TOCOPHEROL CONTENT OF ALMOND OILS PRODUCED IN EASTERN MOROCCO

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INTRODUCTION

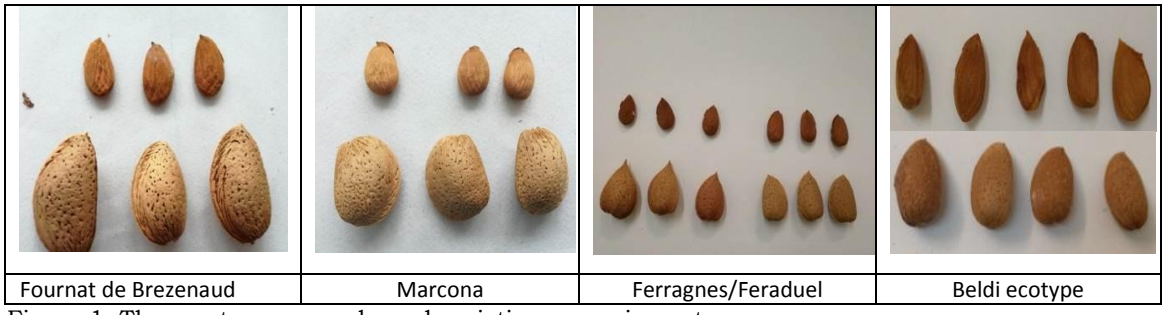
Almond is the most important tree nut crop in Morocco in terms of acreage and production value. Almond plantations cover a total area of 151,000 ha with an estimated average annual production of 99.000 tons of shelled products. 9% of this area which provides up to 14% of Moroccan production of almonds is located in eastern Morocco (MAPM, 2014). Recently eastern Morocco region was supported by the Belgian development agency "BTC" through the "PROFAO*" project for planting 6000 ha of almond trees and for the improvement of almond value chain at the post-harvest level, particularly the evaluation of almonds and its derived products (oil and other co-products). Almonds are a good dietary source of tocopherols (vitamin E), sterols, and flavonoids, suggesting playing a role in health promotion. Furthermore consumption of tocopherols have been associated with the natural antioxidant benefits and health outcomes (Maguire et al., 2004). The concentrations of tocopherols in fully ripened almond kernels have been studied in different regions of Morocco (Kodad et al., 2014), but tocopherol contents in eastern Morocco has not yet been studied. The goal of this study concerns tocopherol analysis in almond oils produced in eastern Morocco. The varieties used in this study are: Ferragnes, Feraduel (F/F) and Fournat de Brezenaud originated from France; Marcona from Spain and Beldi local ecotype from eastern Morocco.

PROFAO*: Projet Filière Amandes de L'Oriental, "The almond value chain in eastern Morocco , Pillar II of the Moroccan Green Plan, supported by Belgian development agency (BTC 2011-2017)

MATERIAL AND METHODS

Plant material

To determine tocopherol contents as a quality parameter of almond oils (AO) produced in eastern Morocco, AO of five main varieties grown in this region (Fournat, Marcona, Ferragnes/Ferraduel couple and local ecotype Beldi) were tested. Almonds were triturated using an oil screw press (KOMET Modèle DD85G). The almonds varieties (Figure 1) are collected in a pilot area in the eastern Morocco (SIDI BOUHRIA: 34°44'13.6" N, 002°20'15.0" W),



Fournat de Brezenaud	Marcona	Ferragnes/Feraduel	Beldi ecotype

Figure 1: The most common almond varieties grown in eastern morocco

Tocopherol contents analysis

The different tocopherol isoforms (α-, β-, γ-and δ-tocopherols) were evaluated following the AOCS method Ce 8-89 (AOCS 1989). An oil hexane solution was analyzed by HPLC with fluorescence detector HPLC-FLD (Agilent Technologies series 1200 system, Agilent Technologies), equipped with an automatic injector, on an Uptisphere 120A° NH_2 column (150 mm *3 mm, 3 µm) Interchim (Montluçon, France) and maintained at 30 °C. The injection volume was 10 µL. The mobile phase was hexane/2-propanol (99:1, v/v) eluted at a flow rate of 1 mL min^{-1}. The tocopherols were identified and quantified by external standardization (Mixture of tocopherols: α-tocopherol, β-tocopherols, γ-tocopherols, δ-tocopherols) obtained from Sigma-Aldrich (Steinheim, Germany).

Statistical analysis

Tocopherol analyses were carried out on triplicate for each sample of almond oil varieties. All statistical analyses were performed with the SPSS software for Windows (SPSS.21, USA). Values of different parameters were expressed as the mean (X□± standard deviation). The normal distribution was verified according to Shapiro Wilk test. Duncan's method was used for mean comparison. Only variables with a confidence level superior to 95% ($P<0.05$) were considered as significant.

RESULTS

Almond Oils extracted from local Beldi ecotype and the main introduced varieties Ferragnes/Ferraduel (F/F), Marcona and Fournat were analyzed for their quantitative and qualitative tocopherol contents. The average of total tocopherol quantities observed is 528.98 mg/kg AO, with the α-tocopherol as a dominant compound in almonds oil. Total tocopherols content and proportion of different tocopherols homologues content (α-, β-, γ and δ tocopherols) of analyzed almond oils by HPLC-FLD are summarized in Table 1.

Table 1: Total content and proportion of main tocopherol homologues in five screw-pressed almond oils (mg/kg AO)

Almond oil / Tocopherols mg/kg AO	Fournat	Marcona	Ferragnes/ Feraduel	Beldi
α-tocopherol	483.98^{ab}±7.83	456.44^{bc}±2.87	425.03^{c}±7.59	517.02^{a}±8.56
β-tocopherol	3.17^{a}±0.78	1.77^{c}±0,01	2.28b^{b}±0.25	2.95^{a}±0.33
γ-tocopherol	14.27^{a}±0.82	2.75^{b}±0.01	5,80^{c}±0.14	9.01^{d}±1.01
δ-tocopherols	ND	ND	ND	ND
Total tocopherols	501.43^{ab}±8.05	460.96^{bc}±2.88	433.11^{c}±7.88	528.98^{a}±9.71

Significant differences are shown by different letters (a-d).
ND: not detected; AO: Almond oil

DISCUSSION

Tocopherol analysis showed the presence of 3 tocopherol isoforms (α-, β- and, γ –tocopherol). Similar results were found by Kornsteiner et al., (2006), Zhu et al., (2015 a, b) and Zhu et al., (2017). The higher α-tocopherol content (517 mg/kg oil) was found in AO Beldi ecotype. While the lower contents were registered in the introduced varieties which range between 484mg/kg oil for Fournat and 425mg/kg oil for the couple F/F. Regarding to β and γ tocopherols, our results show that β-tocopherol contents range from 1.77 to 3.17 mg/kg, and γ-tocopherol from 2,75 to 14,27 mg/kg oil respectively for Marcona and Fournat, while intermediate values are recorded for F/F. The total tocopherol content of the introduced varieties cultivated in eastern Morocco is much higher (Table 1) compared to the same varieties cultivated in Spain (Marcona: 374.1, Fournat: 402.4, F/F: 385.2mg/kg oil) (Kodad et al., 2011) This is an important parameter for the valorization of these products for their uses as food stars and in cosmetics as well. Although the Beldi ecotype is characterized by high diversity related to natural hybridization between the natives almond trees (Melhaoui et al., 2017) and by a strong presence of doubles its tocopherol richness can be considered as an add value for the local production and could be exclusively orientated toward virgin almond oil extraction. Since almond oil extraction by screw press can preserve natural antioxidants and fat-soluble bioactive compounds which make this oil with interesting nutritional and cosmetic properties.

CONCLUSION

This study shows a large variability of contents for different tocopherol homologues in the analyzed almond oils with α-tocopherol as a dominant compound. This variation is related to the genotype as well as to the geographical localization. Moreover, tocopherol richness in Beldi ecotype could be used as an add value for virgin almond oil extraction with interesting nutritional and cosmetic properties.

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