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Safflower and biodiesel quality in Turkey

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Abstract

Oilseed crops have always been an important segment in Turkey agriculture**.** Totally a 2.5 mil MT oilseed crop is produced annually. Major oilseed crops are sunflower and cottonseed, account for over 95 % of local production. It also produces groundnut, soybean, sesame, linseed and recently started rapeseed and safflower. Production of safflower in Turkey is going to increase in the years ahead. Bio-fuels project is one of the most important opportunities for improvement.. In the case of production increase, safflower seems most likely for drought lands.

Key Words: Safflower – biodiesel – quality - Turkey

Introductıon

Safflower (*Carthamus tinctorius* L.) is an annual oilseed crop. The origins of this plant are some herbalists suggest the basin of the **Euphrates River** in Anatolia. In fact, it is believed that safflower has its origin in Euroasia, including Turkey and the neighboring countries (Esendal 2001).

Safflower is one of humanity's oldest crops, but generally it has been grown on small plots for the grower's personel use, and it remains a minor crop with world seed production**.** Over 60 countries grow safflower, but over half is produced in India. The important safflower growing countries, besides India, are the USA, Mexico, Ethopia, Spain, the USSR and Australia. China has a significant area planted to safflower, but the florets are harvested for use in traditional medicines and the crop is not reported internationally (Dajue and Mündel 1996).

The seed oil content of safflower ranges from 30-45 % percent. Its oil is used by both food producers and by industry. High linoleic safflower oil is used in human nutrition, but in recent years market demand has drastically shifted from the traditional high linoleic oils to high oleic oil. High linoleic oil is valued as a drying agent in paints and varnishes because of its non-yellowing characteristic. High oleic safflower oil is lower in saturates and higher in monounsaturated than olive oil (Berglung et al. 2007).

High oleic safflower oil has promise as a pollutant-reducing diesel fuel additive to reduce smoke and particulate emissions. High oleic safflower oil as a diesel fuel additive would also reduce acid rain, the greenhouse effect, and surface pollution because safflower oil is virtually free of sulfur, totally lacks fossil carbon dioxide, and is biodegradable (Bergman and Flynn 2001).

Safflower seed is also marketed as birdseed. It is however spineless varieties use as a dry-cut and colored flowers for decoration in Turkey. Its fresh flowers are beneficial for quality honey production.

Turkey oılseed ındustry

Turkey has a population of almost 70 million and an area of 77 million ha. It currently makes use, for all types of agricultural production, of approximately 33.1 % of (27 million ha) its cultivated land, but every year about 22 mil ha of it used as agriculture production. Because of drought and unfertile soil problems the remainder of it is fallowed such as parts of the Central and South East Anatolia. Main field crops are cereals, sugar beet, potatoes, pulses and maize. Approximately 7 % of (1.5 mil. ha) total area is used for oilseed crops. A significant portion of the remaining land, that is approximately about 3.5 million hectares (except fallowed land), is considered to be suitable for crop plantation which can be used for oilseed crops instead cereals.

Oilseed crops have always been an important segment in Turkey agriculture**.** Totally 2.5 mil MT oilseed crop is produced annually. Sunflower (800-900 000 MT) and cottonseed (1.3-1.4 mil. MT) the major oilseed crops, account for over 95 % of local production. It also produces groundnut, soybean, sesame, linseed and recently started rapeseed and safflower. Mainly cotton is produced for textile industry and cotton seed used for edible oil for internal use. In the last decade, total production of oilseed crops has increased, but the per capita availability and consumption has declined due to high population pressure.

Turkey has a major deficit in oil seed production to meet its current needs; only 35-40 % of oil seed needs are met by crops grown in Turkey. Every year it produces 0.60 million ton of edible oil compared to the consumption of 1.50 million ton. Imports in crude oil and oilseed and its cost has increased especially in last 5 years. The country has to import oils and oilseeds, at a cost of $852 mil. in 2003 and expanding to $1.75 billion in 2007 (Akınerdem and Öztürk 2007).

Turkey's oilseed industry is dynamic, complex and the capacity is about 4.5 million ton crude oil processing. New uses of canola and safflower such as bio-energy, will also provide opportunities for the oil industry to grow and excel. Turkey is also exporting refined sunflower and olive and meal olive. On the other hand production of meal olive is the first in world.

Safflower ın Turkey

It is believed that cultivated safflower was first introduced into Turkey from Western Part in the 1930's by Turkish imigrants (Dinçer 1964). Commercial production attempts were made to adapt safflower slowly in the 1945-1950's. During the period 1972 to 1977 attempts were made to adapt safflower to commercial production, but varieties available then were too low in oil.

Very limited research has been done on safflower in Turkey, because of its small acreage and lesser economic importance (Esendal 2001). In order to reduce deficiency in oil production, oilseed crop production areas and oil yield should be increased or alternative oil crops should be introduced. Safflower (Turkish: Aspir) have a potential to meet much of Turkey's oil demand. Regarding growth conditions, safflower is not selective and is more tolerant to drought and low temperatures than other oil crops. In particular, in arid conditions, it can be planted in fallow areas. It is mostly grown on arable dryland following cereals or lentils, chickpea and tobacco. Therefore, safflower has a great potential for arid areas of Turkey (mainly in Central and South Eastern Anatolia).

Since it is resistant to drought, it could be grown successfully on dry lands of Central Anatolia and transition region between western and central Anatolia surrounding regions which have insufficient precipitation such as Ankara, Eskişehir and Konya provinces. Safflower is even less known than canola farming but looks like a worthy product to pursue. In addition, safflower will gain importance in biodiesel production in Turkey. Its cultivation is much easier and cost of production is lower than wheat, sunflower and rapeseed.

Total production of safflower was 1600 tones in 1976 which had decreased to 20 tons in 2000's in Turkey. Acreage has varied from nearly 1,000 to 7,000 ha. Acreage and yield trends of safflower over the last 50 years are depicted in Table 1.

Table 1. Turkey's Safflower Production[1]

Years	Area sown (ha)	Producted (tons)	Yield (kg ha^{-1})
1950	1 073	765	712
1970	1 170	900	769
1990	146	124	849
2000	30	18	600
2004	165	150	909
2007	4 000	4 000	1 000
2008*	7 000		-

[1] Turkish Agricultural Ministry, * Approx

Safflower cultivation is possible in winter and spring in Turkey. Winter cultivation is Western and Southern of Anatolia, but spring or early-spring in Central and Eastern Anatolia depending on climatic condition. For best results on Central Anatolia, seed must be planted before April. In the Southern Anatolia, planting may take place from September through mid-November, and in the

Western part in late February and early March. In other areas and in years with low soil moisture, late March and early April are usually the best planting times. Average safflower yield performance from different sowing dates and row spacings at Konya premises was shown in Table 2. As shown in Table 2, in the late sowings and wider intra-row spacings, yield was affected negatively. This research indicated that delays in sowing from mid- March to early April could result in lower seed yield.

Table 2. Average safflower yield (kg $ha^{-1)}$ performance from different sowing dates and row spacings at Konya premises

Sowing date	**Row spacing (cm)**				
	30	40	50	60	Mean
March 15	1320.7	1074.0	655.3	925.6	**994.3**
March 30	1060.7	787.5	871.9	837.4	889.6
April 10	683.1	695.3	584.2	609.8	642.8
Mean	1021.0	852.6	792.6	702.8	842.2

Öztürk et al. 2000

In Turkey, three registered safflower varieties, **Dinçer, Yenice and Remzibey,** were used. All varieties have become adapted well to dry land conditions of Central Anatolia (Coşge et al. 2007). These are released local varieties and their characteristics are given as follows:

Dinçer: Spineless, orange flowered, mid-late, medium tall, high yield and seed oil content (32 %).

Yenice: Spineless, orange flowered, late maturing, tall, low yield and seed oil (30 %).

Remzibey: Spine, yellow flowered, mid-late, short tall, high yield and seed oil (35 %).

Biodiesel and safflower

Vegetable oil, is the main raw material used in producing biodiesel. 70 % of biodiesel is produced from imported palm oil or its derivatives, although the best oilseeds for biodiesel production in Turkey are safflower and rapeseed. Because Turkey's own energy supply is insufficient, we are trying to develop new energy sources like biofuels. In spite of the oil supply deficiency, biodiesel project will be benefitical for Turkey to produce oilseed crops in the near future. This may be a compulsory idea, but it is good for the Turkish oil and biofuel industry. On the other hand, importation of crude oil and oilseed as a raw material for oil industry is getting more difficult from neighbouring countries. Technological improvement in those countries is required to sell (export) processed (refined) oil. It is hoped that this idea will coming true in ten years. This state is a big change and opportunity to put in to place of safflower production in Turkey.

Table 3. Characteristics of biodiesel derived from safflower *

PROPERTIES	DİNÇER		REMZİBEY		MOTORIN
	crude oil	biodiesel	crude oil	biodiesel	
Seed oil content (%)	20.23		21.98		
Density (kg m^{-3} at 15 ^{0}C	924	897	923	896	838.8
Kinematic-viscosity (mm^2s^{-1})at 40 ^{0}C	30.19	6.09	32.15	5.97	2.83
pH	5	7	5	7.5	5
Cloud point (^{0}C)		-7		-8	-8
Pour point (^{0}C)		-13		-14	-18
Freezing-point (^{0}C)		-16		-16.5	-20
Corrosion degree		1a		1a	1a
Flashpoint (^{0}C)		121		133	68
Cold-filter plugging point (CFPP) (^{0}C)		-9		-10	-10
H_2O content (mg kg^{-1})	829.34	274.5	1249	288	23
Iodine number (g iodine 100 g^{-1})		128.3		117.9	
Acid number (mg KOH/g)		0.067		0.052	
Caloric value (cal g^{-1})		9332		9167	

*Öğüt et al, 2007.

Farmers in Turkey don't produce safflower in a large scale because it does not have any market guarantee and subvention of the goverment up to now. Recently, the Turkish Government has supported biodiesel production and oilseed farmers to produce oilseed crops by supplying market premium, distribution of quality seed, and obtaining and providing technical information and assistance. Biodiesel properties from Dinçer and Remzibey safflower varieties was given Table 3.

Except Iodine number (according to Turkish biodiesel standards up to 120 iodine number accepted), other amounts are suitable to Turkish biodiesel standards. Analysis amounts stated above were analysed at Selçuk University Bio-fuels laboratories.

Summary

We can say that, studies about bio-fuels in Turkey started intensively in early 2000's. In these years, agriculture undertook the duty to guarantee the energy security as a second duty excluding to guarantee the food security.

In these years, Turkey's potential of producing raw material for food and energy sector. So that, high rates VAT in bioediesel produced from unrefined imported oil and no taxing in the case of using domestic raw material will be increased oilseed crops.

Applying highly supporting policies to farmers, caused a serious demand through domestic raw material production. As a result of the biodiesel programme and because of some advantages of safflower, production must be raised in Turkey.

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