

A Review on Medicinal Properties of Calotropis Procera Fiber and Uses

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Abstract - Nature has gifted humans a vast variety of medicinal plant, which are rich source in medicinal compounds. Calotropis Procera (CP) is a shrub from the Asclepiadaceae family, which can be found in several regions of the world. It is an evergreen plant and an important medicinal plant too. It is a natural fiber consisting mainly of cellulose, hemicellulose, lignin, pectin, and wax, as well as hydrophobicity and oleophilic properties. In this reviewed article, the main focus on the medicinal properties and its usage of the plants for building materials, natural pesticides, animal feed and bio remediative purposes were summarized.

Keywords- Anti-fertility, Antihelminthic Activity, Arka, Calotropis Procera, giant milkweed

I. INTRODUCTION

Calotropis procera is a soft-wooded, perennial shrub of the family Apocynaceae and subfamily Asclepiadaceae (the milkweed family)[1]. *Calotropis procera* (Vern. Aak), commonly known as Aak, is a valuable plant that is easy to grow in dry and arid climates and requires minimum water[2]. The word “*Calotropis*” is derived from Greek, meaning “beautiful,” which refers to its flowers; whereas “*procera*” is a Latin word referring to the cuticular wax present on its leaves and stem [3]. It is known by various common names such as apple of sodom, calotrope, giant milkweed, Indian milkweed, wild cotton, rubber tree, ushar, etc., in different parts of the world[4].

It has been widely used in traditional medicinal systems in North Africa, Middle East Asia, South Asia, and South-East Asia[5]. It has also been utilized for fiber, fuel, fodder, and timber purposes since antiquity (Batool et al., 2020)[6].

The potential of using milk- weed plants as a source of pulp for paper was also studied [7]. *Calotropis procera* is considered as a great source of renewable energy

[8]. The dry stem of this plant is used as a good source of fuel, firewood, and timber in some areas of the world [9]. The ash obtained from the plant is used to make gunpowder. The latex of the plant is processed for use in the treatment of vertigo, baldness, hair fall, toothaches, intermittent fevers, rheumatoid/joints swellings, and paralysis [10]. The silky strong and durable bark fiber is used in the manufacturing of cordage, ropes, carpets, fishing nets and lines, bowstrings and twines, and sewing thread whereas the seed floss is used for stuffing purposes [11].

The leaves of *Calotropis procera* are large, up to 18 cm and up to 13 cm broad.[12] *Calotropis procera* has a profusion of five-petaled, sweetsmelling white flowers, 3.8 to 5.1 cm in size, with a marked purple tip. The grey-green fruits of *C. procera* are 8 – 12 cm long, containing 350-500 seeds with tufts of white, silky hair.[13]

Vernacular names of *Calotropis procera* are given in table no. 1

Table 1: Vernacular Names of *Calotropis procera* [2,14]

English	Giant Indian Milkweed, Sodom Apple, Small Crown Flower, Rooster tree, French Cotton, Calotrope
Hindi	Aaka, Aanka, Ark
Sanskrit	Arka, Arka, Alaka, Ravi
Malayalam	Bukam, Dinesam
Kannada	Arkagida
French	Cotton-France, Arbre De Soie, and Bois Canon, Pomme de Sodome
German	Wahre Mudarpflanzer, Gomeiner
Spanish	algodón de seda, Bomba
Italian	Calotropo
Arabic	Oshar
Malaysia	Remiga
Thailand	Rak
Marathi	Akanda, Lalakara
Indonesia	Rubik

II. SOURCE OF FIBER

Calotropis procera is an emerging source of natural fiber. It is a wildy growing, evergreen, erect under shrub with a woody base and available in large quantity in the sandy tracts of Haryana, Rajasthan, Uttar Pradesh and Gujarat States of India [2]. Its fiber is natural, renewable with low density, high strength, crude oil sorption capacity (about 75 times its weight), and hydrophobic-oleophilic characteristics [15]. Alkali treatment may enhance the tensile strength, modulus, and length of the fiber [16]. Also, fiber length can be improved by a cell expansion mechanism derived from plasma membrane intrinsic proteins (Aslam et al., 2013)[17].

III. FIBER EXTRACTION

Two different methods were studied to extract high quality fibers from stems of *Calotropis procera*. The extraction procedure was carried out with initial 20.0 g of dried stems of *Calotropis procera*. As the inner bark was tough and not suitable for extracting fibres, the fibres were peeled out from outer surface of the stems. The first extraction procedure was based on alkali treatment and heating the stalks at higher temperature [18].

The dried stems after retting were dipped in 0.5N sodium hydroxide solution with a solution to stem ratio of 10:1 at room temperature overnight. The solution was then heated to 80°C for 30 min. The extracted component along with the solution was drained out. Fibers from the outer portion of the stems peeled out and then thoroughly washed first in warm and later in cold water. The inner bark was very tough and not suitable for extracting fibers. The fibers were rinsed with acetic acid to neutralize the remaining alkali and air dried. Maceration of the fibers were done by dipping it in equal amount of 10% nitric acid and 10% chromic acid solutions for 24 h after initiating the reaction by heating the solution at 60°C for 5 min (Ruzin, 1999)[19].

The alternate established procedure of fiber extraction used in the current study was based on the acidic treatment of the stalks (Brendel, et al., 2000)[20]. Stems of *Calotropis procera* were crushed into small pieces and dipped in solution of 80% acetic acid and concentrated nitric acid in the ratio of 10:1 in an oakridge tube. The reaction mixture was heated at 40°C for 40 min. The reaction mixture was tapped in every 5 min. Thereafter the solution was allowed to cool down. The cap of the tube was slowly removed due to building up of over-pressure. The solution mixture was discarded from the tube. Fibers were peeled out from the crushed stem pieces. Ethanol was added to the fibers, capped, invert shaken and centrifuged for 5 minutes at 10,000 rpm. After removing the supernatant the fibers were washed with distilled water, centrifuged for 5 minutes at 10,000 rpm. The supernatant was removed and acetone was added. Centrifugation was done at 10,000 rpm for 2 min. The

samples were then dried thoroughly by placing the fibers in the oven overnight.

Pretreatment of *Calotropis procera* fiber (CPF) was first washed and dried. The pretreatment process of CPF included alkali treatment, delignification and bleaching treatment (Ray et al. 2001; Neto et al. 2013)[21] [22]. Firstly, the cleaned CPF, 1 g, was immersed in NaOH solution (2 wt%), 100 mL, at room temperature and stirred for 3 h to finish the alkali treatment to remove the impurities including pectin, wax. The alkali-treated fiber was washed thoroughly till neutral. The delignification process was carried out with dewaxed CPF, 1 g, suspended in acetic acid (93% v/v), 50 mL, and hydrochloride acid solution (0.3% v/v) under strong stirring for 3 h at 90 °C and then washed till neutral pH value. The bleaching procedure was performed by adding the obtained delignified CPF into the mixture of H₂O₂ (5 wt%) and NaOH (3.8 wt%) at a ratio of 1:50 and stirred at room temperature for 3 h before washing thoroughly.

IV. MEDICINAL PROPERTIES OF CALOTROPIS PROCERA

Calotropis procera exhibits many important medicinal properties. Some of its reported studies on medicinal actions are summarized below:

A. Anti-microbial

The anti-microbial behavior of *Calotropis procera* on bacterial and fungal strains have been conducted by Kareem et al. . They use six bacterial strains viz. *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus albus*, *Streptococcus pyogenes*, and *Streptococcus pneumoniae*. The fungal strains used were *Aspergillus niger*, *Aspergillus flavus*, *Microsporium boudardii* and *Candida albicans*. It was observed that ethanolic extract of the leaf and latex of the plant exhibited great antimicrobial actions against bacterial strains. Ethanol and chloroform extract showed antifungal actions. *Candida albicans* was significantly inhibited by the ethanol extract. The study concluded that plant possess good anti-microbial activity [23].

B. Anti-oxidant

Methanolic extract of the *Calotropis procera* is strongly associated with the anti-oxidant activities and effective in radical scavenging of 1,1-diphenyl-2-picryl hydroxyl (DPPH) free radical during the analysis. The study suggested that *Calotropis procera* can be a good source of anti-oxidant drugs [24].

C. Anti-fertility

Circosta et al., studied the effect of *Calotropis procera* in female rat models. They observed that ethanolic and aqueous extracts of roots significantly interrupted the estrous cycle of the models. A consequent temporary inhibition of ovulation

was also noticed in the models treated with ethanolic and aqueous extracts. The findings of the study suggested the use of *Calotropis procera* as anti-fertility agent [25].

D. Anti-inflammatory

Parihar et al., performed in-vivo study on experimental animal models and suggested that the ethanolic extract of *Calotropis procera* at the dosage of 100 and 200 mg/kg had preventive actions against Complete Freund's Adjuvant (CFA) induced arthritis in models. The inhibition of associated polyarthritic index was also noticed in (CFA) induced arthritic inflammation. [26] Kumar et al., studied the anti-inflammatory behavior of *Calotropis procera* in rat models. They use carrageenin and formalin to induce paw edema in the models artificially. It was observed that aqueous suspension of the dried latex at the single dosage effectively produced an acute anti-inflammatory response [27]. Whereas in the models with acetic acid-induced vascular permeability, ethanolic extract effectively helped in the reduction of dye leaking. The extract significantly changed the lipid peroxidation, glutathione content (GSH) [26].

E. Anti-cancer

Choedon et al., conducted an investigatory study on the X15-myc transgenic mouse model to test the anti-cancer potential of dried latex (DL) of *Calotropis procera* against hepatocellular carcinoma. The oral administration of aqueous suspension of (DL) at the dosage of 400 mg/kg for 5 d/week for 15 significantly protected the models against hepato carcinogenesis. It also lowered down the serum levels of vascular endothelial growth factor (VEGF) [28].

F. Anti-ulcer

Bharti et al., investigated the anti-ulcerative potential of *Calotropis procera* in rat models. The models were artificially induced with ulcers by ethanol, pyloric ligation and aspirin. The results revealed that dried latex (DL) and methanol extract (MeDL) both significantly inhibited the gastric mucosal damage in the aspirin and ethanol models [29].

G. Anti-diarrhoeal

Kumar et al., carried out an in-vivo study on rat models to study the antidiarrheal behavior of *Calotropis procera*. The models were administered with castor oil to induce diarrhoea artificially. It was observed that the oral administration of dry latex (DL) of *Calotropis procera* at the dosage of 500 mg/kg significantly decreased the frequency of defecation and diarrhoeal severity. DL significantly provided protection against diarrhoea [30].

H. Wound Healing

Rasik et al., studied the anthelmintic potential of *Calotropis procera* in an in-vivo study. Back of guinea pigs were

inflicted with thickness excisional wounds of 8.0 mm diameter. It was observed that 1.0% sterile solution of the latex on topical application significantly healed the wound by increasing collagen, DNA, and protein synthesis and epithelization, which leads to the reduction of the wound area [31].

I. Anti-helminthic

The fresh and aqueous extracts of dried latex had anti-helminthic actions in dose-dependent manner as they inhibited the spontaneous motility (paralysis) and evoked responses to pin-prick. The study suggested that *Calotropis procera* has anti-helminthic property [32].

J. Anti-asthmatic

Aliyu et al., showed the anti-asthmatic property of *Calotropis procera* in in-vitro and in-vivo tests by investigating anti-histaminic and bronchodilator activity. The study suggested that *Calotropis procera* plant can be used in allergic conditions like asthma [33].

V. USES OF CALOTROPIS PROCERA PLANT

A. Use as a Building Material

The *Calotropis* plant has been used as a material, where cultivated at 1 to 1.5 m spacing as done in certain regions in South America and the Caribbean, annual yields of up to 500 kg fibre production per ha can be expected [34]. The stem of the plant is used for roof-making. The use of the stem fibre for paper, nags and nets has also been reported [35]. Currently, the fibers are still used for rope making [36] in both Africa and South America. Floss (silky hair, akund floss, 2-3 cm long, 12-42 microns wide) from seed stands have been used as stuffing for pillows and mattresses [37]. Seed hair has been tested as a thermal insulating material and has been found comparable to Rockwool mineral fibers in its insulating properties. Tests have also been performed with insulating boards made from seed hair [38]. Insulating material from a composite of *Calotropis procera* fibres and phenol-formaldehyde resins has been shown to have high water repellency [39]. *Calotropis procera* flax has been forwarded as a binding material for the improvement of acoustic plaster [40]. Lately, the use of fibers from *Calotropis procera* as a reinforcement material for thermoplastic composites was suggested, with polypropylene (PP) as matrix polymer and maleated polypropylene Epolene G-3003 as coupling agent [41]. *Calotropis procera* fibers were tested as reinforcement material in an epoxy matrix, too [42]. During World War 1, rubber for tyres was produced from the *Calotropis procera*'s latex [33]. Although, the composition of the latex of the plant is very complex, it can consist of up to 25-35% of natural rubber [poly(cis-1,4-isoprene, 1), Fig. 2] [43].

B. Use as Adsorbent

The water-resistance and hydrophobicity of *Calotropis* fibers, treated and untreated, lend them the potential to be used as adsorbents for hydrocarbons, such as for oil [44,45]. Excellent and selective oil sorption behavior properties of *Calotropis procera* blended with cotton and polypropylene fibers were observed by Thilagavathi et al. [46].

Dried leaf powder of *Calotropis procera* has been used successfully as adsorbent for the dyes malachite green [47] and Congo red [48] from aqueous solutions.

C. Use as Fuel

The wood of *Calotropis procera* is utilized as cooking fuel in some areas [49,50]. Also, the plant is being studied extensively as a source of biofuel [51] with the gross heat content of the plant estimated at 6.1 kcal/g [52]. The heat values of whole plant fractions extracted with benzene, with petroleum ether and with ethyl acetate have been given as 9.6 kcal/g, 13.7 kcal/g, and 7.4 kcal/g, respectively [53]. The seeds of *Calotropis procera* is judged as having the potential of providing biodiesel conforming to European and ASTM standards [54] and have a relatively high oil-content[55]. Seed oil from *Calotropis procera* of North Eastern Brazil has been shown to have an oil content of 21%, with a range between 19.7% and 24.0% [56]

The use of dry biomass of *Calotropis procera* to produce biogas has been studied closely since 1992. The fermentation of a suspension of 4% (w/v) of dried leaves of *Calotropis procera* in water at an initial pH of 7.5 has been found to give 2.9 to 3.6 litres of biogas day⁻¹ litre⁻¹. The fermentation was found to be fast with 66% of dry material loaded being degraded during the first 2 days of incubation at 30°C with the resulting biogas containing 56–59% (v/v) methane [57].

Calotropis procera been studied as potential petrocrops. Extraction of the plant itself, especially with hexane and heptane, has led to high-yielding hydrocarbon fractions, which have been forwarded as potentially useful chemical feedstock [51].

Calotropis procera derived biomass has been found to lead to a lowering of the activation energy as compared to cracking petroleum vacuum residue alone [58].

D. Pesticidal Use of the Plant

Traditionally, extracts from *Calotropis procera* have been used alone or in combination with that of other plants, such as in a combination of the extract of *Calotropis procera* flowers, *Azadirachta indica* and *Nicotiana tabacum* leaves, and *Trachyspermum ammi* seeds used against the common cattle tick *Rhipicephalus microplus* (*Boophilus*) [59].

E. Molluscicidal Activity

Alcoholic extracts of fruits, leaves, stems, and roots of *Calotropis procera* were found to show molluscicidal

activity against *Biomphalaria arabica* [60], the intermediate host of the trematode *Schistosoma mansoni* in Saudi Arabia.

F. Plant Fungicidal Use

Extracts of *Calotropis procera* were found to inhibit growth, sporulation, and the conidial germination of *Drechslera biseptata* and *Fusarium solani* [61]. Others have reported the fungi toxic properties of extracts of the plant [62], especially also against seed-borne mycoflora of wheat, which includes *Alternaria alternata*, *A. clamydophora*, *Aspergillus niger*, *A. flavus*, *Rhizopus oryzae*, *Mucor* spp., *Fusarium* spp., *Drechslera australiensis*, *Penicillium* spp., *Curvularia lunata* and *Cladosporium* [63]. Extracts of *Calotropis procera* were found to be active against the fungal pathogen *Alternaria solani*, which causes early blight disease in tomatoes [64].

G. Nematicidal/Antihelminthic Activity

Aqueous and methanolic extracts of dried flowers of *Calotropis procera* have antihelminthic effect as studied on live *Haemonchus contortas* [65]. Sheep infected with gastrointestinal nematodes were treated with the extracts and the egg counts in treated sheep decreased significantly [65] although the activity was found to be lower than that of levamisole. Also, the latex of *Calotropis procera* has been shown to have antihelminthic effect in sheep [66,67].

VI. CONCLUSION

Calotropis procera is a popular tribal shrub used extensively in the folk medicinal system to treat a variety of diseases. From the literature study, *Calotropis procera* plant is associated with various medicinal properties such as, anti-inflammatory, anti-asthmatic, anti-ulcer and wound healing etc. Experimental studies by scientists and researchers using different animal models suggest the utmost significance of this plant. Through this can easily identify the medicinal property of *calotropis procera* and its other uses in the developmental world were discussed.

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