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REGULAR ARTICLE

POTENTIAL OF UTILIZING *CALOTROPIS PROCERA* FLOWER BIOMASS AS A RENEWABLE SOURCE OF ENERGY

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SUMMARY

Calotropis procera, a laticiferous arid plant has been identified as a potential petrocrop. It is a potential plant for bioenergy and biofuel production in semi arid regions of the country. *Calotropis procera* is an erect much branced shrub, 2-3 m high with leaves about 10-13 cm wide by 17-19 cm long. It is a soft wooded evergreen perennial bush and with its conspicuous purplish pink flowers it is one of the most common and impressing plants in arid region. The plant grows well up to 2 meters, and its roots are said to reach down to a depth of even 3 meters. Almost all the parts of *Calotropis procera* yield hydrocarbons. Biocrude obtained from this plant is reported to be a rich source of tri-terpenoid type of hydrocarbons. Hexane extract of different parts of *Calotropis procera* viz. whole plant, stem, leaves and pods have been evaluated. Flowers of *Calotropis procera* contribute significantly to the total biomass of the plant. The flowers are available throughout the year. They are bitter, digestive, astringent, anthelmintic, tonic, anti-inflammatory, spasmolytic, stomachic, hepatoprotective & antioxidant and useful in cold, asthma, catarrh, anorexia, inflammations, tumours. Present work highlights the biomass and biocrude from flowers of *Calotropis procera*. The biomass of flowers was evaluated for different seasons shows maximum fresh biomass of 799.10 gm in summer season. The dried biomass of *C. procera* flowers was subjected to non-polar (petroleum ether 60-80) and polar (methanol) solvent extraction to check its extractibilities. The total extractive yield was found maximum in monsoons 4.5 % (petroleum ether extract) and 27.9 % (methanol extract). The flower biomass of *Calotropis procera* can, therefore, be exploited as a potential source of bioenergy.

Key words: *Calotropis procera*, flowers, extractability, biomass, bioenergy
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1. Introduction

There is a global realization that fossil-based fuels cannot meet the demands of fuels for transport and industrial requirements. Worldwide energy consumption is projected to grow by 44% over the next two decades, according to the International energy Outlook, 2009. One third of the projected demand of energy is expected to occur in the developing nations of Asia. Renewable energy sources are the fastest-growing energy source, increasing by an average of 2.9 percent per year [11]. Current commercial and non commercial use of biomass for energy is estimated between 20-60KJ of energy which represents about 6- 17% of worlds primary energy. The pattern of energy consumption in India shows that 56.5 % of total energy is from the commercial sources like coal, oil, electricity and remaining 43.5% is non-commercial energy. Fire wood, charcoal, agricultural residues, vegetable wastes, cow dung, urban and industrial wastes, forest residues are the main sources of this non-commercial energy. The non-commercial biomass fuels are the main sources of energy available in the rural areas [9].

Biomass resources are potentially the world's largest energy resource. Biomass conversion to fuel and chemicals is becoming an important alternative to replace oil and coal. Biomasses reduce CO2 emissions and reduce

import of fossil fuels by being a resource for scarcity of fossil fuels. The biomass resource should be of low cost and should have no negative impact on food supply and environment. *Calotropis procera* is an erect, tall, large, much branched and perennial shrubs or small trees that grow to a height of 2-3 m high with leaves about 10-13 cm wide by 17-19 cm long. It belongs to family Asclepiadaceae or Milkweed family which includes 280 genera and 2,000 species of world-wide distribution but most abundant in the sub-tropics and tropics, and rare in cold countries. It is found in most parts of the world in dry, sandy and alkaline soils and warm climate. In India it is found from Punjab and Rajasthan to Assam and Kanyakumari up to an altitude of 1050 m. It grows well on rubbish heaps, waste and fallow lands, roadsides, sand dunes and as a weed in agricultural lands [19]. The plant has a growth potential of 2 dry tones to 40 dry tonnes per ha depending on the agro climatic conditions of its growth [12]. The plant, commonly known as aak, is known for its medicinal properties in Ayurveda. *Calotropis* is used as a traditional medicinal plant with unique properties [14-16]. Traditionally *Calotropis* is used alone or with other medicinals [5] to treat common diseases such as fevers, rheumatism, indigestion, cough, cold, eczema, asthma, elephantiasis, nausea, vomiting, diarrhea [8]. According to Ayurveda, dried whole plant is a good tonic, expectorant, depurative, and anthelmintic. Flowers of *Calotropis procera* are used in traditional medicine in treatment of cold, asthma, catarrh, anorexia, inflammations and tumours [1, 21]. The plant yields valuable hydrocarbons which could be converted into diesel substitutes [6,7]. Evaluation of different parts viz. latex, stem, leaves and pods, of *Calotropis procera* as a source of hydrocarbons has been studied [3]. The bio-diesel derived from *Calotropis procera* is free from NOx gases, $S0_2$ and suspended particulate matter (SPM) and has high cetane value [10, 13, 17, 18]. *Calotropis procera* has big inflorescence with very prominent purplish pink flowers. These occur throughout the year. No studies on the available flower biomass and biocrude are reported. So a preliminary study to explore the possibility of using flowers for producing hydrocarbons, an alternate source of energy was undertaken.

2. Material and Methods

Calotropis procera flowers were collected from areas in and around Arid Forest Research Institute, Jodhpur (2003-2006) in three seasons winter, summer and monsoon. The flowers were dried in shade and grinded in a mixer grinder. Powdered flowers (200 g) were successively extracted exhaustively with petroleum ether (60-80) and then exhaustively with methanol. The extracts were filtered and concentrated to dryness. The extract obtained in the form of a semi solid mass, was weighed and yield of total extractives determined on dry weight basis.

For biomass determination *Calotropis procera* plants were selected in area around the Pali bypass, Jodhpur. Plants selected were of three variable heights and their crown diameter was recorded in triplicates (Table 1). Flowers were collected and fresh weight and dry weights were recorded.

Table 1 Crown diameter of *Calotropis procera* plants with variable height

Replicate Plant	Crown diameter of plants with approx ht 200 cms (in cms)	Replicate Plant	Crown diameter of plants with approx ht 150 cms (in cms)	Replicate plant	Crown diameter of plants with approx ht 300 cms (in cms)
C1H1R1	195	C2H2R1	137.5	C3H3R1	210
C1H1R2	175	C2H2R2	120	C3H3R2	207.5
C1H1R3	155	C2H2R3	112.5	C3H3R3	202.5

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3. Results and Discussion

In the sandy desert soils of Rajasthan, *Calotropis procera,* a soft wooded evergreen perennial shrub with conspicuous purplish pink flowers, is one of the most common and most impressing plants (4, 20). *Calotropis* flowers are available throughout the year and can be harvested 3 times in a year (Figs. 1 &2).

Fig. 1 *Calotropis procera* in natural habitat

Fig. 2 Harvested flowers of *Calotropis procera*

Biomass determination

Biomass study shows that with increase in height of the plant the total flower biomass increases (Table 2- 4). Analysis of the results shows that maximum biomass is recorded in summer season (799.10 gm/plant) and minimum in winter season (455.2 gm/plant). About 1957 gms of flowers can be obtained in a year from one plant of *Calotropis procera*. No direct relation of biomass yield with crown diameter was observed.

Table 2 Total fresh & dry Biomass (gm/plant) of *Calotropis procera* flowers in winter season

Plant	Fresh Biomass	Dry Biomass	Average biomass
C1H1R1	511	82.086	
C1H1R2	516	78.847	77.44
C1H1R3	441	71.382	
C2H2R1	211	38.793	
C2H2R2	193	35.126	42.66
C2H2R3	332	54.059	
C3H3R1	605	91.73	
C3H3R2	834	132.041	98.73
C3H3R3	454	72.427	
Total Biomass	455.2	72.9	

Table 3 Total fresh and dry biomass (gm/plant) of *Calotropis procera* flowers in summer season

Plant	Fresh Biomass	Dry biomass	Average biomass
C1H1R1	666.98	91.49	
C1H1R2	422.41	61.62	85.72
C1H1R3	1233.8	159.05	
C2H2R1	561.02	76.75	
C2H2R2	325.07	49.31	67.8
C21H2R3	492.90	77.41	
C3H3R1	1039.48	137.13	
C3H3R2	1502.04	191.13	153.27
C3H3R3	948.18	131.54	
Total Biomass	799.10	108.38	

Table 4 Total fresh and dry biomass of *Calotropis procera* flowers in Monsoon season

Plant Description	Total Fresh Biomass	Total Dry biomass	Average biomass
C1H1R1	864.72	121.03	
C1H1R2	646.92	98.19	98.9
C1H1R3	495.77	77.49	
C2H2R1	442.71	65.47	
C2H2R2	463.88	65.54	65.3
C2H2R3	454.641	64.99	
C3H3R1	753.48	107.03	
C3H3R2	1184.10	162.53	140.4
C3H3R3	1019.33	151.66	
Total Biomass	702.83	101.54	

Extraction of biocrude

The non-polar biocrude was extracted from flowers of *Calotropis procera* by petroleum ether 60-80, whereas polar biocrude was recovered by methanol extraction. The total petroleum ether and methanol extractive are presented in table. The total extractive yield was found maximum in monsoon season The lowest yield of petroleum ether extracts was in summer season and that of methanol extracts was in winter season. This shows that the non polar biocrude is maximum in monsoon and winter season and the polar crude is maximum in summer and monsoon seasons in case of *Calotropis procera*. In a study, the petroleum ether extractives from stem and leaves of *Calotropis procera* are 3.8 % and 5.1%. and the methanol extractives are 18.5 and 12.2% respectively (Table 5 & 6) . Our results show that the average petroleum ether extractives obtained from flowers are 2.9% which are comparable with those present in its stem and leaves [2,10]. The methanol extractives from flowers are 23.4% which is higher that that obtained from its stem and leaves.

Table 5 Yield of petroleum ether extracts of *Calotropis procera* flowers in different years & seasons

Seasons	Yield (%)		
	I Year	II Year	III Year
Summer	1.7	2.9	2.0
Monsoon	7.0	3.3	3.2
Winter	4.2	3.0	2.4

Table 6 Yield of methanol extracts of *Calotropis procera* flowers in different years & seasons

Seasons	Yield (%)		
	I Year	II Year	III Year
Summer	22.2	26.2	16.6
Monsoon	32.1	28.2	23.6
Winter	26.1	20.1	15.6

4. Conclusion

With fast disappearing petroleum reserves renewable resources like biomass are of great significance. Petrocrop, *Calotropis procera* is a wild shrub and does not compete with food and fodder crops for land. The flowers of *Calotropis procera* have biomass and extractives which can make it a potential source of hydrocarbons and its use as a renewable source of energy. Recently ethanol derived from renewable biomass has emerged as a major contender expected to

replace liquid petroleum fuel. The potential of these flowers as a source of ethanol can further be studied.

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