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REVIEW ARTICLE

An ethnobotanical role of *Calotropis procera* (Aiton) R. Br. rubber bush (apple of Sodom) widely grown in a desert environment – A review

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ABSTRACT

Calotropis procera (Aiton) R. Br. is flowering desert plant species. *C. procera* is a broad leaves, evergreen shrub of the milk weed family. *C. procera* is playing a positive economic and ecological role in the conditions of aridity. The seedling growth ability of *C. procera* found well adapted in dry climatic conditions. The different parts (leaves, fruits, flower, bark, stem, whole part) of *C. procera* used for the treatment of diarrhea, malaria, cancer, jaundice, rheumatism, fever, diabetes, and many skin disease problems traditionally since long period of human beings. *C. procera* also utilized for fodder, fuel, phytoremediation and synthesis of nanoparticles.

The published research article data was searched from different electronic engines English databases likewise, Google, Google Scholar, NIH (National Library of Medicine), Conbio (Society for Conservation of Biology), PubMed and science direct.

The goal of this review was to search and analyze the research articles available covering period of 1981-2024 on *C. procera.* The *C. procera* is playing helping role in balancing the desert ecosystem due to its better adaptation potential to such diverse climatic conditions. Many researchers have reported that the change of climatic conditions, scarcity of water and indiscriminate discharge of various types of toxic pollutants, overgrazing, and some natural activities responsible for the main reason of decline of this plant species since last couple of decades very rapidly. The present review findings would be helpful for conservation groups, ecologist, nongovernmental organizations, and governmental sectors, researchers, land manager, environmental manager and field management, industrial sectors and pharmaceutical sectors are working on this aspect at regional and international levels.

Keywords: alkaloids; biodiversity; climate change; ecology; essential oils; grazing; latex; phytochemicals; pollution; revegetation; richness; seedling

1. Introduction

C. procera is multipurpose ever green shrub and commonly known as giant milk weed. *C. procera* is a member of the family *Apocynaceae* and prefer to grow successfully in arid and semiarid at global level include, Brazil, Middle East, Saudi Arabia, India, Pakistan and some parts of Africa. The beneficial use of *C. procera*

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comprised on the fiber production, phytoremediation, biofuel and synthesis of nanoparticles. The ethnobotanical studies on *C. procera* was reported from cholistan desert of Punjab and federally administrated tribal areas in Pakistan[1]. Similarly, Eisikowitch[2] examined the different morphoecological aspects of *C. procera*. The synthesis of gold nanoparticles from the aqueous extract of *C. procera* latex was determined[3].

C. procera traditionally used in medicinal systems for the cure of various ailments such as asthma, cough, cancer, diarrhea, dysentery jaundice, malaria, wound healing, and skin related diseases by native across North Africa, Middle East Asia, and South-East Asia[4,5]. The usefulness of latex in terms of the mechanism of action of the compound with some clinical trials was obtained[6]. However, latexes of different plants exhibit diverse activities against invaders[7]. The latex of the *Calotropis* plant contains compounds that possess anti-inflammatory properties, permanent endothelial cell injury[8,9]. Similarly, Abebe and Emire[10] used to manufacture of fresh cheese using east African *C. procera* leaves extract crude enzyme as milk coagulant.

However, in recent years the growth and distribution of *C. procera* is under threats due to human and expansion of industrial and agricultural areas. Furthermore, natural disturbances as wind storm, salt concentrations, global warming and changes in temperature regime are the additionally contributing key factors on the growth and habitat of *C. procera*. Therefore, the main objectives of this review was obtained from the published literature on the ethnobotanical properties of *C. procera.* The findings would be also helpful in understanding the use of *C. procera* in industrial sectors. This study will guide researchers working for the improvement of vegetative cover for the fields of food science, herbal medicine, and pharmaceuticals.

2. Materials and method

This review contains more than 200 references with emphasis on the ethno botanical potential on *C. procera*. The information related to topic was gathered from scientific published data with the help of searching different English online data bases electronic search engines likewise, Google, Google Scholar, NIH (National Library of Medicine), Conbio (Society for Conservation of Biology), PubMed, Scopus, Web of Science, springer open, springer link, and science direct. AMA style of reference citation in alphabetical order was selected. The key words as alkaloids; biodiversity; biodegradability; climate change, diversity; ecology; grazing; invasive species; latex; medicinal plants; natural recovery; phytochemicals; plant community; pollution; revegetation; richness; salt; seeding; species composition were used.

3. Botanical description – distribution

C. procera a latex bearing plant species found in the arid and semi-arid region of the world and has the capability of tolerance to drought, salinity, high temperature and drier parts of the tropical and subtropical areas also successfully. The botanical, ecological, pharmacological, and physicochemical properties of *C. procera* was examined extensively around the world by plant researchers (**Table 1-4**).

Additionally, *C. procera* is evergreen, a Petro crop, which implies that it is capable of producing biofuel promising candidate for biogas production (Padmaja *et al.,* 2009).

Table 1. Botanical description of Caloropis procera.

	Picture of *Calotropis procera* (Calotrope) taken from the Malir Hault bus stop, Karachi, Pakistan. Description: desert plant Owner: (Author): Muhammad Shafiq Ph.D.
Botanical classification	Apocynaceae>*Asclepiadaceae*>*Calotropis*>*Calotropis procera* Ait.
Common name	Apple of Sodom, Indian milkweed (English), Aak (Hindi). Akonda in (Bengali). Aak or Madar in Hindi.
Traditional use	The seed oil used for the treatment of inflammation. Its flowers offered for worshipping Lord Shiva, a Hindu God. Local application produces an intense inflammatory response and its latex contain plenty of pharmacologically active compounds. It is medicinal plant has been cultivated in for the production of fibres.
Inflorescences	Terminal and extra-axillary, each with subumbelliform clusters of flowers.
Leaves	Leaves 5-15 x 1.8-10 cm, young leaves covered with white cottony tomentum.
Fruit	6.5-9.5 x 3-5.1 cm, large bladdery 'pod' greyish-green in colour.
Flower	Flowering all the year round.
Seeds	Seeds ovate and 6-8 mm long.
Environmental potential	It thrives on poor soils.
Propagation – seed dispersal	The tree seeds freely, and natural regeneration is common.
Distribution	Algeria, Egypt, Morocco, Ethiopia, Sudan, Somalia, Kenya, Tanzania, Nigeria, South West Asia (India, Pakistan, Afghanistan, Iran, Nepal) Arab world (Iraq, Arabia, Oman, Yemen and Jordan) and common in the Middle East and Thailand and Vietnam.
Habitat	A weed along degraded roadsides, waste areas, near inland watercourses, coastal sand dunes, grasslands, open woodlands and pastures.
Invaded species	Its unnatural expansion has been witnessed in the regions of South America, the Caribbean Islands, Australia, Mexico, and several Pacific Islands.
Biomass yield	4.47 and 13.74 kg/plant.
Bioenergy / fossil fuel	Stem of the plant achieved a biogas yield of 17,744 ± 12 mL.
Habit	This upright xerophytic shrub that can grows upto a height of 6 m and above.
Miscellaneous uses	It is cultivated for the production of fibres, intensive energy, petro plant (biogas), liquid fuel.
Weed – biological control	Bionomics and damage potential of fruit fly *Dacus persicus* (*Diptera: Tephritidae*): a prospective biological control agent of *C. procera*.
References: [11-24].	

3.1. Renewable sources of energy and potential as petro crop

The latex bearing plants *C. procera* as a petro crop has a potential of renewable sources of energy. The different parts or whole parts of *C. procera* showed the variable level of elemental composition, liquid fuels,

hydrocarbons, crude protein and ash[25]. The biomass of *C. procera* was made to assess the biogas potential for energy production on wet basis before and after digestion in Chad [26].

3.2. Bioremediation of heavy metals from contaminated environment

The environmental contamination due to addition of heavy metals causing a serious health risk to living organism. The plants are alternatives to remove pollutants from the contaminated environment. In this context, *C. procera* was identified as a good example of removal of heavy metals from contaminated soils in Urban North Central India[27]. In another studies, *C. procera* and *Citrullus colocynthis* showed a better potential of bioaccumulation of heavy metals [28,29]. *C. procera recorded* helpful for crude oil removal[30].

3.3. A biotic stress toxicity and tolerance to salts and pollutants

C. procera reported drought, salinity and salt tolerance and water stresses in plant species[31-35]. The latex peptidases of *C. procera* was used as an alternative to treatment of toxic sodium sulfide pollutant during dehairing of leather[36]. The pollution induced toxicological changes in physiology, defence system and biochemical characteristics of *C. procera*[37]. The accumulation of airborne particulate matter, toxic heavy metals pollution by *C. procera* in the environment of urbanized areas were observed[38,39]. The tolerance capacity of *C. procera* for the detoxification of hexavalent chromium, nickel, and lead was also investigated[40].

4. Bioactive compounds and biological activities

Plants are green resources of many bioactive compounds and play an important role in many biological activities (**Table 2**). The survey data showed the presence of lignans, terpenes, and coumarins, phenolic acids of phytochemicals in leaves and latex of *C. procera*. The common biological activities and phytochemical mainly includes on the phenolic, antioxidant, anti-inflammatory, antitumoral, hypoglycemic, gastric protective, anti-microbial, insecticide, anti-fungal, anti-parasitic and antiradical[41-46].

Table 2. Identification of Phytochemical compounds from Calotropis procera.

Elements	Chemical compounds	Reference
Calotropis cork	The composition contains a large amount of inorganic material such as 21.5 % of ash.	[47]
Root bark	Norditerpenic ester and pentacyclic triterpenoids	[48]
Leaves, stem, bark and whole plant	Carbon contents varied from 38.5% to 44.9%.	[49]
Plant	Phenolics as potential antioxidant therapeutic agents.	[50]
Whole plant	Polyphenolic compounds	[51]
Flowers	Cytotoxicity and polyphenolic content activities.	[52]
protease from the latex	Isolated protease from the latex of *C. procera* by an aqueous two-phase system (ATPS) using Polyethylene glycol (PEG 1000, 2000 and 3000) at a concentration of 12, 15, and 18% (w/w) with salts ((NH4)2SO4, K2HPO4 and MgSO4) at a concentration of 14, 17, and 20% (w/w). The results showed the highest protease recovery (74.6%) was found in the PEG-rich phase of the system ($p<0.05$), comprising of 18% PEG 1000 and 14% MgSO4.	[53]
Root bark	New ursane type triterpenes.	[54]
Plant extract	The isolation of four flavonoid glycosides.	[55]
Aqueous root extract.	The total phenol and flavonoid contents.	[56]

Whole plant	Essential oil composition from Iran.	[57]
Root barks	Proceraside A, a new cardiac glycoside.	[58]
Root bark	Calotroposides H–N.	[59]
Root	Acyclic diterpenic constituents.	[60]
Plant material	Traditionally used for its digestive and anti-asthmatic effects.	[61]
Seed fiber	Characterization of nanocelluloses isolated from Ushar.	[62]
Fruits, flowers, leaves from Saudi Arabia	isolation of lignan 7'-methoxy-3'-O-demethyl-tanegool-9-O-β-d-glucopyranoside.	[63]
The ethanolic leaf extracts	The fatty, palmitic, linoleic and amino acid.	[64]
Whole plant	Phenolic contents.	[65]
The whole plant material	Aldehydes, ketones, organic acids, phenols and alcohols.	[66]
The fresh and healthy branches	The chemical profiles of the essential oils (Eos) from both ecospecies of Saudi Arabia and Egypt.	[67]
Leaves and bark	Pharmaceutical potential and phenolics profiling.	[68]
Root bark	dihydroquercetin glycoside isolated.	[69]
Whole plant	Soluble laticifer proteins.	[70]
Aqueous leaf extract	Rich in phenols and flavonoids.	[71]
all the plant parts extracts	Tannins, alkaloids, flavonoids, phenols, glycosides.	[72]

Table 2. (*Continued*).

4.1. Phytochemical profile

The identification of phytochemical constituent, biological activities and isolation of essential oil, total phenols as the active constituents from *C. procera* was isolated by different researchers[73-80] and plant hydrocarbons[81].

4.2. Allelopathic and insecticidal potential

The allelopathic potential of *C. procera* (giant milk weed) on weeds, growth of *Brassica oleracea* var. botrytis (broccoli) and inhibition of some plant species was noted [82,83]. The allelopathic activity of *C. procera* was also tested against different weeds such as *Bidens pilosa* (Spanish needle) and *Dactyloctenium aegyptium* – (crowfoot grass) and *Portulaca oleracea* (Pigweed) and *Chenopodium murale* (Salt green)[84]. The aqueous extracts from *C. procera* showed the insecticidal potentialities against (Melon lady bird beetle) *Henosepilachna elaterii* Rossi[85].

4.3. Antimicrobial potential against fungal and bacterial

The *C. procera* plant extract was against selected pathogenic microorganisms was reported by researchers[86-92]. The leaves extract of *C. procera* with various concentrations (1%, 2.5%, 4%, 5.5% and 7%) showed their antifungal potential against *Macrophomina phaseolina* (Tassi) Goid on an important pulse crop, Mung bean[93]. The essential oils treatment from *C. procera* was examined for antimicrobial activities against seven bacterial and two fungal strains. Similarly, the phyto-nanoparticles of iron showed their antifungal potential against *Alternaria alternata* in the presence of *C. procera* leaf extract[94]. The bioactive compounds from the roots of *C. procera* were used to treat infection. The anthelmintic activity of *C. procera* latex against *Haemonchus contortus* infection in Najdi sheep was observed[95]. Aswal *et al.,*[96] isolated white rot fungi for lignin degradation of *C. procera* fibre.

5. Ethno medicinal properties of *C. procera*

The *C. procera* used as medicine for the control of rheumatism, painful muscular spasms, fever, dysentery, diabetes, malaria, asthma and as antioxidant, antimicrobial, anticancer agent and pharmacological properties all over the world since early civilization[97-99]. Many research studies have explored the different aspects of *C. procera* about this medicinally endangered plant likewise studied in the Northern regions of Pakistan[100].

Table 2. The beneficial medicinal properties of Calotropis procera.

Treatment	Reference
Corticosteroid and antiviral therapy.	[101]
Antiulcer activity.	[102]
Anti-diarrhoeal activity.	[103]
Gastrointestinal smooth muscles.	[104]
The corneal edema resolved.	[105]
Human cancer cell lines.	[106]
Induced keratitis (eye corneal ulcer).	[107]
Human cancer cell lines.	[108]
Anti-inflammatory and gastromucosal.	[109]
Analgesic activities.	[110]
Tumor cells.	[111]
Wound healing.	[112]
Diabetic neuropathy.	[113]
Calotropis induced ocular toxicity.	[114]
Effective against selected dermatophytes.	[115].
The healing action against surgical wounds.	[116]
An inhibitors of key enzymes linked to diabetes mellitus.	[117]
Against tumor cell lines.	[118]
Anti-diarrheal.	[119]
Beneficial effect in gastrointestinal disorder.	[120]
Anti-ulcerative colitis activity.	[121]
Antidiabetic potential.	[122]
Anticancer effects on breast cancer cells (MCF-7).	[123]
A promising alternative for oral mucositis treatment.	[124]
Snake bite, body pain, asthma, epilepsy, cancer, sexual disorders, skin diseases.	[125]
Effective in treating disorders of gastrointestinal system and cancer.	[126]
The antiproliferative effects on human colon (HCT-116) and breast (MCF-7) cancer.	[127]

5.1. Anti-oxidant activity

An antioxidant effect of different solvent extract of latex of *C. procera* were evaluated[128-139]. The aqueous and ethanol extract of Calotropis procera leaf and latex were tested against pathogenic organisms (*Eschericia coli, Salmonella typhi, Bacillius subtilis, Candida albicans, Aspergillus niger*) using the Agar well

diffusion method[140]. The results revealed that ethanol was found more effective extractive solvent for antimicrobial activity of leaf and latex of *C. procera*.

Table 3. Microbial, antiradical, insecticidal and biopesticide potential of Calotropis procera.

Treatment-investigation	Reference
Antifungal and molluscicidal properties.	[141]
Anti-inflammatory activity.	[142]
Control of Musca domestica.	[143]
toxicity upon egg hatching of *Aedes aegypti* (L.).	[144]
Larvicidal properties against mosquito larvae.	[145]
Antifungal effect on *Epidermophyton flocosum* and *Trichophyton gypseum.*	[146]
Antioxidant and antibacterial activities.	[147]
Efficacy in controlling *anopheles arabiensis* and *Culex Quinquefasciatus* mosquitoes.	[148]
The insecticidal efficacy against *Musca domestica*.	[149]
Growth inhibition of sarcoma 180.	[150]
Larvicidal efficacy against *Culex quinquefasciatus*.	[151]
Osmotin a new insights into structure and antifungal properties.	[152]
Antimicrobial potential.	[153]
Biological activity against *Anopheles stephansi* Larvae.	[154]
Antibacterial properties.	[155]
Anti-plasmodia activity.	[156]
Antibacterial.	[157]
Identified novel protein that can suppress tumor growth in breast cancer.	[158]
Treat ringworm infection.	[159]
Potential use against two coleopteran pests of stored rice.	[160]
Antifungal activities of *C. procera*.	[161]
Effect on parasitological parameters of broilers.	[162]
The antioxidant properties with different anti-diabetic drugs.	[163]
The insecticidal efficacy against cotton mealy bug (*Phenacoccus solenopsis*) .	[164]
Remarkable antibacterial activity.	[165]
Latex effects on *Haemonchus contortus.*	[166]
Revealed the presence of steroid and saponins.	[167]
Antifungal activity of cysteine peptidases.	[168]
As a bioadsorbent remove Acid Red 73 dye.	[169]
Anti-proliferative, antioxidant effects on lung cancer cells (H1299) and its ameliorative effect on expression of CD146 on blood cells.	[170]
Against an antimicrobial activities.	[171]
Antimicrobial, antigenotoxicity, and characterization of its rhizosphere inhabiting actinobacteria.	[172]
The variable anticoccidial activities on *Eimeria stiedae* Oocysts Isolated from Rabbits.	[173]
Deterrent effect on feeding of *Plutella xylostella* (L.)	[174]

6. Environmental relevance

High salinity has resulted in dramatic losses of arable land[175]. The plants are known to synthesize carbohydrate binding proteins upon exposure to stresses like drought, high salt, hormone treatment and pathogen attack[176] and become invader due to their capabilities of adaptation in such stressful environment. The seedling growth of the invader *C. procera* in seasonally dry forest soils was observed[177] . *C. procera* was recognized as an invasive alien species (IAS) in South America, forming vast clusters in disturbed areas due to the presence of the dry environments[178]. Amini *et al.,* (2022)[179] investigated the salt impurities removal using twig, leaf and flower extracts of *C. procera*. *C. procera* invaded nearly 3.7 million hectares of drier areas in Australia[180].

7. Potential application in nanotechnology

Nanotechnology is playing promising role in improving the quality of agriculture, pharmaceutical products, biopesticides, fertilizers, pest control and healthy environment. The copper oxide nanoparticles of *C. procera* and their anti-pathogenic activities against phytopathogens was evaluated[181].

The significant biological potentials and potent antioxidant activity against plant pathogens by NPs well documented in scientific literature. The anthelmintic efficacy of *C. procera* and its synthesized silver nanoparticles (AgNPs) against the eggs and miracidia of *Fasciola* zoonotic species was recorded[182]. In addition, Nanotechnology is playing promising role in solving the challenges issues of food, agriculture and environment and improve the performances of agriculture, medicine, environmental and remediation sectors. The application strategies for various pesticides/biopesticides with current and future scenarios was discussed with the use of nanoparticles (NPs) against pests as well as the antifeedant, larvicidal, and pupicidal actions of the products[183].

8. Conclusion

This review evaluated the ethno botanical potential of *C. procera* through the survey from articles published in scientific literature. The *C. procera* proved well adapted in harsh desert environment. The seedlings when damage produced white latex material. The different parts of *C. procera* plant sspecies are traditionally in use in clinical trials and treatments of different types of ailments such as an antioxidant, antimicrobial, and anticancer agent by human beings since dawn of civilization. Also, this review gives a sound technical basis and suggested for further research in economic, pharmaceutical and environmental sustainability field. This review might be helpful for making decision of *C. procera* cultivation by policymakers, governmental, nongovernmental, farm manager, and land management to save. *C. procera* is under abiotic stress and might become extinct from the universe due to different types of anthropogenic activities. The findings from this study conclude that this species can use as sustainable energy alternatives and resources in developing countries to overcome the electricity issues.

Author contributions

The validation investigation, resources, data curation, and writing of manuscript worked by MS. The original draft was reviewed and checked by MZI and MA. All authors contributed to the manuscript. All the authors read and approved the final manuscript.

Conflict of interest

All authors declare no conflict of interest exist.

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References

1. Azhar MF, Siddiqui MT, Ishaque M, Tanveer A. Study of ethnobotany and indigenous use of Calotropis procera (Ait.) in cholistan desert, Punjab, Pakistan. Journal of Agricultural Research, 2014:52(1): 117-126.
2. Eisikowitch D. Morphoecological aspects on the pollination of Calotropis procera (Asclepiadaceae) in Israel. Plant Systematics and Evolution, 1986:152: 185-194.
3. Das RK, Sharma P, Nahar P, Bora U. Synthesis of gold nanoparticles using aqueous extract of Calotropis procera latex. Material Letters, 2011:65: 610–613. doi: 10.1016/j.matlet. 2010.11.040
4. Abhishek D, Ashish MC, Ameeta GA. Medicinal utility of Calotropis procera. (Ait.) R. Br. as used by natives of village Sanwer of Indore District, Madhya Pradesh. International Journal of Pharmacy and Life Sciences, 2010:1:188-190.
5. Iqbal U, Hameed M, Ahmad F. Structural and functional traits underlying the capacity of Calotropis procera to face different stress conditions. Plant Physiology and Biochemistry, 2023: 203, 2023, 107992, doi: 10.1016/j. plaphy. 2023.107992
6. Dogara AM. A systematic review on the biological evaluation of Calotropis procera (Aiton) Dryand. Futur Journal of Pharmaceutical Sciences, 2023: 9,16 (2023). doi: 10.1186/s430 94-023-00467-3
7. Nawrot R, Musidlak O, Bałdysz S, Węglewska M, Warowicka A, Goździcka-Józefiak A. Chapter Ten - Traditional use and perspectives for the application of plant latex and its constituents in agriculture, medicine and industry—A follow-up of ABR volume 93 "Latex, laticifers and their molecular components from functions to possible applications", Editor(s): Jean-Pierre Jacquot. Advances in Botanical Research, 2021: 100: 301-327. doi: 10.1016/bs.abr.2021.01.006
8. Arya S, Kumar VL. Antiinflammatory efficacy of extracts of latex of Calotropis procera against different mediators of inflammation. Mediators of Inflammation, 2005(4):228–232. doi: 10.1155/MI.2005.228
9. Al-Mezaine HS, Al-Amry MA, Al-Assiri A, Fadel TS, Tabbara KF, Al-Rajhi AA. Corneal endothelial cytotoxicity of the Calotropis procera (ushaar) plant. Cornea, 2008: 27(4):504-6. doi: 10.1097/ICO.0b013e3181611c34. PMID: 18434859.
10. Abebe B, Emire S. Manufacture of fresh cheese using east African *Calotropis procera* leaves extract crude enzyme as milk coagulant. Food Science Nutrition, 2020:8: 4831–4842. doi: 10.1002/fsn3.1765
11. von Maydell H. 1990. Trees and Shrubs of the Sahel. Their Characteristics and Uses. Deutsche Gesellschaft fur Technische Zusammenarbeit; Germany.
12. Akinloye A, Abatan M, Alaka O, Oke B. Histomorphometric and histopathological studies on the effect of Calotropis procera (giant milkweed) on the male reproductive organs of wistar rats. African Journal of Biomedicine Research, 2002: 5:1–2.
13. Gilbert MG. Calotropis. Flora of Somalia, 2006: 3: 144.
14. Campbell S, Roden L, Crowley C. Calotrope (Calotropis procera): a weed on the move in northern Queensland, in Proceedings of the 12th Queensland Weed Symposium, 2013: eds M. O'Brien, J. Vitelli, and D. Thornby 11–14.

15. Menge EO, Bellairs SM, Lawes MJ. Disturbance dependent invasion of the woody weed, Calotropis procera, in Australian rangelands. Rangeland Journal, 2017b:39:201–211. doi: 10.1071/RJ16120
16. Menge EO, Stobo-Wilson A, Oliveira SLJ, Lawes MJ. The potential distribution of the woody weed Calotropis procera (Aiton) WT Aiton (Asclepiadaceae) in Australia. Rangeland Journal, 2016b:38:35–46. doi: 10.1071/RJ15081.
17. Al Ghadeer H, Al Gethami A, Al Sulaiman H, Bukhari T. Corneal toxicity after self application of Calotropis procera (Ushaar) latex: Case report and analysis of the active components. Middle East African Journal of Ophthalmology, 2019:26(1):40-42. doi: 10. 4103/meajo.MEAJO_180_18. PMID: 31114124; PMCID: PMC 650 73 79.
18. Farahat E, Galal T, El-Midany M, Hassan L. Effect of urban habitat heterogeneity on functional traits plasticity of the invasive species Calotropis procera (Aiton) W.T. Aiton. Rendiconti Lincei – Scienze Fisiche e Naturali, 2015:26: 193–201. doi: 10.1007/s12210-015-0408-3
19. Kiran K, Mahey S, Sharma A, Kumar V, Sharma A, Arora S. et al. Post-infectional changes associated with the progression of leaf spot disease in Calotropis procera Aiton. Physiological and Molecular Plant Pathology, 2020: 112:101519. doi: 10.1016/j.pmpp.2020.101519.
20. Mettwally WSA, Zahran HA, Khayyal AE, Ahmed MKE, Allam RM, Saleh DO. Calotropis procera (Aiton) seeds fixed oil: Physicochemical analysis, GC–MS profiling and evaluation of its in-vivo anti-inflammatory and in-vitro antiparasitic activities. Arabian Journal of Chemistry, 2022: 15(9), 2022, 104085. doi: 10.1016/j.arabjc.2022. 104085.
21. FSI (Facts Sheet INDEX). 2023. Weeds of Australia. https://keyserver.lucidcentral. Org / weeds/data/media/Html/ calotropis_ procera. htm. Visited on 23-09-2023.
22. Melo IM, Sarte MF, Tavares SJS, Lustosa MS, Oliveira JS, Alencar NMN, Ramos MV, Lima V. Calotropis procera latex protein reduces inflammation and bone loss in ligature-induced period ontitis in male rats. Archives of Oral Biology, 2023: 147, 2023, 105613. doi: 10.1016/j.archoralbio.2023.105613
23. UTP (Useful Tropical Plants) 2023. Calotropis procera. https://tropical.theferns.info/view tropical.php?id= Calotropis+procera. Visited on 22-09-2023.
24. Eflora. Flora of Pakistan. 2024. http://www.efloras.org/florataxon.aspx?flora_id=5& taxon_id =2500 77161. Visited on 16-04-2024.
25. Padmaja KV, Atheya N, Bhatnagar AK, Singh KK. Conversion of Calotropis procera biocrude to liquid fuels using thermal and catalytic cracking. Fuel, 2009:88:780-785. doi: 10.1016/j.fuel.2008.11.020
26. Djimtoingar SS, Sarfo ADN, Atta KF, Sarquah K. Anaerobic digestion of Calotropis procera for biogas production in arid and semi-arid regions: a case study of Chad. Cogent Engineering, 2022:9:0-17. doi: 10.1080/23311916. 2022.2143042
27. D'Souza RJ, Varun M, Masih J, Paul MS. Identification of Calotropis procera L. as a potential phytoaccumulator of heavy metals from contaminated soils in Urban North Central India. Journal of Hazardous Materials, 2010:184:(1-3):457–464. doi: 10.1016/j.Jha zmat.2010.08.056
28. Al-Yemni MN, Sher H, El-Sheikh MA, Eid EM. Bioaccumulation of nutrient and heavy metals by Calotropis procera and Citrullus colocynthis and their potential use as contamination indicators. Scientific Research and Essays, 2011:6:966–976.
29. Almehdi A, El-Keblawy A, Shehadi I, El-Naggar M, Saadoun I, Mosa KA. et al. Old leaves accumulate more heavy metals than other parts of the desert shrub Calotropis procera at a traffic polluted site as assessed by two analytical techniques. International Journal of Phytoremediation, 2019: 21:1254–1262. doi: 10.1080/15226514.2019. 1619164
30. dos Anjos RB, Hilário LS, de Moraes Juviniano HB, da Silva DR. Crude oil removal using Calotropis procera. BioResources, 2020: 15: 5246–5263

31. Ibrahim AH. Tolerance and avoidance responses to salinity and water stresses in Calotropis procera and Suaeda aegyptiaca. Turkish Journal of Agriculture and Forestry: 2013: 37(3): 350-360. Article 12. doi: 10.3906/tar-1202-62.
32. Leal LC, Meiado MV, Lopes AV, Leal IR. Germination responses of the invasive Calotropis procera (Ait.) R. Br. (Apocynaceae): comparisons with seeds from two ecosystems in Northeastern Brazil. Anais da Academia Brasileira de Ciências, 2013: 85(3):1025-34. doi: 10.1590/S0001-37652013000300013. PMID: 24068090.
33. Mutwakil MZ, Hajrah NHA, Edris A, Sabir S, Al-Ghamdi MJ, El-Domyati FM. 2017. Transcriptomic and metabolic responses of Calotropis procera to salt and drought stress. BMC. Plant Biology, 17:231. doi:10.1186/s12870-017-1155-7
34. Coêlho MRV, Rivas R, Ferreira-Neto JRC, Bezerra-Neto JP, Pandolfi V, Benko-Iseppon A. M. et al. Salt tolerance of Calotropis procera begins with immediate regulation of aquaporin activity in the root system. Physiology and Molecular Biology of Plants, 2021: 27: 457–468. doi: 10.1007/s12298-021-00957-9
35. Siraj, Khan N, Ali K, Khan MEH, Jones DA. Phytoaccumulation of Heavy Metals by Sodom Apple (Calotropis procera (Aiton) W. T. Aiton) along an Urban–Rural Gradient. Applied Sciences, 2022: 12(3):1003. doi: 10.3390/app12031003
36. Lopéz LMI, Viana CA, Errasti ME, Garro ML, Martegani JE, Mazzilli GA. et al. Latex peptidases of Calotropis procera for dehairing of leather as an alternative to environmentally toxic sodium sulfide treatment. Bioprocess and Biosystem Engineering, 2017: 40:1391–1398. doi: 10.1007/s00449-017-1796-9
37. Khalid N, Noman A, Sanaullah T, Akram MA, Aqeel M. Vehicle pollution toxicity induced changes in physiology, defence system and biochemical characteristics of Calotropis procera L. Journal of Chemical Ecology, 2018: 34:565–581. doi: 10.1080/02757540.2018.1452917
38. Galal TM, Farahat EA, El-Midany MM, Hassan LM. Nutrients and heavy metals accumulation by the giant milkweed Calotropis procera (Aiton) WT Aiton in urbanized areas, Egypt. Rendiconti Lincei, 2016: 27: 241–250. doi: 10.1007/s12210-015-0468-4
39. Gajbhiye T, Pandey SK, Lee SS, Kim KH. Size fractionated phytomonitoring of airborne particulate matter (PM) and speciation of PM bound toxic metals pollution through Calotropis procera in an urban environment. Ecological Indicators, 2019: 104: 32–40. doi: 10.1016/j.ecolind.2019.04.072
40. Kanwar P, Kumar M, Srivastava S. Investigation of phytoextraction and tolerance capacity of Calotropis procera for the detoxification of hexavalent chromium, nickel, and lead. Environmental Technology & Innovation, 2023: 32, 2023, 103238. doi: 10.1016 /j.eti. 2023.103238
41. Varahalarao V, Chandrashekhar N. In vitro bioactivity of Indian medicinal plant Calotropis procera. Journal of global Pharma Technology, 2010: 2(2):43-45.
42. Gholamshahi S, Vakili MA, Shahdadi F, Salehi A. Comparison of total phenols and antiradical activity of flower, leaf, fruit and latex extracts of milkweed (Calotropis procera) from Jiroft and Bam cities. International Journal of Bioscience, 2014:4:159–164.
43. Banerjee S, Kaushik S, Tomar RS. Effect of different solvents on antioxidant activity of leaf extracts of Calotropis procera and Azadirachta indica. Asian Journal of Pharmaceutical and Clinical Research, 2016: 10:1–5.
44. Quazi S, Mathur K, Arora S, Wing P. Calotropis procera: An overview of its phytochemistry and pharmacology. Indian Journal Drugs, 2013:1:63–69.
45. Al Sulaibi MA, Thiemann C, Thiemann T. Chemical constituents and uses of *Calotropis procera* and *Calotropis gigantean*: A review (Part I–the plants as material and energy resources) Open Chemistry Journal, 2020:7:1–15. doi: 10.2174/1874842202007010001

46. Hassan S, Atef A, Ali HM, Alshamrani R, Ramadan A. First report of triterpenes pathway in Calotropis procera revealed to accumulate beta amyrin. Saudi Journal of Biological Sciences, 2022: 29(5):3647-3653. doi: 10.1016/j. sjbs. 2022.02.055.
47. Pereira H. Structure and chemical composition of cork from Calotropis Procera (AIT.) R. Br. IAWA Journal, 1988:9(1):53-58. doi: 10.1163/22941932-90000468
48. Ansari SH, Ali M. Norditerpenic ester and pentacyclic triterpenoids from root bark of Calotropis procera (Ait) R. Br. Pharmazie, 2001: 56: 175–177.
49. Kalita D, Saikia CN. Chemical constituents and energy content of some latex bearing plants. Bioresource Technology, 2004: 92:219-227. doi: 10.1016/j.biortech.2003.10.004
50. Soobrattee MA, Neergheen V, Luximon-Ramma A, Aruoma O, Bahorun T. Phenolics as potential antioxidant therapeutic agents: mechanism and actions. Mutatant Research / Fundamental and Molecular Mechanisms of Mutagenesis, 2005:579:200–213.
51. Khasawneh MA, Elwy HM, Fawzi NM, Hamza AA, Chevidenkandy AR, Hassan AH. Antioxidant activity, lipoxygenase inhibitory effect and polyphenolic compounds from Calotropis procera (Ait.) R. Br. Research Journal of Phytochemistry, 2011:5: 80-88. URL: https://scialert.net/abstract/?doi=rjphyto.2011.80.88
52. Prabha MR, Vasantha K. Antioxidant, cytotoxicity and polyphenolic content of Calotropis procera (Ait.) R. Br. Flowers. Journal of Applied Pharmaceuticl Science, 2011: 1:136–140.
53. Rawdkuen S, Pintathong P, Chaiwut P, Benjakul S. The partitioning of protease from Calotropis procera latex by aqueous two-phase systems and its hydrolytic pattern on muscle proteins. Food and Bioproducts Processing, 2011:89(1):73-80. doi: 10.1016/j.fbp.2010.02.001
54. Ibrahim SRM, Mohamed GA, Shaala LA, Banuls LMY, Van Goietsenoven G, Kiss R. et al. New ursane-type triterpenes from the root bark of Calotropis procera. Phytochemistry Letters, 2012:5:490–495. doi: 10.1016/j.phytol.2012.04.012
55. Nenaah G. Antimicrobial activity of Calotropis procera Ait. (Asclepiadaceae) and isolation of four flavonoid glycosides as the active constituents. World Journal of Microbiology Biotechnology, 2013:29:1255–1262. doi: 10.1007/s11274-013-1288-2
56. Kumar S, Gupta A, Pandey AK. Calotropis procera root extract has the capability to combat free radical mediated damage. International Scholarly Research Notices, 2013:1–8. doi: 10.1155/2013/691372
57. Nikbin M, Sepehrimanesh M. Essential oil composition and antioxidant activities of Calotropis procera from Iran. In: The 5thInternational Congress of Biochemistry and Molecular Biology and the 13th Iranian congress of Biochemistry, 2013.
58. Ibrahim SR, Mohamed G, Shaala L, Moreno L, Banuls Y, Kiss R, Youssef D. Proceraside A, a new cardiac glycoside from the root barks of Calotropis procera with in vitro anticancer effects. Natural Product Research, 2014: 28:1322–1327.
59. Ibrahim SRM, Mohamed GA, Shaala LA, Banuls LMY, Kiss R, Youssef DTA. Calotroposides H–N, new cytotoxic oxypregnane oligoglycosides from the root bark of Calotropis procera. Steroids, 2015:96:63–72. doi: 10. 1016 /j. steroids.2015.01.012
60. Mittal A, Ali M. Acyclic diterpenic constituents from the roots of Calotropis procera (Ait.) R. Br. Journal of Saudi Chemical Society. 2015:19:59–63. doi: 10.1016/j.jscs.2011.12.019
61. Kazemipour N, Nikbin M, Davarimanesh A, Sepehrimanesh M. Antioxidant activity and mineral element contents of Calotropis procera from Iran: a traditional medicinal plant in Middle East. Comparative Clinical Pathology, 2015:24:1147–1150.
62. Oun AA, Rhim JW. Characterization of nanocelluloses isolated from Ushar (Calotropis procera) seed fiber: Effect of isolation method. Materials Letters, 2016:168:146–150. doi: 10.1016/ j.matlet.2016.01.052

63. Al-Taweel AM, Perveen S, Fawzy GA, Rehman AU, Khan A, Mehmood R, et al. Evaluation of antiulcer and cytotoxic potential of the leaf, flower, and fruit extracts of Calotropis procera and isolation of a new lignan glycoside. Evidence Based Complementary and Alternative Medicine, 2017:8086791. doi: 10.1155/2017/8086791
64. Pattnaik PK, Kar D, Chhatoi H, Shahbazi S, Ghosh G, Kuanar A. Chemometric profile & antimicrobial activities of leaf extract of Calotropis procera and Calotropis gigantea. Natural Product Research, 2017:31(16):1954-1957. doi: 10.1080/14786419.2016.1266349. Epub 2016 Dec 9. PMID: 27936921.
65. Kumar D, Prakash D, Agrawal V, Nebapure S, Ranjan A, Jindal T. Phenolic contents, antioxidant activity, free radical scavenging capacity and efficacy of Calotropis procera as biocontrol agent. Indian Journal of Agricultural Biochemistry, 2019:32:208–211.
66. Radhaboy G, Pugazhvadivu M, Ganeshan P, Ramshankar P. Analysis of thermo chemical behaviour of Calotropis procera parts for their potentiality. International Journal of Ambient Energy, 2019:43(1):252-258. doi: 10.1080/01430750.2019.1630309
67. Al-Yahya MA, Al-Meshal IA, Mossa JS, Tariq M. 1985. Phytochemical and pharmacological studies on Calotropis procera. Proceeding of the 3rd International Conference of traditional and Folk Medicine, Lecatecas, Mexico.
68. Mehmood T, Arshad H, Nawaz S, Ullah A, Hafeez A, Anwar F, Ahmad MM, Iqbal M (2020) Pharmaceutical potential and phenolics profiling of leaves and bark of Calotropis procera in relation to extraction solvents. Pharmacy Chemistry Journal, 2020: 54:631–641. doi: 10.1007/s11094-020-02250-7
69. Usman A, Mohammad R, Abdullahi A, Zakari A, Usman N. Isolation of dihydroquercetin glycoside from the root bark of Calotropis procera and antioxidant and cytotoxic screening of the crude extracts. Journal of Chemical Society of Nigeria, 2021:46:0083–0093.
70. Saher U, Omer MO, Javeed A, Anjum AA, Rehman K, Awan T. Soluble laticifer proteins from Calotropis procera as an effective candidates for antimicrobial therapeutics. Saudi Journal of Biological Sciences, 2023: 30(6),103659. doi: 10.1016/j.sjbs.2023.103659
71. Nejhad AA, Behbahani BA, Hojjati M, Vasiee A, Mehrnia MA. Identification of phytochemical, antioxidant, anticancer and antimicrobial potential of Calotropis procera leaf aqueous extract. Science Report, 2023:13(1):14716. doi: 10.1038/s41598-023-42086-1. PMID: 37679486; PMCID: PMC10485245.
72. Mamat A, Lame Y, Adeline FYS, Yvette N, Herman ON, Roger BA, Dieudonné N. In vitro nematocidal potential of hydro-ethanolic and aqueous extracts of Calotropis procera (Aiton) W.T. Aiton, 1811 (Apocynaceae) and Faidherbia albida (Delile) A. Chev., 1934 (Fabacae) against Onchocerca ochengi and Caenorhabditis elegans. Heliyon, 2023: 9(5): 2023, e16379. doi: 10.1016/j.heliyon.2023.e16379
73. Hassan S, Bilbis F, Ladan M, Umar R, Dangoggo S, Saidu Y, Abubakar M, Faruk U. Evaluation of antifungal activity and phytochemical analysis of leaves, roots and stem barks extracts of Calotropis procera (Asclepiadaceae). Pakistan Journal of Bioloical Sciences, 2006: 9(14):2624–2629. doi: 10.3923/pjbs.2006.2624.2629
74. Kawo AH, Mustapha A, Abdullahi BA, Rogo LD, Gaiya ZA, Kumurya AS. Phytochemical properties and antibacterial activities of the leaf and latex extracts of Calotropis procera (Ait. F.). Bayero Journal of Pune and Applied Sciences, 2009:2(1):34-40.
75. Kakkar A, Verma DR, Suryavanshi S, Dubey P. Characterization of chemical constituents of Calotropis procera. Chemistry of Natural Compounds, 2012: 48:155–157. doi: 10.1007/s10600-012-0189-1
76. Jucá TL, Ramos MV, Moreno FBMB, Viana MP, de Matos JDB, Marinho-Filho RAM, Monteiro-Moreira ACDO. Insights on the phytochemical profile (cyclopeptides) and biological activities of Calotropis procera latex organic fractions. Science World Journal, 2013. doi: 10.1155/2013/615454
77. Kumar M, Dandapat S, Kumar A, Sinha M. Phytochemical properties and antioxidant activity of Calotropis procera (Ait.) R. Br. Br (November 11, 2013). Ecoscan Special Issue, 2013: 4:195–199.

78. Chundattu SJ, Agrawal VK, Ganesh N. Phytochemical investigation of Calotropis procera. Arab Journal of Chemistry, 2016:9:S230–S234. doi: 10.1016/j.arabjc.2011.03.011
79. Batool H, Hussain M, Hameed M, Ahmad R. 2020. A review on Calotropis procera its phytochemistry and traditional uses. Big Data In Agriculture (BDA), 2020:2(2):56-58. doi: 10.26480/bda.02.2020.56.58
80. Bankole AA, Thiemann T. Chemistry, biological activities, and uses of Calotropis Latex. In: Murthy, H.N. (eds) Gums, Resins and Latexes of Plant Origin. Reference Series in Phytochemistry. Springer, 2022: Cham. doi: 10.1007/978-3-030-76523-1_33-1
81. Erdman MD, Erdman BA. Calotropis procera as a source of plant hydrocarbons. Economic Botany, 1981: 35(4):467-472.
82. Gulzar A, Siddiqui MB. Allelopathic effect of Calotropis procera (Ait.) R. Br. on growth and antioxidant activity of Brassica oleracea var. botrytis. Journal of Saudi Society Agricultural Science, 2017:16: 375–382. doi: 10.1016/j.jssas.2015.12.003
83. Hussain F, Rasool A, Aziz K, Raisham S, Aziz S, Badshah L. et al. Allelopathic inhibition of germination, seedling growth and cell division of selected plant species by Calotropis procera (Ait.) Ait. Plant Science Today, 2020: 7:1–8. doi: 10.14719/pst.2020. 7.1.606
84. Al-Harbi NA. Allelopathic effect of Calotropis procera, Hyoscyamus muticus and Pulicaria undulata extracts on seed germination of Portulaca oleracea and Chenopodium murale. Pakistan Journal of Biological Sciences, 2020:23:1260–1266. doi: 10.3923/pjbs.2020
85. Ahmed UAM, Zuhua S, Bashier NHH, Muafi K, Zhongping H, Yuling G. Evaluation of insecticidal potentialities of aqueous extracts from Calotropis procera Ait. against Henosepilachna elaterii Rossi. Journal of Applied Sciences, 2006:6: 2466-2470. doi: 10.3923/jas.2006.2466.2470. URL: https://scialert. net/abstract/? doi=jas.2006.2466.2470
86. Akhtar N, Malik A, Ali SN, Kazmit SU. Proceragenin, an antibacterial cardenolide from Calotropis procera. Phytochemistry, 1992: 31:2821–2824.
87. Jain S, Sharma R, Jain R, Sharma R. Antimicrobial activity of Calotropis procera. Fitoterapia, 1996: 67:275–277.
88. Mann A, Abalaka M, Garba S. The antimicrobial activity of the leaf extracts of Calotropis procera. Biomedical Letter, 1997: 55:205–210.
89. Kareem S, Akpan I, Ojo O. Antimicrobial activities of Calotropis procera on selected pathogenic microorganisms. African Journal of Biomedical Research, 2008: 11:105–110.
90. Joshi M, Kaur S. In vitro evaluation of antimicrobial activity and phytochemical analysis of Calotropis procera, Eichhornia crassipes and Datura innoxia leaves. Asian Journal of Pharmaceutical and Clinicl Research, 2013:6:25–28.
91. Bilal H, Ali I, Uddin S, Khan I, Said A, Rahman MU, Khan AM, Shah AB, Khan AA. Biological evaluation of antimicrobial activity of Calotropis procera against a range of bacteria. Journal of Pharmacognosy and Phytochemistry, 2020: 9:31–35.
92. Amini MH, Ashraf K, Salim F, Lim SM, Ramasamy K, Manshoor N, Sultan S, Ahmad W. Important insights from the antimicrobial activity of Calotropis procera. Arabian Journal of Chemistry, 2021:14(7): 2021, 103181. doi: 10.1016/j.arabjc.2021.103181
93. Waheed N, Jabeen K, Iqbal S, Javaid A. Biopesticidal activity of Calotropis procera L. against, Macrophomina phaseolina. African Journal of Traditional, Complementary and Alternative Medicines, 2016: 13(6):163-167. doi: 10.21010/ajtcam.v13i6.23. PMID: 28480374; PMCID: PMC5412188.
94. Ali M, Haroon U, Khizar M, Chaudhary HJ, Munis MFH. Facile single step preparations of phyto-nanoparticles of iron in Calotropis procera leaf extract to evaluate their antifungal potential against Alternaria alternata. Current Plant Biology, 2020a:23:100157. doi: 10.1016/j. cpb.2020.100157

95. Al-Qarawi A, Mahmoud O, Sobaih M, Haroun E, Adam S. A preliminary study on the anthelmintic activity of Calotropis procera latex against Haemonchus contortus infection in Najdi sheep. Veterinary Research Communications, 2001: 25:61–70, PMID: 11214673 doi: 10.1023/a:1026762002947
96. Aswal S, Chauhan S, Bhatnagar P. Identifying efficient isolates of white rot fungi for lignin degradation of Calotropis procera fibre in handmade papermaking. Journal of Scientific Research, 2020:64: 183–191. doi: 10.37 398/JSR. 2020.640226
97. Al-Snafi AE. The constituents and pharmacological properties of Calotropis procera - An Overview. International Journal of Pharmaceutical Review Research, 2015:5: 259-275.
98. Chaudhary P, Ahamad S, Khan NA. A review on medicinal utility of Calotropis procera. World Journal of Pharmaceutical and Medical Research, 2017:3(1):335-42.
99. Yaniv Z, Koltai H. Calotropis procera, Apple of Sodom: Ethnobotanical review and medicinal activities. Israel Journal of Plant Sciences, 2018:65(1-2):55-61. doi: 10.1163/22238980-00001018
100. Siraj and Khan N. Quantitative ethnobotany of Calotropis procera and associated vegetation: a step forward for conservation and management practice in northern areas of Pakistan. Ethnobotany Research and Applications, 2021: 22:1–17.
101. Olsen TW, Hardten DR, Meiusi RS, Holland EJ. Linear endotheliitis. American Journal of Ophthalmology, 1994: 117(4):468-74. doi: 10.1016/s0002-9394(14)70006-6. PMID: 8154528.
102. Basu A, Sen T, Pal S, Mascolo N, Capasso F, Nag AK. Studies on the antiulcer activity of the chloroform fraction of Calotropis procera root extract. Phytotherapy Research, 1996: 11(2):163-5.
103. Kumar S, Dewan S, Sangraula H, Kumar VL. Anti-diarrhoeal activity of the latex of Calotropis procera. Journal of Ethnopharmacology, 2001:76(1):115-8. doi: 10.1016/s0378-8741(01)00219-7
104. Kumar VL, Shivkar YM. In vivo and in vitro effect of latex of Calotropis procera on gastrointestinal smooth muscles. Journal of Ethnopharmacology, 2004: 93: 377-379.
105. Al-Mezaine HS, Al-Rajhi AA, Al-Assiri A, Wagoner MD. Calotropis procera (ushaar) keratitis. American Journal of Ophthalmology, 2005:139(1):199-202. doi: 10.1016/j.ajo.2004.07.062. PMID: 15652855.
106. de Oliveira JS, Bezerra DP, de Freitas CDT, Marinho Filho JDB, de Moraes MO, Pessoa C, Costa-Lotufo LV, Ramos MV. In vitro cytotoxicity against different human cancer cell lines of laticifer proteins of Calotropis procera (Ait.) R Br. Toxicology in Vitro, 2007: 21: 1563–1573.
107. Pandey N, Chandrakar AK, Garg ML, Patel SS. Calotropis procera induced keratitis. Indian Journal of Ophthalmology, 2009:57(1):58-60. doi: 10.4103/0301-4738.44492. PMID:19075415; PMCID : PMC2661522.
108. Verma R, Satsangi GP, Shrivastava JN. Ethnomedicinal profile different plant parts of *Calotropis procera* (Ait.) R. Br.. Ethnobotanical Leaflets, 2010:14: 721-42.
109. Tour N, Talele G. Anti-inflammatory and gastromucosal protective effects of Calotropis procera (Asclepiadaceae) stem bark. Journal of Natural Medicines, 2011:65:598–605. doi: 10.1007/s11418-011-0522-1
110. Saba A, Oguntoke P, Oridupa O. Anti-inflammatory and analgesic activities of ethanolic leaf extract of Calotropis procera. African Journal of Biomedical Research, 2011: 14:203–208.
111. Harne S, Sharma A, Dhaygude M, Joglekar S, Kodam K, Hudlikar M. Novel route for rapid biosynthesis of copper nanoparticles using aqueous extract of Calotropis procera L. latex and their cytotoxicity on tumor cells. Colloids Surf. B: Biointerfaces, 2012:95:284–288. doi: 10. 1016/j.colsurfb.2012.03.005
112. Aderounmua A, Omonisib A, Akingbasotec J, Makanjuolad M, Bejide R, Orafidiya L, Adelusolae K. Wound healing and potential anti-keloidal properties of the latex of Calotropis procera (Aiton) Asclepiadaceae in rabbits. African Journal of Traditional, Complementary and Alternative Medicine, 2013:10:574–579.

113. Yadav SK, Nagori BP, Desai PK. Pharmacological characterization of different fractions of Calotropis procera (Asclepiadaceae) in streptozotocin induced experimental model of diabetic neuropathy. Journal of Ethnopharmacology, 2014:152:349–357.
114. Waikar S, Srivastava VK. Calotropis induced ocular toxicity. Medical Journal of Armed Forces India. 2015: 71(1):92-4. doi: 10.1016/j.mjafi.2012.08.017
115. Aliyu, Abubakar RM, Kasarawa MB, Dabai AB, Lawal YU, Bello N, Fardami MB. 2015. Efficacy and phytochemical analysis of latex of Calotropis procera against selected dermatophytes. Journal of Intercultural Ethnopharmacology, 4:314.
116. Tsala DE, Nga N, Thiery BNM, Bienvenue MT, Theophile D. Evaluation of the antioxidant activity and the healing action of the ethanol extract of Calotropis procera bark against surgical wounds. Journal of Intercultural Ethnopharmacology, 2015: 4:64–69.
117. Kazeem MI, Mayaki AM, Ogungbe BF, Ojekale AB. In-vitro Studies on Calotropis procera leaf extracts as inhibitors of key enzymes linked to diabetes mellitus. Iranian Journal of Pharmaceutical Research, 2016: 15(Suppl):37-44. PMID: 28228802; PMCID: PMC5242350.
118. Viana CA, Ramos MV, Filho JDBM, Lotufo LVC, Figueiredo IST, de Oliveira JS. et al. Cytotoxicity against tumor cell lines and anti-inflammatory properties of chitinases from Calotropis procera latex. Naunyn Schmiedebergs Archives Pharmacology, 2017:390, 1005–1013. doi: 10.1007/s00210-017-1397-9
119. Rawat P, Singh PK, Kumar V. Evidence based traditional anti-diarrheal medicinal plants and their phytocompounds. Biomedicin and Pharmacotherapy, 2017: 96:1453–1464.
120. Kumar A. Alternative biomass from semiarid and arid conditions as a biofuel source: Calotropis procera and its genomic characterization," in Biofuels: Greenhouse Gas Mitigation and Global Warming, eds A. Kumar, S. Ogita, and Y. Y. Yau (New Delhi: Springer), 2018: 241–269. doi: 10.1007/978-81-322-3763-1_14
121. Awaad AA, Alkanhal HF, El-Meligy RM, Zain GM, Adri VDS, Hassan DA, Alqasoumi SI. Anti-ulcerative colitis activity of Calotropis procera Linn. Saudi Pharmaceutical Journal, 2018: 26:75–78.
122. Nadeem M, Mumtaz MW, Danish M, Rashid U, Mukhtar H, Anwar F, Raza SA. Calotropis procera: UHPLC-QTOF-MS/MS based profiling of bioactives, antioxidant and antidiabetic potential of leaf extracts and an insight into molecular docking. Journal of Food Measurement and Characteristics, 2019: 13:3206–3220.
123. Al-Qahtani MAM, Farah MA, Abou-Tarboush FM, Al-Anazi KM, Al-Harbi NO, Ali MA. et al. Anticancer effects of Calotropis procera latex extract in MCF-7 breast cancer cells. Pharmacognosy Magazine, 2020:16: 550–556. doi: 10.4103/pm.pm_156_20
124. Ramos MV, Bandeira GdP, Freitas CDTd, Nogueira NAP, Alencar NMN, Sousa PASd, Carvalho AFU. Latex constituents from Calotropis procera (R. Br.) display toxicity upon egg hatching and larvae of Aedes aegypti (Linn.). Memórias Inst Oswaldo Cruz, 2006: 101:503–510.
125. Wadhwani BD, Mali D, Vyas P, Nair R, Khandelwal P. A review on phytochemical constituents and pharmacological potential of Calotropis procera. RSC Advances, 2021: 11(57):35854-35878. doi: 10.1039/d1ra06703f. PMID: 35492791; PMCID: PMC9043578.
126. Kumar A. 4 - Plant alkaloids, Editor(s): Awanish Kumar, In Developments in Applied Microbiology and Biotechnology, Phytoconstituents and Antifungals, Academic Press, 2022, Pages 53-64. doi: 10.1016/B978-0-323-91792-6.00009-1
127. Malhab LJB, Bajbouj K, Shehab NG, Elayoty SM, Sinoj J, Adra S, Taneera J, Saleh MA, Abdel-Rahman WM, Semreen MH, Alzoubi KH, Bustanji YB, El-Huneidi W, Abu-Gharbieh E. Potential anticancer properties of Calotropis procera: An investigation on breast and colon cancer cells. Heliyon, 2023: 9(6), 2023, e16706. doi: 10.101 6/j. heliyon.2023.e16706

128. Joshi R, Sharma A, Jat BL. Analysis of antioxidant activity in extracts of Calotropis procera (Ait.) R. Br. Journal of Applied Bioscience, 2009:17:899–903.
129. Ramesh J, Anshul S, Jat B. Analysis of antioxidant activity in extracts of Calotropis procera (Ait.) R. Br. Journal of Applied Bioscience, 2009: 17:899–903.
130. Chavda R, Vadalia KR, Gokani R. Hepatoprotective and Antioxidant Activity of Root Bark of Calotropis procera R.Br (Asclepediaceae). International Journal of Pharmacology, 2010:6: 937-943. doi: 10.3923/ijp.2010. 937.943 URL: https://scialert.net/abstract/?doi=ijp.2010.937.943
131. Ahmad N, Anwar F, Hameed S and Boyce MC. Antioxidant and antimicrobial attributes of different solvent extracts from leaves and flowers of Calotropis procera. Journal of Medicinal Plants Research, 2011:5(19):4879-87.
132. Mohanraj R, Usmani MA. Antioxidant Activity of the Leaf Extracts of Calotropis procera. International Journal of Advanced Biotechnology and Research, 2012: 2:47–52.
133. Ahmad M, Gwarzo M, Anwar S. Antioxidative and anti-hyperglycaemic effect of Calotropis procera in alloxan induced diabetic rats. Journal of Medicinal Plants Research, 2016:10:54–58.
134. Faruki MZ, Jha MK, Rahman MM, Alam M, Mazumder M, Rana MS. In-vitro antioxidant and cytotoxic potential of Calotropis procera (R. br.) root. International Journal of Pharmaceutical Sciences and Research, 2011: 2:2132–2135.
135. Chaudhary P, de Araújo Viana C, Ramos MV, Kumar VL. Antiedematogenic and antioxidant properties of high molecular weight protein sub-fraction of Calotropis procera latex in rat. Journal of Basic and Clinical Pharmacy, 2015: 6:69.
136. Kenganora M, Bhaskaran M, Santhepete MN, Hukkeri VI. Antioxidant potential of a toxic plant Calotropis procera R. Br. Free Radicals and Antioxidant, 2017: 7:143–151.
137. Banerjee S, Kaushik S, Tomar RS. Efficacy assay of crude leaf extracts of Calotropis procera and Azadirachta indica for antioxidant activity. Research Journal of Pharmacy and Technology, 2018: 11:4480–4486.
138. Dayana K, Manasa MR. Antioxidant activity of ethanolic extract of Calotropis procera root in wistar rats. International Journal of Basic and Clinical Pharmacology, 2018: 7 (11): 2107. doi: 10.18203/2319-2003.ijbcp2018 4212
139. Usman K, Al Jabri H, Abu-Dieyeh MH, Alsafran MHSA. Comparative assessment of toxic metals bioaccumulation and the mechanisms of chromium (Cr) tolerance and uptake in Calotropis procera. Frontier in Plant Science, 2020: 11:883. doi: 10.3389/fpls.2020.00883
140. Shobowale OO, Ogbulie NJ, Itoandon EE, Oresegun MO, Olatope SOA. Phytochemical and antimicrobial evaluation of aqueous and organic extracts of *Calotropis procera* Ait leaf and latex. *Nigerian Food Journal,* 2013: 31(1):77-82. doi: 10.1016/S0189-7241(15)30059-X
141. Larhsini M, Bousaid M, Lazrek H, Jana M, Amarouch H. Evaluation of antifungal and molluscicidal properties of extracts of Calotropis procera. Fitoterapia, 1997: 68:371–373.
142. Kumar V, Basu N. Anti-inflammatory activity of the latex of Calotropis procera. Journal of Ethnopharmacology, 1994: 44:123–125.
143. Morsy TA, Rahem M, Allam K. Control of Musca domestica third instar larvae by the latex of Calotropis procera (Family: Asclepiadaceae). Journal of the Egyptian Society of Parasitology. 2001: 31:107–110.
144. Ramos MV, Demarco D, da Costa Souza IC, de Freitas CDT. Laticifers, latex, and their role in plant defense. Trends Plant Science, 2019: 24(6):553-567. doi: 10.1016/j.tplants.2019.03.006
145. Singh R, Mittal P, Dhiman R. Laboratory study on larvicidal properties of leaf extract of Calotropis procera (Family-Asclepiadaceae) against mosquito larvae. Journal of Communicable Diseases, 2005: 37:109–113.
146. Kuta F. Antifungal effect of Calotropis procera stem bark on Epidermophyton flocosum and Trichophyton gypseum. African Journal of Biotechnology, 2008: 7:2116–2118.

147. Yesmin MN, Uddin SN, Mubassara S, Akond MA. Antioxidant and antibacterial activities of Calotropis procera Linn. American Eurasian Journal of Agricultural and Environmental Sciences, 2008: 4:550–553.
148. Elimam AM, Elmalik KH, Ali FS. Efficacy of leaves extract of Calotropis pProcera Ait. (Asclepiadaceae) in controlling anopheles arabiensis and Culex Quinquefasciatus mosquitoes. Saudi Journal of Biological Sciences, 2009:16(2):95–100.
149. Begum N, Sharma B, Pandey RS. Evaluation of insecticidal efficacy of Calotropis procera and Annona squamosa ethanol extracts against Musca domestica. Journal of Biofertilizers and Biopesticides, 2010: 1:1–6.
150. Oliveira JS, Costa-Lotufo LV, Bezerra DP, Alencar N, Marinho-Filho JDB, Figueiredo IST, Moraes MO, Pessoa C, Alves APN, Ramos MV. In vivo growth inhibition of sarcoma 180 by latex proteins from Calotropis procera. Naunyn-Schmiedeberg's Archives of Pharmacology, 2010: 382:139–149.
151. Shahi M, Hanafi-Bojd A, Iranshahi M, Vatandoost H, Hanafi-Bojd M. Larvicidal efficacy of latex and extract of Calotropis procera (Gentianales: Asclepiadaceae) against Culex quinquefasciatus and Anopheles stephensi (Diptera: Culicidae). Journal of Vector Borne Diseases, 2010: 47:185–188.
152. de Freitas CDT, de SouzaLopes JL, Beltramini LM, de Oliveira RSB, Oliveira JTA, Ramos MV. Osmotin from Calotropis procera latex: new insights into structure and antifungal properties. Biochimica et Biophysica Acta (BBA) Biomembranes, 2011: 1808(10):2501–2507. doi: 10.1016/j.bbamem.2011.07.014
153. Goyal M, Mathur R. Antimicrobial potential and Phytochemical analysis of plant extracts of Calotropis procera. International Journal of Drug Discovery and Herbal Research, 2011: 1(3):138-143.
154. Doshi H, Satodiya H, Thakur MC, Parabia F, Khan A. Phytochemical screening and biological activity of Calotropis procera (Ait). R. Br. (Asclepiadaceae) against selected bacteria and Anopheles stephansi Larvae. Proteins, 2011: 3:29–33.
155. Mainasara M, Aliero B, Aliero A, Dahiru S. Phytochemical and antibacterial properties of Calotropis procera (Ait) R. Br. (Sodom Apple) fruit and bark extracts. Intrnational Journal of Modern Botany, 2011: 1:8–11.
156. Mudi S, Bukar A. Anti-plasmodia activity of leaf extracts of Calotropis procera Linn. Biokemistri, 2011: 23:29–34.
157. Mako G, Memon A, Mughal U, Pirzado A, Bhatti S. Antibacterial effects of leaves and root extract of Calotropis procera Linn. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences, 2012: 28:141–149.
158. Samy RP, Rajendran P, Li F, Anandi NM, Stiles BG, Ignacimuthu S, Sethi G, Chow VT. Identification of a novel Calotropis procera protein that can suppress tumor growth in breast cancer through the suppression of NF-κB pathway. PLoS ONE, 2012: 7:e48514. doi: 10.1371/journal.pone.0048514
159. Olaitan OJ, Wasagu SU, Adepoju-Bello AA, Nwaeze KU, Olufunsho A. Preliminary anti-fungal activity of the aqueous bark extract of Calotropis procera (Asclepiacaceae). Nigerian Quarterly Journal of Hospital Medicine, 2013:23(4):338-41. PMID: 27276766.
160. Nenaah GE. Potential of using flavonoids, latex and extracts from Calotropis procera (Ait.) as grain protectants against two coleopteran pests of stored rice. Industrial Crops and Products, 2013a:45: 327–334. doi: 10.1016/j.indcrop.2012.12.043
161. Ahmed M, Khan RA, Shahzaib S, Khan A, Zaif AW, Ahmed W. Antifungal, antioxidant and antibacterial activities of Calotropis procera. International Journal of Biosciences, 2014: 5:75–80. doi: 10.1078/09 44711041495146
162. Chauhan S, Singh VS, Thakur V. Effect of Calotropis procera (madar) and amprolium supplementation on parasitological parameters of broilers during mixed Eimeria species infection. Veterinary World, 2017:10(8):864-868. doi: 10.14202/vetworld.2017.864-868. Epub 2017 Aug 5. PMID: 29070931; PMCID: PMC5591470.
163. Bajpai S, Hooda H, Singh R, Mishra R. Comparative analysis of antioxidant properties of extracts of Calotropis procera with different anti-diabetic drugs. International Journal of Herbal Medicine, 2018: 6:104–109.

164. Kumar VL, Pandey A, Verma S, Das P. Protection afforded by methanol extract of Calotropis procera latex in experimental model of colitis is mediated through inhibition of oxidative stress and pro-inflammatory signaling. Biomedicine and Pharmacotherapy, 2019:9:1602-1609. doi: 10.1016/j.biopha.2018.10.187. PMID: 30551414.
165. dos Santos MR, da Silva FAG Jr., Ferrais PP, de Lima RS, da Costa MM, de Oliveira HP. (2020). Polyaniline-coated Calotropis procera L. hollow tubular fibers with remarkable antibacterial activity. SN Applied Sciences, 2:1550. doi: 10.1007/s42452-020-03345-2
166. Cavalcante GS, de Morais SM, André WPP, de Araújo-Filho JV, Muniz CR, da Rocha LO. et al. Chemical constituents of *Calotropis procera* latex and ultrastructural effects on Haemonchus contortus. Revista Brasileira de Parasitologia Veterinária, 2020: 29: e00 1320. doi: 10.1590/s198 4-29612020045
167. Usman A, Onore R, Opaluwa D, Ibrahim A. Phytochemical, antioxidant and cytotoxic screening of the leaves of Calotropis procera extracts. Trends in Science Technology Journal, 2020: 5:525–528.
168. Freitas CD, Silva RO, Ramos MV, Porfírio CT, Farias DF, Sousa JS, Oliveira JP, Souza PF, Dias LP, Grangeiro TB (2020) Identification, characterization, and antifungal activity of cysteine peptidases from Calotropis procera latex. Phytochemistry, 2020: 169:112163.
169. EL-Adawy HA, Alomari AA. Evaluation of Calotropis procera fruits as a bioadsorbent for removing of Acid Red 73 dye from the aqueous solutions. Egyptian Journal of Chemistry, 2020:63:3217–3228. doi: 10.21608/ejchem.2020.23834.2415
170. Olajuyin AM, Olajuyin AK, Wang Z, Zhao X, Xu Z, Zhang Q, Zhang X. Anti-proliferative, antioxidant effects of methanol extract of Calotropis procera leaf on lung cancer cells (H1299) and its ameliorative effect on expression of CD146 on blood cells. International Journal of Phytomedicine and Phytotherapy, 2021: 7:1–12. doi: 10.1186/s40816-021-00289-x
171. Abbas M, Arshad M, Rafique MK, Altalhi AA, Saleh DI, Ayub MA, Sharif S, Riaz M, Alshawwa SZ, Masood N, Nazir A, Iqbal M. Chitosan-polyvinyl alcohol membranes with improved antibacterial properties contained *Calotropis procera* extract as a robust wound healing agent. Arabian Journal of Chemistry, 2022:15(5):103766. doi: 10.1016/ j. arabjc. 2022.103766
172. Saddiq AA, Tag HM, Doleib NM, Salman AS, Hagagy N. Antimicrobial, antigenotoxicity, and characterization of Calotropis procera and its rhizosphere inhabiting actinobacteria: In Vitro and In Vivo Studies. Molecules, 2022:27(10):3123. doi: 10.3390/molecules27103123. PMID: 35630600; PMCID: PMC9146570.
173. Murshed M, Aljawdah HMA, Mares M, Al-Quraishy S. In Vitro: The Effects of the anticoccidial activities of Calotropis procera leaf extracts on Eimeria stiedae Oocysts Isolated from Rabbits. Molecules. 2023 Apr 10;28(8):3352. doi: 10.3390/molecules 2808 3352. PMID: 37110585; PMCID: PMC10141090.
174. Vats TK, Rawal V, Singh AK, Mullick S. Deterrent effect of Calotropis procera R. Br. on feeding, oviposition and egg hatchability of Plutella xylostella (L.) (Lepidoptera: Plutellidae). Journal of Asia Pacific Entomology, 2023:26, 2, 2023, 102081. doi: 10.1016/j.aspen.2023.102081
175. Nishiyama R, Le DT, Watanabe Y, Matsui A, Tanaka M, Seki M, Yamaguchi-Shinozaki K, Shinozaki K, Tran LS. Transcriptome analyses of a salt tolerant cytokinin deficient mutant reveal differential regulation of salt stress response by cytokinin deficiency. PLoS One, 2012: 7(2):e32124.
176. Hove VJ, Stefanowicz K, De Schutter K, Eggermont L, Lannoo N, Al Atalah B, Van Damme EJ. Transcriptional profiling of the lectin ArathEULS3 from Arabidopsis thaliana toward abiotic stresses. Journal of Plant Physiology, 2014:171(18):1763–73.
177. de Oliveira SHF, Negreiros D, Fernandes GW, Barbosa NPU, Rocha R, Almeida-Cortez JS. Seedling growth of the invader Calotropis procera in ironstone rupestrian field and seasonally dry forest soils. Neotropical Biology and Conservation, 2009:4: 69–76. doi: 10. 4013/nbc.2009.42.01

178. Gonçalves-Oliveira RC, Rodrigues HB, Benko-Iseppon AM. Range distribution of the invasive alien species Calotropis procera in South America dry environments under climatic change scenarios. Journal of Arid Environments, 2022: 205, 2022, 104819, doi: 10.1016 /j.jaridenv.2022.104819
179. Amini MH, Ashraf K, Lim SM, Ramasamy K, Manshoor N, Afiq A, Salim F. Phytochemical profiling, salt impurities removal and in vitro antibacterial evaluation of Calotropis procera twig, leaf and flower extracts. South African Journal of Botany, 2022: 151, Part B:367-378. doi: 10.1016/j.sajb.2022.03.041
180. Kaur A, Batish DR, Kaur S, Chauhan BS. An overview of the characteristics and potential of Calotropis procera from botanical, ecological, and economic perspectives. Frontiers in Plant Science, 2021:12:690806. doi: 10.3389/fpls.2021.690806
181. Shah IH, Ashraf M, Sabir IA, Manzoor A, Malik MS, Gulzar S, Ashraf F, Iqbal J, Niu Q, Zhang Y. Green synthesis and characterization of copper oxide nanoparticles using Calotropis procera leaf extract and their different biological potentials. Journal of Molecular Structure, 2022: 1259, 2022, 132696. doi: 10.1016/j.molstruc.2022.132696
182. Okeke IJ, Oyeyemi OT, Morenikeji OA. Ovicidal and miracicidal activities of Calotropis procera and its green synthesized nanotized derivative: A quest for new antifasciola agents. Acta Tropica, 2022: 236, 2022, 106700, doi: 10.1016/j.actatropica.2022.106700
183. Lade BD, Gogle DP, Lade DB, Moon GM, Nandeshwar SB, Kumbhare SD. Chapter 7 - Nanobiopesticide formulations: Application strategies today and future perspectives, Editor(s): Opender Koul. Nano-Biopesticides Today and Future Perspectives, Academic Press, 2019:179-206. doi: 10.1016/B978-0-12-815829-6.00007-3