

# Effect of Sun, Oven and Freeze-Drying on Anthocyanins, Phenolic Compounds and Antioxidant Activity of Black Grape (Ekşikara) (*Vitis vinifera* L.)

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**The aim of this study was to determine whether a change occurs in the phenolic compounds and antioxidant activity of grapes after drying. Grapes pre-treated with potassium hydroxide solution were dried using three different drying methods, namely freeze drying, oven drying and sun drying. The effectiveness of the drying methods was evaluated in terms of total phenolic content, antioxidant activity (ABTS, FRAP and DPPH), individual phenolics and anthocyanins. Losses in total phenolic content of the grapes were found to be 1.89, 20.26 and 46.79% for freeze-, oven- and sun-dried grapes respectively. The DPPH and ABTS antioxidant activities of the grapes decreased after drying by all three methods, while an increase was observed in the FRAP value of freeze-dried grapes compared to the fresh sample. No significant effect of drying methods was observed on the gallic acid, 2,5-dihydroxybenzoic acid and (-)-epigallocatechin gallate contents of the grapes. The highest levels of procyanidin B1, (+)-catechin, (-)-epicatechin, (-)-epicatechin gallate, chlorogenic acid, *trans*-resveratrol and rutin were determined in freeze-dried grapes. Sun and oven drying caused drastic decreases in all anthocyanins, while no loss of anthocyanin was observed in freeze-dried grapes. Sun drying was found as the most detrimental drying method for grapes in terms of phenolic compounds and antioxidant activity when compared to the other drying methods.**

## INTRODUCTION

Grapes are one of the most important agricultural products and are available in almost all parts of the world. World grape production in the 2014/2015 season was reported as 20 637 000 metric tons (USDA, 2016). In the same season, Turkey was ranked as the world's third largest grape producer with an amount of 3 226 000 tonnes (TSI, 2016). According to 2014/2015 data on agricultural production, 1 361 000 tonnes of dried grapes were produced worldwide. Turkey was the largest manufacturer and exporter of dried grapes in 2014, and this constituted 24% of the total world dried grape production (INC, 2016). The USA, Iran, China and India follow in descending order after Turkey in terms of dried grape production.

Drying, one of the oldest methods of food preservation, is widely used to extend the shelf life of fruit in order to keep them available throughout the season. On the other hand, drying methods have a significant effect on the quality characteristics of dried fruit, such as phenolic compounds and sensorial properties (Angulo *et al.*, 2007; Tseng & Zhao, 2012). The sun-drying method has the advantage of being more cost-effective than the other drying methods. However, because of the slow drying rate it takes a long time. Grape drying takes nearly 20 days for untreated fruits and eight to

10 days for pre-treated ones (Jairaj *et al.*, 2009). Sun-dried grapes have a high risk of contamination due to their direct exposure to the environment (Jairaj *et al.*, 2009). To shorten the drying time and reduce the contamination risk, different methods such as solar, oven and hot-air drying could be used in raisin production. Sensorial properties, nutritional quality and cost of product are usually taken into consideration in choosing an appropriate drying method (Angulo *et al.*, 2007). The grape berry contains water, sugar, minerals, polyphenolics, organic acids, vitamins, aroma and nitrogen compounds (Armstrong & Stratton, 2016). Polyphenols are one of the most important constituents of grapes and contribute to the colour, taste and aroma (Armstrong & Stratton, 2016). Grapes also possess antioxidant activity by chelating metal ions and scavenging hydroxyl radicals ( $\cdot\text{OH}$ ) and superoxide anion radicals ( $\cdot\text{O}_2^-$ ) (Kong *et al.*, 2003; Akbulut *et al.*, 2008).

Grapes contain phenolic acids (hydroxybenzoic and hydroxycinnamic acid, and their derivatives), stilbenes, flavonols, anthocyanins, flavan-3-ols and condensed tannins (Montealegre *et al.*, 2006). Anthocyanins are natural plant pigments that are responsible for colours ranging from red to violet, and are located especially in the exocarp of the grape

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