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# Performance and emission evaluation of a diesel engine fueled with methyl esters of rubber seed oil

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**Abstract**

Recent concerns over the environment, increasing fuel prices and scarcity of its supply have promoted the interest in development of the alternative sources for petroleum fuels. At present, biodiesel is commercially produced from the refined edible vegetable oils such as sunflower oil, palm oil and soybean oil, etc. by alkaline-catalyzed esterification process. This process is not suitable for production of biodiesel from many unrefined non-edible vegetable oils because of their high acid value. Hence, a two-step esterification method is developed to produce biodiesel from high FFA vegetable oils. The biodiesel production method consists of acid-catalyzed pretreatment followed by an alkaline-catalyzed transesterification. The important properties of methyl esters of rubber seed oil are compared with other esters and diesel. Pure rubber seed oil, diesel and biodiesel are used as fuels in the compression ignition engine and the performance and emission characteristics of the engine are analyzed. The lower blends of biodiesel increase the brake thermal efficiency and reduce the fuel consumption. The exhaust gas emissions are reduced with increase in biodiesel concentration. The experimental results proved that the use of biodiesel (produced from unrefined rubber seed oil) in compression ignition engines is a viable alternative to diesel.


*Keywords:* Rubber seed oil; Biodiesel; Esterification

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## 1. Introduction

The diesel engines dominate the field of commercial transportation and agricultural machinery due to its ease of operation and higher fuel efficiency. The consumption of diesel oil is several times higher than that of petrol. Due to the shortage of petroleum products and its increasing cost, efforts are on to develop alternative fuels especially, to the diesel oil for fully or partial replacement. It has been found that the vegetable oils are promising fuels because their properties are similar to that of diesel and are produced easily and renewably from the crops.

Vegetable oils have comparable energy density, cetane number, heat of vaporization and stoichiometric air–fuel ratio with that of the diesel fuel. None other than Rudolph Diesel, the father of diesel engine, demonstrated the first use of vegetable oil in compression ignition engine. He used peanut oil as fuel for his experimental engine. During the World War II, attempts were made to use vegetable oils as fuel in diesel engines. Viscosity of vegetable oils is several times higher than that of diesel. Viscosity of liquid fuels affects the flow properties of the fuel, such as spray atomization, consequent vaporization, and air–fuel mixing in the combustion chamber. Higher viscosity of oils had an adverse effect on the combustion in the existing diesel engines.

In recent years, systematic efforts were under taken by many researchers to determine the suitability of vegetable oil and its derivatives as fuel or additives to the diesel [1–5]. Blending, emulsification, thermal cracking and transesterification are the commonly adoptable methods to use the vegetable oil as fuel in diesel engines. Recent years, biodiesel have received significant attention both as a possible renewable alternative fuel and as an additive to the existing petroleum-based fuels. Biodiesel exhibits several merits when compared to that of the existing petroleum fuels. Many researchers have shown that particulate matter, unburned hydrocarbons, carbon monoxide, and sulfur levels are significantly less in the exhaust gas while using biodiesel as fuel. However, an increase in the levels of oxides of nitrogen is reported with biodiesel. Presently, considerable research has been undertaken to understand the performance characteristics of biodiesel-fueled engine as well as the biodiesel production technology [6,7].

Biodiesel is a chemically modified alternative fuel for use in diesel engines, derived from vegetable oils and animal fats. Biodiesel is produced commercially by the transesterification of vegetable oils with alcohol. Methanol or ethanol is the commonly used alcohols for this process. These can also be produced from the biomass sources. The direct use of alcohols as fuel causes corrosion of various parts in the engine. The transesterification process solves this problem. The carbon cycle of vegetable oils consists of release and absorption of carbon dioxide. Combustion and respiration process release carbon dioxide and crops for their photosynthesis process absorb the carbon dioxide. Thus, the accumulation of carbon dioxide in atmosphere reduces. The carbon cycle time for fixation of $CO_2$ and its release after combustion of biodiesel is quite small (few years) as compared to the carbon cycle time of petroleum oils (few million years) [8,9].

Christopher [10] conducted some tests in Chicago using biodiesel as the alternative fuel for in-service motor coaches. This was an exploratory investigation to determine the effect of fuel on the engine performance characteristics and infrastructure needed to use this fuel. This testing proved that the biodiesel could easily be used as a feasible alternative fuel.