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Examination of Fuel Properties of Biodisel Which Obtained From Terebinth Oil and Blending*

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Abstract: In this study, biodiesel (MYME) was produced from terebinth tree's fruits grown in Konya region, having oil content of %38,74 on average by the method of transesterification. Fuel properties of produced biodiesel and blend product (volumetric as diesel oil was mixed B50, B20, B5, B2 ratio) of those were examined. Laboratory of Faculty of Agriculture Biodiesel, Selcuk University was used for the production and analysis of the biodiesel. Results of the study showed that fuel properties of biodiesel and blend products were within the standard limits except its few values. As a result of examination, the density and water content of the fuel B50 were %1,4 and %45,68, respectively higher than that of standards. The flash point of fuel B100 was lower than standard values at a rate of %0,5. When this values are compared with diesel oil. It can be used easily. It was concluded that according to standards, that diesel fuel B100 and blends can be used in temperate climate TİP A climate.
Key words: Terebinth oil, biodisel, blending ratio, fuel properties

Menengiç Yağından Elde Edilen Biyodizelin ve Karışımlarının Yakıt Özelliklerinin İncelenmesi

Özet: Bu çalışmada Konya Bölgesi'nde yetişen ortalama %38,74 oranında yağ içeren menengiç ağacının meyvelerinden elde edilen yağa transesterifikasyon yöntemi uygulanarak biyodizel (MYME) üretilmiş ve üretilen biyodizel ile karışım (hacimsel olarak motorinle B50, B20, B5, B2 oranlarında karıştırılmış) yakıtlarının yakıt özellikleri incelenmiştir. Biyodizel üretimi ve analizi için Selçuk Üniversitesi, Ziraat Fakültesi Biyodizel Laboratuarı kullanılmıştır.
Araştırma sonuçlarına göre, üretilen biyodizel ile karışım yakıtlarının yakıt özelliklerinin büyük oranda standart sınırlar içerisinde olduğu gözlenmiştir. İncelemeler neticesinde B50 yakıtının yoğunluğu ve su muhtevası değerleri standart değerden sırasıyla %1,4 ve % 45,68 oranında yüksek çıkmıştır. B100 yakıtının parlama noktası değeri de standartta verilen değerden %0,5 oranında düşük çıkmıştır. Bu değerler motorin ile kıyaslandığında rahatlıkla kullanılabileceği ancak standartlara göre B100 yakıtının ve karışımların standartlara göre yaz mevsiminde TİP A'da rahatlıkla kullanılabileceği sonucuna varılmıştır.
Anahtar Kelimeler: Menengiç yağı, biyodizel, karışım oranları, yakıt özellikleri

INTRODUCTION

Energy is the most significant phenomena that human beings need in order to meet their requirements and it is motive of economic development. Considering that practically all nations confront energy problem, the matter of energy is of great importance. Energy sources used in the world in 2008 can be seen in figure 1. As understood in figure 1 great amount of (approximately 88 %) energy sources used on earth are obtained by fossil fuels (Anonymous 2008b).

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* This paper is a summary of Ayşe Betül Balcı's Master Thesis

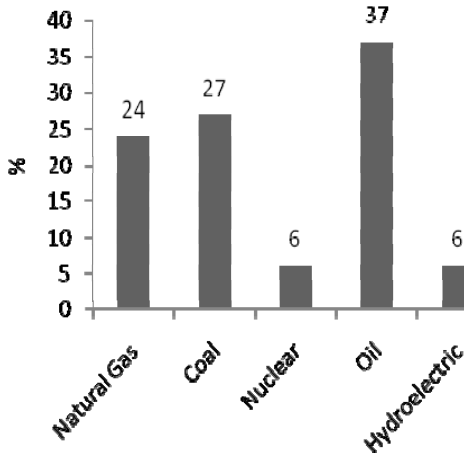

Figure 1. Energy sources used in the world

Oil with a high consumption rate, is consumed at almost 3,6 million tonnes per year in our country. The quantity of imported raw oil is 25,5 million tonnes domestic production is 2,2 million tonnes. In other words, only 8.6 % of raw material refined in our plants can be met with domestic production (Anonymous 2008b). This is an indication that our country is dependent on export in oil.

Furthermore, environment pollution caused by fossil fuels (coal, natural gas, oil) and greenhouse gases, mainly carbondioxide (CO_2) that are emitted to the atmosphere as a result of this cause to keep sunlight in the atmosphere for longer and also cause to rise heat on earth. Besides, according to the researches, if there is no shift in using energy sources it is warned that there will be global energy deficit and pollution is likely to rise at a rate of 50 % by 2030 (Anonymous 2006, Anonymous 2008a).

Thus new and renewable energy sources have great value. 'Biomass' among all these energy sources is of great potent. All materials, with vegetable and animal origin, which are made up of carbon and hydrogen compounds are defined as 'biomass energy resource' and energy that is produced by these resource is defined as 'biomass energy' (Karaosmanoğlu 2002 ve Haşimoğlu 2005). Wood oily seed plants (rapeseed, sunflower, soybean etc.) carbohydrate plants (potato, wheat, corn) fibers plants (linen, hemp plant, miskantus) protein plants (peas, beans), vegetable wastes (stem, straw, root) animal wastes and urban and industrial wastes are assessed in the field of biomass energy technologies and a great many solid, liquid and gas fuels exist as an alternative to available ones. Biodiesel is the most important alternative diesel fuel which has biomass origin (Öğüt ve Oğuz 2006).

Biodiesel is oil acid methly ester that is made up of vegetable oiled seeds (canola, linen, cotton, safflower, soybean bean, peanut, coconut, palm etc.) wasted frying oils, animal oils and any kind of biologic origin oils which are formed as a result of their reaction with short-chained alcohol accompained with a catalyst and that is used as fuels(Karahan 2005, Akay 2007).

Biodiesel is a primary option in our country which is an agricultural country. As a result, biodiesel will contribute to strengthen economical structure of rural regions and improving side industries as well as employement opportunities. However, the fact that biodisel is produced by vegetable oils causes biodiesel fuel to be much more expensive than diesel fuel. Therefore, alternative oily seeds with high oil rate and not used for cooking which can produce biodiesel are looked for.

Basic aim of this study is to fulfill biodiesel production by applying transesterification method to oil acquired by fruits of terebinth which has no kitchen consumption with approximately 38.74% oil rate, and to determine fuel features of biodiesel and its compounds.

MATERIAL and METHOD

Material

In this study oil acquired by fruit of terebinth (pistacia terebinthus) was used. In figure 2 and 3 terebinth tree and its fruit can be seen.

This is how oil can be obtained; because it is a hard crusted fruit, it is broken in a breaker machine then heated and crushed in 200 tonnes hydrolic press after being cold. 5,5 kg oil was obtained by 19 kg terebinth fruits which were used.

In order to produce terebinth biodiesel (Terebinth Oil Methyl Ester = MYME) from terebinth oil and analyse its fuel Selçuk university agricultural faculty DPT 2007/4 project supported biodiesel laboratory has been used.

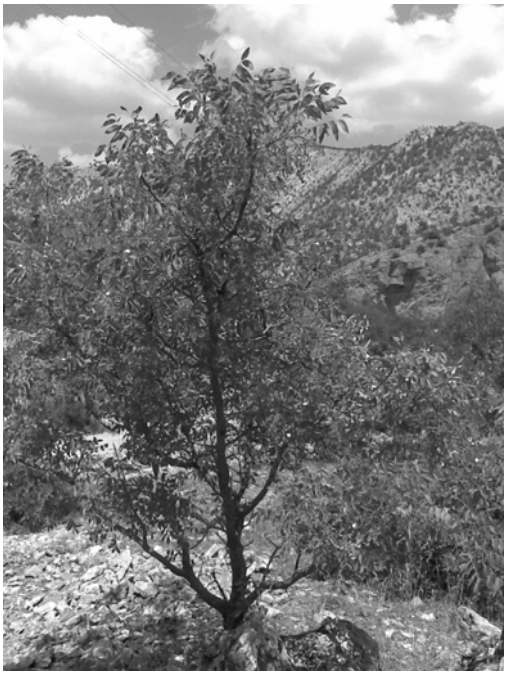

Figure 2. Terebinth tree

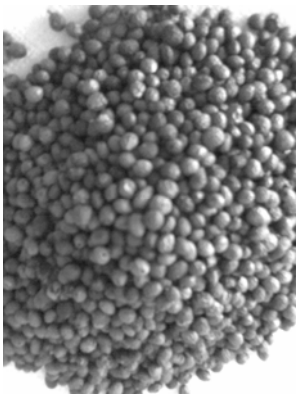

Figure 3. Terebinth fruit

Method

MYME is produced by terebinth oil that is obtained by the method of transesterifcation. This MYME is both used as direct B100 fuel and blend with diesel fuel volumetricly at the rate of 2%, 5%, 20%, 50%. Fuel properties of alternative fuel B100, B50, B20, B5, B2 and diesel fuel were determined.

Biodiesel production from terebinth oil

With the method of transesterification terebinth oil was produced after determining necessary alcohol and catalyst quantities for 1 litre raw oil. In conformity with this, a quantity of 20 % methyl alcohol (200 ml) and 3,5 gr sodium hydroxide catalyst was determined. Methyl alcohol and sodium hydroxide was blend in an appropriate cover till melted and methoxide was acquired. This mixture was added to raw oil which is heated at 55 °C in a heater with thermostat controlled and magnetic mixer. Acquired mixture was kept for falling after mixing for an hour. 13.7 % glycerol was taken from biodiesel that is produced as a result of falling. Biodiesel which is isolated from glycerol was rinsed with pure water. Rinsing process was performed with misting unit by using pure water at 50 °C with the quantity of 20 % of raw biodiesel (during rinsing biodiesel is 50 °C water is 50 °C). Biodiesel was prepared as availlable after drying process.

Acquired terebinth oil methyl ester (MYME) was mixed with diesel fuel volumetricly at the a rate of 2%, 5%, 20%, 50% as shown in Table 1 and it was filled into glass covers as shown in figure 4. During blending process at first biodiesel was put then diesel fuel was added to this mixture for adequately enough to provide the mixture rate and after 10 minutes homogenenesator and homogeneous mixture was provided.

Table 1. Biodiesel blend rates

Total blend quantity (ml)	Blend rate (%)	Biodiesell (ml)	Diesel fuel (ml)
200	B2	4	196
200	B5	10	190
200	B20	40	160
200	B50	100	100
200	B100	200	-

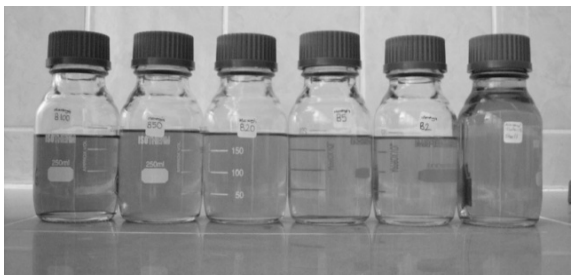

Figure 4. biodiesel, biodiesel blend rates (B50, B20, B5, B2) and diesel fuel

B100, blends (B50, B20, B5, B2) and diesel fuel properties(Density, kinematic viscosity, flash point, water content, Copper Strip Corrosion, acid value, iodine value, cloud point, pour point, cold filter plug point (CFPP), Heat Combustion, ASTM colour test, pH, were determined.

According to standarts whether terebinth oil biodisel of TS EN 14214, blends and diesel fuels TS 3082 EN 590 proper or not was determined by performiy tests that are given in this criteria.

RESEARCH FINDINGS

Research and applications have revealed that oils containing long leafed and single coupled oil acids are chemically suitable diesel alternatives and that increasing unsaturated level have affected size of cetane number adversely. This situation has a great importance on oils rich in oleic acid (Karaosmanoğlu ve Aksoy 1994, Öğüt ve Oğuz 2006).

Table 2. Terebinth oil acid concentration (%)

Oil Acids		Terebinth Oil Concentration
Lauric acid	(C12:0)	-
Myristic acid	(C14:0)	-
Palmitic acid	(C16:0)	15.58974
Stearic acid	(C18:0)	1.98155
Oleic acid	(C18:1)	41.55659
Linoleic acid	(C18:2)	18.40534
Linolenic acid	(C18:3)	14.57581
Araşidic acid	(C20:0)	-
Behenic acid	(C22:0)	-
Erusic acid	(C22:1)	-
Lignoseric acid	(C24:0)	-
Other		7.8910

Oxidation resistance is better at vegetable oils with high oleic acid. Monounsaturated chains are preferred for oxidation resistance. Polyunsaturated chains provide poor oxidation resistance, but improve its behavior at low heat. Heat resistance of Saturated oil acid chain is quite little. So required oil has mostly a mixture of monaunsaturated and poly unsaturated chains and minimum saturated chains(Oğuz ve Öğüt 2001, Öğüt ve Oğuz 2006). Oil acid concentrations of terebinth oil that acquired has been shown in Table 2. In Table 2, oleic acid quantity of terebinth oil is seen to be high.

Result of checked oil properties of B100, B50, B20, B5, B2 raw oil and diesel fuel were shown at Table 3, besides standards of TS EN 14214, TS EN 14213 and TS 3082 EN 590 respectively were shown at Table 4, 5 and 6. As seen at Table 3 because viscosity of raw oil is high viscosity was primarily lowered and then its fuel properties were examined.

According to examined fuel properties, fuel properties of B100, B50, B20, B5, B2, are in the sphere of standard limitations and only B50 fuel's density is over standard value with the rate of 1,4 % and its water content is over standard value with the rate of 45,68 Flash point value of B100 fuel is lower than standard with the rate of 0,5%. It can be concluded that B100 fuel and mixtures are used properly at TYPE A during summer months according to the standards, while during winter months, they are used at TYPE E with the help of additives. (According to TS EN 14214 standard 'in Turkey TYPE A will be used in summer, TYPE E will be used in winter' starting and ending dates of summer and winter periods; as October 1 - March 31 (±15) for winter, April 1- September 30 (± 15) for summer was determined)

Table 3. B100, B50, B20, B5, B2, raw oil and diesel fuel properties

Fuel properties	B100	B50	B20	B5	B2	Ham yağ	Motorin
Density kg/m³ (15 ^{0}C de)	882,2	856,9	845,6	839,6	838,5	920,0	837,0
Kinematic viscosity mm²/s (40 ^{0}C de)	4,450	3,296	2,943	2,928	2,703	38,14	2,681
Flash point ºC	97	70	65	61	60	-	57
Water content (ppm)	498,81	291,37	147,55	69,274	57,928	557,14	56,166
Copper Strip Corrosion	1a	1a	1a	1a	1a	1a	1a
Heat Combustion mj/kg	41,658	44,406	44,816	46,710	47,330	39,924	47,853
Cloud point	10,5	-3	-3,5	-4	-4,5	_	-5
Pour point	0,2	-12	-15,6	-18	-20	-	-22
CFPP	5	-5	-5	-6	-6	-	-7
Acid value mg KOH/g	0,0925	-	-	-	-	0,3204	-
Iodine value	98,176	-	-	-	-	98,176	-
Colour test	2	1,9	1,8	1,4	1,2	2,2	0,9
pH value	6	5,5	5	5	5	5	5

Table 4. TS EN 14214 automotive fuels –fatty acid methyl esters (fame/biodiesel) - diesel engines - standarts

Properties	Unit	Limits		Test method
		Minimum	Maximum	
Ester content	% (m/m)	96,5	-	EN 14103
Density at 15 °C	kg/m³	860	900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm²/s	3,5	5,0	EN ISO 3104
Flash point	°C	101	-	EN ISO 3679
Sulfur content	mg/kg	-	10,0	EN ISO 20846 EN ISO 20884
Carbon residue (%10 distillet residue)	% (m/m)	-	0,30	EN ISO 10370
Cetane number		51,0	-	EN ISO 5165
Sulfated ash content	% (m/m)	-	0,02	ISO 3987
Water content	mg/kg	-	500	EN ISO 12937
Total contamination	mg/kg	-	24	EN 12662
Copper strip corrosiveness (50°C'ta 3 hour)	degree	Class 1		EN ISO 2160
Oxidation stability 110 °C'de	h	6,0	-	EN 14112
Acid number	mg KOH/g	-	0,50	EN 14104
Iodine value	g iodine/100 g	-	120	EN 14111
Linolenic acid methyl ester	% (m/m)		12,0	EN 14103
Poly unsaturated (>=4 double bonds) methyl esters	% (m/m)	-	1	
Methanol content	% (m/m)	-	0,20	EN 14110
Monoglyceride content	% (m/m)	-	0,80	EN 14105
Diglyceride content	% (m/m)	-	0,20	EN 14105
Triglyceride content	% (m/m)	-	0,20	EN 14105
Free glycerol	% (m/m)	-	0,02	EN 14105 EN 14106
Total glycerol	% (m/m)		0,25	EN 14105
Grup I metaller (Na+K) Grup II metaller (Ca+Mg)	mg/kg mg/kg		5,0 5,0	EN 14108 EN 14109 prEN 14538
Phosphours content	mg/kg	-	10,0	EN 14107

Cold Filter Plug Point									
Climate vary	Properties	Unit	Limits						Test method
Mild climates	CFPP	°C maximum	Tip A	Tip B	Tip C	Tip D	Tip E	Tip F	EN 116
			+5	0	-5	-10	-15	-20	

Table 5. TS EN 14213 heating fuels – fatty acid methyl esters (fame) standards

Properties	Unit	Limits		Test method
		Minimum	Maximum	
Ester content	% (m/m)	96,5	-	EN 14103
Density at 15 °C	kg/m³	860	900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm²/s	3,5	5,0	EN ISO 3104 ISO 3105
Flash point	°C	120	-	EN ISO 3679
Sulfur content	mg/kg	-	10,0	EN ISO 20846 EN ISO 20884
Carbon residue (%10 distillet residue)	% (m/m)	-	0,30	EN ISO 10370
Sulfated ash content	% (m/m)	-	0,02	ISO 3987
Water content	mg/kg	-	500	EN ISO 12937
Total contamination	mg/kg	-	24	EN 12662
Oxidation stability 110 °C'de	h	4,0	-	EN 14112
Acid number	mg KOH/g	-	0,50	EN 14104
Iodine value	g iodine/100 g	-	130	EN 14111
Poly unsaturated (>=4 double bonds) methyl esters	% (m/m)	-	1	
Monoglyceride content	% (m/m)	-	0,80	EN 14105
Diglyceride content	% (m/m)	-	0,20	EN 14105
Triglyceride content	% (m/m)	-	0,20	EN 14105
Free glycerol	% (m/m)	-	0,02	EN 14105 EN 14106
Cold Filter Plug Point (CFPP)	°C	-		EN 116
Pour point	°C	-	0	ISO 3016
Net Heat Combustion (counted)	MJ/kg	35	-	DIN 51900-1 DIN 51900-2 DIN 51900-3

Table 6. TS 3082 EN 590 automotive fuels – diesel(diesel fuel) Standard

Properties	Unit	Limits		Test method
		Minimum	Maximum	
Cetane number		**51,0**	-	EN ISO 5165
Cetane index		46,0	-	EN ISO 4264
Density at 15 °C	**kg/m³**	820	**845**	EN ISO 3675 EN ISO 12185
Polysiclic aromatic hydrocarbons	**% (m/m)**		**11**	EN 12916
Sulfur	mg/kg	-	**350** (for 31.12.2004 or **50,0**	EN ISO 20846 EN ISO 20847 EN ISO 20884
			10,0	EN ISO 20846 EN ISO 20884
Flash point	°C	Over 55	-	EN 22719
Carbon residue g (%10 distillet residue)	% *(m/m)*		0,30	EN ISO 10370
Ash	% (m/m)	-	0,01	EN ISO 6245
Water	mg/kg	-	200	EN ISO 12937
Total contamination	mg/kg	-	24	EN 12662
Copper Strip Corrosion (3 h, 50 °C'da)	Derece	1		EN ISO 2160
Oxidation stability	g/m³	-	25	EN ISO 12205
Property of oiling, scale of erosion print that is levelled (wsd 1,4), 60 °C'ta	µm	-	460	ENISO 12156-1
Viscosity , 40 °C'ta	mm²/s	2,00	4,50	EN ISO 3104
Distillation 250 °C'ta obtained % (V/V) 350 °C'ta obtained %(V/V) **%95'in (V/V) obtain tempature**	% (*V/V*) % (*V/V*) °C	- 85 -	<65 - **360**	EN ISO 3405
Fatty acid methyl ester (FAME)	% (V/V)	-	5	EN 14078
Note – Dark written statements are related to European Fuels Directive 98/70/EC including Amendmentl 2003/17/EC [2]				

Cold Filter Plug Point									
Climate vary	Properties	Unit	Limits						Test method
Mild climates	CFPP	°C maximum	Tip A	Tip B	Tip C	Tip D	Tip E	Tip F	EN 116
			+5	0	-5	-10	-15	-20	

DISCUSSION and CONCLUSION

As a result, it was concluded that terebinth oil biodiesel and its blends are appropriate alternative fuel for diesel engines.

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