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A comparison of the effect of genotype and weather conditions on the nutritional composition of most important commercial nuts

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ABSTRACT

The beneficial effects of nut consumption on human health have been largely confirmed. However, these benefits are variable as a wide range of factors have main influence on the nutritional composition of nuts. This is the case of the specific cultivar considered, as different almond, pistachio and walnut cultivars produce nuts with differentiated composition. Still, there are factors beyond cultivar effect that need to be further analysed. This is the case of weather conditions during nut development. In this study, we evaluate the influence of genotype and the crop year (weather conditions) on nuts health-promoting properties. With that purpose, the nutritional composition of 29 different nut cultivars has been evaluated during two consecutive crop years (2015–2016). The objective of this study was to evaluate in which extend uncontrollable weather conditions during nut development affect the nutritional composition of almonds, pistachios and walnuts. This variability was compared to that resulted from the use of different cultivars. Results show that by using different cultivars, some of the main nutritional parameters of nuts, such as oil content or concentration of linoleic can be controlled. However, for some of the decisive factors on nut nutritional quality, such as protein content, phytosterols concentration and presence of minerals such as iron or sulphur, the weather conditions of the considered crop year are determinant. In this scenario, the health-promoting properties of nuts might be compromised by the climate variability associated to climate change.

1. Introduction

The interest of nut consumption is associated to its health-promoting properties. Nuts consumption improves the flood lipoprotein profile, shows anticancer and antitherogenic effect, contributes to the regulation of immunological activity and inflammatory response, shows high antioxidant capacity, and reduce mediators of chronic diseases such as oxidative stress, visceral adiposity, insulin resistance, endothelial dysfunction or the metabolic syndrome (Abbey et al., 1994; Amaral et al., 2005; Awad and Fink, 2000; De Souza et al., 2017; Gentile et al., 2007; Kodad et al., 2011; Martínez et al., 2006; Robbins et al., 2011; Yang et al., 2009). Moreover, nut consumption is not associated to weight gain, even in large amounts (Hollis and Mattes, 2007; Ibarrola-Jurado et al., 2013; Katz et al., 2012).

Generally, nuts show high lipid content. In almonds, lipids compound 40–67% of dry weight (Yada et al., 2011), with similar values for pistachio, around 50–62% (Catalán et al., 2017). In walnuts, this concentration is even higher, reaching 60–72% of walnut dry weight (Amaral et al., 2003; Kodad et al., 2016). Among lipids, nuts contain high concentration of unsaturated fatty acids, mainly oleic, that constitutes more than 50% of total lipids in almond and pistachio (Catalán et al., 2017; Roncero et al., 2016), and linoleic that exceeds 50% of total lipids in walnuts (Crews et al., 2005; Martínez et al., 2006). Beyond fatty acids, nuts contain interesting concentrations of high quality proteins, as they show high digestibility and high concentration of essential amino acids (Sze-Tao and Sathe, 2000). Nuts also have remarkable concentrations of essential minerals (Roncero et al., 2016), such as magnesium, calcium and potassium, that together prevent bone demineralization, reducing blood pressure and the risk of coronary heart disease (Segura et al., 2006).

Recently, most of the research regarding nuts has focused on minor components due to their influence on nuts nutritional quality. Nuts are an interesting source of vitamin E as they have high content of tocopherols. Total tocopherol concentration ranges from 194 to 297 mg/kg in walnut (Amaral et al., 2005) and 350–550 mg/kg in almonds (Kodad et al., 2014) with average values around 350 mg/kg in pistachios (Ling et al., 2016). Other minor components of interest are phytosterols. They appear in very high concentrations in pistachio oil, up to 271.9 mg/100 g of oil. In almond and walnut oils, phytosterols concentration is lower, around 140–160 mg/100 g of oil (Crews et al., 2005;

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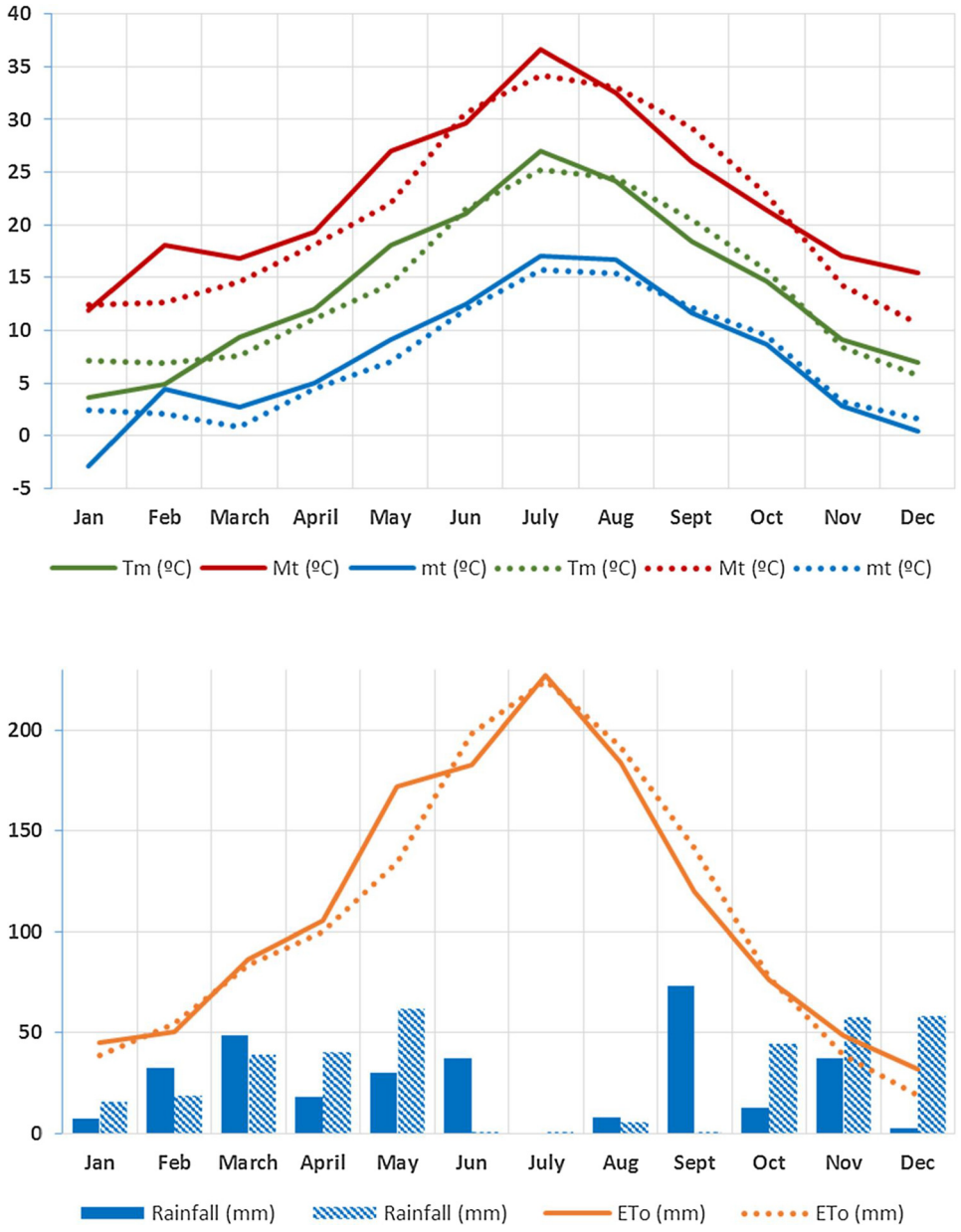

Fig. 1. Weather conditions measured at the crop station during 2015 and 2016 crop years.
Abbreviations: Average monthly temperatures (Tm), average maximum monthly temperatures (Mt), average minimum monthly temperatures (mt) and reference evapotranspiration (ETo). Solid lines and bars show data from 2015 and dotted lines and bars show data from 2016.

Kornsteiner-Krenn et al., 2013).

All the positive effects of nuts on human health are the result of the presence and concentrations of previously mentioned components among others. However, these components vary attending to the nut considered, but also attending to other factors, such as the specific cultivar selected. Almond, pistachio and walnut have been largely spread around the Mediterranean basin and other areas with Mediterranean type climates, such as California, Central Asia and Australia. This expansion has resulted in the development of different cultivars adapted to the environmental conditions of their growing areas or the preferences of local markets. All these cultivars compose a huge genetic resource of plant material that should be studied in order to face the uncertain conditions for the production of nuts due to climate change.

Different pistachio cultivars show differences in the fatty acid profile, triglycerides, phytosterols, amino acids and minerals (Bellomo and Fallico, 2007; Bellomo et al., 2009; Dyszel and Pettit, 1990; Küçüköner and Yurt, 2003; Mahmoodabadi et al., 2012). In almonds, significant differences have been found in the total oil content, fatty acid profile, triglycerides or tocopherols (Kodad et al., 2014, 2011; Roncero et al., 2016; Yada et al., 2011). Similar conclusions have been reported for walnuts (Amaral et al., 2005, 2003; Bada et al., 2010; Crews et al., 2005; Kodad et al., 2016).

Beyond cultivar, weather conditions and cultural practises on the crop field are also important factors to consider, as they all have effects on nut nutritional properties (Carbonell-Barrachina et al., 2015; García-López et al., 1996; Kodad et al., 2014; Sánchez-Bel et al., 2008; Yada et al., 2011; Zhu et al., 2015). Pistachio cultivars grown under different conditions in Tunisia (Chahed et al., 2008; Ghrab et al., 2010), Turkey (Harmankaya et al., 2014; Küçüköner and Yurt, 2003; Seferoglu et al., 2006) or Iran (Kamangar and Farsam, 1977; Mahmoodabadi et al., 2012) show significant differences in their chemical parameters. Similar results have been obtained for walnuts (Amaral et al., 2005; Crews et al., 2005) and almonds (García-López et al., 1996; Maestri