Comparative study of four safflower oils (Carthamus tinctorius) varieties grown in eastern of Morocco

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Introduction

Safflower (*Carthamus tinctorius*) is an oilseed crop, which, for many years, has been grown on a relatively small scale in parts of North Africa and Middle East (Purdy and al., 1959). Safflower is a tap-rooted annual crop which can tolerate environmental stresses including salinity and water stress (Lovelli and al., 2007). Therefore it has a good yield potential in Morocco's semiarid areas where research work, particularly breeding, started early in the 60's (Nabloussi and Boujghagh, 2006). Safflower was originally grown for the flowers that were used in making red and yellow dyes for clothing and food preparation. In recent years, considerable attention has been generated in the consumption and development of safflower seed oil as an excellent health care product and health benefits derived from it include prevention and treatment of hyperlipaemia, arteriosclerosis, coronary heart disease (Han and al., 2009).

The aim of this present work is to complete our precedent investigation laboratory by characterization of safflower seeds produced in North Eastern of Morroco (Zraibi and al., 2012). The objective is to determine the chemical composition of four safflower seeds varieties cultivated in this region. Parameters like quality (acidity index, peroxide value) fatty acid, triacylglycerols and phenols composition of their lipid fraction are compared.

Material and Methods

- ✓ Plant material : four *Carthamus tinctorius* varieties (pure lines) from different origins: '*Cartafri*' and '*Cartamar*' (Morocco), 'Rancho' (Spain) and '*Sharda*' (India). Seeds of all these varieties were kindly provided by the National Institute for Agricultural Research (CRRAM), Regional Research Center of Meknes (Morocco).
- ✓ Lipid extraction : After rinsing the seeds with distilled water, the lipids were extracted by the soxhlet method.
- ✓ Chemical analysis
  - Fat content : (AOCS Ag 1-65; AOCS, 1993).
  - Titrable acidity : (ISO 660:2009)
  - Peroxide value : (ISO 3960:2007)
  - Colorimetric determination of total phenols : (Ollivier and al.2004)
- ✓ Fatty acid composition analysis : Analyzed by a HP 6890 series GC System chromatograph, equipped with an FID detector.
- ✓ HPLC analysis of triacylglycerols: The chromatographic system consisted of Shimadzu model LC-6AD, CBM 20A controller and refractive index detector RID 10A

Results

Table 1. Physicochemical quality of safflower oils samples.

Physicochemical parameters	Varieties			
	Rancho	*Cartamar*	*Cartafri*	*Sharda*
Fat content (%)	35,38	28,84	31,54	30,48
Free Acidity (% of Linoleic acid)	0,70±0,03^{b}	0,63±0,05^{a}	0,67±0,04^{ab}	0,70±0,02^{b}
Peroxide value (meq O_2/Kg)	31,21±1,41^{c}	4,58±1,04^{a}	15,64±1,59^{ab}	15,81±3,73^{ab}
Total phenolic compounds (mg/Kg)	143,64±27,92^{b}	125,78±5,28^{ab}	118,14±15,76^{ab}	97,47±15,87^{a}

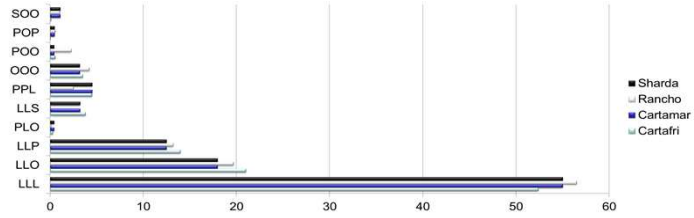
Values are the means of the four different safflower oils samples (n=3) ± standard deviations. Significant differences in the same row are shown by different letters (a–c) varieties (P<0.05).

Table 2. Fatty acid composition (% GC area) of safflower oils.

Fatty acid	*Rancho*	*Cartamar*	*Cartafri*	*Sharda*
C14 :0	0,12 ± 0,01	0,13 ± 0,02	0,16 ± 0,02	0,15 ± 0,04
C15 :0	ND	0,07 ± 0,03	ND	ND
C15 :1	ND	0,44 ± 0,07	ND	ND
C16 :0	7,36 ± 0,54	7,20 ± 0,73	8,60 ± 0,64	8,12 ± 1,26
C16 :1	0,08 ± 0,01	0,09 ± 0,01	ND	0,10 ± 0,02
C17 :1	ND	ND	ND	ND
C18 :0	2,19 ± 0,01	2,39 ± 0,13	2,00 ± 0,20	2,15 ± 0,08
C18 :1	10,63 ± 0,13	11,29 ±0,19	10,61 ± 0,43	9,50 ± 0,53
C18 :2	79,49 ± 0,67	77,94 ±0,47	78,62 ± 0,03	79,98 ± 1,77
C18 :3	ND	0,09 ± 0,00	ND	ND
C20 :0	ND	0,19 ± 0,06	ND	ND
C20 :1	ND	ND	ND	ND
C22 :0	ND	0,16 ± 0,06	ND	ND
ΣSFAs	9,67	10,14	10,76	10,42
ΣMUFAs	10,71	11,82	10,61	9,60
ΣPUFAs	79,49	77,94	78,62	79,98

Values are the means of the four different safflower oils samples (n=2) ± standard deviations. SFA, saturated fatty acid; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid. C16:0, palmitic acid; C16:1, palmitoleic acid; C17:0, margaric acid; C17:1, margaroleic acid; C18:0, stearic acid; C18:1, oleic acid; C18:2, linoleic acid; C18:3, linolenic acid; C20:0, arachidic acid and C20:1, gadoleic acid. C22:0, behenic acid.

Fig 1. Relative percentages of the main molecular species of triacylglycerol of different samples



Discussion

Safflower seeds oil content of the four varieties ranged from 28,84 g/100g (Cartamar) to 35,38 g/100g (Rancho). The observed values for oil contents were close to those reported by (Gecgel and al, 2007; Ashrafi and Razmjoo 2010)

According to varieties, significant differences in peroxide and free fatty acid values were found ($p<0.05$). The comparison of the free acidity and peroxide values of the four oil varieties shows that Rancho oil presents the higher free acidity and peroxide values wile Cartamar presents the most lowers values.

The level of total phenolic compounds in the four varieties studied were showed to be highly in Rancho with 143.65 ppm, Cartamar with 125.78 ppm followed by Cartafri 118.15 ppm and Sharda with 97.46 ppm, the observed value of total phenolic compound were close to those reported by Mailer (2008). Significant difference in the values of total phenols according to varieties were found ($p<0.05$).

We note a clear predominance of unsaturated fatty acids compared to saturated fatty acids. For safflower oils analyzed total based on fatty acids, the proportion of saturated fatty acids (SFA) slightly varies between 10.76% and 9.67%, the unsaturated fatty acids (UFA) varies between 90.2% and 89.23%.

Analysis of molecular species of triacylglycerols by HPLC/IR (Fig.1) allow to distinguishe essentially ten molecular species TAG (LLL, LPL, LLO, PLO, LLS, POP, OOO, POO, SOO, PPL). For the four varieties studied, there are three major species which represent more than 80% of total TAG of all varieties.

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Conclusion

The present study shows that the four safflower varieties cultivated in eastern of morocco could be a good source of oil rich in linoleic and phenolic acid. The varietal differences are not significant regard to the fatty acid and triglycerides molecular species. But we can note that Rancho cultivar presents the most amount of LLL, hight amount of insaturated fatty acids, free fatty acids (Acid value), peroxide value (PI), and phenolic content. The hight value of IP could be result of degradation of insaturated fatty acids which is promoted by high phenolic contents. Phenols could act as prooxydants (Aruoma and al, 1993; Kobayashi and al., 2004.) if some conditions are combined, in this case high temperature during oil extraction (soxhlet) and high phenolic and unsaturated fatty acids content.

The hight linoleic acid and phenolic acid contents make safflower oil nutritionally valuable and usable as cooking oil in eastern Morocco where only source of oil is olive which the price is high and can not satisfy the needs in oils area.

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