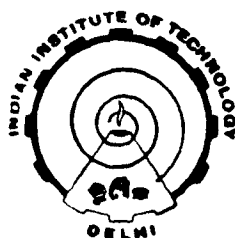


AN INTEGRATED APPROACH TO THE UTILIZATION OF BIOMASS :
STUDIES ON
Bougainvillea spp. AND Calotropis procera (Ait) R.Br.

by
GODUGUNUR GIRIDHAR

Thesis submitted
in fulfilment of the requirements
for the degree of
DOCTOR OF PHILOSOPHY

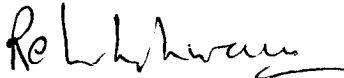


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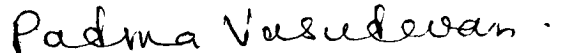
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CERTIFICATE

This is to certify that the thesis entitled, "AN INTEGRATED APPROACH TO THE UTILIZATION OF BIOMASS: STUDIES ON *Bougainvillea* AND *Calotropis procera* (Ait) R.Br.", submitted by Mr.G.GIRIDHAR has been prepared under our supervision in conformity with the rules and regulations of Indian Institute of Technology, Delhi. The research report and results presented in this thesis have not been submitted for any degree in any other University/Institution.



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To

Dear

Amma and Appa

ACKNOWLEDGEMENTS

To my teacher, philosopher and friend more than a guide, Prof. Padma Vasudevan, whose academic excellence and constant encouragement steered me through the work all the way and all the time. I am one of the few privileged students who could bask in her total academic freedom, personal affection and supervision.

To Dr. R.C. Maheswari for his total involvement, discussions and sincere guidance without which the thesis would not have taken the present form.

To Arvind Singh for his assistance and many helpful suggestions.

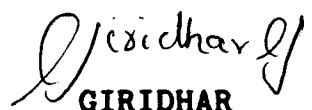
To all the faculty members of the Centre, specially to Dr. Santosh for her constant inspiration.

When one owes so much to so many, it is almost impossible and even invidious to single out names. However, I am thankful to my colleagues Gujral, Ragini, Dahiya, Jain, Tandon, Sampath and Mrinalini. To Manju for her help in the work on smoke analysis. To my hostelmates Srinu, Subbu, Naidu, Prabhakar, Anil, Sudarshan for keeping my spirits high. Mr. D.R. Mohan Rao, Sharada, Lakshmi, Saila and her parents for their warm affection and good wishes.

To all my brothers and sisters Syamanna, Venkat, Rama Murty, Janaki, Raja, Prabha, Vasu, Gopinath, Gita, Gopi and all bhabhijis for keeping me cheerful and aloof from all domestic difficulties. To all my KATTA members, in particular Jayanth, Ramana, Ravi, Sridhar, Satyamurty, Gopi, Goutham, Ramesh N and N.V. and Nagamani G and J for the fun and frolic which always kept me away from the travails involved in the persuance of Doctor of Philosophy.

To the Department of Non Conventional Energy Sources for their financial assistance and I.I.T., authorities for providing me facilities to carry out the research work. To Jagdish K. Lohia for Typing.

But for my Kamala's incessant pestering and prayers I would not have completed the task so successfully.


GIRIDHAR

ABSTRACT

In a world of diminishing fossil resources and increasing needs, the strategy for development should focus on man and ecology. Especially in the context of developing countries, small decentralised technologies based on renewable resources are highly relevant. Biomass, the most important of all alternate energy sources, has been exploited since times immemorial for food, fodder, fuel, fertilizer and fibre - the five basic necessities of man. Since, land is finite, technologies must be evolved for putting the marginal and unproductive wastelands into effective use. A variety of underexploited plants, including weeds which have high growth potentials, need to be evaluated for production of biomass on such lands. The present thesis is a study on two such plants, Bougainvillea and Calotropis. The former is a popular ornamental plant with prolific growth and the latter, a well known weed, is a potential petrocrop.

Both the plants are hardy and multiply under tropical agroclimatic conditions, with little agricultural inputs and management. Bougainvillea could be easily propagated by vegetative methods and coppiced regularly. The dry biomass yields recorded (50 - 80 tonnes per hectare per annum) are comparable to or even higher than the reported yields of many fast growing species. On the other hand, Calotropis with a biomass yield of 17 - 20 tonnes (dry) per hectare per

annum could neither be propagated vegetatively nor coppiced regularly.

Besides, direct burning, biomass could be converted to useful fuels by pyrolysing to charcoal, anaerobic digestion to methane, gasification to carbon monoxide and hydrogen and fermentation to ethanol. Some of these conversions were studied in detail in the present work. The hard biomass (stem) was converted to charcoal in different types of pyrolytic chambers. Both stems and leaves were separately digested anaerobically in laboratory scale bio-reactors.

Experiments were conducted to exploit the toxic constituents present in the *Calotropis* latex in mosquito and termite control. The different segments of the plant were also evaluated as a hydrocarbon source by estimating the yields of the different solvent extracts like benzene, acetone, methanol and hexane. Fuel characteristics of these extracts were determined. The aerial biomass (leaf and stem) of both the plants were converted to oxalic acid by oxidation with nitric acid and by-product recovery was attempted.

From the study the following salient points emerged. *Bougainvillea* with its high biomass potential and ease of propagation could become a good source of energy through direct burning or charcoal production. It can also be used as mixed feed in biogas along with cowdung. When digested

alone it generated 100 litres of biogas per kilogram of dry biomass containing about 50% of methane.

Calotropis with its low biomass yields and difficult propagation may not be attractive as a source of energy, unless biomass production can be enhanced employing techniques such as nursery raising or tissue culture. But once established it has the ability to survive under severe agroclimatic conditions. Its toxic nature could make it useful in termite and mosquito control. As it yields hydrocarbons, it is a potential petrocrop.

Both the plants could be used to produce oxalic acid, if yields are improved and by products properly recovered.

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