Review Article

www.ijrap.net

(ISSN Online:2229–3566, ISSN Print:2277–4343)

IN VIVO STUDY OF PHARMACOLOGICAL ACTIVITIES OF *CALOTROPIS PROCERA*: AN OVERVIEW

Ashishkumar A. Kale [1]*, Meghsham P. Anjankar [2], Ashwin V. Nikam [3], Uday V. Pawade [4]

[1] PG Scholar, Department of Agadtantra, Shri Ayurveda Mahavidyalaya, Nagpur, Maharashtra, India

[2] Assistant Professor, Department of Agadtantra, Shri Ayurveda Mahavidyalaya, Nagpur, Maharashtra, India

[3] HOD and Professor, Department of Agadtantra, Shri Ayurveda Mahavidyalaya, Nagpur, Maharashtra, India

[4] Associate Professor, Department of Agadtantra, Shri Ayurveda Mahavidyalaya, Nagpur, Maharashtra, India

Received on: 30/03/22 Accepted on: 25/04/22

***Corresponding author**

E-mail: drashish5694@gmail.com

DOI: 10.7897/2277-4343.130356

ABSTRACT

Calotropis is one of the widely distributed plants along the world's geographical area. Many studies have been conducted to prove the pharmacological activities of *Calotropis procera* (Arka). It is classified as Upavisha in Ayurveda by Bhavprakasha and Rasatarangini. In its therapeutic application mentioned in various classical texts, *Calotropis procera* is treating almost 58 diseases having its 547 formulations which are indicated. It contains many phytochemical constituents like Cardenolides, Benzoyllineolone, Calactin, Calotropagenin etc. These phytoconstituents have proven anti-inflammatory, anticonvulsant, hepatoprotective, antitumor, and cytotoxic properties. In this review, a thorough literature search has been done through various textbooks, research magazines and internet search engines like PubMed, Google Scholar etc. Different *In Vivo* studies carried out on *Calotropis procera* to assess its pharmacological activities are considered. Meticulous analysis of these studies has been done with special reference to plant parts and their extraction method, animal models, assessment criterion and study outcomes. This provides additional information to carry out further research on *Calotropis procera*. The present review may be useful to researchers as a ready reckoner for their studies.

Keywords: *Calotropis procera*, Upavisha, pharmacological activity, Phytochemicals.

INTRODUCTION

Medicinal plants have incredible importance because of the presence of many components, and they become the source for the synthesis of active pharmaceutical ingredients (API). The plant *Calotropis procera* is widely distributed along the world's geographical area.

By Bhavaprakasa and Rasatarangini, *Calotropis procera* is classified as Upavisha in Ayurveda. In various classical texts, plant *Calotropis procera* (Arka) therapeutic application mentioned, *Calotropis procera* has 547 formulations, which are indicated in treating almost 58 diseases[1]. This plant is a rich source of phytoconstituents. It has many proven pharmacological activities such as anticancer, cytotoxic, antitumor, antiproliferative, anthelmintic, hepatoprotective, anti-inflammatory, antidiarrheal, antibacterial and antinociceptive and many more[2-7].

This plant contains many phytochemical constituents like Cardenolides, Benzoyllineolone, Calactin, Calotropagenin etc. These phytochemicals constituents are effective against cancer and various diseases[8].

The plant *Calotropis procera* and its phytoconstituents have been extensively studied for various biological and anticancer activities. Various preclinical studies have been reported on *Calotropis procera* to prove its activities by using different animal models and cell lines such as HCT-15, HCT-8, HCT-29, Hep-2, KB (Oral), SNB-78, MCF- 7 etc.

Searching for new therapeutic agents is a big challenge for scientists of the present modern era, and plants are the most significant source of these agents. Screening plants for their pharmacological properties with the hope of finding a safe and effective agent is essential. Many synthetic compounds are available, but their use is restricted due to their hazardous effects on the environment and adverse effects on the human body. To find the agents from plant sources which are safe, effective, and environmentally friendly, *C. procera* is one of them.

The initial phase of the drug development process consists of the preclinical phase, which helps assess the safety and efficacy of a new drug by using *In Vitro* and *In Vivo* models. Vivo studies act as a middle ground between *In Vitro* experiments and human trials. Researchers often use *In Vitro* methods for fundamental investigations like disease processes at the cellular level. *In Vivo* studies expand on data from *In Vitro* studies by monitoring biological responses in a living organism.

The objective of the present study is to provide systematic information about the pharmacological actions of various extracts of *Caloropis procera* and its parts. Thus, this is an attempt to collect all possible references of *In Vivo* pharmacological activities of *Calotropis procera*.

Review of Literature

***Calotropis procera* (Arka)**

Latin Name: *Calotropis procera* (Ait.) R.Br

Family: Asclepiadaceae

Vernacular Names:

- Sanskrit: Raktarka, Arkaparna, Kshiraparna, Arkanama, Vikirana, Shuklaphala,
- Marathi: Rui
- Hindi: Aak, Madar

- English: Madar

Types– Shwetarka- *Calotropis gigantea* (Linn.) R. Br Ait.
Raktarka- *Calotropis procera* (Ait.) R. Br

Classification: Modern: Irritant, Organic, Vegetative poison.
Ayurved: Akritrim, Sthavara, Vanaspatija visha, Upavisha

Botanical Description: *Calotropis procera* is an erect shrub of about 1-2 m. Leaves are subsessile, broad, ovate, usually 6-15 cm long and 4.5-8 cm broad. Flowers are in umbellate cymes, white, purple-spotted or pink. Root bark taproots with prominent tops and rounded heads. Complex roots are greyish white. The bark is yellowish-grey outside and yellowish-white inside. The root is corky, soft and rough with longitudinal fissures.

Parts used: Roots, Leaves, Root Bark, Flowers, Latex (Kshira).

Active Principles: β-amyrin, Calotropin, Calotoxins, Calactin, Uscharin, Trypsin in Kshira

Fatal Dose: Not determined

Fatal period: About 12 hours.

In *Calotropis procera,* different parts of the plant have been reported to possess various phytochemicals containing cardiotonic agents such as calotropin, calotropagenin, calotoxin, calotropagenin and voruscharine, steroids, di and triterpenes such as stigmasterol, β-sitosterol, flavonoids, polyphenol compounds, and various newer reported hydrocarbons and proteins shown in Table 2.

The pharmacological activities of major primary phytoconstituents are tabulated in Table 3.

A thorough literature search has been done through various textbooks, research magazines and internet search engines like PubMed, Google Scholar etc., to find out different *In Vivo* studies carried out on *Calotropis procera* to assess its pharmacological activities. These studies are tabulated according to plant parts and their extraction method, animal models, assessment criterion and study outcomes in Table 4. [9,10,11]

DISCUSSION

Currently, established drugs are primarily synthetic and derived from chemical origin. These synthetic drugs have shown some side effects like drug induce toxicity. So, it is today's need to search for alternative safe medicines. Medicines derived from plant origin are supposed to be safer and more effective. Hence various attempts have been made to discover the new safe alternative drug.

The plant *Calotropis procera* is a rich source of phytoconstituents with proven pharmacological activities. Various preclinical studies have been reported on *Calotropis procera* to prove different pharmacological activities. Other plant parts of *Calotopis procera* contain many phytoconstituents, as shown in Table 2. These phytoconstituents have many pharmacological activities such as antitumor, cytotoxic, antiulcer, antioxidant, anti-inflammatory, cardioprotective, and antipyretic, as shown in Table 3.

Table 1: Properties and action of Arka[12]

Rasadipanchak	Arka
Rasa	Katu, Tikta
Guna	Tikshna, Sara
Virya	Ushna
Vipaka	Katu
Doshaghnata	Kapha,Vata
Karma	Vatahara,Vranahara, Vishaghna, Dipana, Krimighna, Shwashara
Therapeutic Uses	Shotha, Shwasa, Sleshmodara roga, Kandu, Krimirog, Vrana, Gulma, Pliharogah, Arsah
Dose	250-750mg of the drug in powder form

Table 2: Phytoconstituents of Various Parts of *Calotropis procera*[13]

Parts used	Phytoconstituents
Latex	∝- amyrin, - β amyrin, - β sitosterol and calotoxin (0.15%), Calactin (0.15%), Calactin composed of calotropagenin, Calotropin, Calactinic acid, Voruscharin (0.45%), and hexose, Uzarigenin, Syriogenin, Proceroside, Uscharin,
Leaves	β - amyrin, cardenolides, calotropagenin, calotropin.
Root Bark	Benzoyllineolone, Benzoylisolineolone, β- amyrin, Three oleanane type triterpenes namely calotropoleanyl ester (olean – 13 (18)- ene- 3 β - yl acetate), Proceroleanenol A and (olean- 13(18)- ene-9∝ - ol) and Proceroleanenol B (olean-5, 13(18)- diene-3 ∝ -ol
Flower	β − amyrin, cyanidin 3-rhamnoglucoside Esters of β − calotropeols, Evanidin 3-rhamnoglucoside, volatile fatty acids and long-chain fatty acids, esters of waxy acids, evanidin- 3- rhamnoglucosides and alcohols.
Stem bark	d- and - β calotropeols - β amyrin, giganteol, a colourless wax, tetracyclic terpene (small quantity), sterols

Table 3: Main Phytoconstituents of *Calotropis procera* and their Pharmacological activities[14, 15, 7]

Phytoconstituents	Pharmacological activities
α amyrin	Anti-inflammatory, Hepatoprotective, Antioxidant, Analgesic, Cytotoxic, Antitumor, Antiulcer, Gastroprotective.
β amyrin	Anti-inflammatory, Hepatoprotective, Gastroprotective, Antioxidant, Analgesic, Antiulcer,
β sitosterol	Anti-inflammatory, Antioxidant, Anticancer, Antitumor, Anorexic, Antibacterial, Antifertility, Antifeedant, Antihyperlipoproteinaemic, Antileukemic, Antilymphomic, Antimutagenic, Antiviral, Antipyretic, Hepatoprotective, Hypoglycaemic, Hypolipidemic, Ulcerogenic.
Calotropin	Antitumor, Cardioactive, Proteolytic
Calactin and Calotoxin	Cardioactive
Stigmasterol	Antioxidant, Antinociceptive, Antiviral, Cancer-preventive, Hypocholesterolaemia, Sedative.

Table 4: *In Vivo* Pharmacological Activities in *Calotropis procera* with special reference to its different parts

Activities	Parts/Extract used	Animal Model	Assessment	Outcome
Cytotoxic Chemopreventive[4]	Dried Latex (aqueous extract)	X-15 Transgenic mouse model	Hepatocellular carcinoma	Cytotoxic Chemo preventive effect
Antitumor[3]	Stem extracts- (Ethyl acetate, acetone and methanol extract)	Adult Swiss albino mice	Sarcoma 180 tumours	Antitumor activity
Antidiarrheal[16]	Leaves (Methanol extract)	Albino mice	-	Methanol extract shows significant Antidiarrheal activity.
Anti - hyperglycaemic effect[17]	Leaves (Hydroalcoholic extract)	1.Male Wistar rats 2. Swiss mice	1.Acute toxicity 2.Oral glucose tolerance test	The hydroalcoholic extract has an anti-hyperglycaemic effect in streptozotocin-induced diabetic rats.
Antioxidant and anti-hyperglycaemic[18]	Dried latex (aqueous suspension)	Wistar rats	1. Blood glucose estimation 2. Estimation of serum insulin levels 3. Detection of urinary glucose and protein 4. Estimation of GSH and TBARS in renal tissue 5. Histological analysis of kidney	Antioxidant and anti-hyperglycaemic property and protection against the complications associated with diabetes.
Antidiabetic[19]	Latex (Phyto-modulatory proteins)	Wistar rats	1. Effect of LP administration in fed animals 2. Measurement of hepatic TNF-α 3. Measurement of insulin levels 4. Intraperitoneal glucose (ipGTT), insulin (ipITT) and pyruvate (ipPTT) tolerance testing 5. Intraperitoneal glucagon tolerance test 6. Western blot analysis 7. Real-time PCR	Therapeutic potential in DM2.
Anti-hyperbilirubinemic and wound healing[20]	Leaves (Aqueous extract)	Wistar rats	-	AECP showed significant bilirubin Lowering and wound healing properties in Wistar rats.
Anti-inflammatory Analgesic[21]	Leaves (Ethanol extract)	1.Wistar rats 2.Swiss mice	1. Anti-inflammatory study Carrageenan induced paw oedema in rats 2. Formalin paw lick test in rats. 2. Analgesic study 3. Acetic acid writhing response in mice 4. Tail flick test.	Ethanol extract shows potent anti-inflammatory and analgesic properties.
Anti-inflammatory[22]	Latex (Methanol Extracts)	Wistar rats	1. Rat paw oedema test 2. Histological changes associated with carrageenin-induced rat paw oedema	Extracts of DL exert their anti-inflammatory effects mainly by inhibiting histamine and BK and partly by inhibiting PGE2.
Anti-inflammatory Proteolytic[23]	Latex (proteins derived from the latex)	Male Swiss mice	1. Platelet count 2. Proteolytic activity 3. Plasma clotting activity 4. Activated partial thromboplastin time 5. Prothrombin time 6. Fibrinogen-agarose plate assay 7. Fibrinogen polymerisation assay 8. Fibrinogenolytic activity 9. Electrophoresis 10. Human plasma clot hydrolysing activity	Anti-inflammatory And proteolytic and therapeutic potential in conditions associated with coagulation abnormalities.
Anti-inflammatory[24]	Latex (Protein Sub-fraction)	Wistar albino rats	1. Joint inflammation 2. Stair climbing ability 3. Motility 4. Dorsal flexion pain 5. Estimation of tissue glutathione level 6. Estimation of tissue thiobarbituric acid reactive substances level 7. Histological analysis	Therapeutic potential in the treatment of arthritis.
Anticonvulsant[25]	Roots (Chloroform and aqueous extract of root)	Female Albino Wistar rats	1. Maximal electroshock seizure (MES) test 2. Pentylenetetrazole-induced seizure test 3. Lithium–pilocarpine-induced seizures 4. Electrically kindled seizures	Chloroform extract and aqueous extract may be beneficial in the absence (ptit mal) and tonic clonic (grand mal) seizures.
Anticonvulsant[26]	leaves (aqueous extract)	Wistar rats	1. Acute study 2. Chronic study 3. Estimation of GABA in the brain	Inhibited PTZ induced seizures in rats.

Hepatoprotective[27]	Flowers (Hydro-ethanol extract 70%)	Wistar rats	1. Hepatoprotective activity 2. Biochemical analysis	Biochemical markers to the near-normal levels of the treatment group.
Hepatoprotective[28]	Dried extracts	Wistar rats	1. Acute toxicity studies 2. Hepatoprotective study	Hepatoprotective activity
Immunomodulatory [29]	Root bark (Ethanol extract)	Swiss albino mice	1. Phytochemical tests 2. Acute toxicity studies 3. Haemagglutinating antibody (HA) titre 4. Delayed-type hypersensitivity (DTH) reactions 5. Peritoneal Macrophage count 6. Vascular Permeability in Mice 7. Peripheral blood count 8. Cyclophosphamide-induced immunosuppression	Immunomodulatory activity
Antipyretic effect[30]	Latex	Albino rats	-	Antipyretic activity
Antinociceptive[31]	Latex (protein fraction)	Male Swiss mice	Pharmacological tests a) Acetic acid-induced writhing b) Formalin test c) Hot plate test	Antinociceptive activity
Cardioprotective[32]	Latex (alcoholic extract)	Albino rats	1. Anti-myocardial-infarction activity 2. Estimation of serum enzyme levels in rats 3. Estimation of lipid peroxide and glutathione content in heart homogenates 4. Histopathological studies	Cardioprotective activity
Gastroprotective[33]	Dried latex and its methanol extract (MeDL)	Wistar rats	1. Effect of DL and MeDL on the gastric mucosa of normal rats 2. Estimation of antioxidant level and protein in gastric tissue 3. Estimation of thiobarbituric acid reactive substances (TBARS) in gastric tissue 4. Histological analysis of stomach	Gastroprotective activity
Lipolytic effect[34]	Leaf (extract)	Albino Wistar rats	Histopathology	Lipolytic activity

In table 4, a meticulous analysis of *In Vivo* studies to assess pharmacological activities of *Calotropis procera* with special reference to plant parts, their extraction method, animal models, assessment criterion and study outcomes has been done. Upvisha, *Calotropis procera,* is a beneficial plant as per Ayurveda and modern view. Many studies are available on the internet about *Calotropis procera* in which 15900 preclinical pharmacological studies have been registered in the last 20 years, including 3470 *In Vivo* studies. 21 *In Vivo* studies with full research papers have been selected for the current review. Also, ten important pharmacological activities out of 27 proven activities have been selected. Animal studies are a middle ground between *In Vitro* experiments and human trials. Most animal studies use laboratory-bred mice, rats, hamsters, guinea pigs etc., rodent species which are almost genetically identical. *In Vitro* methods are deployed for foundational investigations like disease processes at the cellular level. At the same time, *In Vivo* studies expand on data generated from *In Vitro* studies by monitoring biological responses in a living organism.

After assessing these studies, it is observed that anti-inflammatory, anticonvulsant, hepatoprotective, anti-hyperglycaemic, and anticancer activities are frequently evaluated. Four studies on anti-inflammatory activity, two studies on anti-hyperglycemic activity, two studies on hepatoprotective, and two studies on anticonvulsant activity are found. Commonly used plant parts are latex and leaves of *Calotropis procera,* but latex is used most frequently. Various extracts have been tested like aqueous extract, ethyl acetate extract, methanol extract, hydroalcoholic extract, protein extract, chloroform extract etc. Most commonly prepared extracts are protein and aqueous extract. These studies' widely used animal models are Wistar rats and Swiss albino mice.

Assessment criteria deliver knowledge about the qualities, characteristics and aspects of an assessment task that will be used to measure their achievement outcomes. Assessment criteria make it clear for researchers what factors will be taken under consideration while making conclusions about their study.

Two anti-hyperglycaemic activity studies have been carried out using two extracts, viz. hydroalcoholic extract of leaves and aqueous extract of dried latex in Wistar rats. After comparing the assessment parameter blood glucose level, the p-value of hydroalcoholic extract of leaves is < 0.05, and an aqueous extract of dried latex is < 0.001. Therefore, aqueous extract of dried latex has more significant anti-hyperglycaemic activity than hydroalcoholic extract of leaves.

Three anti-inflammatory activity studies have been carried out using three extracts viz. ethanol extract of leaves, methanol extract of latex and protein extract of latex in Wistar rats. In two studies, the carrageenan-induced paw oedema model was used, and in the third study, joint inflammation was assessed. By comparing p-value it is found that p-value of leaves ethanol extract is < 0.05, latex extract < 0.001 and protein extract of latex < 0.05. Out of these three studies, it is concluded anti-inflammatory activity of latex extract of *Calotropis procera* has given the most significant results.

In two anticonvulsant studies, three different extracts, viz. chloroform and aqueous extract of roots and aqueous extract of leaves, were assessed. These studies have the same model (PTZ induce convulsion model), similar study population (Wistar rats) and similar assessment criteria, i.e., delay in the time of convulsions. After comparing the p values of these studies, chloroform extract of the root is highly significant.

Two hepatoprotective activity studies were compared. In both studies, the Paracetamol induces hepatotoxicity model was used in which extracts of leaves and flowers were assessed in Wister rats. Parameters compared were SGOT, SGPT, Alkaline phosphate, and Total bilirubin level. Both studies showed a similar p-value ($p < 0.01$), so both extracts showed significant hepatoprotective activity.

The present study provides systematic information and meticulous analysis of *In Vivo* pharmacological actions of various extracts of *Caloropis procera* and its parts. Thus, this is an attempt to collect all possible references of *In Vivo* pharmacological activities of *Calotropis procera*.

CONCLUSION

From the above review, the extract of different parts of *Calotropis procera* (Upavisha Arka) has shown other pharmacological activities in various *In Vivo* studies. Hence, *Calotropis procera* has significant potential in treating different diseases. The present review may help provide additional information to further preclinical and clinical research on its use in treating various conditions.

REFERENCES

1. Anagha R, Rabinarayan A. Pharmacotherapeutic archives of arka. Journal of Medicinal Plants Studies 2016; 4(4): 94-108.
2. Bhagat M, Arora J, Saxena A. *In vitro* cytotoxicity of extracts and fractions of *Calotropis procera* (Ait.) Roots against human cancer cell lines. International Journal of Green Pharmacy 2010: 36-40.
3. Magalhes H, Ferreson P, Maura E, Torres M, Alves A, Pressia O *et al*. *In vitro* and *In vivo* antiproliferative activity of *Calatropis procera* stem extract. Annals of Brazzilian Academy of science 2010; 82(2); 407-416.
4. Choedon T, Matham G, Arya S, Kumar V L, Kumar V. Anticancer and Cytotoxic properties of the latex of *Calatropis procera* in atransgenic Mouse model of Hepatocellular Carcinoma. World J Gastroenterol 2006; 12(16): 2517-2522.
5. Wagh SJ, Gujar JG, Gaikar VG. Experimental and modelling studies on extraction of amyrins from latex of mandar (*Calotropis gigantea*). Indian Journal of Chemical Technology 2012; 19: 427-433.
6. Soodabeh S, Azadeh Manayi, Ahmad R Gohari, Mohammad Abdollahi. The story of Beta-sitosterol - A review. European journal of medicinal plants2014; 4 (5); 590-609.
7. Eric Wei Chiang Chan, Nuha I. Sweidan, Siu Kuin Wong, Hung Tuck Chan. Cytotoxic Cardenolides from Calotropis Species: A short Review. Records of Natural Products 2017; 11 (4): 334-344.
8. Ali Esmail Al-Snafi. The constituents and pharmacological properties of *Calotropis procera*- An overview. International Journal of Pharmacy Review & Research 2015; 5(3):259-275.
9. Sharma PV. Dravyaguna, vol. 2. Chaukhamba Bharti Academy, Varanasi, reprint 2001; p 433-435.
10. Parikh. Textbook of Forensic medicine and Toxicology. 7th edition chapter Vegetable poison. CBS Publishers and Distributors New Delhi 2016; 572.
11. Upadhyay R. Ethnomedical pharmaceutical and pesticide use of *Calotropis procera* (Ait.) (Family-Asclepiadaceae). Department of Zoology, Gorakhpur, Uttar Pradesh Revised 13/12/2013 accepted 6/03/14;135-145.
12. Govt of India. The Ayurvedic Pharmacopoeia of India. Controller of publications civil lines, New Delhi, 1st Reprint 2001; Part 1(vol-1):10-11.
13. Sharma PC, Yelne MB, Dennis TJ. Database of Medicinal Plants used in Ayurveda, CCRAS New Delhi Reprint 2005; 2: 69-72.
14. Wagh SJ, Gujar JG, Gaikar VG. Experimental and modelling studies on extraction of amyrins from latex of mandar (*Calotropis gigantea*). Indian Journal of Chemical Technology 2012; 19: 427-433.
15. Soodabeh S, Azadeh Manayi, Gohari AR, Abdollahi M. The story of Beta-sitosterol - A review. European journal of medicinal plants2014; 4(5): 590-609.
16. Patil SH, Adkar PP, Shelke TT, Oswal RJ, Borase SP. Antidiarrhoeal Activity of Methanol Extract of Leaves of *Calotropis procera* R.Br. IJPI'S Journal of Pharmacology and Toxicology 2011;1(3):26-30.
17. Netoa Mário CL, Vasconcelosa CFB, Thijana VN, Caldasa GFR, Araújob AV. Evaluation of antihyperglycemic activity of *Calotropis procera* leaves extract on streptozotocin-induced diabetes in Wistar rats. Brazilian Journal of Pharmacognosy2013; vol 23: 913-919.
18. Kumar VL, Padhy BM, Sehgal R, Roy S. Antioxidant and protective effect of latex of *Calotropis procera* against Salloxan-induced diabetes in rats. Journal of Ethnopharmacology, 2005; 102 (3): 470-473.
19. Oliveira RS, Figueiredo IS, Freitas LB, Pinheiro RS, Brito GA, Alencar NM *et al*. Inflammation induced by phytomodulatory proteins from the latex of *Calotropis procera* (Asclepiadaceae) protects against Salmonella infection in a murine model of typhoid fever 2012; 61(7): 689-698.
20. Patil RA, Makwana AB. Anti- hyperbilirubinemic and wound healing activity of aqueous extract of *Calotropis procera* leaves in Wistar rats. Indian journal of pharmacology 2015; 47(4): 398-402.
21. Saba AB, Oguntoke PC, Oridupa OA. Anti-inflammatory and analgesic activities of ethanolic leaf Extract of *Calotropis procera*. Afr. J. Biomed. Res 2011; 14(3):203-208.
22. Singh H, Kumar S, Dewan S, Kumar VL. Inflammation-induced by latex of *Calotropis procera* A new model to evaluate anti-inflammatory drugs. Journal of Pharmacological and Toxicological Methods 2000; 43: 219-224.
23. Ramos MV, Viana CA, Silva AFB, Freitas CDT, Figueiredo IST, Oliveira RSB *et al*. Proteins derived from latex of *Calotropis procera* maintain coagulation homeostasis in septic mice and exhibit thrombin and plasmin-like activities. Naunyn Schmiedebergs Arch Pharmacology 2012; 385:455-63.
24. Freitas AP, Bitencourt FS, Brito GAC, de Alencar NM, Ribeiro RA, Lima-Júnior RC *et al.* Protein fraction of *Calotropis procera* latex protects against 5-fluorouracil-induced oral mucositis associated with downregulation of pivotal pro-inflammatory mediators. Naunyn Schmiedebergs Arch Pharmacology 2012; 385:981-990.
25. Jalalpure SS, Sahahuddin M, Shaikh MI, Manvi FV. Anticonvulsant effects of *Calotropis procera* root in rats. Pharmaceutical biology 2009; 47 (2): 162-167.
26. Ramachandra VH, Shenoy S, Madhyastha M, Desai R, Ghosh S. Evaluation of effect of aqueous extract of leaves of *Calotropis procera* in pentylenetetrazole induced seizures in rats. Int J Basic Clin Pharmacol. 2016; 5(3): 643-646.
27. Setty SR, Quere AA, Swamy Viswanath AHM, Patil T, Prakash T, Prabhu K *et al*. Hepatoprotective activity of *Calotropis procera* flowers against paracetamol-induced hepatic injury in rats. Fitoterapia 2007; 78 (1): 451-454.
28. Manivannan E, Rajaram S, Kothai R, Arul B, Jayakar B. Effect of *Calotropis procera* Linn. against Paracetamol induced hepatotoxicity in rats. International Journal of

Research in Pharmaceutical and Biomedical Sciences 2011; 2(2):701-703.
29. Parihar G, Balekar N. Immunomodulating potential of *Calotropis procera* (Ait.) root barks ethanolic extract on experimental animal. J Adv Pharm Educ Res 2014; 4:268-76.
30. Dewan S, Kumar S, Kumar VL. Antipyretic effect of latex of *Calotropis procera*. Indian Journal of Pharmacology 2000; 32: 252.
31. Soares PM, Lima SR, Matos SG, Andrade MM, Patrocinio MCA, Ramos MV *et al*. Antinociceptive activity of *Calotropis procera* latex in mice. Journal of Ethnopharmacology2005;99(1):125-129.
32. Ahmed KKM, Rana AC, Dixit VK. Effect of *Calotropis procera* latex on isoproterenol-induced myocardial infarction in albino rats. Phytomedicine 2004; 11: 327–330.
33. Bharti S, Wahane VD, Kumar VL. Protective effect of *Calotropis procera* latex extracts on experimentally induced gastric ulcers in rats. Journal of Ethnopharmacology 2010; 127:440–444.
34. Akinloye K, Abatan MO, Onwuka SK, Alaka OO, Oke BO. Lipolytic effect of *Calotropis procera* in the skin of Wistar rats. Afr J Biomed Res 2001; 4:143-145.

Cite this article as:

Ashishkumar A. Kale *et al*. *In vivo* study of pharmacological activities of *Calotropis procera*: An overview. Int. J. Res. Ayurveda Pharm. 2022;13(3):44-49 http://dx.doi.org/10.7897/2277-4343.130356

Source of support: Nil, Conflict of interest: None Declared