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Distribution of free amino acids, polyphenols and sugars of *Ziziphus jujuba* pulps harvested from plants grown in Tunisia

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Ziziphus jujuba pulps are very much appreciated by the inhabitants and have been recently exported. This article reports on the chemical composition (amino acids, polyphenols and sugars) of the pulps of four *Z. jujuba* ecotypes (Choutrana, Mahdia, Mahres and Sfax). The major amino acids identified were proline, aspartic acid and glutamic acid. Among these, proline was the most abundant amino acid (17.4 mol). Considerable differences in total phenolic contents (15.85 mg/L) were found. Predominant phenols identified by using HPLC were rutin (1.09 mg/L) and chlorogenic acid (2.57 mg/100 g). Sugars isolated from *Ziziphus* pulps were found at a rate of 43.52%. Using HPLC method, three sugars from the pulp extract were identified: glucose, galactose and sucrose. The Mahdia ecotype was the richest in these sugars with 0.45, 136.51 and 113.28 mg/L, respectively.

Keywords: *Ziziphus*; pulps; ecotype; amino acids; polyphenol; sugar; HPLC

1. Introduction

Ziziphus jujuba, known as Chinese jujube, is a highly valued plant native to China (Memon et al. 2012). The *Z. jujuba* fruit has multiple bioactivities (anticancer, anti-inflammatory, etc.), which was confirmed by Yu et al. (2012). Other studies were conducted on fatty acid compositions in the different parts of *Z. jujuba* plant (El Aloui et al. 2011, 2014). Amino acids ranged from 9.8/100 to 5.3/100 g in pulps and seeds, respectively (Suk-Hyun et al. 2011). Polyphenols extracted from *Z. jujuba* fruits ranged from 25 to 42 mg GAE/g (Kamiloglu et al. 2009). In Tunisia, some people have been using different parts (leaves, seeds, pulps) of the *Z. jujuba* plant in traditional medicines (tea, infusion, etc.). However, there have not been any studies on the chemical compositions of *Z. jujuba* fruits from Tunisia. Therefore, we examined the distribution of free amino acids and polyphenols in the pulps from four *Z. jujuba* ecotypes.

2. Results and discussion

2.1. Free amino acids

The typical GC profile (Chromatogram S1a and S1b) showed the existence of large variations in the amino acid contents between the four ecotypes (Sfax, Choutrana, Mahres and Mahdia). The major amino acid observed was proline at a level of 12.83 mol (Sfax ecotype) and 17.40 mol (Choutrana ecotype) of the total amino acids (Figure 1).

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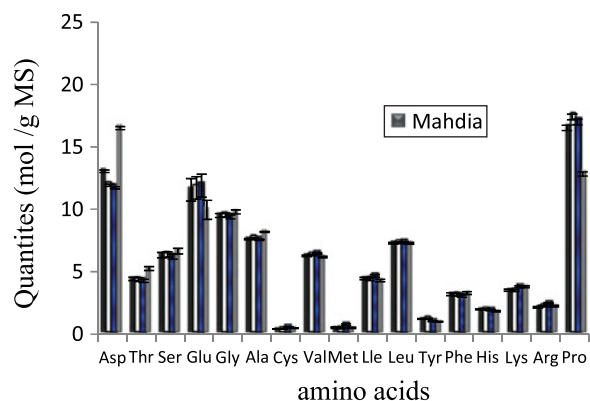


Figure 1. Free amino acids in the pulps of *Z. jujuba* ecotypes. The data are means values of three measurements. The confidence intervals were calculated at the threshold of 5%.

2.2. Phenolic compounds

The analysis of the total phenolic composition of *Z. jujuba* pulps varied from 10.43 mg/L (ecotype Mahres) to 15.85 mg/L (ecotype Sfax).

In Barbary fig, phenols were present in stems at the rate of 6.91 mg EAG/g (Rsaissi et al. 2013). Chlorogenic acid and rutin were detected as major phenolic compounds in the jujube pulps (Chromatogram S2). Chlorogenic acid ranged from 1.91 (Sfax ecotypes) to 2.57 mg/100 g (Choutrana ecotype). Rutin was detected in the levels of 0.16 and 1.1 mg/100 g in Mahres and Mahdia ecotypes, respectively.

In other species, such as *Ziziphus lotus* and *Ziziphus mauritiana*, the polyphenols were present at rates of 20.09 mg/g (Ghalem et al. 2014) and 12.8 mg/g (Memon et al. 2012) in roots and fruits, respectively. In comparison to other fruits, Soares et al. (2008) reported that the total content of insoluble phenolic acids in apple was between 11.08 g/g and 4.05 mg/g. In date seeds, this amount did not exceed 2.194 g/kg (Hosam et al. 2014). In *Ziziphus spina-christi* fruits, chlorogenic acid was the most predominant compound (6.20 ppm) (Amany et al. 2013).

This richness in polyphenols, with high pharmacological activities as radical scavengers (Cook & Samman 1996), can reduce the incidence of human diseases such as cancer and cardiovascular diseases. In addition, numerous studies investigated on the therapeutic roles of these compounds (antioxidant, anti-inflammatory, anti-stressful, anti-cancerous, antimicrobial, anti-allergic, anti-diabetic, etc.). Many authors (Ielpo et al. 2000; Petit et al. 2007) confirmed this. In plants, these natural active compounds may contribute to respiration, photosynthesis, cell growth, seeds germination and prevention of some diseases. Also, the polyphenols are responsible for fruit quality and nutritional value by modifying colour, taste, aroma, and flavour.

2.3. Sugar composition

The distribution of sugar yields in different ecotypes showed that the rate exceeded 43.52%, with the highest rate in the Mahdia ecotype. The HPLC profile showed the existence of large variation in sugar distributions in all ecotypes (Chromatogram S3). The major sugar observed was glucose at levels of 136.51% and 131.01% of the total sugar in Mahdia and Mahres ecotypes, respectively (Table S1). Sucrose was the major compound in the Mahdia ecotype (113.28%). Pareek (2013) found that *Z. jujuba* pulps contained 18.6% of fructose and 19.2% of glucose. In comparison to other fruits as mango, apples, dates total sugars ranged respectively from 11.16% (Doreyappa Gowda & Huddar 2001) to 12.6% (Funke & Blanke 2005) and 80%.

Information on the sugar composition of *Z. jujuba* pulps may be of great importance to consumers to implicate the jujubes in their diets as fruit juices, jams, cakes, etc. In fact, free sugars contribute to the nutritive property, the flavour and the sweet taste of many fruits such as apples, persimmon, berries and strawberries (Hirvi & Honkanen 1983).

4. Conclusion

Z. jujuba pulps are good sources of protein contents (especially proline and aspartic acid), phenolic compounds (especially rutin and chlorogenic acid) and sugars (glucose, sucrose and fructose). These high rates of extracts illustrate the importance of using the jujube pulps in cosmetics and pharmaceutical industries. *Z. jujuba* ecotype Sfax and ecotype Choutrana can be used as accessible sources of polyphenols and as a possible food supplement. Thus, many efforts and encouragements (enclosure and planting) should be set to allow the expansion of this endangered species. In addition, it is necessary to encourage the pharmaceutical and cosmetic industries to manufacture products based on jujubes.

Supplementary material

Experimental details relating to this paper are available online, alongside Table S1, Figure S1 and Chromatograms S1–S3.

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