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Original Research Article

Fuel Properties of Biodiesel Produced from Balci Variety Oil of Safflower (*Carthamus tinctorious* L.)

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Abstract

In this study, the production of biodiesel from the cold pressed oil of safflower (*Carthamus tinctorius* L.) of Balci variety grown in Yozgat ecological condition has been carried out. The oil yield of Balci seed and the biodiesel output of the oil were studied in order to know the productivity of the oil. The fuel properties of biodiesel assessed includes, density (15ºC), flash point, kinematic viscosity (40ºC), cloud point, pour point, freezing point, water content, calorific value, pH and copper strip corrosion. The fuel properties of the biodiesel produced were compared with that of TS EN 14214.

Key words: Safflower, Balci, biodiesel, fuel properties

Nomenclature

BS	*:* Balci Seed
BSCO	*:* Balci Seed Crude Oil
BSCOB	*:* Balci Seed Crude Oil Biodiesel
CFPP	*:* Cold Filter Plugging Point

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1. Introduction

The safflower, which is an annual plant in Compositae (Asteraceae) family, is a multipurpose oilseed crop grown mainly for animal feed, horticultural crop (vegetables, cut flowers and medicinal), paint and textile industry and food industry [1]. Unfortunately, it has not found its long deserved place in the industrial plant production patterns yet. The safflower, which is produced at low amounts in various parts of the world [2], is known to be used in a wide range of sectors from cosmetics to paint industry, from pharmaceutical industry to soap and varnish industry, whose product we widely use in our daily lives [3-5]. Today it is emphasized that safflower can also be a source of food for humans as it features highly unsaturated fatty acids obtained from its seeds (%78 linoleic) and vitamin E [6-7].

A large part of the world suffers from scarcity of water and water consumption per person has been gradually decreasing due to increasing human population and global climate change. To weather water crisis that awaits populations with minimum damages, it is of vital importance to use arid lands in agricultural production for sustainable agriculture and a healthy community. One way of realizing this is to harness arid areas for agricultural production. Safflower can be considered to be a plant that can grow in dry and arid places due to its low production cost and ability to grow in dry areas [8-9].

Over the past several decades, demand for energy has grown, and is expected to continue growing, drastically around the world [10]. Energy continues to be an indispensable factor for economic and social developments of countries and thus enhancing wealth of societies. The phenomenon of climate change resulted from widespread use of fossil fuels refers to change in global system and thus in ecosystems as a result of excessive increase in the concentration of greenhouse gases in the atmosphere due to human activities. In this context, greenhouse gases emissions mainly resulting from the use of fossil fuels in energy, transportation, industry, agriculture, logging and waste management sectors, primarily alters atmosphere densities. As a result of warming linked to this, unpredictable changes are seen in global climate systems, and the changes in ecosystems which depend on climatic data natural resources cause harm to human beings and all living beings alike. The results of these changes are indirectly reflected in our socio-economic structure and directly affect our future.

The strategic position of biodiesel is a fact that cannot be ignored. Biodiesel can be produced from vegetable oils, animal fats and used waste cooking oil. Biodiesel can be used in diesel engines in blends with diesel fuel at different rates or in 100% pure form without requiring any modifications to the engine. Biodiesel does not contain sulfur, aromatic hydrocarbons, metals and crude oil wastes, which have negative effects on the combustion efficiency and emissions of diesel engines. From this point of view, biodiesel is more ecological in nature compared to diesel fuel [11].

As it is realized that natural sources are not limitless, science circles place great emphasis on the concept of "sustainability". In this context, sustainability is to be carefully addressed in agricultural production. It is of great prominence to use agricultural resources in a renewable way, which requires protection of biological liveliness. Crop production patterns are to be diversified to improve and sustain biological liveliness. Current agricultural production has become a sort of monotony in terms of regions, that is, certain plants are only produced in certain geographical regions. While only cereals and edible legumes are grown in dry and arid areas, industrial plants are produced in wetlands. When this monotony is considered in terms of total quality value, it can be seen that it gradually damps down biological liveliness. Safflower, which is a plant in Asia Minor Gene Center which also includes Turkey, can be one of the plants to be considered as a part of solution to this problem of biological liveliness.

2. Material and Method

Balci (spined) seed, which is a variety of safflower (*Carthamus tinctorius* L.) registered to Turkey, was obtained from Eskisehir Agricultural Research Institute and grown in Yozgat province. Crude safflower oil was obtained from the seeds produced by using a screw press with a US-made Kern&Kraft brand 3.5 kW electrical engines and with pulp outfall of 12 mm. Biodiesel was produced from this resulting oil in Biofuel Lab in Department of Biosystems at the Faculty of Engineering and Architecture in Bozok University via transesterification method.

For the first reaction, 75% methanol (Merck, d=0.791-0.792 kg/l), 50% NaOH (Merck) catalyst, that is 150 mL of methyl alcohol and 1.75 g NaOH were resolved in magnetic mixer and methoxide was obtained. This mixture of methoxide was added to the oil mixed at 55ºC. For the mixing, the circulation rate was set to 1000 1/min and the mixture was mixed for 90 minutes. Later on, the mixer and heater were switched off. After waiting for 120 minutes for glycerol to subside, glycerol was removed. Later on, we proceeded to the second stage.

For the second reaction, 25% methyl alcohol (50 mL), 50% NaOH (1.75 g) were resolved in magnetic mixer and methoxide was obtained. The crude biodiesel, whose first reaction was realized, was heated up to 55ºC again by starting maxing and was submitted to reaction for 60 minutes. Then, the mixer and the heater were turned off. The resulting mixture was left to rest and glycerol was removed. The temperature of the crude biodiesel was increased up to 75ºC and methyl alcohol was removed. After 15 hours of waiting for glycerol to subside, glycerol was taken. Meanwhile, the pH value of the biodiesel was measured and distilled water was added as reaction of basic characteristics till neutralization. It was submitted to washing off using the douching method. The aim of washing off is to remove alcohol which does not get involved in reaction, remaining fatty acids, Na+, K+ ions, catalyst substance and glycerol which could have remained during separation. During washing, the temperature of biodiesel and distilled water was 50ºC and a total of 200 mL of distilled water was used for washing. After the washing process, it was rested for 12 hours for water to subside. The subsided water was taken with the help of separating funnel. The washed biodiesel was taken to magnetic mixer with heater again and was heated up to 120ºC which is above water goes beyond biodiesel. For biodiesel, drying was made at 120ºC for 2 hours. Thus crude biodiesel was produced from safflower seed (Balci-spined). Some fuel analysis of the biodiesel obtained was carried out in Biosystems Engineering Department Biofuel Lab at the Faculty of Engineering and Architecture. Fatty acid composition of the crude oil of Balci seed was determined in Medical and Aromatic Plants Lab at Field Plants Department of Faculty of Agriculture, Selcuk University.

3. Results and Discussion

The fatty acid composition of the Balci seed used in the study is given in Table 1.

Table 1. Fatty acid compositions of Balci seed crude oil

Fatty Acids	wt%	[12]
Myristic (C14:0)	0.07	nv
Palmitic (C16:0)	6.19	6.44
Palmitoleic (C16:1)	0.09	0.10
Heptadecanpic (C17:0)	-	0.03
Heptadecanoic (C17:1)	-	0.04
Stearic (C18:0)	1.92	2.26
Oleic(C18:1)	15.33	13.25
Linoleic (C18:2)	75.83	76.80
Linolenic (C18:3)	0.10	0.07
Arachidic (C20:0)	0.22	0.31
Eicosenoic (C20:1)	0.20	-
Tricosenoic (C23:0)	-	0.05
Lignoseric (C24:0)	-	0.06

As a result of fatty acid analysis, it was determined that Balci seed oil was composed of 8.40% saturated and 91.60% unsaturated fatty acids. Among unsaturated fatty acids, linoleic acid was predominant with 75.83%,

which is followed by oleic acid with 15.33%. Among saturated fatty acids, palmitic acid had the highest rate with 6.19%. The monounsaturated rate in this oil was 15.62%, polyunsaturated rate was determined to be 75.93%. Molecular weight of crude oil of Balci seed was calculated to be 875.975 g/mole by using fatty acid composition. Table 2 presents fuel characteristics of Balci seed oil and biodiesel fuel.

In this study which was carried out using Balci variety of safflower which is a variety registered in Turkey and grown in the climate conditions of province of Yozgat, 29.2% of oil was obtained. The high amount of oil in this variety is of great importance in terms of economy. It was found that density crude oil in Balci variety was 924.82 kg/m^3, pH was 5, copper strip corrosion value was 1a and water content was found to be 955.18 mg/kg. In their study on Balci seed oil, Ogut et al., (2012) determined its density to be 930 kg/m^3 and its kinematic viscosity value to be 30 mm^2/s.

As a result of the analysis of the biodiesel from Balci seed crude oil, its density was found to be 886.31 kg/m^3, pH was found to be 6, the flash point was 176^{o}C, copper strip corrosion was 1a, water content was 438.08 mg/kg, heating value was 38.612 MJ/kg, clouding, viscosity and freezing points were -5.1^{o}C, -13.4^{o}C and -15.2^{o}C, respectively. Ogut et al.,(2012) determined its density as 860 kg/m^3, kinematic viscosity value as 4.8 mm^2/s, pH value as 6, flash point as 260^{o}C, copper strip corrosion value as 1a, water content as 167.16 mg/kg and heating value as 40.09 MJ/kg, and cloud, pour and freezing points as -9.5^{o}C, -12^{o}C and -16^{o}C, respectively and they determined cold filter blockage point to be -8^{o}C and acid value to be 0.067 mgKOH/g.

As a result, it was seen that the biodiesel produced from crude seed oil of Balci safflower was within the limiting values specified in TS EN 14214. It was concluded that safflower is suitable for biodiesel production as its oil rate is high and adequate in terms of oleic acid.

Table 2. Fuel properties of biodiesel produced from Balci seed crude oil

Property	BS	BSCO	BSCOB	TS EN 14214	
				Min.	Max.
Density at 15^{o}C, kg/m^3		924.82	886.31	0.860	0.900
pH		5	6		
Flash Point, ^{o}C		215	176	101	
Copper Strip Corrosion, (3 h, 50^{o}C)		1a	1a		1
Water Content, (mg/kg)		955.18	438. 08		500
Calorific Value, (MJ/kg)			38.612		
Cloud Point, ^{o}C			-5.1		
Pour Point, ^{o}C			-13.4		
Freezing Point, ^{o}C			-15.2		
CFPP, ^{o}C			-8.1*		
Seed Oil Content, (%)	29.2				
Seed Moisture Content, (%)	5.3				

*Calculated.

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4. References

[1] Emongor, V., Oagile, O. and Kedikanetswe, B., "Effects of Plant Population on Growth, Development and Oil Yield of Safflower", Journal of Agricultural Science and Technology B 3, 321-333, 2013. ISSN 1939-1250

[2] Cosge, B., Gurbuz, B. and Kıralan, M., "Oil Content and Fatty Acid Composition of Some Safflower (*Carthamus tinctorus* L.) Varieties Sown

In Spring and Winter", International Journal of Natural and Engineering Sciences, 1(3):11-16, 2007.

[3] Dajue, L. and Mundel, H. H., "Safflower, *Carthamus tinctorus* L. Promoting the Conservation and Use of Underutilized and Neglected Crops", 7th Institue of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome, Italy, 1996. ISBN 92-9043-297-7

[4] Corleto, A., Alba, E., Polignano, G.B. and Vonghia, G., "Safflower: A Multipurpose Species with Unexploited Potential and World Adaptibility", The research In Italy, IVth International Safflower Conference, Bari-Italy, 2-7 June, 23-311, 1997.

[5] Cosge, B. and Kaya, D., "Performance of Some Safflower (*Carthamus tinctorus* L.) Varieties Sown In Late-autumn and Late-spring", Suleyman Demirel University, Journal of Natural and Applied Sciences, 12(1):13-18, 2008.

[6] Metcalfe, D. S. and Elkins, D. M., "Crop Production Principles and Practeses", Mac. Millan Pub. Co. Inc, New York, 1980.

[7] Arslan, B., Altuner, F. and Tuncturk, M., "The Research on Yield and Yield Properties of Some Safflower (*Carthamus tinctorius* L.) Varieties Grown in Van", Turkey 5. Field Crops Congress, Diyarbakır, 13-17 October, 468-472, 2003.

[8] Weiss, E.A., "Safflower In: Oilseed Crops", Blackwell Sci. Ltd., Victoria, Australia, pp.606, 2000.

[9] Karakaya, A., Basalma, D. and Uranbey, S., "Response of Safflower (*Carthamus tinctorus* L.) Genotypes to Rust Disease", Journal of Agricultural Sciences. 10(1):93-95.

[10] Bosnjakovic, M., "Biodiesel from Algae", Journal of Mechanics Engineering and Automation 3, 179-188, 2013.

[11] Ozcelik, A. E. and Ogut, H., "Determination of the Effects of Safflower Biodiesel and Its Blends with Diesel Fuel on Lubricating Oil in a Single Cylinder Diesel Engine", Journal of Environmental Science and Engineering A 1, 1338-1345, 2012.

[12] Ogut, H., Oguz, H., Bacak, S., Menges, H. O., Kose, A. and Eryilmaz, T., "Investigation of the Characteristics from Balci Species of Safflower", Journal of Agricultural Machinery Science, 8(3):297-300, 2012.