

Investigation of the Characteristics of Biodiesel from Balci Species of Safflower

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Abstract: Safflower whose genetic origin is Anatolia was forgotten in time; however, it started to attract attention again as a raw material supply when biodiesel was started to be used in Turkey. Thus, its production has increased. The species like Yenice, Dinçer Remzibey 05 were cultivated. In addition to these three species, Balci safflower species was cultivated and introduced to public. In this study, Balci safflower which is a new species was obtained from Anatolian Agricultural Research Institute and oil was extracted from this safflower and biodiesel was produced from this oil. Oil acid components and some fuel characteristics of the biodiesel produced were examined.

Key words: Safflower, Balci species of safflower, Biodiesel

INTRODUCTION

Safflower is 80 to 100 cm tall with yellow, red, orange or white flowers. It is an annual oil plant which has spinal or non-spinal forms that can grow in 130 to 150 days. This summer characteristic plant has seeds that have 30 to 45% oil (Öğüt et al., 2007)

Safflower which is tolerant to dryness and cold compared to other summer plants is a significant plant to fill plant oil deficit in our country as it can enter rotation especially in arid agricultural lands (Kolsarıcı et al., 2007).

The most apparent characteristic of safflower oil is that saturated fat acid rate is low and the rate of unsaturated fat acids are high. As there is very little if any linoleic acid in oil acid compositions, its color is not dark. Because of its colorlessness, it is consumed as margarine, mayonnaise and salad oil. Safflower oil which is in semi-drying oils is also used in paint, polish, varnish and soap production (Öğüt and Oğuz 2006).

Safflower (*Carthamus tinctorius* L.) which is a member of *Compositae* family is cultivated in 1.121.212 ha of land all over the world. It is cultivated mostly in India in an area of 700.000 ha with 400.000 tons of yield which accounts for 70% of world safflower production. India is followed by the US, Mexico and China (Katmer et al. 2005).

As Ministry of Agriculture and Rural Affairs determined subsidy premium to be 0,23 Turkish Lira for sunflower, 0,275 Turkish Lira for canola and 0,30 Turkish Lira for safflower, farmers in Thrace Region, Central Anatolia and passage regions inclined towards safflower. As a matter of fact, as wheat and canola production cultivation has become more lucrative, sunflower cultivation area in Thrace decreased by 5% in 2009. With subsidies, cultivation area of canola and safflower increased. In Table 1, the cultivation areas and production values of the oily seed plants are given.

In spite of high oil quality of safflower, it could not have its deserved place in our country and in the world. The basic reason behind this is that oil rates of the plants developed and cultivated in Turkey have oil rates of 30 to 32 % and this plant has not yet been introduced to Turkish farmers adequately. However, when safflower was started to be subsidized in 2006, its importance rose in the following years with the development of species with higher oil rate. Recently, there has been significant increase in safflower cultivation area and production. Over the last 20 years, the cultivation area of safflower has increased 145 times to 215.237 thousands decares in 2009 and its production increased 160 times to 20.076 tonnes.

Up to recent times, there were 3 species of safflower in our country. 2 of them (Yenice and Dinçer) were registered till 1983 and 1 was registered in 2005. The hat which was previously produced under the name of 5-154 was registered as Remzibey-05 in 2005. These

species were developed by Anatolian Agricultural Research Institute (Babaoğlu 2005). The comparison of the safflower species cultivated in Turkey is given in Table 2.

Table 1. Cultivation area and production values of oily seed plants in Turkey (Uyanık and Kara 2011)

Crop		1990	1995	2000	2005	2007	2009
Sunflower	Cultivation Area (da)	7.1600.000	5.850.000	5.420.000	5.660.000	5.546.778	5.840.000
	Production (Tonne)	860.000	900.000	800.000	975.000	854.407	1.057.125
Soybean	Cultivation Area (da)	740.000	310.000	150.000	86.000	86.747	105.210
	Production (Tonne)	162.000	75.000	44.500	29.000	30.666	38.442
Cotton seed	Cultivation Area (da)	6.412.230	7.566.940	6.541.770	5.468.800	5.302.528	4.200.000
	Production (Tonne)	1.047.360	1.287.527	1.295.066	1.291.180	1.320.831	1.021.200
Rape	Cultivation Area (da)	20.170	70	820	7.000	106.830	327.767
	Production (Tonne)	2.100	9	187	1.200	28.727	113.886
Sesame	Cultivation Area (da)	850.000	730.000	509.000	424.500	297.807	280.916
	Production (Tonne)	39.000	30.000	23.800	26.000	20.010	21.036
Peanut	Cultivation Area (da)	240.000	290.000	283.000	258.500	259.423	253.345
	Production (Tonne)	63.000	70.000	78.000	85.000	86.409	90.081
Safflower	Cultivation Area (da)	1.460	1.340	300	1.730	16.941	215.237
	Production (Tonne)	124	125	18	215	2.280	20.076
Total	Cultivation Area (da)	15.423.860	14.748.350	12.904.890	11.906.530	11.526.714	11.222.475
	Production (Tonne)	2.173.584	2.362.661	2.241.571	2.407.595	2.343.330	2.361.846

Table 2. Comparison of safflower species cultivated in Turkey

Safflower Species	Barbed	Flowers Color	Plant length (cm)	Seed color	Oil rate (%)	1000 weight (g)
Yenice	Barbless	Red	100-120	White	24-25	38-40
Dinçer	Barbless	Orange	90-110	White	25-28	45-49
Remzibey 05	Barbed	Yellow	60-80	White	35-40	46-50
Balci	Barbed	Yellow	55-70	Cream	38-40	40-48



Figure 1. Screwed Press

In this context, Balcı spinal safflower species which is superior to available to species in terms of oil rate and which endures arid climate was developed in Anatolian Agricultural Research Institute and was publicized in a press meeting in May 2011. With the addition of Balcı species, the number of species cultivated in Turkey raised up to four.

MATERIALS and METHOD

In this study, Balcı species safflower was obtained from Anatolian Agricultural Research Institute and its oil was extracted in the press in Bio-fuel laboratory in Faculty Agriculture in Selçuk University and then biodiesel was produced in the same laboratory. The press used in oil extraction is shown in Figure 1.

CHARACTERISTICS of BALCI SAFFLOWER

Year of Registration: 2011

Method of Development: Selection

Morphological characteristics

- Plant length 55-70 cm
- Yellow flowers and spines
- Seed color: cream

Agricultural Characteristics

- Moderately Early Plant
- Summer
- Endures arid climate and its yield under these conditions varies between 120-240 kg/da.

Quality Features

1000 weight is between 40 and 48 g, internal rate of 57-59%, oil rate ranges between 38 and 40%. It is superior in terms of these characteristics.

Regions Recommended For Cultivation:

It is recommended for arid and semi-arid areas in Central Anatolia and Passage regions.

Oil acid components of Balcı Safflower oil

Oil acid components of Balcı safflower were analyzed in Examination and Analysis Laboratory in Bursa Food Control and Research Institute. The

components of Balcı safflower oil acid components are given in Table 3.

Table 3. Components of Balcı Safflower Oil Acid

Oil Acid		%
Myristic acid	C 14:0	nv
Palmitic	C 16:0	6,44
Palmitoleic acid	C 16:1	0,10
Heptadecanpic acid	C 17:0	0,03
Heptadecanoic acid	C 17:1	0,04
Stearic acid	C 18:0	2,26
Oleic acid	C 18:1	13,25
Linoleic acid	C 18:2	76,80
Linolenic acid	C 18:3	0,07
Arachidic acid	C 20:0	0,31
Erusic acid	C 22:1	-
Trikosenoic acid	C 23:0	0,05
Lignoseriic acid	C 24:0	0,06

As it is shown in Table 2, unsaturated oil acid rate of Balcı safflower is 96% and oleic acid rate is 13,25%, linoleic acid rate is 76,80%. Some characteristics of biodiesel depend on the raw material it is produced from. Oil acids used in biodiesel can be produced from saturated, single and multiple unsaturated oil acids. It is preferable that oil from which biodiesel will be produced is to have high single unsaturated rate (Öğüt and Oğuz 2006).

Biodiesel from Balcı safflower was produced in laboratory at Department of Agricultural Machines at Agriculture Faculty, Selçuk University. This laboratory was established as a part of DPT project 2004/7. In the production, methyl alcohol was used and NaOH was used as catalyzer. Transesterification was used as production method.

Table 4. The relation between Oil Characteristics and Biodiesel Characteristics (Öğüt and Oğuz 2006)

	Saturated	Single Unsaturated	Poly Unsaturated
Fatty acid	12:0, 14:0, 16:0, 18:0, 20:0, 22:0	16:1, 18:1, 20:1, 22:1	18:2, 18:3
Cetane Number	High	Middle	Low
Cloud point	High	Middle	Low
Stability	High	Middle	Low
NO _x	Decrease	Easy increase	extremely increase

Table 5. Fuel characteristics of biodiesel produced from Balci safflower

	Safflower Oil of Balci Species	Biodiesel of Balci Species Safflower	TS EN 14214	
			Min	Max
Density, kg/m ³ at 15 °C	930	860	860	900
Kinematic Viscosity, mm ² /s at 40 °C	30	4,88	3,50	5,00
pH		6		
Cloud Point, °C		-9,5		
Pour Point, °C		-12		
Freezing Point, °C		-16		
Copper Strip Corrosion (3 hours at 50 °C)		1a		1
Flash Point, °C		260	101	-
Cold Filter Plugging Point (CFPP) (°C)		-8		
Water content mg/kg		167,16	-	500
Acid Value, mg KOH/g		0,067		
Calorific value MJ/kg		40,9		
Color		2,1		

The devices in laboratory at Department of Agricultural Machines at Agriculture Faculty, Selçuk University were used in the analyses of the oil and the biodiesel from this oil. The characteristics of oil and fuel characteristics biodiesel from this oil are given in Table 5.

Among factors determining quality biodiesel ester content, density, flash point, sulphur content, cetane number, esterification reaction completion, free glycerol, alcohol and catalyzer residual, viscosity, iodine number, acid value, water content, oxidation stability and storage condition can be listed.

RESULTS and DISCUSSION

Oil rates of the Dınçer and Remzibey 05 safflowers cultivated in Turkey are not above 30%; therefore, more than 40% oil rate of Balci safflower is significant for economy.

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The cultivation area and climate conditions of the oil seeds cultivated are limited. Safflower is one of the oil plants which have a great potential for filling herbal oil deficit and harnessing uncultivated arid areas in our country.

In biodiesel produced from Balci safflower, density was measured to be 860 kg/m³, Copper strip corrosion was 1a, Flash point was 260 °C, Cold filter plugging point was -8 °C, water content was 167,16 mg/kg, Acid number was 0,067 mg KOH/g. The fuel characteristics of biodiesel produced from Balci safflower were found to be within limit values specified in TS EN 14214 standards.

As a result, Balci safflower is an ideal raw material for biodiesel as it has high oil yield and oil acids suitable for biodiesel production.

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