Clean Energy Production from Jatropha Plant as Renewable Energy Source of Biodiesel

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ABSTRACTS

Population of the world is increasing very rapidly, due to which energy demand is also increasing unfortunately. Pakistan has deficiency of petroleum of reservoir. Pakistan is producing about 64% of its primary energy from fossil fuel which has serious burden on its economy. At the same time, Pakistan has been blessed by bio-energy production from different types of biomass waste, jatropha is a wild plant which can at any type of land like in Thar, Thal, Cholistan, and other barren land zones. Sample of jatropha raw oil was collected from local market and it was converted into biodiesel by transesterification process. Purified jatropha oil was used to produce biodiesel by Transesterification method. Due to transesterification being reversible, excess alcohol is used to shift the equilibrium towards the product. This project can be started in below 10 million capital cost and operating cost is about 0.6 million per month. According to our calculation the bio-diesel production cost will be approximately less than Rs. 30 per liter. If the government and concern department focused on the production of jatropha plant and bio-diesel production by jatropha, it will great contribution in saving import expenditures.

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1. INTRODUCTION

Fossils reserves are limited on Earth which are going to be depleted in near future. Projected to run out in the next 50 years. World population will be 9.9 Billion in 2050. Double amount of energy will be required which fossils cannot provide. Energy and Environment are directly interlinked with each other. World is facing a serious problem of global warming and climate change due to higher consumption of fossil fuel. In the prospect of Pakistan, it also producing about 64% of its primary energy from fossil fuels, Pakistan is also importing oil and gas from other country on which a huge percentage of GDP invested every year. On the other hand, Pakistan is also facing a serious issue of environmental pollution due to Municipal solid waste production. While among fossil fuel only coal is emitting 86 air pollutant out of 184. These air pollutants are cause of many problems climate change and agriculture. For human health air pollutant can cause skin cancer, Asthma and many others (Raza et al., 2021). Due higher emission of air pollutant, the use of coal is shifting for other purposes instead of combustion and energy production. There are more than 1000 of chemicals can be extracted from coal like humic acid graphene and many others (Asif, 2022). Release carbon dioxide and other greenhouse gases which is primary contributors to global warming and climate change. Also pollutes Air & Water. High fuel prices due to limited sources and importation of fossil fuels in developing countries. Emissions of gases and toxic elements cause serious health complications, low lung functioning, and cardiovascular diseases (Jain & Sharma, 2010). The major issue of fossil fuel combustion is the emission of CO₂, which has been tried by many different ways like its separation and sequestration through different membranes (Asif & Hasher, 2021). To overcome this issue of CO₂ and global warming the renewable energy resources are suitable alternatives.

1.1. Biodiesel Feasibility for Pakistan

Biodiesel is a renewable & Biodegradable fuel manufactured from vegetable oils, animal fats, recycled restaurant grease plants and Algae. It can be made by using oils from different seed plants. Agricultural land can be used for the production of these plants. Biodiesel can reduce the emissions of pollutants, up to 78% reduction in CO₂. Decreases rate of Global Warming. Biodiesel is cheaper as compared to the fossil diesel. And can be synthesized within the Country without importation of Raw material. Tropical Plant which grows in wide range of regions. Can be grown in waste land and even in Desserts with limited supply of water. Starts yielding within one year. Gives high seed yield nearly 6-7 ton/hectare/year. Seeds contains 30-40% oil. So, yield up to 2tons of raw oil. All other vegetable oils are part of food and cannot be used because it will destroy the food chain. Pakistan is in clutch of serious energy crisis that is distressing of economy (Basumatary et al., 2021).

1.2. Energy Crises in Pakistan

Energy is the key source to grow the economy of country, High price of import oils is one of the reasons for energy crisis, Supply of energy is essential for sustainable economic progression, Fabrication of Biodiesel is a prerequisite to sustainable growth and will lessen reliance on imported fuels, Therefore Biodiesel will be valuable for improving socioeconomic settings of the country. National Biodiesel Program Economic Coordination Committee (ECC) permitted use of biodiesel as an alternate energy source on 14th Feb. 2008 which was 5% contributor by the year 2015 and 10% by 2025. Oil Marketing Companies (OMCs) are purchasing biodiesel (B-100) from biodiesel manufactures (Figure 1).
1.3. Jatropha Cultivation in Pakistan

In 2009, Kijani Energy capitalized approximately US$ 150 million in the use of 200,000 acres of land in Cholistan, Tharparker and Khairpur for Jatropha cultivation, growing plantation of jatropha plant in different areas of Pakistan are given in figure 2.

2. EXPERIMENTATION

In this research work raw jatropha oil sample was collected from local market of Pakistan, and its characterization was performed by using standard approaches such as Elemental composition by using Elemental Analyzer (Leco-USA). Raw oil purification was performed by sedimentation process, and then sample was centrifuged for 45 min with 4500RPM, Supernatant solution was separated and saved for bio-diesel production. Purified jatropha oil was used to produced bio-diesel by Transesterification method.
Figure 3. Purified jatropha oil was used to produce bio-diesel by Transesterification method

Due to transesterification being reversible, excess alcohol is used to shift the equilibrium towards the product. A successful transesterification reaction produces ester and crude glycerol. Though esters are the desired products of transesterification reactions, glycerin recovery is also important due to its numerous applications in daily products. By-products were separated by gravity settling method. A complete process flow diagram from jatropha cultivation to end product (bio-diesel) production has been presented below (figure 4) (Ho et al., 2020):

Figure 4. Process flow diagram for bio-diesel production from jatropha plant

3. RESULTS AND DISCUSSION

On basis of our experimentation jatropha plant may be a Good Alternative option for biodiesel production in Pakistan. The detail calculation results are mentioned in the table 1. Jatropha is a source of renewable energy and it will contribute in global warming and climate change. Biodiesel produced by jatropha plant has less cost for per liter, due to which all other commodities of life might be cheaper.
Table 1. Operating Cost and Capital Cost

| Parameters       | Operating Cost | Capital Cost |
|------------------|----------------|--------------|
| Required         | Required       | Required     | Cost       | Required | Cost       |
| Electricity      | Per month      | Land         | 16 Canals  | 30.00000 | 1000000   |
| Technician       | 3              | Buildings    | 5 Canals   | 22.50.000| 200.000   |
| Tank helpers     | 2              | Transport    | 144.00000  | 1000 L/day| 20.00000  |
| Total cost per month | 1.45.000   | Storage Tank | 25 tones (1)| 1.60.000  |
|                  |                | Total Capital Cost | 76.10.000 |           |

Revenue Earned

Sales price of Biodiesel : 60 Rs/L
Capacity produced : 1000L/day
Number of hours Operational : 16h
Return per Month : 60*1000*30 = 18,00000 Rs
Revenue earned per month by excluding expenditure: 18,00000 – 1,45,000 = 16,55000

3.1. Business Model for Jatropha Biodiesel

A business Model for bio-diesel produced from jatropha plant has been given which shows its best application and productive use for the society (Table 2).

Table 2. Business model for jatropha biodiesel

| Key Partnerships | Key Activities | Value Proposition | Customer Relationship | Customer Segments |
|------------------|----------------|-------------------|-----------------------|-------------------|
| 21. PSO          | 15. Selecting  | 1. More eco       | 6. Communities        | 1. Domestic       |
| Pakistan         | Jatropha as    | friendly          |                       | 10. (Farmers, local |
|                  | biodiesel      |                   |                       | transport companies, Small |
| 22. SGS          | 16. Processing | 2. Quality of      | 7. Co-creation         | 11. International |
| Pakistan         | jatropha crude | marketed          |                       | 12. Blue Marble    |
|                  | oil to become  | Biodiesel is in    |                       | Energy (US)       |
|                  | Biodiesel      | accordance with    |                       | Billion.13.       |
| 23. BIO TECH     | 17. Selling    | 3. Distribution cost is less |                       | Fujian Zhongde    |
| ENERGY           |                | 4. Can fulfil the  |                       | (China)           |
| $44.3B           |                | Increased ldwide is Projected demand |           | 14. Green Biofuels |
| Opportunity      |                | Of energy the year |                       |                   |
| to build poised  |                | 20255. Better fuel economy: |           |                   |
| to reach over.   |                |                   |                       |                   |
| Capital cost     | 18. Human      | 8. Capital Market/stock to grow byexchange | | |
|                  | Biodiesel      | 9. Commodity exchanges |           | |
|                  | Market         | US$19.3           |                       |                   |
|                  | Woresources    |                   |                       |                   |
|                  | 19. Raw material |                   |                       |                   |
|                  | US$44.3 Billion |                   |                       |                   |
|                  | Billionresources by |               |                       |                   |
|                  | 20. Financial  |                   |                       |                   |
|                  | resources      |                   |                       |                   |

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4. CONCLUSION

The sample was collected from local market any biodiesel was produced by using transesterification processes. The main focus in the research was to produce renewable energy (biodiesel) to overcome the consequences of the diesel which produced by the fossil fuels as this biodiesel was seen to be more ecofriendly and cheaper. The efficiency of this biodiesel was measured that was comparable with the diesel produced by the fossil fuel. The glycerin was produced as byproduct and main product biodiesel which shows less than Rs. 30 per liter which is a very low. The production of the jatropha plants in local areas which are unable to be used for agriculture and the biodiesel production from jatropha can be increased and it may be the subject of future study.

5. AUTHORS’ NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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