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Soluble sugars and mineral nutrient contents in kernels of three Tunisian almond cultivars

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Abstract. Almond is an important food crop grown mainly in the Mediterranean region and the USA. The kernel is the edible part of the nut and is considered a rich source of many nutrients. In the present study, total soluble sugars and mineral nutrient contents were quantified in the kernel of three local *Prunus dulcis* (Mill.) D.A. Webb cultivars selected from Tunisia. Cultivars are from three different origins. 'Tozeur 1' is from the south (Tozeur region), 'Achaak' is from the centre (Sfax region) while 'G25-5' is from the north (Mornag region). Mineral composition was analyzed by atomic absorption spectrometer and the amount of Mg, K, Na, Ca, Fe, Zn, Cu and Mn was determined. Among mineral nutrients, K, Ca and Mg were the predominant elements in kernels. Moreover, potassium (K) was the major mineral element for which amounts up to 683 mg/100 g (dry matter). 'Achaak' had higher Ca level (234.6 mg/100 g), however, there was no significant difference in K and Mg contents between three studied cultivars. Total soluble sugar contents showed difference among cultivars and the highest value (5.7 g/100 g) was found in 'G25-5' kernels. So, the obtained results showed that almond kernels are being potential sources of mineral elements which might be used as useful dietary supplements. Additionally, results of this study may provide relevant data for future studies on the chemical composition and will be useful to know about the nutritional properties of the local almond kernels.

Keywords. Almond – Kernel – Minerals – Total sugars.

Détermination de la teneur en sucres solubles et en éléments minéraux des amandons de trois cultivars tunisiens d'amandiers

Résumé. La culture de l'amandier est très répandue dans le bassin méditerranéen et aux Etats Unis d'Amérique. L'amandon est la partie comestible; il est considéré comme une source riche en nutriments. Dans la présente étude, les sucres solubles totaux et les teneurs en éléments minéraux ont été quantifiés dans l'amandon de trois cultivars tunisiens d'amandiers *Prunus dulcis* (Mill.) D.A. Webb. Ces cultivars proviennent de trois différentes régions: la variété 'Tozeur 1' provient des oasis de Tozeur au sud, la variété 'Achaak' provient de la région de Sfax au centre et la variété 'G25-5' provient de la région de Mornag située au nord de la Tunisie. Les teneurs en Mg, K, Na, Ca, Fe, Zn, Cu et Mn ont été déterminées par spectrométrie d'absorption atomique. Nos résultats ont montré que le potassium (K), le calcium (Ca) et le magnésium (Mg) sont les éléments prédominants dans les amandons et que le potassium est l'élément minéral majeur (683 mg/100 g en matière sèche). La variété 'Achaak' est la plus riche en Ca (234,6 mg/100 g), alors qu'il n'y a aucune différence significative pour le K et Mg entre les trois variétés étudiées. La teneur en sucre solubles totaux diffère significativement entre les cultivars. La variété 'G25-5' étant la plus riche: 5,7 g/100 g. Dans l'ensemble, les résultats obtenus montrent que les amandes sont des sources potentielles d'éléments minéraux qui pourraient être utilisées comme suppléments alimentaires. En outre, ces résultats peuvent fournir des données pertinentes pour de futures études sur la composition minérale et les propriétés nutritionnelles des amandiers locales.

Mots-clés. Amandier – Amandon – Composition minérale – Sucres solubles totaux.

I – Introduction

The cultivated almond [*Prunus dulcis* (Mill.) D.A. Webb; syn. *P. amygdalus* (L.) Batsch] is considered as one of the oldest nut crops. This crop is cultivated mainly in the Mediterranean region and the USA. The almond species is well adapted to Mediterranean climate. In Tunisia, almond is the second agricultural product after the olive tree. Almond plantations are located throughout all the country in different climatic conditions and are characterized by an important genetic diversity (Gouta *et al.*, 2010).

Almond kernels have an economic value where they are mostly consumed as fresh fruit, raw or toasted and salted, as snack. Moreover, kernels are widely used in cooking as ingredients for both savory and sweet dishes. The demand for almond fruits is increasing, partly because of their associated health benefits. Indeed, almond fruits exert health-promoting effects that have been attributed to their supply of wide variety of nutritional components such as fiber, vitamin, mineral elements, proteins, fats; especially high level of monosaturated acid (Karatay *et al.*, 2014). Hence, almonds are nutritious and delicious fruits.

Although there are several reports of evaluating almond kernels composition worldwide, there are few studies regarding to the nutritional properties of Tunisian almond kernels. Therefore, the aims of this work were to evaluate the total soluble sugars as well as mineral nutrient contents in kernels of two autochthonous almonds cultivars 'Tozeur 1' and 'G25-5'. They are originated from two different regions, but, they are cultivated and grown in the same open field. Results were compared to those of 'Achaak', which is much appreciated by consumers for the quality of its fruit in local market.

II – Materials and methods

Fruits of two cultivars of almond 'Tozeur 1' and 'G25-5' were collected by hand in late July and mid-July 2014, respectively, from seven years old trees growing in the Experimental Station of the Tunisian National Agricultural Research Institute (INRAT), located in the city of Mornag (the north of Tunisia). Cultivars were originated from two different regions. 'Tozeur 1' is from the south (Tozeur) and obtained by seedling selection while 'G25-5' is from the north (Mornag) and obtained by chance seedling. The third cultivar used in this study is an old local cultivar 'Achaak' which originated from the centre (Sfax region). Dried fruits were transferred to laboratory in polypropylene bags under cool conditions. Kernels were obtained from shells by hand processing and stored at 6°C until analyzed.

Kernels were milled by a grinder (Sunbeam Osterizer blender, Boca Raton, USA) just before analysis. To avoid overheating, the sample was flaked for 10 s, then grinding was halted and the sample was shaken for another 10 s, and the milling process was continued. For ion analyses, 1g of dry ground kernels was extracted with 20 ml of 0.1 M HNO₃. After filtration, Mg, K, Na, Ca, Fe, Zn, Cu and Mn contents were determined with an atomic absorption spectrometer (Avanta, GBC, Australia). Total soluble sugars were determined according to the method of Robyt and White (1987).

The data were subjected to an analysis of variance (ANOVA) using SAS statistical software version 6.12 (SAS Institute, Cary, NC, USA). A completely randomized design with three replicates was used. Where applicable, means were separated by Duncan's multiple range test with the level of significance $P \leq 0.05$. Results are reported as average of at least six repetitions.

III – Results and discussion

It was reported that the individual mineral elements found in almonds are calcium (Ca), copper (Cu), iron (Fe), magnesium (Mg), manganese (Mn), potassium (K), phosphorus (P), selenium (Se), sodium (Na) and zinc (Zn) (USDA, 2010). The mineral nutrient contents of almond kernels belonging

to the three studied cultivars are reported in Table 1. Our results revealed that K, Mg and Ca were the most abundant minerals (Table 1). Similar findings were reported by Piscopo *et al.*, (2010). Potassium was the most abundant element and levels ranging from 645 (Tozeur 1) to 683 mg/100 g (G25-5). These values were lower than those observed in kernels of some almond varieties originating from Turkish orchards where values ranged between 1314 to 1510 mg/100g (Ozcan *et al.*, 2011). However, such values were close to those reported by previous works (Ayadi *et al.*, 2006 and Piscopo *et al.*, 2010). K and Mg did not varied significantly among cultivars. The variety 'Achaak' showed the highest level in Ca (234.54 mg/100 g) in comparison to others two varieties.

The obtained results of the three almond cultivars showed that the almond kernels showed high levels of magnesium, potassium and calcium and, in contrast, very low levels of sodium, zinc, copper, manganese and iron. Accordingly, such composition confirmed the nutritional interest of almond kernel and allows us to consider the almond an excellent source of bioelements. Indeed, magnesium and potassium may improve blood pressure and it is important to maintain the proper proportion of calcium to potassium. Moreover, their high magnesium content makes them a very suitable food to offset deficiencies in this mineral (Tapia *et al.*, 2013).

Table 1. Mineral content in almond kernels. Data are expressed as mg/100 g of dry matter. Mean separation within columns by Duncan's Multiple Range Test ($P \leq 0.05$). Different letters indicate significant differences between cultivars for a given element

Cultivar	Ca	Cu	Fe	K	Mg	Mn	Na	Zn
'Tozeur 1'	193.59b	0.6a	2.16ab	645.09a	150.36a	1.73a	0.93b	2.60b
'Achaak'	234.54a	0.34c	1.93b	661.37a	143.42a	1.85b	0.86a	2.91a
'G25-5'	204.8b	0.43b	2.52a	683.39a	144.95a	1.68ab	0.96ab	2.65b

The mean values and standard deviations of total soluble sugar contents for the kernels of the three studied cultivars are presented in Fig 1. The higher value of total soluble sugar contents was detected in 'G25-5' cultivar (5.7 g/100 g); however, 'Achaak' and 'Tozeur 1' showed similar content which was

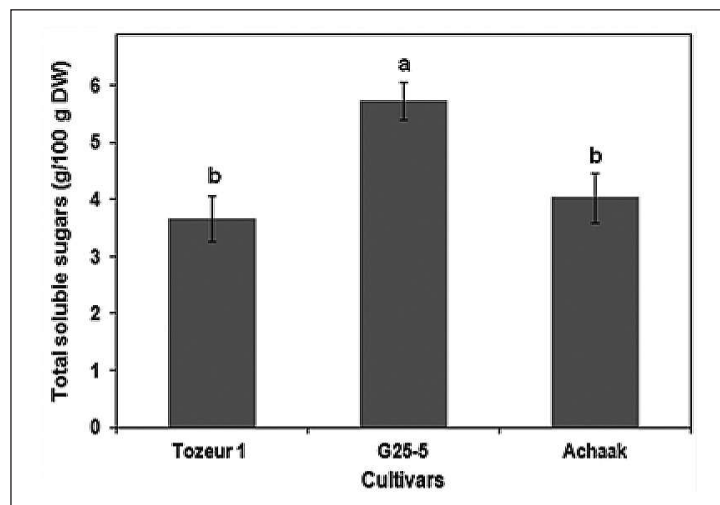


Fig. 1. Soluble sugars content in kernels of three studied cultivars. Each point represents the mean (\pm SE) of six replicates. Mean separation by Duncan's Multiple Range Test. Different letters indicate significant differences between treatments ($P \leq 0.05$).

about two-thirds of that observed in 'G25-5'. A wide range of soluble sugar contents in almond kernels is reported in the literature. Indeed, published values for sugar were comprised between 3.3 to 7.1 g/100 g (Socias i Company *et al.*, 2008), with sucrose representing the predominant sugar in kernel (Schirra, 1997). According to the USDA SR database, the value provided for total sugars (3.89 g/100 g natural almonds) is the sum of determinations of individual mono- and disaccharides that include sucrose, glucose, fructose, galactose and maltose (USDA, 2010). Based on this standard, 'G25-5' had higher total sugar contents, while the other two cultivars were in a similar range.

IV – Conclusions

Our results prove that the three studied almond cultivars constitute a natural source of sugars and many minerals, mainly, potassium, calcium and magnesium that may prevent many diseases. Although the two varieties 'G25-5' and 'Tozeur 1' were not well known in market as 'Achaak', mineral nutrient contents were almost similar for three studied cultivars. Therefore, such data shows the potential of 'G25-5' and 'Tozeur 1' that could be interesting cultivars. Also, it is very interesting to accomplish this study by other investigation to know the nutritional properties of our local almond cultivars.

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