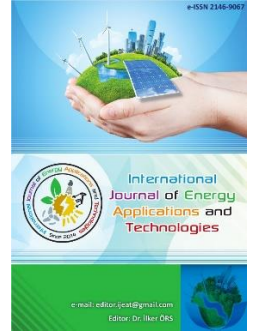




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Review Article

### Investigation of the effects of biofuels on vehicle performance and emissions

Muhammed Mahmut Yıldız<sup>1</sup>, Abdullah Engin Özçelik<sup>2\*</sup>

<sup>1</sup> Department of Automotive Engineering, Institute of Science, Selçuk University, Konya, Turkey

<sup>2</sup> Department of Mechanical Engineering, Faculty of Technology, Selçuk University, Konya, Turkey



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\* Corresponding author  
[ozcelik@selcuk.edu.tr](mailto:ozcelik@selcuk.edu.tr)

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#### ABSTRACT

Most of the world's energy needs are met from fossil sources. However, the decrease in fossil resources and the burning of the fuels obtained from these sources have negative aspects such as environmental pollution, acid rain or global warming. The sensitivity shown to the environment is directly related to the economic and welfare levels of the countries. Therefore, the amount of harmful substances that can be found in the exhaust emission in economically developed countries has been determined by standards. Due to such negative effects, studies are carried out on alternative energy sources. Alternative energy sources are a product that is released as a result of the reaction of vegetable oils or animal oils obtained from oilseed plants such as canola, sunflower, corn, cotton, camelina etc. with methanol, a short-chain alcohol, in the presence of a catalyst and used as fuel. Domestic frying oils and animal based oils can also be used as biodiesel raw materials. The eurodiesel fuel used in diesel engines is the main energy source for transportation and freight transportation. Biodiesel produced from oils are important alternative fuels for diesel engines. In this study, the effects of vehicles using different biofuels and mixtures in our country and the world on the chassis dynamometer were investigated, especially on vehicle performance and emissions.

*Keywords:* Biofuel; Chassis dynamometer; Emission; Engine performance

#### 1. Introduction

In the world, with the increasing population and industrialization, energy consumption has also increased. The decrease in fossil fuels we use to generate energy and the increase in air pollution caused by the use of fossil fuels have prompted scientists to seek alternative fuels [1-2]. One of the alternative energy sources is biofuels. Since our country is suitable for agriculture, producing biofuels is important both economically and in terms of independence. Some of the research is about vegetable oils. Vegetable oils are obtained from renewable plants such as canola, rapeseed, soybean, camelina, sunflower seed, cotton seed, corn, coconut [2-3]. The high viscosity and low volatility of vegetable oils are the features that make it difficult to use as fuel [4]. High viscosity

causes clogging of the engine fuel system and filter, increase in injector opening pressure, bad atomization and longer combustion times compared to petroleum based fuels. Therefore, in many countries, vegetable oils are not used as pure, they are consumed by adding diesel fuel in certain proportions, heating or esterification (converting to biodiesel) [5-6]. When vegetable oil is turned into biodiesel, many of its properties approach diesel fuel properties. However, its density is generally slightly higher than that of diesel fuel. In some sources, it has been stated that biodiesel causes a slight increase in motor moment and power and this is due to the complete combustion of the oxygen in the structure of biodiesel in the rich flame zone [7-8]. Although there are many methods in biodiesel production, the method of esterification of alcohol and oil

(transesterification) using basic catalysts such as sodium hydroxide or potassium hydroxide is preferred due to its low cost [9]. Ethanol or methanol is used as alcohol in the production of biodiesel. Methyl ester means methanol and biodiesel derived from vegetable oils. Ethyl Ester means biodiesel obtained from ethanol and vegetable oils [10].

The diesel engine was discovered by Rudolf Diesel (1858-1913) and was first tested on 10 August 1893 in Augsburg, Germany. He then exhibited his engine at the 1898 Paris World Fair, where peanut oil was used as fuel [11].

With the preparation of European Union (EU) and American standards in 2002, commercial applications of biodiesel increased. Although the use of vegetable oils as fuel during the oil bottlenecks that emerged from time to time has come to the agenda, scientific studies on the subject have intensified with the oil crisis in the 1970s [12].

One of the most important factors determining the future fuel choice is the low cost of the fuel, the suitability of its physical and chemical properties, and storage conditions. In addition, the impact of fuel combustion emissions on human and environmental health will be an important factor in determining the alternative fuel type. Today, new types of renewable energy sources are increasing, some of which have economic advantages. Cost analysis was made on some of them and new energy sources emerged [13].

The transesterification reaction is carried out with or without a catalyst. The transesterification reaction using catalyst is based on both acid and basic catalysts for base catalysis, acid catalysis, two stages, enzyme catalysis. If the proportion of free fatty acids in the vegetable or animal oil is more than 1%, the acid catalyst is preferably used for biodiesel production. Hydrochloric acid (HCl), sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) and sulfonic acid (RSO<sub>3</sub>H) are used as acid catalysts in the transesterification reaction [14].

Biodiesel can be used as generator and heating fuel in transportation, greenhouse cultivation, mining and many industries. It is well known that the product is not harmful to the environment, it can be dissolved at a rate of 95% when released into water biologically, and its ratio in diesel is

around 40%. Carbon monoxide and sulfur dioxide (especially carbon dioxide) emissions are lower than diesel. In addition, since it converts carbon dioxide through photosynthesis and accelerates the carbon cycle, there is no increase in the greenhouse effect [15]. It contains less biologically toxic substances. Since the cetane number is lower, it enables the engine to run less noise. The high flash point allows for safe storage. In addition, positive effects of biodiesel such as having lubricity properties compared to diesel, easy availability, not causing acute oral toxicity, skin irritation and aquatic toxicity in the environmental sense have been reported [16].

The purpose of this study is to examine the researches of vehicles using different biofuels in our country and in the world, which have been carried out on the chassis dynamometer, and determine their effects on vehicle performance and emissions.

## 2. Biofuels

### 2.1. Biodiesel

Biodiesel is an energy source that is released as a result of the reaction of vegetable oils or animal oils obtained from oilseed plants such as rapeseed (canola), sunflower, soybean, safflower with a short chain alcohol (methanol or ethanol) in the presence of a catalyst and used as fuel. Biodiesel is a less costly and easy to produce energy source compared to other alternative energy sources such as wind and solar energy. However, the fact that biodiesel production allows especially the agriculture, industry and environmental sectors to work together and provides additional employment and income opportunities to these sectors causes the rapid development of biodiesel technology. Although there are different methods for biodiesel production, the most used method is transesterification. The most used raw materials are vegetable, animal and waste oils. In the transesterification method, the oil reacts with a short chain alcohol (CH<sub>3</sub>OH or C<sub>2</sub>H<sub>5</sub>OH) in the presence of a catalyst such as NaOH or KOH to form the fatty acid methyl / ethyl ester [17-18]. Figure 1. shows a cycle of biodiesel production and use.

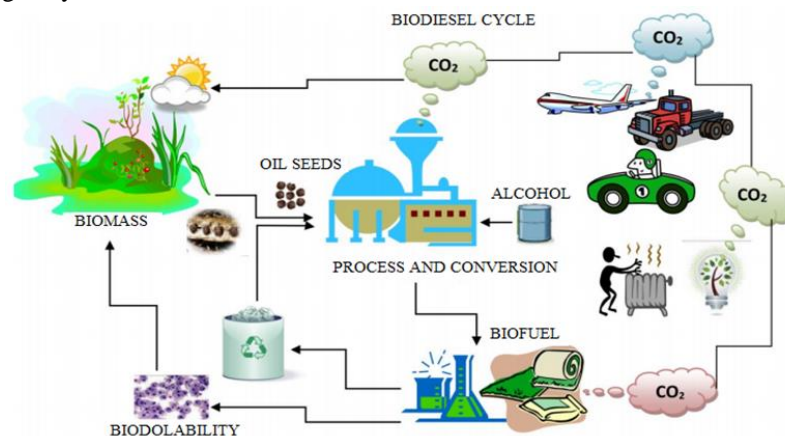


Fig. 1. Biodiesel Cycle [19]

**Table 1.** EU (EN 14124: 2016) biodiesel standards [22]

Feature	Unit	Limit Values	Test Method
Ester content	% (m/m)	96.5	EN 14103
Density (15 °C)	kg/m <sup>3</sup>	860-900	EN ISO 12185
Kinematic viscosity (40°C)	mm <sup>2</sup> /s	3.50-5.00	EN ISO 3104
Flash Point	°C	101 min	EN ISO 3679
Sulfur content	mg/kg	10 maks	EN ISO 20846
Carbon residue	% (m/m)	0.30	EN ISO 10370
Cetane number		51min	EN ISO 5165
Sulphate ash content	% (m/m)	0.02 maks	ISO 3987
Water content	mg/kg	500 maks	EN ISO 12937
Total impurity	mg/kg	24 maks	EN 12662
Copper strip corrosion	Corrosion Degree	No 1 maks	EN ISO 2160
Oxidation stability (110 C)	Hour	8.0 min	EN 14112
Acid value	mg KOH/g	0.5 maks	EN 14104
Iodine value	g I <sub>2</sub> /100 g	120 maks	EN 14111
Linolenic acid methyl ester	% (m/m)	12 maks	EN 14103
High unsaturated (≥4 double bond)	% (m/m)	1 maks	EN 15779
Methanol content	% (m/m)	0.20 maks	EN 14110
Monoglyceride content	% (m/m)	0.80 maks	EN 14105
Diglyceride content	% (m/m)	0.20 maks	EN 14105
Triglyceride content	% (m/m)	0.20 maks	EN 14105
Serbest gliserol	% (m/m)	0.02 maks	EN 14105
Total glycerol	% (m/m)	0.25 maks	EN 14105
Group I Metals (Na + K)		5.0 maks	EN 14108
Group II Metals Ca + Mg)	mg/kg	5.0 maks	EN 14109
Phosphorus content	mg/kg	4.0 maks	EN 14107

**Table 2.** ABD (ASTM D6751-12) biodiesel standards [22]

Feature	Unit	Limit Values	Test Method
Kinematic viscosity (40°C)	mm <sup>2</sup> /s	3,5 – 6,0	D445
Flash Point	°C	101 min	D93
Monoglyceride Content	% (mass)	0.40 maks	D6584
Sulfur content S15 S500	mg/kg	15 maks 500 maks	D5453
Cetane number		47 min	D613
Sulphate ash content	% (m/m)	0.02 maks	D874
Water and Sediment	% (v/v)	0.05 maks	D2709
Filtering in Cold State (-12 C and below fuel temperture)	Second	200 maks	D7501
Copper strip corrosion (3 hours, 50 ° C)	Corrosion Degree	No 3 maks	D130
Carbon residue	% (m/m)	0.5 maks	D4530
Oxidation stability	hour	3.0 min	EN 15751
Acid value	mg KOH/g	0.5 maks	D664
Phosphorus content	%(m/m)	0.001 maks	D4951
Free glycerol	% (m/m)	0.02 maks	D6584
Total glycerol	% (m/m)	0.24 maks	D6584
Group I Metals (Na + K)	µg/g	5.0 maks	EN 14538
Group II Metals (Ca + Mg)	µg/g	5.0 maks	EN 14538
Alcohol Control (One must be met) 1.Methanol Content 2. Flash Point	% (mass) °C	0.2 130	EN 14110 D93
Distillation Temperature 90% Recovery	°C	360	D1160
Cloud Point	°C	Local	D2500

For biodiesel, the European Union EN 14214 and the American Standard ASTM D 6751 are in force. TSE Standard has been prepared based on EN 14214 Standard. Table 1 and Table 2 respectively TS biodiesel produced in Turkey are required to provide the specifications according to EN 14214 and ASTM D6751-12 standard [20-21].

### 2.1. Bioethanol

Although it is a definition that includes fuel alcohol, methyl alcohol and ethyl alcohol, this name is commonly used for ethyl alcohol (ethanol-bioethanol) obtained from biomass sources. The most widely used fuel among biofuels in the world is bioethanol and more than 95% of bioethanol production is obtained by processing agricultural products. production and use of bioethanol in the world to Turkey rates are quite high. In many countries of the world, the use of bioethanol in vehicles has become compulsory and the rate

of this has been diversified in each country according to their own production sizes. There is also a requirement to use biofuels in EU countries. The minimum bioethanol addition was increased from 2% to 5.75% in 2010, it is expected to increase to 10% in 2020 and 25% in 2030 [23].

Bioethanol is obtained by transforming organic substances, whose origin is sugar, by microorganisms in the fermentation medium. The content properties of the raw material used and the sugar content it contains significantly affect the bioethanol yield to be obtained at the end of fermentation. Bioethanol production steps are carried out from three different raw materials, mainly sugar compounds, starchy compounds and cellulosic materials. While sugar and starch containing products are generally handled in the common area, cellulosic raw materials are kept separate as they require longer and more complex processes as pretreatment. Since the basic structure of starchy substances is based on sugar,

the sugar they contain can be easily revealed with several different pre-treatments. Examples of these are corn, which is used in many parts of the world. Apart from this, grains such as wheat and barley also contain high levels of sugar. Sugar is directly released in agricultural products such as sugar cane and sugar beet [24].

The idea of using bioethanol in motors is mostly seen in countries with large agricultural areas. E80 fuel, which is a mixture of 80% bioethanol and 20% gasoline, has been used in automobiles for years in the states where agriculture is engaged in the USA. In Brazil, where there are almost no oil reserves but especially sugar cane is abundant, automobiles have been working with bioethanol since 1988 [25]. Process diagram of bioethanol production from different raw materials is given in Figure 2.

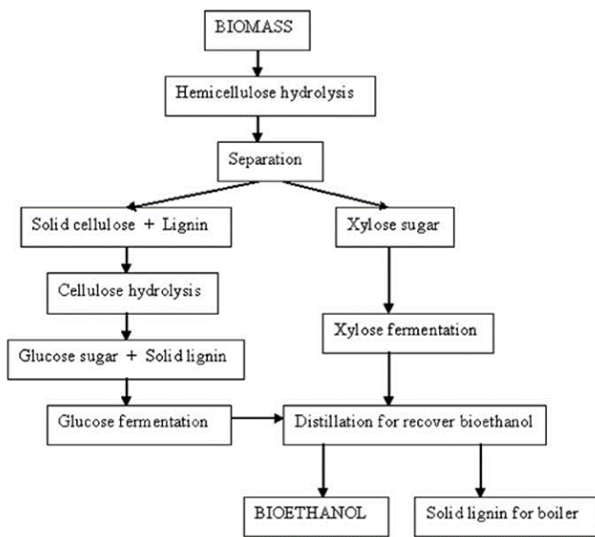


Fig. 2. Process diagram of bioethanol production [24]

**2.3. Biogas**

The rapid increase in the world population and industrialization rapidly increases the energy need in the

world. It meets the world's energy needs from approximately 24.2% natural gas, 29% coal and 32.8% oil. The remaining part is only nuclear energy, hydro energy and renewable energy. Natural gas, coal and oil reserves are running out of energy resources in the world. In addition, since these energy sources increase the carbon dioxide (CO<sub>2</sub>) emission in the atmosphere, these energy sources are actually quite harmful for the nature. This situation is very different in biogas energy, which is one of the renewable energy sources. Because CO<sub>2</sub>, which is one of the biogas energy components, is equal to the carbon dioxide used by nature and therefore it is not harmful to the atmosphere and does not cause pollution. Biogas obtained from biomass, on the other hand, is the greatest potential that can replace the consumed natural gas energy thanks to the methane (CH<sub>4</sub>) gas it contains. Using biomass, different energy products can be obtained in solid, liquid and gas forms for different needs. The easy storage of biomass energy also provides an advantage over other renewable energy sources. Biomass can be used with 6 different methods in general. These can be used in energy production by using biofuels and coal fuels together by direct burning, gasification, pyrolysis, anaerobic digestion and co-firing method [26].

Biogas is a colorless, odorless, lighter than air gas mixture that burns with a bright blue flame resulting from the fermentation of organic waste and residues in an oxygen-free environment. Depending on the composition of organic substances in its composition, approximately; It contains 40-70% methane, 30-60% carbon dioxide, 0-3% hydrogen sulfide, and very little nitrogen and hydrogen [27].

For the production of biogas, garden waste, animal manure, food and food waste, agricultural waste, industrial waste (paper, leather, textile, forest, sugar, etc.) and waste water treatment plant waste are used. In the production of biogas, animal and plant wastes can be used alone or by mixing according to certain principles [27].

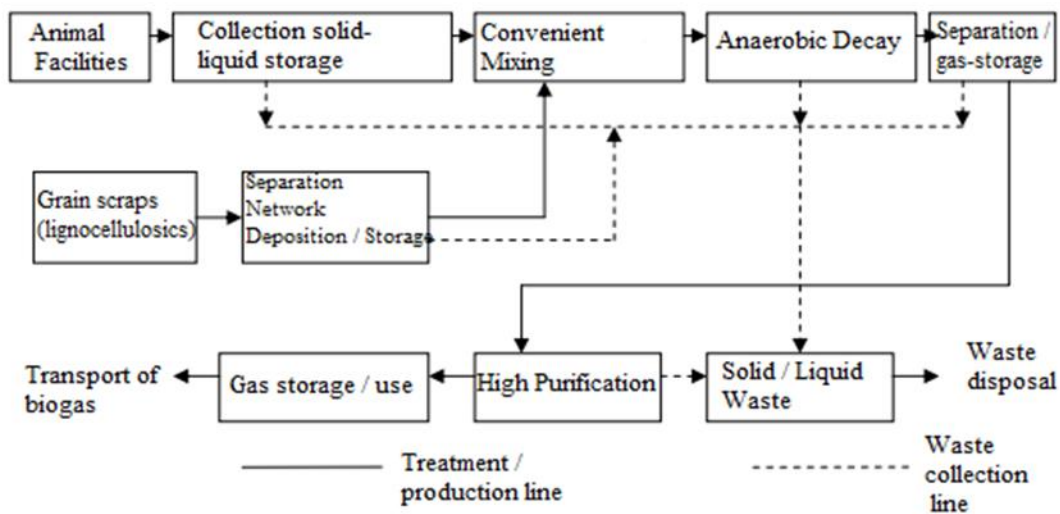


Fig. 3. Biogas Production Process Diagram [28]

### 3. Vehicle Performance Test Methods: Chassis Dynamometer

It is the system used by services and measurement centers working on every brand of vehicle. The drive wheels of the vehicle are placed between two cylinders located at ground level. The vehicle is fixed and the measurement is made by keeping the vehicle at a constant speed in full throttle position. Measurements can be made differently as motor output or wheel output. A picture of a typical chassis dynamometer is given in Figure 4 [29].



Fig. 4. Chassis Dynamometer [30]

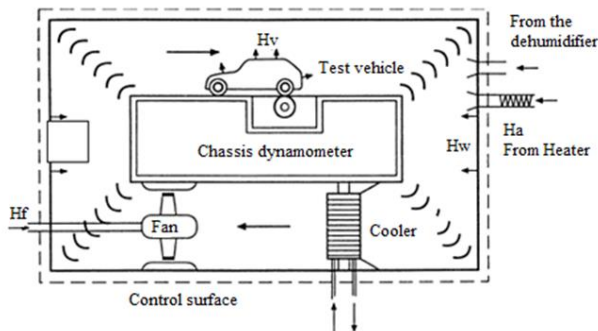


Fig. 5. Chassis Dynamometer Schematic Representation [29]

#### 3.1. Variety of chassis dynamometer

##### a) Liquid cooled chassis dynamometers

This dynamometer variant is best suited for noise testing in a semi-anechoic room. Compared with the cylinder / DY separation type, the space saving characteristic is evident. Therefore, a large reduction in construction costs can be expected.

##### b) Air-cooled chassis dynamometers

This type of dynamometer comes in an integrated form with rollers suspended on both shaft ends of the FREC dynamometer. A highly accurate torque measurement system was implemented in a space-saving environment. Inertial mass simulation adopts a high-speed response control type total electric inertial compensation system.

##### c) Chassis Dynamometers for Motorcycles

This type of dynamometer comes in an integrated configuration with a dangling roller at the shaft end of the low inertia FREC dynamometer. To save space, the flywheel has been removed to realize high precision torque

measurement. For inertial mass simulation, fully electrical inertia compensation system, which is a high speed response control type, is adopted. It can be applied to any motorcycle from light to heavy weights. Optional equipment is available for chassis dynamometers such as vehicle cooling fans, tire cooling fans, vehicle safety gear and others [31].

### 4. Effects of Biofuels on Vehicle Performance and Emissions

In this section, researches on the chassis dynamometer of vehicles using biofuels in our country and in the world have been examined. The effects of alternative fuels, which can be used instead of petroleum-based fuels, both in terms of economic independence and environmental aspects, without making any changes in different vehicles, on engine power and torque, and on exhaust emissions were investigated.

The effects of Eyidogan, ethanol-gasoline (E5, E10) and methanol-gasoline (M5, M10) fuels on engine performance, combustion characteristics and exhaust emissions were investigated. Experiments were carried out in a four-stroke, four-cylinder vehicle with spark-ignition engine, using a chassis dynamometer at 60, 80, 100 km/h vehicle speed and 5, 10, 15, 20 kW constant power conditions. The results obtained from E5 (5% ethanol + 95% Gasoline), E10, M5 and M10 fuels were compared with reference to the test data with gasoline. As a result of the experiments, it was observed that while the specific fuel consumption of ethanol-gasoline and methanol-gasoline mixtures increased, CO, HC, CO<sub>2</sub> and NO<sub>x</sub> emissions decreased [32].

Sakthivel et al. Used a chassis dynamometer to measure the emission values of a two-wheeled vehicle with fuels E0 (100% gasoline) and different ethanol-gasoline mixtures such as E10, E20, E30, E40 and E50. The emission test was measured using a Fourier transform infra-red (FTIR) analyzer. It was observed that saturated hydrocarbon emissions (methane and ethane) increased with mixtures in which the E20 fuel mixture and ethanol ratio increased. It was observed that aromatics (toluene), unburned ethanol emissions were higher with E30, E40 and E50 compared to pure gasoline and blends. It was observed that all emission components decreased with the increase in vehicle speed [33].

Experiments on a motorcycle with E0 and E30 (30% ethanol and 70% cloth) using a chassis dynamometer were conducted by Sakthivel et al. Combustion, performance and emission characteristics have been studied under steady state (wide open throttle - WOT) and transient (India driving cycle - IDC) operating conditions. In the emission test, while CO and hydrocarbon emissions decreased, NO<sub>x</sub> values increased with E30 compared to E0. Specific fuel consumption was higher with the E30, but there was a reduction in engine power. Combustion analysis results showed that with E30,

the burning time increased and there was a delay in the rate of heat release [34].

Biodiesel, by synthesizing the triglycerides in vegetable, animal and waste oils by transesterification method, Bannister et al. they produced. They mixed 5%, 10%, 20%, 30% and 50% of biodiesel with diesel and these mixtures measured engine performance and emissions in experiments on a chassis dynamometer with a common-rail direct injection vehicle. There was also a reduction in exhaust emissions, excluding NO<sub>x</sub>. As the biodiesel rates increased, a decrease in engine traction was observed. It has been observed that as the rate of biodiesel in fuel consumption increases, consumption increases [35].

Talibi et al. Investigated the effects of diesel fuel displacement with hydrogen on exhaust emissions, both in a single-cylinder research engine and in a demonstration vehicle. In the first phase, tests were carried out on a supercharged, direct injection, single-cylinder diesel research engine at different engine loads, intake air pressures and EGR levels. With the addition of H<sub>2</sub>, it was observed that while CO<sub>2</sub> and particles decreased, NO<sub>x</sub> increased. At the other stage, tests were carried out on the chassis dynamometer with a small van equipped with a multi-cylinder version of the single-cylinder research engine. The minibus is fitted with a programmable H<sub>2</sub> magnification system with H<sub>2</sub> addition levels determined by the accelerator pedal position. Increasing H<sub>2</sub>, decreases in CO, NO<sub>x</sub> and particle numbers were observed, but a higher total mass of PM was recorded [36].

A chassis dynamometer to test and analyze a Euro VI standard heavy-duty diesel vehicle under different load, fuel, driving conditions to investigate the impact of different heavy diesel vehicles on emissions. It was used by. It was found that the full load case increased NO<sub>x</sub> emissions by about 0.107 g / km (30%) and particulate matter (PM) 0.003 g/km (18%) compared to the empty load case. Compared to the Chinese V diesel, the NO<sub>x</sub> emissions of the Beijing VI diesel decreased by 0.065 g/km (18%) and PM 0.004 g/km (25%) [37].

Örs used gasoline-ethanol blends containing 10-20-30% ethanol by volume as fuel. According to the experimental results; The highest increase in wheel drive force was 9.56% with E20 fuel at 20 km / h vehicle speed in the case of 2nd gear. The highest decrease in wheel drive force was 5.75% with E30 fuel at vehicle speed of 100 km / h in the case of 4th gear. The highest increase in wheel drive power is 9.56% with E20 fuel at a vehicle speed of 20 km / h in the case of 2nd gear. The biggest decrease in wheel drive power was 5.44% with E30 fuel in the case of 4th gear. Looking at the emissions; The highest drop in CO emission was approximately 5 times with E20 fuel at a vehicle speed of 140 km / h in the 4th gear case. The highest reduction in HC

emission was about 9 times with E10 fuel at 20 km / h vehicle speed in the case of 2nd gear [38].

The effects of bioethanol-gasoline mixtures on the exhaust emissions and in-cylinder combustion of a four-stroke motorcycle in chassis dynamometer Costagliola et al. They investigated. An experimental study of bioethanol / gasoline blends (bioethanol range 5-10-20-30%) was conducted on a large-sized motorcycle with a Euro 3 engine. The results showed that for up to 30% bioethanol the engine does not need any control unit adjustments. Regarding the exhaust emissions, they found that the higher the bioethanol ratio in gasoline, the lower the emissions [39].

The fuel consumption and exhaust emissions of the vehicle with a spark ignition engine fed with methane-enriched biogas (93% CH<sub>4</sub>) and base CNG (89.14%) were tested using a chassis dynamometer under a modified Indian driving cycle (MIDC). The experimental results showed that the emission characteristics (CO, HC and NO<sub>x</sub>) of the vehicle in terms of time are much higher for both fuels in the urban cycle (low speed) than in the extra-urban cycle (high speed). Since methane-enriched biogas performs similar to fossil CNG, enriched biogas can be used as fuel for spark ignition engines Subramanian et al. They determined [40].

Peterson et al. Tested the effects of a 20% biodiesel-80% diesel blend on emissions compared to pure diesel fuel. The vehicle to be tested is a van with a 5.9 L turbocharged and water-cooled direct injection diesel engine. Vehicle emission tests have been carried out on the chassis dynamometer. As the iodine number increased from 7.88 to 129.5, NO<sub>x</sub> increased by 29.3%. They found that fatty acids with two double bonds have a greater effect on the increase of NO<sub>x</sub> emissions than fatty acids with a single double bond [41].

They investigated the exhaust emissions and fuel consumption (Lim et al., 2014) of a vehicle with an engine powered by biogas and natural gas. They tested it on a chassis dynamometer of a large CNG vehicle used as a city bus in Korea. They used a CH<sub>4</sub> enriched biogas (97.6% CH<sub>4</sub>) and 5 natural gases with different CH<sub>4</sub> content (81.6-94.0% CH<sub>4</sub>) as test fuels. They found that while total hydrocarbons (THC), CO, NO<sub>x</sub> and CO<sub>2</sub> emissions were higher for all fuels tested, fuel consumption fell by 43.7-51.5%. HC emissions were higher than 133.3-577.8% due to incomplete combustion in urban driving mode. The opinions are that the number of particulate matter is 33.2-123.8% higher in urban driving mode [42].

Regulated emissions from 21 heavy-duty diesel vehicles in use were determined by Yanowitz et al. In a heavy-duty chassis dynamometer through three driving cycles using low-sulfur diesel fuel. Tests have been made by. Particulate matter (PM), nitrogen oxides (NO<sub>x</sub>), carbon monoxide (CO), total hydrocarbon (THC) and PM sulfate fraction emissions were measured in these experiments. When the emissions are converted to g / gal basis, the effect of the drive cycle for

NO<sub>x</sub> is eliminated and for PM to a large extent. Sulphate accounted for less than 1% of emitted PM for all tools and test cycles. A strong correlation was observed between CO and PM emissions. An 11% increase was achieved in cold, PM emissions starting at 25 ° C. Multivariate regression analyzes showed that PM emissions in use were decreasing at a slower rate than expected according to motor certification test standards introduced since 1985 [42].

In this study, the effect of using biodiesel obtained from waste oil as an alternative fuel to diesel engines on engine performance and emissions was investigated. A four-stroke single-cylinder direct injection engine was used in the experiment. The test engine was tested with diesel and pure biodiesel at constant speed and different loads. According to the test results, the use of biodiesel compared to diesel can increase the unit fuel consumption of the brake by 3% and reduce the unit energy consumption of the brake by 5%. In addition, it was determined that diesel, NO<sub>x</sub>, CO and soot emissions decreased by 17%, 33% and 31%, respectively, while HC emissions increased by 24% [44].

The purpose of this article is to determine and investigate the effect of changes in small differences in test conditions when measuring fuel consumption. The results revealed that most tested parameters had significant effects on fuel consumption. The chassis dynamometer was used to measure these effects. An 8.7 percent increase in fuel consumption was observed after the battery ran out at the end of 90 minutes from vehicle headlights. It increased by 5.5% when the rig was run at 3 km/h faster in a driving cycle and 2.6% when air-lowered tires were used at 0.5 bar. As a result, statistical tolerance was used for typical tolerances values for test hardware setup variables. For example, it was recommended to check the tire pressure within 0.1 bar and check the test equipment speed within 0.3 km/h. More studies have been conducted on the effect of battery discharge, deceleration time and engine cooling. These show that battery voltage is not an ideal measure of variation in alternator loading, but the need for strict battery charge management. For many control variables that affect the rolling resistance of the vehicle, deceleration time has been found to be a good control value. As a result, the cumulative engine temperature over the entire driving cycle was used to measure the different output values in engine cooling. These were found to be related to good fuel consumption [45].

This study aims to examine the B20 blend level and emission characteristics of first, second and third generation biodiesel. The engine, which is a naturally aspirated, single-cylinder diesel engine, was operated at an engine speed of 1500 rpm and at different engine loads at 25% intervals. In addition, emission characteristics such as smoke, carbon dioxide (CO<sub>2</sub>), particulate matter (PM), nitric oxide (NO) and summary of emission (SE) were obtained by analyzing the engine. Numerical simulation is performed using pure diesel

(D100), first, second and third generation B20 (80% diesel + 20% biodiesel). The reduction in emissions results for the biodiesel blend as smoke from diesel fuel (BSN) 54.68% for jojoba, 4.8% for coconut, 52.0% for jojoba and 7.1% for fish oil, 38.2% for NO jatropha curcas and 8.8% for SE soybeans, It was found to be 12.9% for jatropha curcas and 8.8% for spirulina, but the carbon dioxide was 0.38% higher for rapeseed and 0.61% for fish oil. The mix of B20 shows a reduction in emissions at 1500 rpm with 100% engine load [46].

In this study, the effect of using gasoline-ethanol mixture as fuel on wheel drive power, CO, HC and CO<sub>2</sub> emissions of vehicles with electronic ignition system and fuel injection system was investigated. A gasoline-ethanol mixture containing 10-20-30% ethanol by volume is used as fuel. According to the experimental results; Compared to E0, when using E20 fuel at 20 km / h, the maximum increase in wheel thrust is 9.56%. Compared to E0, using E30 fuel at 40 km / h the maximum reduction in wheel drive force is 9.8%. Control emissions; In the third gear gearbox, compared to E0, the highest reduction in CO emissions is about 12.7 times that of E20. In second gear, when vehicle speed is 20 km / h, using E10 fuel the highest reduction in HC emissions is 9.2 times compared to E0[47].

In this study, bioethanol produced from sugar beet was used as a blending agent. Gasoline-bioethanol mixtures containing 2% and 5% ethanol by volume are used as fuel in vehicles with gasoline engines, and 95 octane gasoline is used as the reference fuel. Experimental results show that the use of ethanol decreases CO, CO<sub>2</sub>, HC and NO<sub>x</sub> emissions and increases the O<sub>2</sub> emission value in the exhaust gas [48].

## 5. Conclusion

A joint research effort has been going on for years, combining research resources from the fields of atmospheric chemistry and automobile development to investigate the possible impact of fossil fuel combustion on air quality, especially in urban areas.

Fossil fuel powered engines are indispensable today. With the use of internal combustion engines, harmful gas emissions have also increased. These harmful gases have many other damages such as environmental pollution, acid rain, climate change due to excessive accumulation of the atmosphere. If biodiesel is used instead of diesel fuel, we will prevent harmful gas emissions. In this way, we both protect nature and leave a livable world to future generations.

The purpose of this research is to examine the researches conducted on the chassis dynamometer of the vehicles using biofuels in our country and in the world and determine the effects of these fuels on vehicle performance and emissions. It has been seen in the researches that many of the biofuels can be used without making any changes in the engines of the

vehicles. Studies have shown to what extent alternative fuels, which can be used instead of petroleum-based fuels, have less impact on the environment in terms of both economic independence and environmental aspects, especially in terms of exhaust emissions.

As a result, the use of biofuels produced from waste oils and vegetable oils as an alternative fuel in internal combustion engines has a positive effect on engine performance. Especially biofuels reduce exhaust emissions and for this reason; It has been understood that the use of biofuels is an important element that will reduce the greenhouse gases that cause global warming and the gases that deplete the ozone layer in the atmosphere.

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#### ORCID

A. Engin Özçelik  0000-0002-8646-0950

M. Mahmut Yıldız  0000-0002-1999-0353

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