Effects of biodiesel fuel obtained from *Salvia macrosiphon* oil (ultrasonic-assisted) on performance and emissions of diesel engine

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**Abstract**

The purpose of this study is to investigate the possibility of biodiesel production from *Salvia macrosiphon* oil (SMO) using the ultrasonic system. The major properties of *Salvia macrosiphon* methyl ester was compared with ASTM standards and the specifications met the requirements of biodiesel standards. This allows *Salvia macrosiphon* oil to be utilized for biodiesel production and be a potential substitute to diesel fuel; it can also be blended with diesel fuel. The performance and the exhaust emissions of a diesel engine operating on *Salvia macrosiphon* biodiesel-diesel blended fuels have been investigated. The experimental test results indicated that by using biodiesel-diesel blends, brake power, torque and concentrations of the CO2 and NOx emissions increased while the specific fuel consumption (SFC) and concentration of CO and HC emissions decreased. The results obtained revealed that high oxygen content of *Salvia macrosiphon* biodiesel resulted in significant overall improvements in the combustion reaction especially in B20 (20 vol% biodiesel and 80 vol% diesel fuel). CO and HC were reduced by up to 25% and 31.82% respectively in B20 compared to neat diesel fuel (B0). The innovated fuel blend also increased engine performances, which are the power and torque, by up to 18% and 15.8% respectively, and decreased specific fuel consumption by 4.6%.

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1. Introduction

At present, with the development of the global economy, demand for energy is growing quickly. With the current oil production and high demand for oil consumption, it is predicted that in 53 years, almost all the oil reserves in the world will be finished. The increase in demand for energy generates the global oil crisis [1]. High demand for energy consumption and industrialization of the world has caused global concerns. Environmental concerns arising from the high consumption of fossil fuels has encouraged researchers to use alternative and renewable fuels [2]. One of the renewable energy sources that can be used as a reliable source to diesel engines fuel is biodiesel. Biodiesel is derived from biological sources such as oil seeds and animal fats [3–10]. Biodiesel is defined as a fuel that contains mono-alkyl esters of long chain fatty acids [11]. One of the advantages of using biodiesel fuel is the significant reduction in emissions such as CO and HC. Therefore, biodiesel produced from oilseed crops can be used as fuel that is required by diesel engines [12,13]. Biodiesel has been produced globally from several products such as palm oil [14], sunflower oil [15], vegetable oil [16], waste cooking oil [17], and rapeseed oil [18]. In Iran, a large area of agricultural land is planted with oilseeds every year. Most of the oilseeds produced in Iran are edible oilseeds, which consist of cottonseed, soybeans, rapeseeds, and sunflowers. These oilseed crops have provided a significant potential for production of biodiesel in Iran [19]. Oils used for biodiesel production are more preferred in terms of being edible by the community. Therefore, replacing the oilseed crops that are less known and less used as food in the society is necessary. In order to achieve this goal, oilseeds produced from wild plants must be explored by researchers [17,18]. In this study, a wild perennial plant that is highly resistant to hot and dry conditions is investigated for the feasibility of producing biodiesel. One of the sources for biodiesel production is *Salvia macrosiphon*, which is often grown in mountains. Its kernel

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