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Short communication

Can the dietary element content of virgin argan oils really be used for adulteration detection?

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ABSTRACT

Levels of eight dietary elements were assessed by ICP-AES in virgin edible and beauty argan oil samples prepared from four remote locations of the argan forest, and over a three-year period. The data showed sufficiently little variability to assess that all argan oil samples present, in terms of dietary elements, a similar composition, independently from the tree location within the argan forest. Therefore, adulteration detection by trace element analysis in edible and beauty argan oil is a method that can be generalised.

1. Introduction

Dietary elements or mineral nutrients are essential to maintain the metabolism of the human body (Underwood & Mertz, 1987). Indeed micro-quantity of these food-provided elements interfere with vital biochemical processes, allowing them to procede properly. However, under a free form, some dietary elements can also increase the production of cell-damaging free radicals (Bassaga, 1990). They can also bioaccumulate and induce long-term toxicity (Dudka & Miller, 1999). Therefore analytical determination of dietary elements is important in food chemistry even though it is still not mandatory. Precise quantification of trace elements, most of which being also dietary elements, has recently been suggested to be also a useful tool for the geographical characterisation of olive oils (Cabrera-Vique, Bouzas, & Oliveras-Lopez, 2012). It could, as well, be an accurate mean to discriminate argan oil from other commonly consumed oils (Gonzalvez, Armenta, & de la Guardia, 2010; Gonzalvez, Ghanjaoui, El Rhazi, & de la Guardia, 2010).

Argan oil is a vegetable oil that has recently conquered the world. Argan oil, which is prepared by press extraction of argan kernels (Charrouf, Guillaume, & Driouich, 2002), is a typical Moroccan product. Indeed, the argan tree is exclusively endemic in Morocco and is not grown anywhere else (Morton & Voss, 1987). The argan forest is an 800,000 ha large area covering the fertile Souss valley region, the foothills of the Anti-Atlas mountains, and the coastal region between Essaouira and Agadir. Because of this large distribution, the soil mineral composition of the argan forest undergoes some variation.

Argan oil exists as beauty and edible oil. Beauty oil that is prepared from unroasted kernels is endowed with numerous dermocosmetologic properties (Guillaume & Charrouf, 2011). Edible argan oil is prepared from roasted kernels. It is the basic ingredient of the Amazigh diet (Charrouf & Guillaume, 2010) and its regular consumption is beneficial for human health (El Monfalouti, Guillaume, Denhez, & Charrouf, 2010). The price of beauty and edible argan oils exceeds by far the price of all other vegetable oils (Lybbert, Aboudrare, Chaloud, Magnan, & Nash, 2011). Therefore the temptation to adulterate argan oil can be high and methods certifying argan oil authenticity are particularly looked for. Even tough, we have recently suggested to use campesterol, a sterol found in low quantity in argan oil, as marker to detect argan oil adulterated by addition of cheaper vegetable oils (Hilali, Charrouf, El Aziz Soulhi, Hachimi, & Guillaume, 2007), any alternative method is of high interest. To generalise the use of the trace element method, it must be demonstratred that all argan oil samples from the whole argan forest present a repeatedly similar trace element content, independently on the forest soil composition. In this paper, we study the

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amounts of eight dietary elements in edible and beauty argan oil prepared from four different locations of the argan forest. Therefore, this study provides a view of argan oil dietary element content in its globality, in terms of location. The study was performed on a three-year period in order to have a view of argan oil dietary element content as a function of time.

2. Materials and methods

2.1. Sampling

Fruit was collected in August 2009–2011 in four locations of the argan forest (Essaouira, Taroudant, Agadir, Ait Baha, Fig. 1). For each harvest, 25 kg of fruit were collected. Fruit was dried and peeled using the argan-cooperative traditional technique (Charrouf & Guillaume, 2008). Argan kernels were manually collected and processed to deliver argan oil after mechanical pressing as previously described (Hilali, Charrouf, El Azziz Soulhi, Hachimi, & Guillaume, 2005). Physico-chemical analysis (acidity, peroxide value, K_{232}, and K_{270}) of each samples was performed prior to the determination of their dietary element content.

2.2. Chemicals

Distilled water (resistivity 18.2 MΩ cm), obtained from a Milli-Q Millipore system (Bedford, MA, USA), was used to prepare aqueous solutions. Nitric acid 69.5% and hydrogen peroxide 30% were reagent grade solvents. A heavy metal standard solution of 1000 mg/L containing eight elements (Cd, Cr, Cu, Zn, Fe, K, Mg, Ca) dissolved in 2% wt HNO_3 supplied by Aldrich (Milan, Italy). All containers, including test tubes with stoppers, were in polypropylene and were cleaned with 5% (v/v) aqueous hydrogene chloride. The blank consisted of the 10% dilute HNO_3 and deionized water.

For the mineralisation assay 0.25 g of sample was mixed with 10 mL of HNO_3 69.5% and 8 mL of H_2O_2 35%. This mixture was heated on a hot plate at 140 °C for 4 h (close to dryness). After cooling, 1 mL of HNO_3 1% was added and the final volume adjusted to 25 mL with deionized water.

Fig. 1. Map of Morocco, hatched area indicates the argan forest. Fruit was harvested in Essaouira, Agadir, Ait Baha, and Taroudant countries.

2.3. Apparatus

Dietary element content was determined using a ICP-AES spectrometer (Jobin Yvon, Ultima 2) with axial viewed plasma. The operating conditions were set as follows: power 1.15–1.2 kW; plasma flow gas 12–14 l/min; auxiliary gas flow 1.5 l/min; nebulizer gas flow 0.2 l/min. The wavelength used for the quantification were: cadmium 214.440 nm, chrome 205.560 nm, zinc 213.857 nm, copper 324.752 nm, iron 238.204 nm, potassium 766.490 nm, magnesium 279.077 nm, and calcium 317.933 nm.

2.4. Statistical analysis

Parameters determined in argan oil were studied as statistical variables. Each given value corresponds to the average of three independent measurements. Variability in each parameter and between both oil groups (roasted and unroasted kernels methods) was analyzed. Possible correlations between metals and between metal content and several quality parameters were also studied; P values $\leqslant 0.05$ were considered to be statistically significant. Statistical analysis was performed using the Statgraphics Plus package.

3. Results and discussion

Due to the argan forest large size, its soil metal content is inherently naturally location dependent. Sometimes, such variability also possibly results from poor sewage, insufficient sanitary conditions, strong erosion, and possibly metal accumulation in natural pits favoured by low rainfall. Therefore, to determine if the dietary element content in argan oil is location dependent, we evaluated the dietary element content of argan oils produced in the four main argan oil production sites of the argan forest: Agadir, Ait Baha, Essaouira, and Taroudant (Fig 1). Since we evaluated this content in beauty and edible argan oil over three years, a total of 192 samples were investigated.

Prior to metal content analysis, we determined the initial quality of all our samples. All of them were prepared using the state-of-the-art half-mechanised method that is known to produce high quality oil (Hilali et al., 2005) and reproducible metal content (Marfil et al., 2008). Evaluated physico-chemical parameters were: acid and peroxide value, and specific extinction at 270 nm (K_{270}) and 232 nm (K_{232}). Results are listed in Table 1. Expectedly, all samples analyzed presented satisfactory physico-chemical properties to be labelled as "extra virgin oil", the highest possible quality described by the official norm (Service de normalization industrielle marocaine (Snima)., 2003): maximum authorised values for acid and peroxide value, and specific extinction at 270 nm (K_{270}) and 232 nm (K_{232}) are 0.8, 15, 2.52, and 0.35, respectively.

Table 2 summarizes the results of the trace element composition found in the oils samples analyzed throughout this study. For most of the dietary elements evaluated, and with respect of the preparative method, similar amounts were found in edible (roasted kernels) and beauty (non-roasted kernels) oils. Calcium was the only element to be frequently in lower amount in beauty oil than in edible oil. Results were also similar to those reported in an independent study (Gonzalvez, Armenta, et al., 2010). Those results demonstrate that the roasting step has no influence on the dietary element content in argan oil. More precisely, it can be said that roasting modifies neither the dietary element content of the kernels nor the subsequent extractibility of these elements during the pressing step. Therefore, and at least for the eight element studied, no metal ion membrane-binding seems to occur between room-temperature and 110 °C. Metal content determination could