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Analytical Methods

Virgin olive oil (VOO) production in Tunisia: The commercial potential of the major olive varieties from the arid Tataouine zone

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ABSTRACT

The commercial potential of olive oils from three consecutive crop years, derived from the main autochthonous olive varieties Chemlali Tataouine, Fakhari Douirat, Zarrazi Douirat and Dhokar Douirat grown in the arid region of Tataounine (Tunisia) was examined with regards to stability and nutrition aspects. Several characteristics such as fatty acid composition, the extremely high phenol-type antioxidant content, and the low levels of green pigments suggested that these oils, the only fat source for the local people, are of promising composition. Efforts to develop commercial products from these varieties could improve antioxidant intake of the local population. The introduction of Good Manufacturing Practices is a prerequisite so that the quality observed for oils obtained by an Abencor system to be achieved also in real life. This can be feasible through appropriate oleoculture, which is often the only viable agricultural activity in remote arid regions such as Tataouine.

1. 1.Introduction

Tunisia is the northernmost African country on the Mediterranean coast (Fig. 1) and the smallest (163,600 km^2) among those situated along the Atlas mountain line. The Sahara desert occupies ~40% of Tunisian territory, while the rest largely consists of particularly fertile soil. The Mediterranean coastline (1300 km) is characterized by moderate temperatures, an important factor in agriculture.

Agriculture is one of the mainstays of the Tunisian economy, and cultivation of the olive tree constitutes one of the principal economical and agricultural sectors. Because of the plasticity of the Tunisian olive oil varieties, the olive-growing areas spread from the northern to the southern regions, where a wide range of edapho-climatic conditions prevail, from lower semi-arid to arid conditions. Thus, about 65 million trees are distributed and spread over 1.6 million hectares, representing the one-third of the cultivated area. Olive farming accounts for 57% of the active rural population and ensures 45% of the agricultural exports with an average of 120,000 T of olive oil per year (COI, 2000). Traditional oleoculture uses autochthonous varieties to produce oil exclusively. Tunisia is next to Spain, Italy and Greece in the world olive oil sector regarding the number of trees and olive oil production; Tunisia produced 144,500 T per year between 2000 and 2006 (Codex Alimenarius Commission, 2007), accounting for ~5.2% of world production and is considered to rank second one with regard to surface use.

Although Tunisia possesses substantial genetic diversity among its olive tree varieties, its oleoculture depends on only two: Chétoui in the northern regions and Chemlali in the central and southern parts. These two varieties account for 95% of the total olive tree orchards and contribute more than 90% of the national production of olive oil. Chemlali alone, covering 60% of the olive-growing surface, is spread from the northeast to the extreme south. Almost all studies on Tunisian virgin olive oil have focused on characterization and/or improvement of these two varieties (Baccouri et al., 2007; Ben Temime et al., 2006; Manaï, Haddada, Trigui, Daoud, & Zarrouk, 2007). Other studies have also examined some of the well-known secondary varieties like Chemcheli, Gerboui, Zalmati and Oueslati (Abaza, Msallem, Daoud, & Zarrouk, 2002).

As a consequence, there is a lack of information on the chemical characteristics of several minor varieties that are sustained in restricted areas in different parts of Tunisia. A good example is the case of Tataouine, a region of southern Tunisia (Fig. 1) bordering Algeria and Libya. Because of the severe pedoclimatic conditions (shallow soils, high temperature and low rainfall), the traditional diet in the region is rather simple and is based on some specific plant foods, like cereals or palm fruits, olive oil being the main fat source. For the local people, virgin olive oil is the everyday

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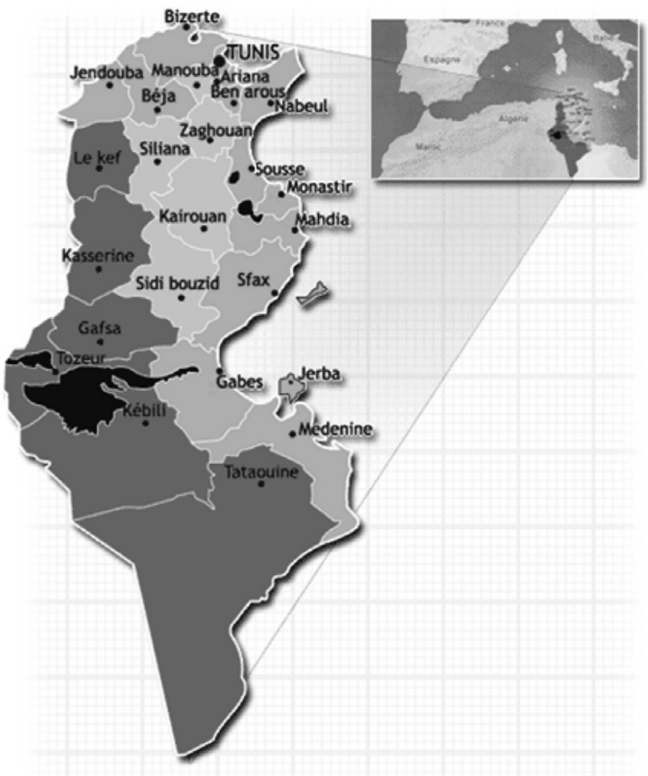

Fig. 1. Position of Tunisia in the world.

source of an array of micronutrients, especially antioxidants in the form of phenolic compounds, vitamin E and carotenes. Although Tataouine is the largest Tunisian governorate (24% of the total area), its olive oil production amounts to only ~150 T per year, corresponding to 0.15% of the total Tunisian olive oil production. Varieties of that region are still commercially unexplored, and their VOO qualities have not been fully characterized.

The present study was motivated by the fact that a rise in temperature, low rainfall and soil erosion are becoming the principal environmental problems associated with olive farming in Mediterranean regions (Tombesi, Michelakis, & Pastor, 1996) and that the genetic heritage of olive tree diversity must be protected from disappearance. Therefore this study assesses the commercial potential of the main olive varieties of the arid Tataouine zone: Chemlali Tataouine, Fakhari Douirat, Zarrazi Douirat and Dhokar Douirat (Trigui & Msallem, 2002). The ultimate objective of this work is to improve local people's diet and income and maintain them in their homelands because oleoculture not only contributes largely to these objectives but is often the only viable agricultural activity in such difficult climates. Studying stability of the above oils with regard to fatty acid composition and to pro-oxidant/antioxidant content of oils from these autochthonous varieties for three consecutive years is the first step to present their commercial potential to producers and draw official attention. A biochemical comparison of these oils with the main Tunisian variety, Chemlali, was also carried out.

2. Materials and methods

2.1. Samples

The analysis was applied to samples of VOOs from the South of Tunisia. The VOO samples chosen for this study were from selected olive varieties: Fakhari Douirat, Dhokar Douirat, Zarrazi Douirat, Chemlali Tataouine, and the main Tunisian variety, Chemlali. The first four cultivars were grown in the locality of Douirat in an arid zone under the same pedoclimatic conditions. Chemlali was grown in the region of Sfax (South of Tunisia). All varieties of olive fruits were harvested by hand from the trees. Only undamaged, healthy drupes were selected. When necessary, sampling was repeated for three consecutive crop seasons (2004–2006) to have representative samples and to see the effect of climatic changes from one year to another on oil characteristics, and two stages of maturity (A and B). Group A included oils obtained from semi-green olives (maturity index (MI) = 2.50–3.55), and group B included oils from mature olives (MI = 4.00–4.63). Maturity index was determined according to the method developed by the Agronomic Station of Jaén as function of fruit colour in both skin and pulp (Uceda & Hermoso, 1998). After harvesting, the olive fruit samples were immediately transported to the laboratory mill, where oil was extracted within 24 h under similar extraction conditions using an Abencor analyser (MC2 Ingenieria y Sistemas, S.L., Sevilla, Spain). A portion of olives (1.5–2 kg) was crushed with a hammer mill, slowly mixed for 30 min at ambient temperature, centrifuged without addition of water or chemicals; then this oil was transferred into dark glass bottles. The bottles were completely filled and stored in the freezer until analysis. Because of the cloudiness of the oil, all the oil samples were filtered in the laboratory using common filter paper before analysis. Sample filtration was performed in the dark.

2.2. Solvents and standards

HPLC grade solvents were used without further purification. *n*-Hexane (95%) and 2-propanol (Chromasolv) were purchased from Sigma–Aldrich Chemie GmbH (Steinheim, Germany); acetonitrile, acetone and diethyl ether were from Merck KGaA (Darmstadt, Germany). Isooctane and ethanol were from Riedel-de Haën (Seelze, Germany) and ethyl acetate was obtained from Scharlau Chemie S.A. (Barcelona, Spain). The solvents were of appropriate purity. Squalene (98–100%) and chlorophyll *a* (Chl *a*) from Anacystis nidulans algae (free of chlorophyll *b*) were purchased from Sigma Chemical Co. (St. Louis, MO, USA). DL-α-Tocopherol (⩾98%) and β-carotene (⩾97.0%) for HPLC were purchased from Fluka Chemie GmbH (Buchs, Switzerland). Fatty acid methyl esters (FAMEs) standards were obtained from Sigma Chemical Co. (St. Louis, MO, USA). Pheophytin α (Pheo α) was obtained by acid treatment of the respective chlorophyll solution (Canjura & Schwartz, 1991).

2.3. Apparatus

Squalene determination was carried out using a solvent delivery system that consisted of a liquid chromatography pump (LC-10AV*vp*, Shimadzu Co., Kyoto, Japan) that was equipped with an injection valve with a 20 μL loop (Model 7125, Rheodyne Cotati, CA, USA). The liquid chromatography system was equipped with a dual-wavelength UV–Vis spectrophotometric detector (SPD-10AV, Shimadzu Co., Kyoto, Japan). A Hewlett Packard 3396 Series II electronic integrator (Avondale, PA, USA) was used to record and quantify the chromatographic peaks.

The solvent delivery system to determine α-tocopherol and pigments consisted of two Marathon IV series HPLC pumps (Rigas Labs, Thessaloniki, Greece), equipped with an injection valve with a 20 μL loop (Model 7125, Rheodyne Cotati, CA, USA). The liquid chromatography system was equipped with a Diode Array Linear UVIS-206 Multiple Wavelength Detector (Linear Instr., Fermont, CA). Column temperature was controlled with an SSI Model 505 column oven. The data were stored and processed using the chromatographic software EZChrom (Scientific Software, Inc., San Ramon, CA, USA).