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Extraction methods of seed oil and oil quality of *Pistacia atlantica* grown in dry land

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Abstract. Wild natural species could offer an important issue for the sustainable development and environmental protection. *Pistacia atlantica* is an interesting wild species wide spreading in arid land in Tunisia. Recent works focused on the use of this species as rootstock for pistachio cultivation and the investigation of oil quality of seeds. This study aims to evaluate three methods of oil extraction from *Pistacia atlantica* seeds. Seed oil was extracted by pressing, supercritical CO_2 and organic solvent and respective oil qualities were determined. Results showed that the supercritical CO_2 method is the most efficient with an extraction rate of 25% compared to extraction by pressing (5.3%) or by solvent (7.9%). The extracted oil was rich in unsaturated fatty acids with similar acid composition between the three extraction methods. However, the supercritical CO_2 method produced better oil quality with higher antioxidant activity and polyphenols and tocopherols contents.

Keywords. *Pistacia atlantica* – Seed oil – Extraction methods – Characterisation.

Méthodes d'extraction et qualité d'huile du* Pistacia atlantica *planté en région aride

Résumé. *Les espèces naturelles sauvages pourraient contribuer au développement durable et à la protection de l'environnement.* Pistacia atlantica *est une espèce sauvage largement répandue dans les régions arides de Tunisie. Des travaux récents ont porté sur l'utilisation de cette espèce comme porte-greffe et l'investigation de la qualité de l'huile extraite des graines. Cette étude vise à évaluer trois méthodes d'extraction d'huile de graines de* P. atlantica. *Il s'agit de l'extraction par pression, par CO_2 supercritique et par solvant organique. La qualité des huiles respectives a été déterminée. Les résultats obtenus ont révélé que le procédé au CO_2 supercritique était le plus efficace avec un taux d'extraction de 25% par rapport à l'extraction par pression (5,3%) ou par solvant (7,9%). L'huile extraite a été riche en acides gras non saturés mais avec une composition en acides similaire entre les trois méthodes d'extraction. Toutefois, le procédé au CO_2 supercritique a produit une meilleure qualité d'huile ayant une activité anti-oxydante élevée et une plus grande richesse en poly-phénols et en tocophérols.*

Mots-clés. Pistacia atlantica – *Huile de graine – Méthodes d'extraction – Caractérisation.*

I – Introduction

Three *Pistacia* species are widely spread in the Mediterranean region. *Pistacia atlantica* is the most characteristic plant species of the pre-Saharian regions in the North Africa (Benabid, 2000; Yousfi *et al*., 2002). Its seed oil has a good nutritive quality because of its content in unsaturated fatty acids and saturated fatty acids (Yousfi *et al*., 2002).

Several studies have been reported on the chemical composition of commercial pistachio species. However, few dealt with wild pistachio species. Previous works on *P. atlantica* reported the fruit composition of this species in flavonoids (Mosharrafa *et al*., 1999), fatty acids and triglycerides (Yousfi *et al*., 2005; Benhassaini *et al*., 2007; Farhoosh *et al*., 2008). Other reports focused on the chemical composition of oleoresin (Delazar *et al*., 2004), and essential oil (Barrero *et al*., 2005; Tzakou *et al*., 2007).

This study investigated the effect of the extraction method on seed oil properties of *P. atlantica* grown in arid land of Tunisia.

II – Materials and methods

Pistacia atlantica fruits were collected from Sidi Bouzid location in the center of Tunisia. The seeds of wild pistachio *(Pistacia atlantica)* were sampled in August. The seed oil was extracted using three extraction methods: cold pressing, organic solvent (hexane) and supercritical CO_2 technique. For each method, a sample of 0.5 kilograms of seeds was used.

The oil extracted by these methods was analyzed. Oil acidity, UV absorption characteristics at 232 and 270 nm (K_{232}, K_{270}), chlorophyll and carotenoid contents, total phenols, and fatty acid composition were performed in accordance to the standard method established by IUPAC (1979) and to the European Official Methods (UE 1989/2003 modifying ECC 2568/91).

A sample of 0.05g of oil was used to separate the fatty acid methyl esters (FAMEs) according to the method of Arena *et al.* (2007). FAMEs were analyzed by gas chromatography using a Shimadzu 17A chromatograph equipped with detector flame ionization and a capillary column. Total phenol contents were determined using Folin-Ciocalteu's colorimetric analysis method and were expressed as parts per million (ppm) of gallic acid.

The antioxidant activity of seeds oil of *P. atlantica* was evaluated in comparison to the 4-hydroxyanisole (BHA).

III – Results and discussion

Table 1 shows the fatty acid composition of *Pistacia atlantica* seed oils. The acidity of oil is expressed as the percentage of total free fatty acids present in the oil and gives information about the alteration level of the product. The supercritical extraction technique reduced alteration through hydrolysis reaction and gave less altered oil with lower acidity level. The main fatty acids from the studied samples were oleic, linoleic and palmitic acids. Oleic acid was the most abundant with a percentage higher than 55% followed by linoleic acid (about 28%). The main saturated fatty acids were palmitic and stearic acids. Similar acidic composition was previously reported by Givianrad et *al*. (2013) for this wild pistachio species. The acidic composition of oils extracted from *P. atlantica* was very close to that of argan oil. Extraction methods seemed to not affect acidic composition.

The colour and taste of oil are in part determined by chlorophyll pigments. These compounds are easily degraded under the action of light. Extraction by organic solvent lead to high chlorophyll content oil in comparison with the other tested methods. It may be the result of the solubility of these compounds in hexane. Moreover, seeds oil of *P. atlantica* was not enough rich with food colorants. The extraction method did not affect the oxidation state of the extracted oils as the oil absorbance at 232 and 270 nm (K_{232}, K_{270}) did not change significantly with the used technique (Table 1).

Polyphenols and tocopherols are among the most natural antioxidants present in vegetable oils in significant quantities. Few studies mentioned the analysis of phenolic compounds in *P. atlantica.* It has been shown that the Anacardiaceae family is characterized by the occurrence of both gallic acid and myricetin derivatives (Umadevi *et al*., 1988). This study revealed that the levels of tocopherols were not affected by the extraction technique, while the polyphenol content decreased significantly when organic solvent extraction was used (Table 1).

Table 1. Oil quality of *P. atlantica* extracted using three extraction methods

	Supercritical CO_2	Pressure	Hexane
Acidity (%)	1.00	3.80	4.45
C16 :0	11.58	11.42	11.16
C16 :1	0.14	0.13	0.23
C17 :0	0.03	0.04	0.04
C17 :1	0.02	0.03	0.03
C18 :0	2.27	2.39	2.42
C18 :1	55.35	56.40	56.35
C18 :2	29.63	28.50	28.74
C18 :3	0.34	0.41	0.35
C20 :0	0.13	0.15	0.14
C20 :1	0.4	0.46	0.46
Chlorophyll (ppm)	1.67	4.99	5.78
Carotenoid (ppm)	2.65	2.21	4.22
K_{232}	2.15	2.17	2.16
K_{270}	0.84	0.93	0.95
Tocopherols (ppm)	446.32	440.36	419.73
Polyphenols (ppm)	2100	1800	500

The seeds of *P. atlantica* had an antioxidant activity much higher than the BHA (results not shown). With regard to oil extraction method, supercritical CO_2 provided oils which had a greater activity than that of the antioxidant BHA. Previous works used BHA to prevent oxidative rancidity of fats (Safer and Nughamish, 1999). Several researches reported the extensive use of these additives in agro alimentary industry.

IV – Conclusions

The oil extracted from *P. atlantica* seeds had interesting physicochemical characteristics. This oil may be used in the fields of cosmetic and phytotherapy industry. Extraction with hexane greatly reduced the quality mainly the content of these oils in polyphenols and subsequently its antioxidant activity.

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