ABSTRACT

Today’s world facing problem of increasing environmental pollution, growing threat of depleting fossil fuels, and ever increasing uncertainty of fuel prices. Indiscriminate extraction and lavish consumption of fossil fuels have led to reduction in underground based carbon resources. This situation offers us a challenge as well as an opportunity to look for substitutes of fossil fuels for both economic and environmental benefits to the country; thus, there is urgent need to explore environment friendly, cost effective, renewable energy sources which can full fill the future energy needs. Among the various renewable energy choices, vegetable oils and biodiesel from seed oil crops have a potential for meeting the increasing requirements of petroleum and its products.

A lot of work has been done on utilization and optimization of several vegetable oils and biodiesels as an alternative fuel for compression ignition engines including edible oils. However, there are plenty of oilseeds which remain unutilized or underutilized for biodiesel production. Thumba oil is one of the underutilized or unexploited non-edible vegetable oil, available in large quantities in Rajasthan and its potential suitability for biodiesel production for diesel engine fuel is still not evaluated comprehensively.

In the present study, extensive experimental investigations have been carried out to assess the potential suitability and practical viability of thumba oil and thumba biodiesel as diesel engine fuel in a single cylinder, direct injection, four-stroke, water-cooled, naturally aspirated variable compression ratio multi-fuel diesel engine. The optimization of engine operation with diesel fuel, thumba oil, thumba biodiesel and their different blends in diesel was also conducted. The engine selected for this study was typical of the ones widely used in agricultural, rural and industrial sector in India. A suitable test rig including pressure pickup, charge amplifier and high speed data acquisition system was developed together with emission measuring equipments like smoke meter and exhaust gas analyzer to analyze performance combustion and emission characteristics of diesel engine.
The analysis of present study suggest that engines performed smoothly and satisfactorily on wide range of specified blends of thumba oil and thumba biodiesel in diesel and no undesirable combustion phenomenon was observed during investigation. The operational difficulties like injector coking, gum formation around injector nozzles and valves, carbon deposition on piston and cylinder walls, sticking of valves and piston etc. were experienced during investigation for neat thumba oil as well as for high concentration thumba oil blends which were reduced substantially for biodiesel fuelled engine.

The present research work experimentally revealed that the 20% content of thumba oil and thumba biodiesel in diesel exhibited best engine performance and emission characteristics. The study also demonstrate that the combination of 19 compression ratio with 203 bars injector needle lift pressure and $23^\circ$ CA BTDC injection timing found to be the optimum engine parameters for optimized thumba blends. The experiments also established that the use of thumba vegetable oils and thumba biodiesel and their blends in a conventional diesel engine resulted in substantial reduction in un-burnt hydrocarbons, carbon monoxide and carbon dioxide emissions compared to diesel fuel engine operation. Adopting biodiesel as an alternative fuel for diesel engines, produced from vegetable oils can improve the agriculture economy, diminish indecision of fuel availability and make farmers more self-confident in addition to environmental benefits.

The present work has resulted in giving a good insight into the combustion, performance and emission characteristics and optimization of engine fuelled with thumba oil, thumba biodiesel and their various blends in diesel. An economic analysis was also done to examine the possibilities of thumba biodiesel production and utilization. The series of engine data analysis proved adequate relevant information that the thumba oil and thumba biodiesel can be used as substitute fuels in existing conventional diesel engines without any major changes in engine hardware.