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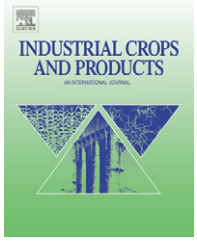

Changes in fatty acid composition of coriander (*Coriandrum sativum* L.) fruit during maturation

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ABSTRACT

Changes in fatty acids were studied during maturation of coriander (*Coriandrum sativum* L.) fruits cultivated in the North-East of Tunisia (Charfine). The fruits matured in 55 days after flowering (DAF). Oil and petroselinic acid synthesis proceeded at a steady rate up to 32 DAF. The first results showed a rapid oil accumulation started at newly formed fruits (9.6 ± 0.2%) and continued until their full maturity (26.4 ± 0.5%). During fruit maturation, fatty acid profiles varied significantly among the nine stages of maturity. At the 32th DAF, palmitoleic, gadoleic, erucic and docosahexenoic acids were not detected and petroselinic acid had a highest amount (84.8 ± 4.5%). Fruits development resulted mainly in an increase of petroselinic acid and a decrease of palmitic acid (C16:0). At full maturity, the main fatty acids were petroselinic acid (80.9 ± 5.7%), followed by linoleic (13.6 ± 2.9%), palmitic (3.6 ± 0.1%) and stearic (0.7 ± 0.1%) acids. Saturated and polyunsaturated fatty acids decreased significantly and monounsaturated fatty acids increased during maturation of coriander fruit. Coriander fruits at the first four stages of maturity have a healthy nutritional value and the last five stages were with important economic and industrial applications. Results of this study indicate that the variation in the fatty acid composition of coriander fruit during maturation may be useful in understanding the source of nutritionally and industrially important fatty acids in this fruit. Coriander fruit is potentially an important source of petroselinic acid which has numerous industrial applications.

1. Introduction

Nowadays, the development of new crops for the production of industrial oils is an area of significant interest both scientifically and environmentally. While methods are being developed for modifying the fatty acid content and composition of oils produced by established crops such as oilseed rape and soya beans (Murphy, 1991), another approach is to investigate alternative species as potential sources of specialist oils. An example of such a crop is the herb plant coriander (*Coriandrum sativum* L.), a member of the Umbelliferae family, whose fruits contain oils with a high concentration of the monounsaturated fatty acid, petroselinic acid. This acid can be oxidatively cleaved to produce a mixture of lauric acid, a compound useful in the production of detergents, and adipic acid, a C_6 dicarboxylic acid which can be utilized in the synthesis of nylon polymer (Murphy, 1991).

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Physical, biochemical, and physiological changes which occur during fruit development imply that intracellular variations play an important role in the distribution of different metabolites in the cells (Izzo et al., 1995). For years food analysts and plant physiologists have been interested in the effects of maturation on the chemical components in the industrial parts of fruits because of their impact in the market quality of some industrial products made with petroselinic acid derivatives.

Lipid components in fruits, though occurring in minor amounts, are presumed to contribute to the development of characteristic aromas and flavours during ripening as they are considered as precursors for various volatile odorous principles of fruits (Gholap and Bandyopadhyay, 1980). Supran (1978) reported that lipids contribute to the industrial and nutritional value as well as characteristic aromas and flavours.

Recent studies on the compositional analysis of *C. sativum* L. fruits have described essential oil changes during maturation (Msaada et al., 2006, 2007a,b, 2008), essential oil composition of different coriander parts (Msaada et al., 2003, 2007a,b) and fatty acid composition (Ramadan and Mörsel, 2002; Ramadan and Mörsel, 2006).

Unlike fruits of other species, changes in lipids and fatty acids during the development and ripening of *C. sativum* L. are still very scarcely reported. These changes have been studied, to our knowledge, only by Lakshminarayana et al. (1981) and Msaada (2007).

In the present study, we investigated for the first time the fatty acid composition isolated from the Tunisian coriander during fruit maturation. The results will be important as an indication of the potential economic utility of *C. sativum* L. as a raw material source for useful industrial oil components.

2. Materials and methods

2.1. Plant material

Coriander fruits were randomly collected at different ripening stages from cultivated plants in Charfine area (North-Eastern Tunisia; latitude 36°44′29.12″(N); longitude 10°40′51.26″(E), altitude 163 m) during May and June 2005. Charfine region is characterized by low annual rainfall of 700 mm and mean annual temperature of 16.8 °C. Harvest period was stretched from 5 days after flowering (DAF) to 55 DAF, the time required for complete maturity. The fruit's colour and relative moisture content were adopted as a ripening criterion (Table 1). Indeed, only full green fruits were harvested at the initial stages of maturity. Green-brown fruits were considered as indicators of the intermediate stages. Only brown fruits were selected for analysis during the final stages of maturity. Each harvest was undertaken after a decrease of moisture content by 10% (Table 1). Moisture contents were determined by heating in an air-oven at 60 °C to constant weight.

2.2. Oil extraction

Three samples of coriander fruits were finely ground in an electric grinder (IKA-WERK. Type: A: 10). Twenty grams of each ground material was extracted in a soxhlet-extractor with 100 ml hexane (Analytical Reagent, LabScan, Ltd., Dublin, Ireland) for 4 h. The extraction was protected from light. The extract was then filtered and after evaporation of the solvent under reduced pressure and temperature, the oil content was determined (Table 1).

2.3. Total lipid extraction and fatty acids methylation

Triplicate sub-samples of 0.5 g were extracted using the modified method of Bligh and Dyer (1959). Thus, fruit samples were kept in boiling water for 10 min to inactivate lipase (Douce, 1964) and then ground manually using a mortar and pestle. A chloroform/methanol (Analytical Reagent, LabScan, Ltd., Dublin, Ireland) mixture (1:1, v/v) was used for total lipid extraction. After washing with water and centrifugation at $3000 \times g$ for 10 min, the organic layer containing total lipids was recovered and dried under a nitrogen stream. Total fatty acids (TFA) were methylated by using sodium methoxide solution (Sigma, Aldrich) according to the method of Cecchi et al. (1985). Methyl heptadecanoate (C17:0) was used as an internal standard. Those fatty acids methyl esters (FAMEs) obtained were subsequently analyzed.

2.4. Gas chromatography

The fatty acid methyl esters were analyzed on a HP 6890 gas chromatograph (Agilent Palo Alto, CA, USA) equipped with a flame ionization detector (FID). The esters were separated on a RT-2560 capillary column (100 m length, 0.25 mm i.d., 0.20 mm film thickness). The oven temperature was kept at 170 °C for 2 min, followed by a 3 °C/min ramp to 240 °C and finally held there for an additional 15 min period. Nitrogen was used as carrier gas at a flow rate of 1.2 ml/min. The injector and detector temperatures were maintained at 225 °C. A comparison of the retention times of the FAMEs with those of co-injected authentic standards (Analytical Reagent, LabScan, Ltd., Dublin, Ireland) was made to facilitate identification.

2.5. Statistical analysis

All extractions and determinations were conducted in triplicate. Data is expressed as mean ± S.D. The means were compared by using the one-way analysis of variance (ANOVA) followed by Duncan's multiple range tests. The differences between individual means were deemed to be significant at $p < 0.05$. A principal component analysis (PCA) was performed in order to discriminate between different maturity stages on the basis of their fatty acids composition. All analyses were performed by the "Statistica v 5.1" software (Statsoft, 1998).

3. Results and discussion

3.1. Oil content

The evolution of oil content during coriander fruit ripening is reported in Table 1. Although a gradual increase was found, there were marked differences in oil content at different stages of ripening. As seen in Table 1, three episodes of oil accumulation can be distinguished. Indeed, a quick accumulation of oil