Poll Res. 40 (3) : 823-827 (2021)

ISSN 0257–8050

ECOLOGY OF BIOFUEL YIELDING PLANT WITH SPECIAL REFERENCE TO *JATROPHA CURCAS* IN SHIMOGA DIST, KARNATAKA, INDIA

B. ANANTHA NAG*, NEETHU PATIL[1], ARJUMAND BANU S.S.[2], RAGHAVENDRA S.N.[2], RAGHU H.S.[2] AND E.T. PUTTAIAH[3]

[*]Department of Environmental Science, Kuvempu University, Shankarghatta, Karnataka, India
[1]Department of Civil Engineering, SJB Institute of Technology, Bangalore, India
[3]Department of Environmental Science, Gulbarga University, Gulbarga, India
[2]Department of Biochemistry, Kuvempu University, Shankarghatta, Karnataka, India

(Received 8 December, 2020; Accepted 28 January, 2021)

ABSTRACT

Biodiesel is one of the best alternatives over the natural petroleum products & their derivatives for meeting the current demands of petro products. Biodiesels are produced from the common renewable raw materials like *Jatropa*, soyabeans etc. and are highly efficient as compared to natural petroleum. It provides a sense of security not only to our natural reserves and the environment, rather it also encourage the social economy. In this study we aimed to reclaim the wastelands by cultivation of oil yielding plant like *Jatropa* and later to estimate the quantity of biodiesel produced over the given area. Further the vegetation samples were collected from the sixteen different locations at regular interval, processed and ultimately biodiesel were produced. The production of biodiesel from the raw biomass material was varied in a range of 27 -30%, while the waste remains were being used for the cattle baits. The major economic factor to consider for input costs of biodiesel production is the feedstock, which is about 80% of the total operating cost.

KEY WORDS : *Jatropha curcas*, Wasteland, Biodiesel, Bio-fertilizers.

INTRODUCTION

Energy is an essential requirement for economic and social development of any country. The world energy demand for the last two decades, witnessed uncertainties in two dimensions. Firstly, depletion of fossil fuels. Secondly, combustion of fossil fuels, main culprit in increasing the global carbon dioxide level. TRANS-ESTERIFICATION: Major problems associated with the use of straight vegetable oils in diesel engine are their high fuel viscosity and high carbon deposits (piston top surface coated (piston ring sticking with oil) with carbon deposit). Biodiesel is an alternative to conventional diesel fuel made from renewable resources, such as non-edible vegetable oils. The oil from seeds (e.g., *Jatropha* and Pongamia) can be converted to a fuel commonly referred to as "Biodiesel." No engine modifications are required to use biodiesel in place of petroleum-based diesel. Biodiesel can be mixed with petroleum-based diesel in any proportion. This interest is based on a number of properties of biodiesel including the fact that it is produced from a renewable domestic source, its biodegradability, and its potential to reduce exhaust emissions. The climate change is presently an important element of energy use and development. Biodiesel is considered "climate neutral" because all of the carbon dioxide released during consumption had been sequestered out of the atmosphere during crop growth. The use of biodiesel resulted in lower emissions of unburned hydrocarbons, carbon monoxide, and particulate matter. Biofuel development in India centers mainly around the

cultivation and processing of *Jatropha* plant seeds which are very rich in oil (40%) (Michael Whitaker, 2009).

MATERIALS AND METHODS

Study Area

Shimoga, a place known for its scenic beauty, flush green lush forests, eye-catching waterfalls, cool climate is situated in the Malnad region bounded by Sahyadri Ghats at an mean elevation of 640 AMSL in the western part of Karnataka.

16 sampling sites were selected from all over the Shimoga district among which *J. curcas* samples were collected from sixteen each sites.

Description of Tested Plants

In Karnataka the important commercial non-edible oil yielding plants are, *Pongamia pinnata, Jatropha curcas, Azadirachta indica, Madhuca longifolia, Schlichera oleosa, Garcinia indica, Calophyllum inophyllum* and many more. The oil obtained from such seeds is chiefly used for manufacture of soaps, candles, paints, varnishes, linoleum, lighting and for medicinal purposes.

Jatropha has been considered as most suitable for bio-diesel as the oil yields per hectare is among the highest of tree borne oil seeds. Its oil, being a potential substitute to diesel, it grows on gravely, sandy or saline soils and also on the poorest stony soils and rock crevices.

Sample Collection

Jatropha seed samples were collected from different taluks of shimoga district, Karnataka state during August 2011 to December 2011. Seed samples of *Jatrohpha curcas* from sixteen each sites and a total of 16 sampling sites all over the study area. The seeds are brought to the laboratory and analyzed to determine the physical and physiological characteristics. The details of sampling sites from where the seed samples were collected are tabulated.

RESULTS AND DISCUSSION

Filed Survey

During the study period field survey conducted in different regions of the Shimogga district, seed samples belonging to *Jatropha curcas* were collected.

Variation of Physical characteristics in *Jatropha curcas*

The variations in physical characteristics of *Jatropha* seeds at 16 different sites of the study area are tabulated in Table 1. Highest seed weight (100 seeds) of *J. curcas* was noticed in the collection at Umblebailu region (78.5 g) while, Thirthahalli (42.0 g), Vaddigere (53.8 g), Varadhahalli (41.5 g), Malavagoppa (50.0 g), Sorabha (65.4 g), Nidige

Table 1. Variation in physical characteristics of *Jatropha curcas* seeds

Location	Seeds per Kg	100 seed Weight (g)	Seed Length (mm)	Seed Breadth (mm)	Seed Thickness (mm)
Agardhahalli	2150 ± 10.0	44.8 ± 1.52	1.45 ± 0.16	1.0 ± 0.55	0.80 ± 0.2
Anandapura	1910 ± 9.0	52.6 ± 1.20	1.64 ± 0.19	1.2 ± 0.63	0.91 ± 0.2
Gonibidu	2008±11.0	46.5 ± 0.99	1.49 ± 0.56	1.0 ± 0.34	0.79 ± 0.7
Hunasegatte	2080± 8.2	45.8 ± 0.82	1.47 ± 0.09	1.0 ± 0.37	0.78 ± 0.8
Jade	1971 ± 7.0	54.8 ± 2.52	1.62 ± 0.26	1.2 ± 0.35	0.89 ± 0.2
Karanagiri	1985 ± 11.0	53.9 ± 1.26	1.61 ± 0.21	1.2 ± 0.13	0.90 ± 0.2
Konandur	2050 ± 8.0	46.1 ± 0.82	1.49 ± 0.06	0.9 ± 0.39	0.71 ± 0.9
Malavagoppa	1895 ± 12.0	56.0 ± 0.29	1.72 ± 0.19	1.3 ± 0.90	1.09 ± 0.4
Nidige	1920 ± 7.0	55.1 ± 1.62	1.58 ± 0.36	1.2 ± 0.53	0.94 ± 0.7
Shankarghatta	2002 ± 8.0	46.5 ± 0.67	1.50 ± 0.07	0.9 ± 0.76	0.73 ± 0.2
Shivapura	1900 ± 6.0	52.8 ± 1.02	1.65 ± 0.27	1.0 ± 0.78	0.79 ± 0.8
Soraba	1945 ± 6.2	55.1 ± 1.00	1.63 ± 0.29	1.0 ± 0.84	0.82 ± 0.2
Thirthhalli	1801 ± 9.1	56.9 ± 1.89	1.77 ± 0.16	1.3 ± 0.99	1.00 ± 0.8
Umblebailu	1792 ± 6.9	57.5 ± 1.10	1.79 ± 0.19	1.3 ± 0.73	1.12 ± 0.5
Vaddigere	1864 ± 8.0	56.2 ± 0.52	1.71 ± 0.16	1.2 ± 0.98	0.95 ± 0.2
Varadhahalli	1875 ± 6.0	56.1 ±1.20	1.72 ± 0.19	1.2 ± 0.56	0.93 ± 0.6

± Standard deviation

(51.0g), Jade (53.1 g), Karanagiri (53.9 gms), Shivapura (52.8 g), Anandapura (52.8 g), Gonibeedu (46.5 g), Shankaraghatta (46.5 g), Konandur (46.1 g), Hunasekatte (45.8 g) stood next in rank and the lowest was noticed from Agaradahalli (30.8 g). Thus, the seed weight was more in Umblebailu and lowest in Agaradhahalli.

In case of seed length, Umblebailu witnessed highest seed length, while seed length was lowest at Agaradahalli. Following the highest seed length, Thirthahalli, Malavagoppa, Varadhahalli, Vaddigere, Shivapura, Anandapura, Sorabha, Jade, Karanagiri, Nidige, Shankaraghatta, Gonibbedu, Konandur, Hunasekatte stood next in descending order.

Seed breadth was noticed to be highest in Umblebailu, Malavagoppa and Thirthahalli while the, lowest among the collected seed samples was witnessed by Shankaraghatta and Shankaraghatta.

Seed thickness was also found to be highest at Umblebailu on the other hand, Konandur witnessed the lowest seed thickness among the collected seed samples.

Number of seeds/Kg was found to be highest at Agaradahalli, on the other hand, Umblebailu has the lowest number of seeds/kg by seeds in one kilogram.

Variation of Physiological Characteristics in *Jatropha curcas*

Seed moisture also showed significant variation among the different locations, ranging from 5.7% in Konandur to 6.8% in Umblebailu. The other sites showed fluctuating values pertaining to the seed moisture.

Gonibeedu (5.8%), Shankaraghatta (5.8%), Hunasekatte (5.9%), Agaradahalli (6.0%), Shivapura (6.0%), vaddigere (6.0%), Varadahalli (6.1%), Soraba (6.1%), Anandapura (6.1%), Jade (6.3%), Karanagiri (6.4%), Malavagoppa (6.6%) and Nidige (6.7%) were followed next to Konandur in a increasing order of seed moisture content.

The highest germination percentage was observed in the seeds collected from Umblebailu area (85%), while at Konandur the percentage of germination (76%) was lowest. The other sampling sites showed varied germination percentage during the study.

Gonibeedu (79%), Vaddigere (79%), Varadahalli (80%), Shankaraghatta (80%), Shivapura (80%), Hunasekatte (80%), Soraba (80%), Karanagiri (81%), Agaradahalli (81%), Jade (82%), Anandapura (83%), Malavagoppa (84%), Nidige (84%), Thirthahalli (84%) stood next to Konandur.

Among all the sampling sites the seeds from five sampling sites showed the germination percentage of 80 and the seeds from Konandur rightly got the lowest percentage of germination by having the least moisture content in them.

Vigour index of the seeds collected from the Umblebailu region was got highest value (2541), while the seeds from the Konandur (2014) showed

Table 2. Variation in Physiological characteristics of *Jatropha curcas* seeds

Location	Moisture content (%)	Percentage Germination	Root Length (cm)	Shoot Length (cm)	Vigour index
Agardhahalli	6.0 ± 0.5	81 ± 1.5	8.9 ± 0.9	18.9 ± 1.0	2251 ± 2.0
Anandapura	6.3 ± 0.2	83 ± 1.3	9.0 ± 0.5	19.2 ± 0.8	2340 ± 3.8
Gonibidu	5.8 ± 0.8	79 ± 1.2	8.9 ± 0.6	18.2 ± 1.1	2140 ± 2.9
Hunasegatte	5.9 ± 0.6	80 ± 0.9	8.8 ± 0.2	19.0 ± 0.5	2224 ± 4.0
Jade	6.3 ± 0.4	82 ± 1.2	9.0 ± 0.7	19.4 ± 0.8	2328 ± 2.8
Karanagiri	6.4 ± 0.7	81 ± 1.5	8.9 ± 0.5	19.6 ± 1.0	2308 ± 7.0
Konandur	5.7 ± 0.4	76 ± 1.0	8.6 ± 0.2	17.9 ± 0.8	2014 ± 1.2
Malavagoppa	6.6 ± 0.7	84 ± 1.1	9.0 ± 0.6	20.0 ± 0.9	2436 ± 5.9
Nidige	6.7 ± 0.5	84 ± 1.7	9.4 ± 0.7	20.2 ± 1.0	2486 ± 5.6
Shankarghatta	5.8 ± 0.3	80 ± 1.0	8.8 ± 0.4	18.0 ± 0.8	2144 ± 7.9
Shivapura	6.0 ± 0.9	80 ± 1.2	9.0 ± 0.6	18.8 ± 1.1	2224 ± 7.3
Soraba	6.1 ± 0.7	80 ± 1.1	9.0 ± 0.3	18.6 ± 1.0	2208 ± 2.9
Thirthhalli	6.5 ± 0.5	84 ± 1.5	9.3 ± 0.5	19.9 ± 0.8	2452 ± 5.8
Umblebailu	6.8 ± 0.7	85 ± 1.0	9.4 ± 0.6	20.5 ± 0.8	2541 ± 2.9
Vaddigere	6.0 ± 0.5	79 ± 0.9	8.7 ± 0.4	18.2 ± 0.7	2125 ± 4.5
Varadhahalli	6.1 ± 0.6	80 ± 1.0	9.2 ± 0.2	19.0 ± 0.8	2256 ± 6.4

± Standard deviation

the lowest value. Sampling sites Vaddigere, Gonibbedu, Shankaraghatta, Soraba, Shivapura, Hunasekatte, Agaradahalli, Varadahalli, Anandapura, Karanagiri, Jade, Malavagoppa, Thirthahalli and Nidige hold the 2 to 15th order.

The shoot length was maximum at Umblebailu (20.5 cms), while it was found to be lowest at Konandur (17.9 cms). The shoot length of seedlings from the Nidige and Malavagoppa (20.2 and 20.0 respectively) stood next to Umblebailu in decreasing order.

Thirthahalli, Karanagiri, Anandapura, Varadahalli, Hunasekatte, Agaradahalli, Shivapura, Soraba, Gonibeedu, Shankaraghatta, Konandur followed the Malavagoppa.

The root length was maximum at Umblebailu (9.4 cms), while it was found to be lowest at Konandur (8.6 cms). Vaddigere, Shankaraghatta, Hunasekatte, Karanagiri, Gonibeedu, Agaradahalli, Anandapura, Jade, Shivapura, Malavagoppa, Soraba, Varadahalli, Thirthahalli and Nidige holds the increasing order of root length.

In case of dry weight of the *J. curcas* seeds, the collection from sites namely Umblebailu, Vaddigere, Varadahalli (1.45 g) witnessed the more dry weight among the collected samples all over the study area. The seeds from Konandur (1.06 g) had the least dry weight among the sixteen sites.

Nidige (1.42 g), Karanagiri (1.35 g), Soraba (1.34 g), Anandapura (1.33 g), Malavagoppa (1.32 g), Jade (1.30 g), Shivapura (1.29 g), Agaradahalli (1.27 g), Hunasekatte (1.25 g), Thirthahalli (1.25 g), Gonibeedu (1.17 g), Shankaraghatta (1.10 g). Showed varied response pertaining to dry weight of the seeds.

Oil Content of *Jatropha curcas*

The oil contents of *J. curcas* at various sampling sites of the study area have showed varied response and the seeds from Agaradhahalli (Ac. No: KRSHADL) of bhadravathi taluk have highest oil content (29.9 %) among the sites, while the seeds from Soraba (Ac.No: KRSHSRB) have the lowest oil content (27 %) among the seed samples from all other sites.

Variation in N, P and K Contents in Seedcakes of *Jatropha curcas*

NPK percentage ratio of seed cakes of *J.curcas* ranged from 3.8:1.6:1.4 to 3.1:1.0:0.9 at Umblebailu and Agaradahalli respectively. The percentage of NPK ratio showed varied response among the sixteen sampling sites of the study area. The mean value for percentage NPK ratio of seed cake at the study area was 3.29:1.25:1.14.

In general the small-scale *Jatropha* biodiesel system for local transportation use shows similar environmental performance as other biofuel systems. Compared to other systems our case study shows a strong reduction in non-renewable energy requirement and a moderate reduction in global warming potential. The trade-off environmental cost for these reductions is an increase in eutrophication and acidification. Expanding the *Jatropha* biodiesel system with biogas production enhances the energy efficiency while other impacts remain stable due to other offsetting factors. As fertilizer and waste applications (mainly N) are important contributors in most impact categories, optimizing fertilization and agronomic practices and improving crop uniformity through breeding are seen as the major system improvement options, along with the efficient use of by-products and technological advances. A national mission on Bio-Diesel has already been proposed by the committee comprising six micro missions covering all aspects of plantation, procurement of seed, extraction of oil, trans-esterification, blending & trade, and research and development. Bio diesel had come to stay. In future, it should also serve to reduce and maintain the price of automobile fuel. The under exploited and un exploited vegetable oils are good sources of biofuel. Our country is endowed with many such plants. Research is being carried out now to convert vegetable oils into biodiesel through biotechnological processes using biodiesel. With a concentrated and coordinated effort. Wide use of bio diesel in our country is going to be a reality in the days to come. So that if we grow this plants in the waste lands regions it could helps in the future. There is clear indication that *Jatropha* cultivation can make a significant contribution to the bio-fuel production and in sustainable development of the country, Although this *Jatropha* system for local use shows some promising LCA results, it has to be noted that these reflect environmental performance and not complete sustainability. The study does not consider socio-economic impacts. Even though the *Jatropha* cultivation on wasteland does not trigger direct (or even indirect) competition with food and is expected to create only low carbon debt it might still compete with other resources (e.g. labour, water, etc.). However a small scale, low input system creates income generation opportunities. Hence, this study is a partial contribution to increase insight in

the sustainability potential of *Jatropha* based biodiesel systems.

REFERENCES

Abdelgadir, H.A., Johnson, S.D., Van Staden and Pollinator, J. 2009. Effectiveness, breeding system, and tests for inbreeding depression in the biofuel seed crop, *Jatropha curcas*. *J Hortic Sci Biotechnol*. 84 : 319-324.

Achten, W., Akinnifesi, F.K., Maes, W.H., Trabucco, A., Aerts, R. and Mathijs, E. ???. Jatropha integrated agroforestry systems – biodiesel pathways towards sustainable rural development. In: Ponterio, C., Ferra, C., editors. *Jatropha curcas as a Premier Biofuel: Cost, Growing and Management. Hauppauge,* NY (USA): Nova Science Publishers, in press.

Achten, W.M.J., Nielsen, L.R., Aerts, R., Lengkeek, A.G., Kjaer, E.D. and Trabucco, A. 2010. Towards domestication of *Jatropha curcas*. *Biofuels*. 1 : 91-107.

Achten, W.M.J., Vandenbempt, P., Almeida, J., Mathijs, E. and Muys, B. 2010. Life cycle assessment of a palm oil system with simultaneous production of biodiesel and cooking oil in Cameroon. *Environ Science Technology*. 44 : 4809 -4815.

Archana Joshi, Pankaj Singhal and Bachheti, 2011. Physico –chemical characterization of seed oil of *Jatropha curcas* in India, Department of Chemistry, Dehradun, India,

Divakara BN, Upadhyaya HD, Wani SP, Laxmipathi Gowda C.L. 2009. Biology and genetic improvement of *Jatropha curcas*. L: a review. *Appl Energy*. 87 : 732-742.

Francis, G., Edinger, R. and Becker, K.A. 2005. concept for simultaneous wasteland reclamation, fuel production, and socio-economic development in degraded areas in India: need, potential and perspectives of Jatropha plantations. *Nat Resource Forum.* 29 : 12-24.

Frost and Sullivan, 2007. *Strategic Analysis of the Indian Biofuels Industry,* San Antonio, Texas.

International Organization for Standardization. Environmental management, 1998. Life cycle assessment – goal and scope definition and life cycle inventory analysis. ISO 14041, Geneva, Switzerland.

Jongschaap, R.E.E., Blesgraaf, R.A.R., Bogaard, T.A., van Loo, E.N. and Savenije, H.H.G. 2009. The water footprint of bioenergy from *Jatropha curcas* L.. *Proc Natl Acad Sci USA*; 106 : E92.

Kim, S. and Dale, B.E. 2005. Life cycle assessment of various cropping systems utilized for producing biofuels:bioethanol and biodiesel. *Biomass Bioenergy*. 29 : 426-439.

Michael Whitaker, 2009. Life cycle assessment of use of Jatropha Biodiesel in Indian Locomotives" National Renewable Laboratory, Colorodo.

Prueksakorn, K. and Gheewala, S.H. 2008. Full chain energy analysis of biodiesel from *Jatropha curcas* L. in Thailand. *Environ Sci Technol*. 42 : 3388-3393.

Reinhardt, G., Gërtner, S., Rettenmaier, N., Münch, J. and von Falkenstein, E. 2007. Screening life cycle assessment of Jatropha biodiesel. Heidelberg (Germany): IFEU;

Zah, R., Böni, H., Gauch, M., Hischier, R., Lehmann, M. and Wäger, P. 2007. Life cycle assessment of energy products: environmental assessment of biofuels. Sankt Gallen (Switzerland): Empa;