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Effect of processing on the quality of edible argan oil

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ABSTRACT

Sensory quality of edible oil is essential to get the consumer acceptance. Modifications during processing can alter edible oil sensory quality. The storage stability and sensory quality of argan oil prepared from (1) mechanically pressed unroasted kernels, (2) mechanically pressed roasted kernels, (3) hand-pressed roasted kernels, and (4) hand-pressed roasted kernels coming from goat-digested fruits was studied at room temperature and under accelerated conditions (60 °C). The roasting process had a positive effect on storage stability of the resulting oils, while argan oil prepared from mechanically pressed roasted kernels provides the optimum storage stability. Oil from hand-pressed roasted kernels originating from goat-digested fruits was not suitable for human consumption because of the unpleasant taste and odoûr. Only oil from mechanically pressed roasted kernels did not produce negative sensory attributes like *fusty* or *Roquefort cheese*.

1. Introduction

Argan tree (*Argania spinosa*) is only endemic in Southwestern Morocco where the argan forest was recognised as a biosphere reserve by the UNESCO in 1998. The argan forest is currently covering slightly more than 800,000 ha, but its extension was twice as large at the end of the nineteenth century (Morton & Voss, 1987). To avoid further deterioration and favour its sustainable development, an increase of its economic value is an absolute necessity. Argan oil has rapidly emerged as the only produce able to bring more wealth to the Berber population (Charrouf, Harhar, Gharby, & Guillaume, 2008), the traditional argan forest dwellers, because of its unique dietary and physiological properties (Charrouf & Guillaume, 1999; Charrouf & Guillaume, 2008). Thus, prospects for better economic return have encouraged dwellers to modernise argan oil production methods for the export market.

For years, argan oil has been prepared exclusively by Berber women following an ancestral multistep process (Charrouf, Guillaume, & Driouich, 2002). Between May and August, fallen ripe fruit are collected through the argan forest. Then, the fruits are sun-dried for a few days and their dried peel is manually removed, resulting in argan nuts. An average of 100 kg of dried-fruits and 15 h (single person) is necessary to obtain 60 kg of argan nuts. Argan nuts are then broken between two stones and the white kernels are collected. From 60 kg of argan nuts, only 6.5 kg of kernels are collected. To prepare edible argan oil, kernels have to be roasted for a few minutes but overheating should be avoided since it negatively influences the final oil taste. The roasted kernels are subsequently crushed using a millstone resulting in a brownish viscous liquid that is mixed with water. This dough is hand-malaxed for several minutes, slowly getting solid and releasing an emulsion from which argan oil is finally decanted.

Unfortunately, this method is very slow (for a single person 58 h of work are necessary to get 2–2.5 L of oil), leading to oil batches having variable organoleptic properties due to non-reproducible roasting (Charrouf, El Hamchi, Mallia, Licitra, & Guillaume, 2006) and chemical composition of oil batches (Hilali, Charrouf, El Aziz Soulhi, Hachimi, & Guillaume, 2005), and finally frequently raising bacteriological concerns.

Recently the preparation process of argan oil has been modified and high-quality argan oil can now be produced on a large scale (Charrouf et al., 2002).

Since edible argan oil is not refined, raw material quality and oil processing directly impact on its quality (Cayuela et al., 2008; Marfil et al., 2008). Sensory quality of vegetable oil can also deteriorate during storage. Changes occurring during fruit or seed storage (Gutierrez, Varona, & Albi, 2000; Kalua, Bedgood, Bishop, & Prenzler, 2008; Matthäus & Brühl, 2008), can also lead to oxidative reactions once the oil has been bottled. In this latter case, tocopherols (vitamin-E-active compounds) and sterols have been shown to be important factors involved in the sensory quality of olive oil

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(Gutierrez & Fernandez, 2002; Rasrelli, Passi, Ippolito, Vacca, & De Simone, 2002).

Up to now, very little is known about the influence of each processing step on the quality of argan oil during storage even though the involvement of tocopherols and sterols on oil quality has been suggested (Verhé, 2009). Therefore, we evaluated the concentration of these two types of compounds in argan oil as a function of storage time; the ultimate aim of the present study being to determine the effects of the production conditions on the sensory quality and storage stability of edible argan oil. Storage was at 20 °C for up to 20 weeks to relate to real storage conditions and at 60 °C for up to 35 days to accelerate the storage condition.

2. Material and methods

2.1. Production of argan oil

Peeled argan fruits (300 kg) were collected in Tiout (Province of Taroudant, Morocco) in 2007. Fruits were sun-dried for two weeks and then mechanically dehulled (SMIR Technotour, Agadir, Morocco). Argan nuts were manually opened using the traditional two-stone method (Charrouf et al., 2002) to get the kernels. A fraction of the nuts was roasted at 110 °C for 30 min (roaster: SMIR, Technotour Agadir, Morocco). Afterwards oil extraction was carried out as done traditionally or mechanically using a Komet DD 85 G press (IBG Monforts Oekotec GmbH & Co. KG, Mönchengladbach, Germany). Goat-digested argan fruits (120 kg) were treated as peeled collected fruits but argan oil was traditionally extracted.

Therefore, four types of argan oil were analysed: (1) argan oil from unroasted kernels, mechanically extracted; (2) argan oil from roasted kernels, mechanically extracted; (3) argan oil from roasted kernels, traditionally extracted; and (4) argan oil from goat-digested seeds, roasted and traditionally extracted.

For each oil type, 2.5 L of oil were prepared and kept in 200 mL brown glass bottles, resulting in the production of eleven bottles for each oil sample.

2.2. Storage of the oils

One bottle was used to evaluate the initial state of the oils with regard to the sensory quality and the oxidative state. Five bottles of a given oil type were stored at 20 °C ± 1 °C for 20 weeks and the five remaining bottles were stored at 60 °C ± 1 °C for 35 days. From the bottles stored at 20 °C, one bottle was used for sensory analysis and investigation of its chemical parameters every four weeks. For the bottles stored at 60 °C, one bottle was used for investigation of its chemical parameters every seven days.

2.3. Sensory evaluation

The sensory evaluation of the oil samples stored at 20 °C was carried out according to the DGF method C-II 1 (07) (DGF, 2008) with a panel of four trained tasters.

In order to perceive the aroma of the argan oils the oils were tasted in special blue coloured glasses typical for the sensory evaluation of olive oils. They were covered with a watch glass to gather/keep the volatile aroma compounds for the time of the sensory assessment session. Every glass was filled with the same amount of about 15 mL of oil to ensure that the oil develops an intense headspace aroma and the volatile compounds diffuse in the covered glass. The oils were evaluated at room temperature. The flavour and taste of the oils were characterised according to a sensory description form, previously developed by the sensory panel over a period of 3 years and assessment of nearly 300 different argan oils from different locations, production facilities, and types of process. A scoring system with a scale from 0 (not detectable) to 5 (strongly detectable) was used to characterise the typical (*nutty*, *roasty*) and atypical (*Roquefort cheese*, *rancid*, *wood-like*, *bitter*, *burnt*, *musty*, *yeast-like*, *fusty*, and others) attributes.

The data sets obtained from the sensory assessments were statistically evaluated in order to improve the reliability and repeatability of the results. Since the mean of the results for one attribute is influenced by every single result, especially by outliers, in the data set the median has been calculated as the best result. In addition the relative coefficients of variation of the results were calculated in order to get a rough estimation whether the final result is an unanimous result or a heterogeneous one. The relative coefficient of variation for the different attributes has to be below 15%.

2.4. Peroxide and anisidine values

The peroxide and anisidine value were determined following the DGF method C-VI 6a and DGF method C-VI 6e, respectively (DGF, 2008).

2.5. Vitamin-E-active compounds

For the determination of vitamin-E-active compounds a solution of 250 mg oil in 25 mL *n*-heptane was used for HPLC analysis. The analysis was conducted using a Merck–Hitachi low pressure gradient system, fitted with a L-6000 pump, a Merck–Hitachi F-1000 Fluorescence Spectrophotometer (detector wavelengths for excitation 295 nm, for emission 330 nm) and a D-2500 integration system. The sample (20 μL) was injected by a Merck 655-A40 autosampler onto a Diol phase HPLC column 25 cm × 4.6 mm ID (Merck, Darmstadt, Germany) used with a flow rate of 1.3 mL/min and heptane/*tert*-butyl methyl ether (99:1, v/v) as mobile phase (Balz, Schulte, & Thier, 1992; DGF, 2008). Results are given as mg vitamin-E-active compounds/kg oil.

2.6. Sterol composition

Sterol composition was evaluated by GLC-FID/capillary column. Briefly, sterols purified from the unsaponifiable matters by HPLC were transformed into their trimethylsilyl ethers counterparts using pyridine, hexamethyldisilazane, and trimethylchlorosilane 9:3:1 (v/v/v). The sterol profile was analysed using a gas-phase chromatograph fitted with a chroma pack CP SIL 8 C B column (30 m × 0.32 mm i.d.) and a flame ionisation detector. The temperature of the injector and detector were both 300 °C. The column temperature was 200 °C and programmed to increase at the rate of 10 °C/min to 270 °C. The carrier gas was dry oxygen-free nitrogen, and the internal pressure was 8.6 bar. Sterol quantification was achieved by use of an internal 0.2% chloroform solution of α-cholestanol.

2.7. Content of hexanal

Hexanal was determined by the method of dynamic headspace concentration (Brühl & Fiebig, 2005): About 200 mg of oil were weighed exactly into a 20 mL headspace vial, sealed and put into a PTA3000 (Axel Semrau, Sprockhövel, Germany) autosampler. Volatiles were purged with nitrogen at 10 PSI with a stream of 20 mL/min over the sample surface at 80 °C and trapped in an on-line Tenax trap (eight fold volume) at −65 °C using carbon dioxide cooling. After 20 min of trapping, all volatiles were removed by heating the trap to 200 °C for 10 min. The purge valve was held at 150 °C and the transfer line (uncoated fused silica) at 200 °C in order to avoid recondensation without any water trap in the system.