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Economic Feasibility of Jatropha Oil as Biodiesel

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Abstract

We studied economic feasibility of biodiesel production from jatropha in current research work. We prepared the biodiesel by process of transesterification of the unfiltered jatropha oil in presence of three percent of KOH catalyst. We added ethanol to oil by 30% volume basis. We kept as reaction temperature at 60 ± 5°C for one hour. The developed batch production unit of 5 litres capacity at Central Institute of Agricultural Engineering, Bhopal was used for biodiesel production from jatropha oil. We obtained 90.20% biodiesel recovery. We calculated the economic feasibility of prepared biodiesel by analysis of economics of jatropha plantation, jatropha oil extraction, jatropha ethyl ester production. We found the cost of oil per kg and JEE production per litre to be ₹ 25.34 and 28.64, respectively.

Keywords: Biodiesel, Transesterification, Jatropha oil, Economics

The most burning issue in the developing countries is the demand of energy. There exist a strong relationship between economic growth and energy consumption. The socio-economic indicator drives the pace of economic development of any country. Concerning population, India is the second largest country in the world and has 17% population. Huge population, from 300 million in 1947 to over one billion people today, is putting the strain on the environment, infrastructure, employment and natural resources (Lodha and Singh, 2006). A programme for the development of energy from raw material, which grows in the rural areas, will go a long way in providing energy security to the rural people (Naik *et al*., 2004). Even though many options like fuel cell run by hydrogen, electric vehicles, etc. are being explored, use of biodiesel as replacement of petrol diesel and ethanol in place of petrol are frontline alternatives, they used without any modification or change in the existing engines avoiding additional investment. Recently, biodiesel has been receiving increasing attention due to its less polluting nature and because it is a renewable energy resource as against the conventional diesel, which is a fossil fuel leading to a potential exhaustion. Biodiesel is prepared from oils like soybean, sunflower, safflower, rapeseed groundnut, and mustard, etc. these oils are essentially edible in nature. We made attempts for producing biodiesel with non-edible oils like Karanja and jatropha available in India. As per the above facts, the present study was undertaken with the following objective to test the economic feasibility of biodiesel from jatropha oil (Anonymous, 2004).

Darodo *et al.* (2006) studied and approached to the economics of to vegetable oil based biofuels in Spain. This study identified that the price of the feedstock was one of the most significant factors. Also, glycerol was found to be a valuable by-product that could reduce the final manufacturing costs of the process up to 6.5%, depending on the raw feedstock used. Biodiesel can only compete with diesel fuel prices. Planning Commission of India (2004) has calculated the cost of biodiesel for jatropha biodiesel considering seed at ₹ 6 per kg. And worked out the cost to be ₹ 20.00 per litre (This is expected at least after four years of plantation from then.). Dindorkar (2006) studied production and energy balance of biodiesel and its performance in CI engine. We calculated economics for biodiesel

production using conjugal PKV biodiesel processor. We found the cost of biodiesel ₹ 29.31 per litre considering seed cost ₹ 5/kg.

Materials and Methods

Mechanical oil expelling was done for Jatropha oil extraction. CIAE, mini oil expeller was used for small-scale oil extraction of Jatropha. We selected Ethanol (C_2H_5OH) as alcohol, as ethanol is produced from biomass and less poisonous. We selected potassium hydroxide (KOH) as catalyst, due to its high reactivity with oil in the presence of ethanol. The batch production unit developed by CIAE, Bhopal used for the production of biodiesel by processing 5 litre of Jatropha oil by using KOH and ethanol in single stage transesterification method. We used single stage transesterification method for the production of JEE from crude oil of jatropha. The general procedure adopted for the various trials was as further:

1. We took Known quantity filtered Jatropha oil.
2. We poured the oil in to transesterification vessel.
3. We used potassium hydroxide about 3% (w/v).
4. We added ethanol 30% (v/v)
5. We mixed ethanol and KOH in stirrer
6. We did stirring slowly by 50 to 100 rpm
7. We poured above mixture slowly in to the transesterification vessel containing jatropha oil
8. We heated that mixture at 65°C in a closed vessel for alcoholics
9. We maintained the same temperature and speed up to one hour, to achieve complete transesterification
10. We poured the material after one hour in the semitransparent settling tank.
11. We kept at room temperature for 2-3 hours for separation of the glycerin.
12. We separated upper orange-brown ester as bio-diesel from lower thick brownish glycerin by using pump or other suitable means in the separate tank.
13. We washed ester with water. We mixed the ester with water in 1:1 proportion followed by the air bubble from the bottom of the vessel using the air pump.
14. We gave two items of washings for 1-2 hours so that pH of the bio-diesel decreases in the range from 6.5 to 7.5.
15. We separated washed bio-diesel from lower whitish water.
16. We heated bio-diesel up to 110°C temperature for 1 hour for 10 m to remove the excess moisture in it.

After cooling, bio-diesel was ready for use in any diesel engine.

Results and Discussion

Table 1 shows the economics of Jatropha oil extraction from Central Institute of Agricultural Engineering (CIAE) mini oil expeller. The capacity of expeller assumed to be 100 kg per hour and life of plant 10 years. The plant was supposed to run for 12 hours/day and in one month for 25 days i.e. in one month for 300 hours and in 10 years 3000 hours The cost of oil estimated ₹ 42.01 by considering the seed ₹ 10 per kg. This study showed that the price of the raw oil was one of the most significant factors. Also, seed hull and oil cake was the by-products that could reduce the final production costs of the process up to 7.8%. The same result was observed by Darodo *et al.* (2006). Table 2 shows the oil cost by using different seed rate. From Table 2 it is seen that, if the seed rate increases by ₹ 2 then oil cost increases by ₹ 8. Table 3 shows the economics of Jatropha ethyl ester production. From table 3 it is seen that if the Jatropha oil rate is ₹ 43/kg then the cost of Jatropha ethyl ester is ₹ 45.64/litre, means production of Jatropha ethyl ester is economically feasible. Same observations were done by Dindorkar (2006).

Table 1: Economics of jatropha oil extraction

Assumptions: i) Capacity of the oil expeller was 100 kg/h of Jatropha
ii) Power requirement 20 Hp motor
iii) Operation per day 12 hr
iv) Production of oil cake 60 kg, oil 24 kg, hull 15 kg, 1 kg waste
v) Sale price of oil cake ₹ 2/kg, and hull ₹ 1/kg

Description	Nos.	Rate	₹
(A) Fixed cost			
(a) Machine cost:	1		
i) Power operated cleaner cum-grader having capacity 150 kg/h	1	10000	12000
ii) Dehuller with 1 Hp motor having about 100 kg/h capacity	1	10000	12000
iii) Flanking unit	1	40000	40000
iv) Oil filter press	1	15000	15000
v) Weighing Scale, 100 kg capacity	1	10000	10000
vi) Pretreatment of Seed	1	10000	10000
vii) Oil expeller	1	100000	100000
Total			199000
viii) Housing, furniture @ 5%			9950
Total			208950
ix) Salvage @ 10%			20895
Total			229845
a)Total per month			19153.75
b) Labour cost:			
i) Skilled operator	1	6000	6000
ii) Helper	2	4500	9000
Total per month			15000
c) Electricity cost per month:			20000
Total Fixed cost (a+b+c)			54153.75
B) Variable cost			
a) Seed cost	30000 kg	10/kg	300000
b) Miscellaneous @ 1%			3000
c) Interest @ 6%			18000
Total Variable cost (a+b+c)			321000
Total cost (A+B)			375153.75
C) Material cost:			
i) Oil cake per month	18000	5/kg	90000
ii) Hull per month	4500	2/kg	9000
Total			99000
D) Total less by product cost [(A+B)-C]			276153.75
Oil cost per kg (D/seed weight)			42.01

Table 2: Effect of seed cost on oil extraction economics

Sl. No.	Seed cost per kg (₹)	Weight of seed per day (kg)	Seed cost per day (₹)	Oil cost per kg (₹)
1.	10	30000	300000	42.01
2.	12	30000	360000	50.34

Table 3: Economics of jatropha ethyl ester production

Sl. No.	Description	Nos.	Rate	₹
A) Fixed cost				
Machine cost:				
1.	Cost of machine	1	50000	50000
2.	Depreciation @ 10%			4500
3.	Interest @ 2%			1000
4.	Maintenance @ 1%			500
	Total			56000
	Cost/day (Capacity 200 l/day)			28.00
B) Variable cost				
1.	Jatropha oil	200 l/day	43/kg	8600
2.	Ethanol	60 l/day	35/l	2100
3.	Catalyst	6 kg/day	10/kg	60
4.	Electricity	10 kW/day	4	40
5.	Labor	1	100/day	100
	Total			10900
C) By-product cost				
	Glycerol	30 l/day	60/l	1800
	Total			1800
	Total cost [A+(B-C)]			9128
	Total cost of JEE per litre			45.64

Economics of Jatropha biodiesel production in the biodiesel processor developed, starts with oil of Jatropha. The cost of production for the processor was around ₹ 50000 and life of plant was considered approximately ten years. The cost of JEE was estimated to be ₹ 45.64 by considering seed and Jatropha oil cost ₹ 10/kg and ₹ 42.01/kg respectively. Biodiesel production was found to be affordable and comparable to the existing diesel prices.

Conclusion

The cost of JEE was found to be ₹ 45.64 per litre (by reducing cost of byproducts) when the rate of jatropha oil was a ₹ 42.01/kg and that of seed were a ₹ 10/kg. Due to this, the biodiesel is gaining worldwide acceptance as a solution for the problem of environmental degradation, energy security, restricting imports, rural employment and attaining better agricultural economy.

References

Anonymous 2004. Report of the Committee on the Development of Biodiesel fuels. Planning Commission, New Delhi, India.

Dindorkar, S.K. 2006. Production and energy balance of biodiesel and its performance in CI engine**.** M.Tech Thesis (Unpub.) Dr PDKV, Akola.

Dorado, M.P., Cruz, F., Palomar, J.M. and Lopez, F.J. 2006. An approach to the economics of two vegetable oil-based biofuels in Spain. *Renewable Energy.* **31**(8): 1231-1237.

Lodha, M. C. and Singh, R. 2006. Jatropha Curcas: A Complete Biodiesel. *Kurukshetra.* 21-22.

Naik, S.N., Das, L.M., Sahu, G. and Naik, M.K. 2004. Optimisation of biodiesel production from Karanja oil. National Conference on Biodiesel for IC Engines-Technologies and Strategies For Rural Application. 95-101.

Planning Commission, 2004. Report of Committee on Development on Biofuels Govt. of India, New Delhi.