Introduction:
India is having vast wastelands available for forest plantation. The proper propagation and cultivation of forest trees like Jatropha, honge, mahua and utilizing the same for producing bio diesel, our nation can change the backward and poor area into very prosperous and developing areas within a decade time. Non-edible oils can prove alternatives to edible oils for bio diesel production. Further, local growth associated in crushing and marketing encourages the entrepreneurs to start small industries to produce raw or finished goods. This is one of the factors that contribute to the concept of sustainable rural areas where environment and people are independent where India could be world lenders in supply of oil. According to a survey conducted in 2002, twelve most important and abundant non-edible oil-bearing trees produce 97 lakh tones of seeds per year, of which only 12% is utilized. These twelve species of trees are Neem, Mahua, Undi, Jatropha, Castor, Kusum, Pilu, Dhupa, Nahor, Kokum and Sal.

According to the estimate of the oil and gas journal, crude oil production is exited to reach a peak somewhere between 2010 and 2015 and from then it is eventually going to decrease. With this, crude oil will be expensive progressively until it becomes unaffordable while enforcing pressure on the import bill and increasing the import bill dully. Thus we need to look at other options as far as energy need is concerned. In Karnataka, the important commercial non-edible oil yielding trees are Pongamia pinnata, Azadirachta indica, Madhuca longifolia and Schlichera oleosa, Garcinia indica, Calophyllun and many more. The oil obtained from such seeds is chiefly used for manufacture soaps, candles, paints, varnishes, linoleum, and lighting and for medicinal purposes.

Keywords: Biodiesel, Vegetable oil, transesterification, performance.
Objectives of the project:

- To identify the source to collect the raw materials i.e. Pongamia oil
- Extraction of Pongamia oil.
- Production of biodiesel from Pongamia oil (transesterification).
- To blend the neat bio diesel with vegetable oil and obtain the various blends.
- To study the fuel properties such as calorific value, viscosity, flash point etc. of the blended fuel samples.
- To carry out the performance analysis and emission tests on Diesel engine for different blends of vegetable oil and diesel samples.
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- To compare the results of the performance and emission characteristics tests obtained for all the above blended fuels.
- To conclude that the diesel engine can also run with SVO blended with biodiesel up to 50% blend without any modification in engine.
- To successfully arrive at a conclusion and put light on future possibilities and scope in this particular sector

Methodology involved in project:

The different stages of works are explained as follows:

Stage 1: Extraction of Pongamia oil

- The oil collected should be first purified by hand picking of coarse and floating impurities.
- It will be later heated to 100 °C to remove all its moisture contents and it will be strained which in turn filtered it. To obtain purified oil /clarified oil.
- Purified oil was used for experimentation.

Stage 2: Free fatty acid test

- 10ml of is propanol is taken in a flask.
- 3-4 drops of phenolphthalein indicator is added to propanol.
- 1 gram of Pongamia oil is then added to propanol and phenolphthalein indicator mixture.
- KOH (0.01) solution is allowed drop by drop to the Pongamia oil solution till the solution become pink for 5-10sec and then disappear.
- KOH (0.01) solution consumed to get pink color is noted down. Depending on the amount of KOH (0.01) consumed fatty acid present in the oil is decided.

Stage 3: Production of Biodiesel by Transesterification Process

Transesterification process was carried out for the purified scum by a 2 stage process depending upon the FFA Test results which involves

- Acid catalyzed Transesterification
- Base catalyzed Transesterification
Acid catalyzed Transesterification

Pongamia oil extracted from the pongamia seeds consist of high FFA contents which were causing the transesterification difficulty. This is a type of reaction that takes place in the presence of methanol (30%) and sulphuric acid (0.5%) at 60˚c with constant stirring (500-600 RPM), helps in the separation of impurities which were dissolved in the methanol as an upper layer and oil in the lower layer. The oil is separated and taken for 2\textsuperscript{nd} stage.

Base catalyzed Transesterification

The settled lower layer of the earlier stages having low FFA is used as a raw material for this stage. The product of earlier stages i.e. pure triglycerides is made to react with methanol (30%) and catalyst, KOH (11.22 gms) for 2.5 - 3 hours at 60˚C with constant stirring rate. The lower portion containing glycerol and other impurities are removed and further excess of alcohol and other impurities present are removed by water wash process. The water wash product then heated above 110˚C in order to remove the moisture content present in the POME.

Stage 4: Testing for properties and Preparation of Blends

- Testing for fuel properties like Density, Specific gravity, Viscosity, Calorific Value, Flash Point and Fire Point of i) Vegetable oil ii) Biodiesel
- For Standard fuel properties, the tests are conducted at Bangalore Test House Bangalore
- Blends such as B0,B10,B20,B40,B60and B80 are prepared for SVO & Diesel, Biodiesel & Diesel and blends B10,B20,B40 for SVO & Biodiesel and checked for layer formation

Stage 5: Experimental works carried out

Experimental works are carried out on single cylinder, 4-stroke, DI computerized diesel engine coupled with Eddy current Dynamometer, situated at our institution R&D Lab for performance and emission parameters of the engine. The exhaust emissions are measured using AVL DIGAS 444 gas analyzer. The Blends of different combinations of fuels are as follows.

- Different blends of Straight Vegetable oil (SVO) and Diesel
- Different blends of Biodiesel (MEOP) and Diesel
- Different blends of Straight Vegetable oil (SVO) and Biodiesel.

Stage 5: Results and Conclusions

The overall studies based on the production, fuel characterization, engine performance and exhaust emission of pongamia oil and its biodiesel blends of various combinations were successfully carried out. The following conclusions can be drawn:

- The production of pongamia biodiesel is a two stage transesterification process.
- The density of pongamia oil 940 kg/m\textsuperscript{3} and density of biodiesel is 880 kg/m\textsuperscript{3} which are more than fossil diesel 850 kg/m\textsuperscript{3}. 

The calorific value of pongamia oil is found to be 37590 KJ/Kg and the calorific value of pongamia biodiesel is found to be 38115 KJ/Kg. The calorific values of pongamia and its biodiesel are found to be less than the fossil diesel (43500KJ/Kg).

The exhaust CO and HC emission for SVO with diesel, diesel with biodiesel are 33.73% and 40%, 16.9% and 26.66% respectively, lower than that of diesel at maximum load for maximum blend.

The exhaust CO and HC emission for SVO with biodiesel are 37.5% and 47.33% lower than that of biodiesel at maximum load for maximum blend.

The NO<sub>x</sub> emission for SVO with diesel, diesel with biodiesel are 14.47% and 38.8% respectively more than that of diesel at maximum load for maximum blend.

The NO<sub>x</sub> emission for SVO with biodiesel are 26.3% respectively more than that of biodiesel at maximum load for maximum blend.

The BTE for SVO with diesel, diesel with biodiesel are 9.43% and 10.73% respectively lower than that of diesel at maximum load for maximum blend.

The BTE for diesel with biodiesel for B20 blend having more efficiency of 12.51% which is more than that of diesel.

The BTE for SVO with biodiesel are 11.52% lower than that of biodiesel.

The BSFC for SVO with diesel, diesel with biodiesel are 15.16% and 14.06% respectively, more than that of diesel at maximum load for maximum blend.

The BSFC for diesel with biodiesel is 9.41% more than that of biodiesel at maximum load for maximum blend.

Emission value of CO and HC decreases as percentage of biodiesel increases in the blends.

**Scope for future work**

- The same studies can be done in future by varying the blends and also by adding additives to the SVO in order to reduce the viscosity and blending it with the biodiesel.
- There is a chance of pre-heating the SVO and blending it with the biodiesel and testing can be done.
- In future, one can carry out the same work studies on the C. I. D. I. engine by varying compression ratio, modifying fuel injection timing
- Also, the increase or decrease in the fuel pressure and injection rate can be done to enhance the engine performance.