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Review Article

Phytochemical and Pharmacological Properties of *Oxalis corniculata:* A Review

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ABSTRACT

Plants have been utilized globally for ages as natural remedies for different ailments. *Oxalis corniculata* Linn., usually termed as creeping wood sorrel, being a valuable, endangered medicinal herb found in tropical and subtropical regions. This review explores its extensive chemical composition, including glycosides, volatile oils, lipids, tannins, polyphenols, alkaloids, flavonoids, steroids. The plant's leaves are particularly rich in medicinal compounds like flavonoids, vitexine-2-O-beta-D-glucopyranoside, isovitexin as well as essential fatty acids such as stearic , palmitic, linolenic, oleic acids. Additionally, it demonstrates a broad spectrum of pharmacological activities, encompassing antioxidant, antimicrobial, anti-inflammatory, anti-cancer, astringent, anthelmintic, febrifuge, cardio- relaxant, diuretic and stomachic properties. Subjective and quantitative data were gathered from about 93 articles. The Review's search included data sets from Research Gate, PubMed, Google Scholar and other relevant published materials.These research papers globally have explored the biological, pharmacological and isolation of biologically active compounds and metabolites in this plant. These reports are promising, suggesting further detailed investigation into the herb for potential therapeutic benefits in the future. This review offers a succinct overview of the medicinal plant, covering its botanical characteristics, traditional medicinal applications, pharmacological attributes and chemical composition. This study aims to consolidate and record the fundamental details related to *Oxalis corniculata*, underscoring the importance of continued research and advancement in this area.

Keywords:*Oxalis corniculata*, Phytoconstituents, Pharmacological properties, Toxicity, Ethnomedicine

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Introduction

Due to the limited availability and expensive nature of conventional medicine and its adverse side effects, a significant portion of the global population turns to traditional or folk medicine. Herbal medicine's acceptance into conventional wisdom is gathering steam in underdeveloped nations.[1] The extensive use of traditional medicine has led to the identification and separation from nature several significant therapeutic plants. Herbs are widely utilized in traditional medicine and their healing properties are extensively recorded. Countries that experiencing slower economic growth and undergoing development, are primarily depend on herbal medicines to manage their healthcare systems.[2-5] From ancient times, herbal therapy has been the pillar of treatment approaches and cures for many diseases on Indian territory. Herbs provide humans with essential life-saving drugs, which are also utilized in modern medicine. There's a notion that herbal therapies pose lower toxicity and fewer risks to the human body compared to synthetic drugs. Modern medical professionals also understand the importance of dietary components, including nutraceuticals, in managing many chronic conditions.

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Constantly investigating the effectiveness and mechanism of action of several plants and their main compounds are ethnopharmacologists, botanists, microbiologists, and natural product researchers. [6,7]
Oxalis corniculata Linn. is distributed throughout America, Europe, Africa, and Asia, and it is a member of the Oxalidaceae family. The Greek word "Oxys," which means "sour," is where the term "Oxalis" originates. It alludes to the sour taste of the leaves of the creeping wood sorrel plant. The word "horned" in the Latin species name "corniculata" refers to the shape of the fruits. It has several synonyms, including *Oxalis monadelpha, Oxalis villosa, Oxalis foliosa, Oxalis repens*. The plant grows in human-inhabited areas, along roadsides, in gardens and yards, particularly in warmer regions of India, including the Himalayas up to 2500 meters in altitude. This herbaceous plant typically found in moist, shaded locations. In Bangladesh, it is well-known for its medicinal properties that area claimed internationally. The plant possesses significant phytochemicals essential for human well-being, like niacin, Vitamin C and β-carotene. Its extract aids in treating stomach issues and jaundice. It also helps in alleviating piles, kapha and vata and it's beneficial for diarrhea, dysentery and skin conditions. In rural Bangladesh, it's commonly consumed as a vegetable and used to enhance flavor. Additionally, it is employed in the management of several illnesses including cough, pyrexia, rhinorrhea, diarrhea, sprains, traumatic injuries, and urinary tract infections. It's also serves as a supplementary remedy for conditions like dyspepsia, anemia, cuts, piles, dementia, convulsions and cancer, having a variety of qualities, including anti-inflammatory, refrigerant, anti-diabetic, antiseptic, anti-scorbutic, diaphoretic, diuretic, anthelmintic, astringent, depurative, febrifuge and stomachic.[8]

Materials and Methods

Literature search strategy
The literature survey on *Oxalis corniculata* was conducted across numerous databases, including Science Direct, ResearchGate, Google

scholar, PubMed. Additional records were identified through other sources. Then records after duplicate were removed (Figure-1).

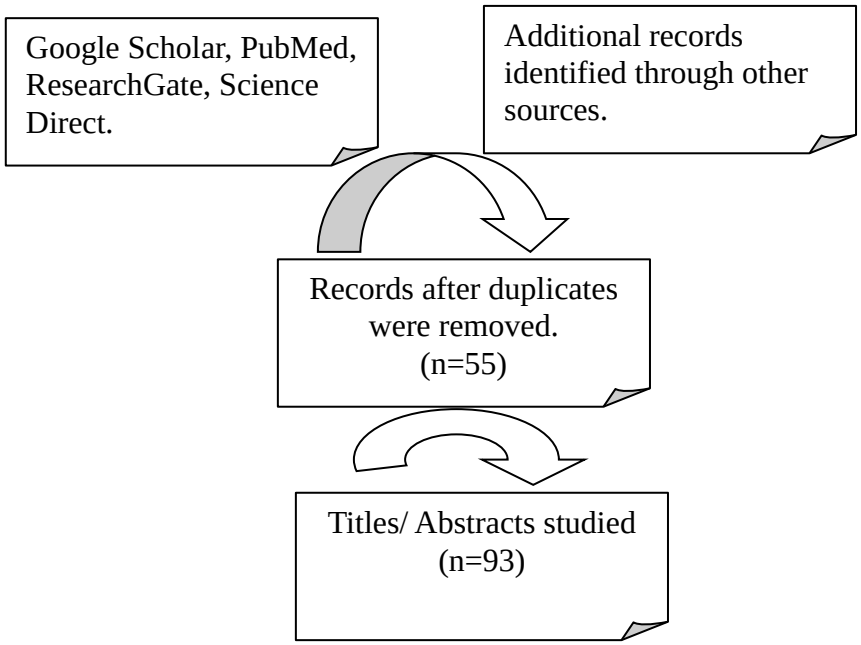

Figure 1: Flow chart of Data extraction

Results and Discussion

Botanical Classification[9]
Kingdom: Plantae, Division: Magnoliophyta, Class: Magnoliopsida, Order: Oxalidales, Family: Oxalidaceae, Genus: *Oxalis*, Species: *Corniculata*,
Botanical Name: *Oxalis corniculata* Linn
Vernacular Names[9]
Sanskrit: Ambasta, Carngari, Kannada: Hulii-huniche, Morele huli, Tamil: Poliyarai, Ataceni. Telegu: Ambotikora, Poli-chintako, Malayalam: Puliyarala, Pollampurachi, Marathi: Umboti, Ambata chuka. Hindi: Amilii, Amrulsak, Maluri, Arabic: Hamemdab, Urdu: Khatt-i-buti, Assamese: Saruu tangesi, Bengali: Amrool

Nutritional value of O. corniculata
The leaves of Oxalis corniculata possess elevated levels of moisture, total carbs, crude protein, and crude fat, rendering them a viable substitute vegetable under emergency circumstances. They are also rich in critical minerals, including magnesium (0.25+0.03%), potassium (2.17+0.31%), sodium (1.12+0.02%), nitrogen (3.56%), and calcium (2.51%), which are vital for regulating metabolic processes in the human body.[10]

GC/MS Analysis
A phytochemical analysis was conducted using GC/MS to identify potential components in fresh leaves of *Oxalis corniculata*. The chromatogram analysis revealed twelve peaks in the methanolic extract, suggesting the existence of phytochemical components. Comparison with reference mass spectra in the NIST library confirmed the presence of compounds such as squalene, vitamin E, glucose and different fatty acids. Among these, squalene was identified as the predominant compound. Squalene is a triterpene commonly present in plant latex and resins and plays a role in defending against diseases. The substance is recognized for its potential anticancer, antioxidant, and various pharmacological effects.[11]

Traditional Uses
O. corniculata is used in traditional medicine to treat a variety of ailments.[12] People in India believe that this plant can help with rectal prolapse, diarrhea, fever, and biliousness. It is also thought to be astringent, antiscorbutic, and cooling.[13]*O. corniculata* is frequently described as a plant that is used to cure diabetes in rural Pakistan and Jammu Kashmir.[14] Herbs are used in ancient medicine systems like Ayurveda, Siddha, and Unani.[15] The plant grows in many places and is known to be a problem weed in Southeast Asia, Tanzania, Egypt, and India, among others.[16, 17,18:] The plant is indigenous to Southeast Asia, where it is widely utilised in medicine. Furthermore, the plant originated in Southeast Asia. The plant has adapted to live in Japan as well as other locations outside.[18] It is a very important medicinal plant because it is flexible and has a wide range of biological effects.[19] In the past, it was used to treat problems like diarrhea, stomach sores, toothaches, and tonsillitis.[13, 20, 21,22] In Tanzania, plant products have been used for medicine for a long time.[22] Southeast Asians often use the plant as medicine, which shows that it has a long history with the people there. This plant is eaten as a leafy vegetable by the locals in the Balasore area of Odisha, India, according to an ethnobotany research conducted there. It is also said to be used as an ethnomedicine to treat digestive problems, especially diarrhea.[18] The leaves of this plant are fed to animals. Besides its conventional application for treating peptic ulcers, the herb has gastroprotective effects that include strong antisecretory and antiulcer properties.[23] This plant's traditional use and bioactivity suggest that it could be used to make medicines and nutritional products.[24]

Distribution
The frail, herbaceous medicinal plant Oxalis corniculata Linn (shown in Figure 1) has a poor growth habit. It is commonly found in various habitats such as roadsides, yards, gardens, parks and other human settlements across warmer regions of Bangladesh. This plant is extensively found in both temperate and tropical climates, encompassing the West Indies, South and Central America, North America, and South America.It is considered a ubiquitous weed, thriving in both the Old World and the New World. This medicinal plant is found not only in Florida but also in the states of Texas and Ontario, as well as in the eastern coastal towns of the United States.[25]

Morphological Structure
Oxalis corniculata exhibits a dense growth pattern and forms a mat-like structure in its growth regions. The upper part of the plants is

slightly erect, smoothy or bushy in texture. At the nodes, it branch out from the base and root. [25]

Leaves:
The leaves of *Oxalis corniculata* are palmately compound and trifoliate, with a thin, heart-shaped structure. The petioles are green, thin, cylindricaland pubescent, measuring approximately 3-9 cm in length . The leaflets are green, obcordate, glabrous and measure 1-2 cm in length. They are either sessile or sub-sessile, with a somewhat sour taste . The leaflets are characterized by a noticeable indentation at the apex. The leaves are positioned alternately along the stem, and the leaflets exhibit a network-like venation pattern.[25]

Stem:
The stem of *Oxalis corniculata* is slender and adorned with fine, short hairs. Its internodes measure 5 to 9 cm in length. The stem has a sour taste and emits an acidic odor. [25]

Root:
The root of *Oxalis corniculata* is dark brownish, slender and branching, possessing a soft texture. It lacks both odor and taste.[25]

Flowers:
The flowers of *Oxalis corniculata* are yellow, axillary and arranged in a sub-umbellate manner. They measure 6-12 mm wide and consist of 5 yellow petals.[25]

Fruits:
The fruits of *Oxalis corniculata* are capsule-shaped, measuring 1-1.5 cm in length. They are covered in fine hairs (tomentose), cylindrical, pointed and have ridges. [25]

Seeds:
The seeds of *Oxalis corniculata* are small, dark brown and numerous, with a rounded shape and a tiny base. They are broadly ovoid, with transverse striations, a pointed tip and a flattened, light brown color. The surface of the seeds is distinctly ridged. Additionally, the plant produces stolons.[25]

Phytochemical Constituents
A wide range of phytochemical compounds has been identified and extracted from the complete plant of Oxalis Corniculata Linn, including glycosides, phytosterols, fatty acids, galactoglycerolipid, β-sitosterol, betulin, methoxy flavones, 7-O-β-D-glucopyranoside-4-hydroxybenzoic acid, ethyl gallate, and apigenin. The leaves of this plant contain isovitexine, vitexine-2”-O-beta-D-glucopyranoside, citric acid, tartaric acid, calcium oxalate, flavones (acacetin and 7,4'-diOMe apigenin), flavonols (3',4'-diOMe quercetin), glycoflavones (4'-OMe vitexin, 4'-OMe iso-vitexin, and 3',4'-diOMe orientin), and phenolic acids such as syringic, p-hydroxybenzoic, and vanillic acids. Global research has verified the existence of three C-glycosylflavones: 6-C-glucosyl luteolin (isoorientin), 6-C-glucosylapigenin (isovitexin), and isovitexin 7-methyl ether (sertisin) in the plant. Additionally, ethanolic and methanolic extracts determined the presence of phytosterols, phenolic compounds, glycosides, flavonoids, volatile oils, calcium, proteins, amino acids, carbohydrates, fibres, and tannins (Table-1).[26, 27]

Pharmacological activities
The *Oxalis Corniculata* plant demonstrates several therapeutic qualities, including anthelmintic, pain-relieving and inflammation-reducing effects, diuretic, astringent, depurative, emmenagogue, relaxant, febrifuge, lithontripic, stomachic and styptic effects. A solution from its leaves is employed to alleviate corneal opacities and soothe itching lids when applied to the eyes. A gargle made from a leaf decoction. Additionally, leaves are utilized as a remedy for poisoning caused by Datura seeds, mercury and arsenic. An infusion can also be used to eliminate hookworms in children. Additionally, the plant is utilised as a remedy for the treatment of scurvy.[9] Previous studies have identified additional pharmacological effects of *Oxalis corniculata* herb, including the following (Table-2):

Wound-healing activity
The effectiveness of alcoholic and petroleum ether extracts from the entire Oxalis corniculata plant in promoting wound healing was evaluated using many rat models, including dead space wounds, excision, and resutured incision. The wound healing effects were significant when both extracts were given at dosages of 300 and 500 mg/kg. This was seen in accelerated wound contraction, enhanced wound tensile strength, and a reduced duration for epithelization. (Table-2).[50]

Anti-diarrheal activity
The anti-diarrheal efficacies of methanolic and aqueous extracts obtained from the plant were studied using rat models of diarrhea induced by castor oil and small intestinal transit. The aqueous extract demonstrated greater efficacy compared to the methanolic decoction across all doses tested. Oral administration of doses between 160 and 640 mg/kg of body weight demonstrated anti-diarrheal effects. The decoctions reduced the transit of charcoal meal in the small intestine and lowered the moisture content of fecal matter during castor oil-induced diarrhea. Additionally, they postponed the start of diarrhea and lessened the frequency of bowel movements (Table-2). [51]

Antioxidant activity
The body can be harmed by free radicals, but antioxidants shield the body from harm by reducing oxidative stress.[52] O. corniculata has been studied for its antioxidant potential in a number of plant parts, including leaves, entire plants, and extracts made in various solvents.[53] O. corniculata contains phytochemicals with antioxidant properties, such as glycosides, phytosterols, tannins, flavonoids, and polyphenols. These substances have demonstrated efficacy in scavenging free radicals and mitigating oxidative stress. [54, 55, 56–59] O. corniculata has been shown to possess antioxidant qualities by numerous studies. When compared to the reference standard, ascorbic acid, methanol extract and its sub-fractions from different solvents showed noteworthy antioxidant capabilities in a study. [53, 60] The methanolic extract of the plant exhibited notable in vivo antioxidant activity in rat paw oedema and cotton pellet-induced granuloma formation.[61] Subsequent research revealed that treatment with methanolic extract significantly diminished the oxidative stress caused by carbon tetrachloride (CCl_4) in rats, as indicated by a reduction in liver enzyme levels.[62] The fractions with the highest antioxidant activity were methanol, ethyl acetate, and ethanol. [53,63] The main active ingredient in the aqueous extract, an acidic polysaccharide, dramatically reduced oxidative damage in both Caenorhabditis elegans and the HEK-293 cell line.64 Moreover, O. corniculata has always been conventionally used for a variety of medicinal purposes. According to a study by Rahman et al. (2019), O. corniculata is used by the locals in Pakistan to treat halitosis and vitamin C insufficiency (Table 2).[65]

Anti-cancer activity
Many research have looked at the anticancer actions of O. corniculata. A study revealed that the ethanolic extract may trigger apoptosis in the MCF7 breast cancer cell line via oxidative stress and exhibit notable anticancer and antitumor effects in Swiss albino mice. The hydroalcoholic extract and ethyl acetate fraction inhibit Hep-G2 cancer cell growth. Molecular docking experiments of O. corniculata's phytoconstituents indicate that apigenin exhibits a strong binding energy of 7.90 kcal/mol against the epidermal growth factor receptor tyrosine kinase, which is greater than doxorubicin's binding energy of 7.63 kcal/mol. Another in silico analysis identified isovitexin to inhibit HPV-18, which may help treat cervical cancer. Ugandan researchers found numerous anticancer plants in traditional use. O. corniculata may fight cancer. The mechanisms of O. corniculata's anticancer actions remain unknown. Bioactive substances like quassinoids and

flavonoids may help fight cancer. O. corniculata may fight cancer through apoptosis and antioxidants, according to a study. O. corniculata's phytochemical profile and biological performance make it an attractive candidate for innovative anticancer treatments. O. corniculata's cancer-fighting mechanisms and therapeutic uses need further study (Table-2).[27]

Abortifacient and Anti-implantation activity
Oral administration of petroleum ether and ethanol extracts from the entire *Oxalis corniculata* plant at doses of 100 and 200 mg/kg body weight was conducted from day 1 to 7 of pregnancy. The findings revealed notable anti-implantation effects observed during laparotomy on day 10. Moreover, pregnant ratstreated from day 8 to 14 of pregnancy displayed significant abortifacient properties (Table-2).[66]

Anti-diabetic activity
In a previous study, it was demonstrated that the plant's aqueous decoction was examined for its ability to inhibit procaine pancreatic amylase. Contrarily, the organic extracts demonstrated no significant inhibition, suggesting that the components responsible for amylase inhibition were present only in the water decoction. The study found that a concentration of 100µg/ml of the extract achieved a maximum 89.27% of inhibition (Table-2). [67]

Antibacterial activity
A previous study reported on the antibacterial properties of ethanol and methanol decoctions of the plant. Both decoctions exhibited notable antibacterial activity against *Xanthomonas* and fourteen strains of bacteria known to be pathogenic to humans. When compared to both Bact-805 and K-cycline, methanolic decoctions showed particularly significant effects against bacteria. Regarding the bacteria that are pathogenic to human, methanolic decoctions displayed moderately notable antibacterial properties in comparison to the standard antibiotic streptomycin.[68] The cup diffusion technique was utilized to evaluate the antibacterial effectiveness of various medicinal plants against fourteen notable bacteria that pose a threat to human health. MIC (Minimum Inhibitory Concentration) values were established for the aqueous extraction of plants exhibited bactericidal action. It was found that only 12 plants (26%) demonstrated bactericidal action contrary to the tested pathogens, with varying levels of activity observed among the pathogens. The inhibitory potency was notably strong in the aqueous extraction of *Lawsonia inermis, Oxalis corniculata* and *Acacia nilotica*. Additionally, maximum plant extraction showed greater bactericidal action compared to bacitracin. MIC values for the hydrous extraction of 12 plants ranged from 4 to 50 µl.[69] The research focused on assessing various biochemical parameters and exploring the antibacterial potential of several medicinal plants from North East India, including *Oxalis corniculata, Leucas aspera, Murraya koengigii, Alternanthera sessilis, Pagostemon benghalensis, Hydrocotyl rotendifolia, Cyathula prostrata, Piper peepuloides* and *Potentilla mooniana*. Observation revealed that the hydrous extraction of these plants exhibited varying degrees of antibacterial actions against *E. coli*, as indicated by the zone of inhibition. Notably, the aqueous extract of *Oxalis corniculata* demonstrated the highest zone of inhibition (60 mm).[70] Furthermore, at a concentration of 50µL, the hydrous extraction of *Oxalis corniculata* showed greater significant bactericidal action against*S. flexneri* when compared to extracts from 48 plants belonging to 33 different families (Table-2).[71]

Antifungal activity
The fungicidal efficacy of aqueous extraction from 04 different plants was assessed against various pathogenic fungi. Each of the four plants exhibited distinct antifungal effects against all tested fungi. Notably, *Oxalis corniculata* demonstrated indicatory fungicidal efficacy against *A. niger*, inhibiting fungal mycelial growth by 71 to 86% following three days of incubation. Specifically, the hydrous extraction of *Oxalis corniculata* exhibited a 31% fungicidal efficacy against *A. niger* and a 10.7% efficacy against *P. theae*. [72]

Anti-inflammatory activity
Rats fed with an ethanolic extract of O. corniculata leaves had significant anti-inflammatory action in an experimentally produced in vivo model of inflammatory bowel disease.[73] In a different animal model, the ethanolic extract demonstrated a reduction in inflammation and pain in mice suffering from acetic acid-induced acute peritonitis.[74] A dose-dependent anti-inflammatory effect was seen in the rat model of carrageenan-induced hindpaw edema, wherein β-sitosterol extracted through petroleum ether extraction, in addition to ethanolic extract, was found to reduce paw edema. (Table-2).[75]

Anti-ulcer activity
In an investigation, the anti-ulcer efficacy of ethanolic and aqueous extracts of the plants was assessed at dosages of 200 and 400 mg/kg.. This assessment involved inducing gastric mucosal ulcers with the organic solvent ethanol and ligating pylorus to induce ulcers. Following treatment with the decoctions, a notable decrease in the stomach volume was observed, along with a reduction in acidity levels. Additionally, levels of catalase and SOD were raised while lipid peroxide levels were reduced in response to both decoctions (Table-2). [76]

Anti-epileptic activity
The anti-epileptic attribute of methanolic leaf decoctions were assessed at doses of 200 and 400 mg/kg body weight using MES (Maximal Electroshock) and Pentylenetetrazole (PTZ) initiated seizure models in animals. Similar dose-dependent outcomes were observed in the Pentylenetetrazole model, where the decoction slowed the initiation of clonic spasm. Complete protection against survival rate was noted in both trials, indicating the decoctions anti-epileptic properties against MES and PTZ induced spasm. These effects may be related to enhancing the function of GABA receptors and their signal transduction mechanisms (Table-2).[77]

Hypolipedemic activity
Hyperlipidemia was instigated in animals by administering a high-fat diet comprising of coconut oil and vanaspati ghee at a dose of 10 ml/kg. The decoction used in the study significantly decreased triglycerides, cholesterol, LDL and MDA levels in the blood. Conversely, SOD, HDL and CAT levels were notably raised (Table-2).[78]

Cardio relaxant activity and cardio protective activity
A methanolic extraction of *Oxalis corniculata* demonstrated dose-dependent relaxant action on isolated rabbit ileum and exhibited cardio relaxant effects on isolated rabbit heart. In anaesthetized rats, a decrease in diastolic pressure, with a smaller decrease in systolic pressure, was also noted. Additionally, anhydrous extraction has been shown to have cardio protective effects in an trial framework of myocardial infarction induced by isoproterenol in rats (Table-2).[79]

Nematocidal activity
The ethanolic extraction of *Oxalis corniculata* has been found to exhibit nematotoxic activity against phytoparasitic nematodes. Another study reported similar activity of the ethanolic extract against *Meloidogyne incognita*. After a 7-day incubation season, immobility of the nematode was noticed under a light microscope, confirming the plant's nematocidal activity (Table-2). [72]

Antiamoebic activity
Oxalis corniculata was found to contain several compounds with anti-amoebic effects in laboratory cultures of E. histolytica. These compounds were identified using nuclear magnetic resonance, infrared and mass spectrometry techniques as follows: (i) Oc-1, a blend of saturated fatty acids ranging from C24 to C28; (ii) Oc-2, a blend of long-chain alcohols ranging from C18 to C28; and (iii) Oc-3, a

singular compound identified as a galacto-glycerolipid (GGL). Among these compounds, GGL exhibited the most potent anti-amoebic effects. [72]

Allelopathic activity
The allelopathic potential of the exudate from dried leaves of 53 plant species, including Oxalis plants, was assessed using the "Sandwich Method" with lettuce (*Lactuca sativa* L. var. Great Lakes 366) as the recipient plant. A wide range of allelopathic activity among different plant species was observed. Results indicated that *Oxalis corniculata* L. and *Begonia spp*. inhibited the growth of lettuce radicle and hypocotyl by approximately 10% or less compared to the control. The study also suggested that the presence of oxalates and other unidentified inhibitory compounds may contribute to the allelopathic effects of these plants abundant in oxalates.[72]

Steroidogenic activity
Scientific studies have shown that Oxalis corniculata has steroidogenic effects; this all-natural substance has several potential applications since it has no negative effects on bodily functions. This was proven by the fact that it had no effect on the adrenal gland, an endocrine organ, which allowed female albino rats treated with the extract to keep working normally. [72]

Toxicological Studies
An experiment was conducted to examine the effects of the methanol extraction on CCl4-induced nephrotoxicity in rats. Increased levels of creatinine, protein, urobilinogen, nitrite, and RBCs and WBCs as well as increased urinary specific gravity were indicators of nephrotoxicity following intraperitoneal injection of CCl4 (1 ml/kg body weight, 20% in olive oil) once daily for seven days. Furthermore, the hepatoprotective effects of hydrous and ethanolic leaf decoctions were tested against thioacetamide-induced hepatotoxicity. The decoctions were given at doses of 200 and 400 mg/kg, respectively. In comparison to the positive control group, those who took 400 mg/kg of aqueous or ethanolic leaf decoctions orally saw a marked decrease in biochemical measures including GGTP, ALP, SGPT, SGOT, and bilirubin extent..[72]

Anti-arthritic activity
The anti-arthritic efficacy of petroleum ether, ethyl acetate, and ethanolic extracts of Oxalis corniculata was assessed utilizing the egg albumin denaturation method and juxtaposed with the standard Diclofenac sodium. Among the extraction, the ethanol extraction exhibited the most significant action, ensued by the petroleum ether extraction. The ethyl acetate extraction showed very little action among the three extraction. The inhibition levels observed with the ethanol extract at all three concentrations were comparable to those of diclofenac, indicating its potential anti-arthritic action, nonetheless the extracts from petroleum ether and ethyl acetate had just moderate efficacy(Table-2).[80-82]

Anxiolytic effect
The anxiolytic efficacy of the ethanolic extract of Oxalis corniculata was evaluated using the open field test, elevated plus maze test, and anti-fighting test, with intraperitoneal dose of diazepam at 1 mg/kg as the reference anxiolytic agent. The administration of dosages at 100 and 300 mg/kg significantly increased the number of squares traversed in the open field test, while concurrently decreasing immobility and fecal pellet count relative to control mice. In comparison to the control group, the extract in the elevated plus maze test increased the frequency of entry into the open arms while reduced the number of entries and length of time spent in the closed arms. Moreover, the extract decreased fighting episodes significantly assimilated to control mice. These findings align with the anxiolytic effect observed with diazepam.[83]

Hepatoprotective activity
The levels of blood bilirubin, AST, ALT, and ALP in rats' livers were significantly lowered by an aqueous leaf extract when exposed to CCl4. When contrasted with the livers of CCl_4-treated rats, it showed less damage.[84] Further research using ethanolic extract showed that it protected rat liver cells against thioacetamide (TAA)-induced damage by stabilizing the cell membranes.[85] A "drug-active ingredient-target-disease" network was developed via network pharmacology in a computational study that used active chemicals from O. corniculata and 30 putative targets, including TP53, AKT1, ALB, and IL6. The investigation uncovered various signaling pathways and biological mechanisms that could be involved in the anti-hepatic effects.(Table-2).[86]

Anthelmintic activity
The research utilized adult earthworms, Eisenia foetida, because of their morphological and physiological resemblances to the intestinal roundworm infection in humans. Both the methanolic and petroleum ether extracts of Oxalis corniculata Linn. were shown to be effective anthelmintics, but the ethyl acetate extract was found to be just as active as the reference medicine, Levamisole. Each extract, at concentrations of 100, 200 and 400 mg/ml, induced Earthworm paralysis varies with dose, leading to a loss of motility followed by a loss of response to external stimuli, ultimately resulting in death (Table-2). [87]

Analgesic activity
The analgesic effect of *Oxalis corniculata*'s ethanolic extract was tested in *Swiss albino* mice weighing 25–30 gm at 200 mg/kg and 400 mg/kg orally b.w. using the acetic acetic acid writhing method. The ethanol extract, when taken orally, considerably decreased the number of times that the subject writhed compared to the control group across both dose levels. The outcomes of the pharmacological test show that the ethanol extract reflects potent analgesic action. Therefore, it can be considered as a better alternative for treatment compared to current NSAID and analgesic drugs(Table-2). [88,89]

Antipyretic activity
The ethanol extract of Oxalis corniculata was tested for its ability to lower body temperature by giving rats Brewer's yeast-induced fever at doses of 200 mg/kg and 400 mg/kg orally. Regarding the control group, oral ethanol extract treatment reduced pyrexia from 1 to 4 hours from beginning (0 hours) in the same group of animals at both dose levels. The findings of the pharmacological test signify that The ethanol extract exhibits significant antipyretic efficacy. Therefore, it can be considered as a better alternative for treatment compared to current NSAID and antipyretic drugs (Table-2).[90-92]

Anti-dipsotropic activity
The anti-dipsotropic potency was assessed using alcohol consumption and withdrawal anxiety models. On day 11 of the study, animals treated with ethanol spent notably much time in the ethanol-associated chamber than the chamber associated with saline ($P<0.001$). The administration of EE at doses of 200 and 400 mg/kg led to a dose-dependent reduction in withdrawal anxiety, as evidenced by a notable increase in the time spent in the open arm ($P < 0.01$). This indicates that EE 200 and EE 400 significantly augmented the duration allocated to the plus maze's open arm, indicating reduced anxiety following alcohol withdrawal and a decrease in total ethanol intake. Oxalis corniculata Linn. exhibits significant anti-dipsotropic activity.[92]

Anti colonizing activity
Oxalis corniculata (Oxalidaceae) was assessed for anti-colonization properties against common intestine harmful bacteria using a suckling mouse model. Mice were orally administered *Shigella flexneri*2a (2457T) and *Shigella* dysenteriae 1 (NT4907) to examine the anti-colonization efficacy. Results demonstrated that the extract had more efficacy against *Shigella* dysenteriae 1 (NT4907) than against *Shigella flexneri* 2a (2457T). Additionally, administering the extract

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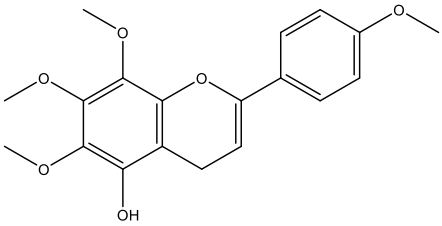
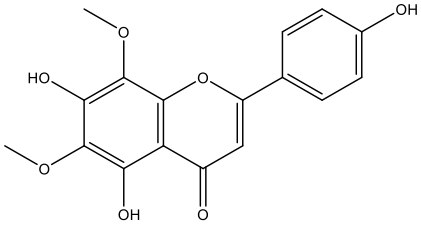
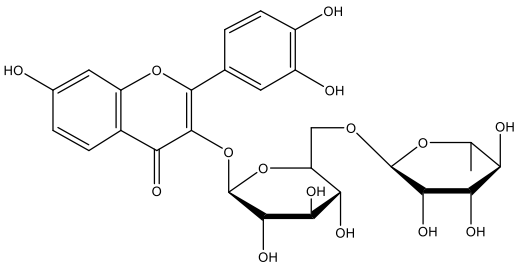
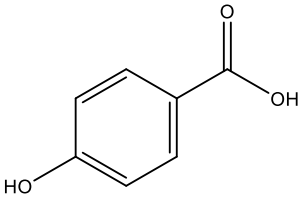
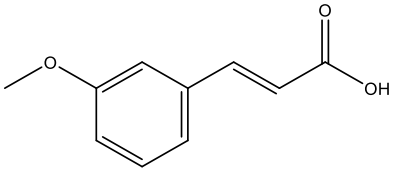
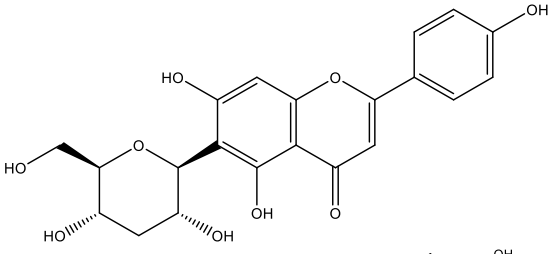
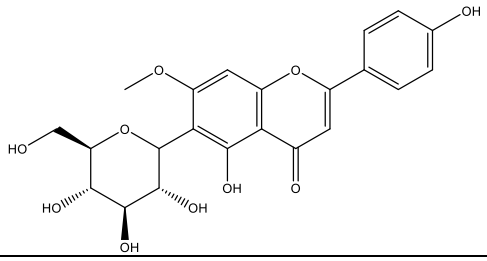
simultaneously alongside bacterial inoculums showed promising anti-colonization potency. Notable potency was seen even when the extract was administered after 3 hours of bacterial inoculation. These findings suggest that *Oxalis corniculata* Linn. exhibits notable anti-colonizing activity.[93]

Table-1: Chemical constituents isolated from *Oxalis corniculata*

Compound	Structure	Plant part	References
5-hydroxy-6,7,8,4'-tetramethoxy flavone		Whole plant	28
5,7,4'-tryhydroxy -6,8-dimethoxy flavone		Whole plant	28
Rutin		Leaves	29,30
P-hydroxybenzoic acid		Leaves	29,31
Ferulic acid		Leaves	29
Isoorientin		Whole plant	32
Swertisin		Whole plant	33, 34

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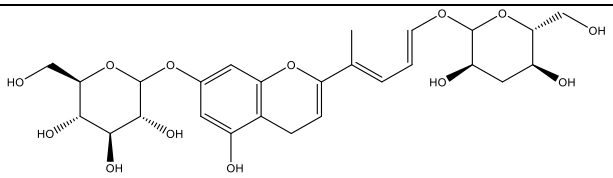
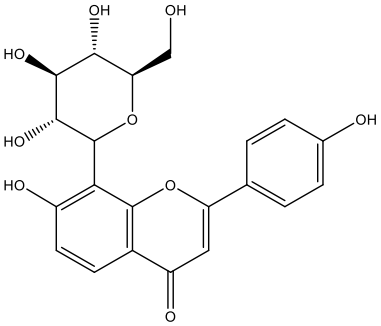
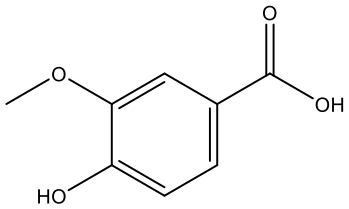
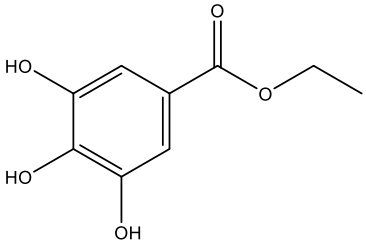
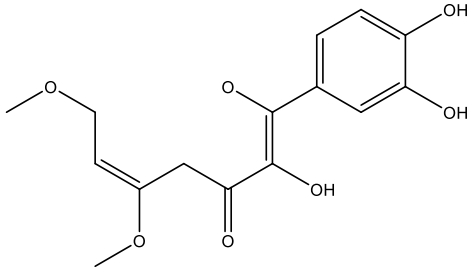
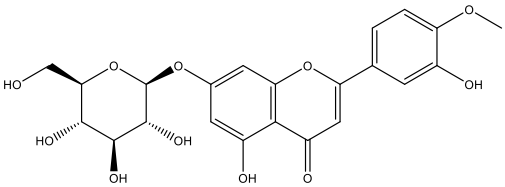
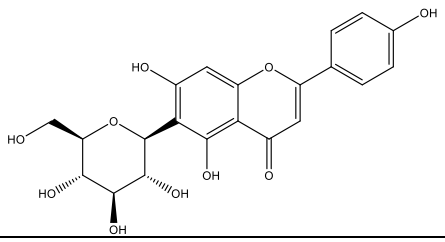
Apigenin 7,4'-diglucoside		Whole plant	35
Vitexin		Whole plant	35 ,36
Vanillic Acid		Whole plant	35,37
Ethyl gallate		Whole plant	35,38
5,7-dimethoxy-3,3',4'-trihydroxy flavone		Whole plant	35
Diosmetin-7-O-beta-D-glucopyranoside		Whole plant	35
Isovitexin		Leaves	34,39

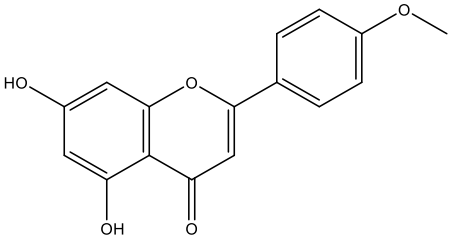
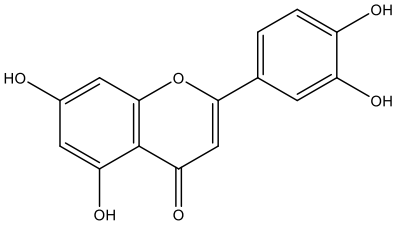
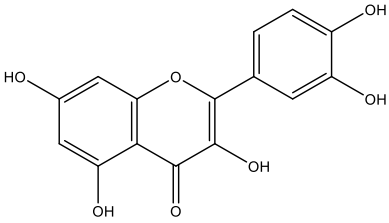
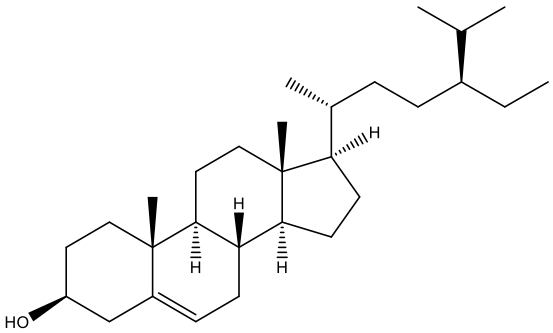
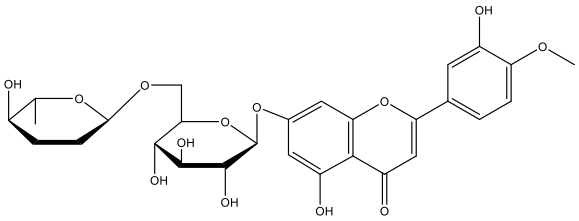
Acacetin		Leaves	40,41,42
Luteolin		Whole Plant	43, 44
Quercetin		Whole Plant	35,45
β-sitosterol		Leaves	46,47
Diosmin		Whole Plant	48,49

Table-2: Pharmacological properties of *Oxalis corniculata*

Pharmacological properties	Plant parts	Solvent	Authors
Wound-healing	Plant	Alcohol, petroleum ether	50
Anti-diarrheal	Plant	Aqueous, methanol	51
Antioxidant	Plant	Methanol, ethanol	33, 52-65
Anti cancer	Plant	Ethanol	27
Abortifacient	Plant	Ethanol, petroleum ether	66
Antidiabetic	Plant	Aqueous	67
Antibacterial	Plant	Ethanol, methanol, aqueous	68-71
Antifungal	Plant	Aqueous	72
Anti-inflammatory	Plant	methanol	73-75
Anti-ulcer	Plant		76
Anti-epileptic	Leaves	Ethanol, aqueous	77
Hypolipedemic	Leaves	Ethanol	78
Cardio relaxant and cardio protective	Plant	Methanol	79
Nematocidal	Plant	Methanol	72
Anti-arthritic	Plant	Ethanol	80-82
Anxiolytic	Plant	Petroleum ether, ethyl acetate, ethanol	83
Hepatoprotective	Plant	Ethanol, aqueous	86

Anthelmintic	Plant	Methanol, petroleum ether, ethyl acetate	87
Analgesic	Plant	Ethanol	88,89
Antipyretic	Plant	Ethanol	90-92
Anti-dipsotropic	Plant	Ethanol	92

Conclusion

The article provides a brief overview of the traditional knowledge and medicinal uses of *Oxalis corniculata* Linn. It highlights the plant's historical use in folk medicine as well as its phytochemical and pharmacological properties that support its therapeutic value. Additionally, it suggests that due to its readily accessible, inexpensive and minimal farming requirements, *Oxalis corniculata* could serve as a supplementary food source. The article concludes by emphasizing the need for further research on this plant due to its promising potential.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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