.6±0.49 and 15.02±0.68 IU/L respectively), ALP (241.86±3.94 and 202.42±5.37 IU/L respectively) and total bilirubin (0.226±0.00 mg/dL 0.288±0.01 mg/dL respectively) content that were lesser than positive control, thioacetamide damaged rats. Histology of the liver sections of the animals treated with the extract also showed dose dependent reduction of necrosis³⁴.

Hypolipedemic activity: The hypolipidaemic and antioxidant activities of leaves of *Phlogacanthus thyriflorus*, *Oxalis corniculata* Linn. and *Fragaria vesca* were evaluated in the study. Hyperlipidaemia was induced in rats by giving high fat diet consisting of coconut oil and vanaspati ghee, in a ratio of 2: 3 v/v at a dose of 10 ml/Kg body weight. The extracts showed a significant decrease in total cholesterol, triglycerides, LDL and MDA in blood. On the other hand, HDL, CAT and SOD were increased significantly³⁵.

Steroidogenic activity: The study proved that the *Oxalis corniculata* linn. has steroidogenic activity and this natural chemical can be safely used as it does not alters the functioning of organs which is proved by its action on one of the endocrine organ-adrenal gland, which functions normally in the extract treated female albino rats³⁶.

Cardio protective effect: The present study evaluated the protective potential of aqueous extract of (*Oxalis corniculata* Linn. OCE) against isoproterenol (ISO) induced myocardial infarction in rats. Myocardial infarction in rats was induced by isoproterenol (200 mg/kg) at an interval of 24 h for 2 days. OCE was given to rats as pretreatment for 30 days orally using an intragastric tube. Isoproterenol caused a significant increase in the activity of cardiac injury marker enzymes like creatine phosphokinase (CPK) and lactate dehydrogenase (LDH) and increased the concentration of serum lipids. OCE pretreatment significantly reduced the concentration of CPK, LDH, serum total cholesterol, LDL cholesterol and triglycerides.

OCE also reduced the activity of lipogenic enzyme, glucose-6-phosphate dehydrogenase in ISO administered rats. Oxidative stress produced by isoproterenol was significantly lowered by the administration of OCE which was evident from increased activities of antioxidant enzymes (catalase and superoxide dismutase) and reduced concentration of lipid peroxidation products (TBARS and conjugated dienes). Concentration of vitamin C, protein sulfhydryl groups and reduced glutathione (GSH) was also high in OCE pretreated rats. Histopathology of heart of ISO administered rat pretreated with OCE showed normal myocardium with very little evidence of inflammatory infiltration. Results of our in vitro findings also confirmed that OCE exhibits significant antioxidant and radical scavenging activity against DPPH, superoxide and nitric oxide radicals³⁷.

Nephrotoxicity: CCl₄ induces oxidative stress in various tissues by altering antioxidant enzymes defense system. In this study we investigated the chemical composition and protective role of *Oxalis corniculata* Linn. methanol extract (OCME) on CCl₄-induced nephrotoxicity in rat. Presence of flavonoids, alkaloids, terpenoids, saponins, cardiac glycosides, phlobatannins and steroids was determined in OCME while tannins were absent. Total phenolic contents estimated were 7.76 ± 0.36 (mg gallic acid equivalents/g extract) while total flavonoid contents recorded were 6.92 ± 0.52 (mg rutin equivalents/g extract). Intraperitoneal injection of CCl₄ (1 ml/kg b.w., 20% in olive oil) once a day for seven days caused nephrotoxicity as evident by elevated levels of urinary specific gravity, RBCs, WBCs, creatinine, protein, urobilinogen and nitrite. Serum

level of creatinine, urea and blood urea nitrogen were significantly increased while protein and creatinine clearance was decreased by CCl₄ treatment in kidney samples. Activity of antioxidant enzymes; catalase, peroxidase, superoxide dismutase, glutathione peroxidase, glutathione-S-transferase, glutathione reductase and glutathione concentration was decreased whereas lipid peroxidation and protein contents were increased along with histopathological injuries. Treatment with OCME caused significant recovery in changed parameters. It could be concluded that OCME has a protective role against CCl₄-induced oxidative stress in rat, due to antioxidant effects of phenolics³⁸.

CONCLUSION: From the time immemorial, plants have been widely used as curative agents for variety of ailments. It is believed that detailed information as presented in this review on its phytochemistry and various biological properties of the extract and the constituents might provide incentive for proper evaluation of the use of the plant in medicine. This is an attempt to compile and document information on different aspects of *oxalis corniculata* Linn. and highlight the need for research and development.

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