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Analytical Methods

Fatty acid composition of edible oils derived from certified organic and conventional agricultural methods

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Abstract

The objective of this study is to compare the fatty acid composition of commercially available edible oils derived from certified organic and conventional agricultural methods. A total of 59 certified organic and 53 conventional oils were purchased from retail markets in Sydney, Australia. Organic and conventional products were matched for comparison according to the description of production methods, labelled total fat content, brand name (wherever possible), and country of origin. Total fat was extracted and the fatty acid composition of the oils was determined by gas chromatography. No consistent overall trend of difference in the fatty acid composition was observed between organic and conventional oils. Saturated (SFA), monounsaturated (MUFA) and polyunsaturated (PUFA) fatty acids were all significantly different between types of oil ($P < 0.001$ in all three), and each had significant interaction between type and production method ($P = 0.002$, $P < 0.001$ and $P < 0.001$, respectively) indicating that organic and conventional oils differed in these components in an inconsistent fashion. Despite this, there were large differences particularly between MUFA and PUFA components in specific pairs of oils, especially in sunflower and mustard seed oils. The absence of an overall difference in the fatty acid composition of organic and conventional oils does not support the tenet that organic foods are of a higher nutritional quality than their conventional counterparts.

Keywords: Fatty acids; Oil; Organic; Conventional

1. Introduction

Organic agricultural practices aim to enhance biodiversity, biological cycles and soil biological activity so as to achieve optimal natural systems that are socially, ecologically and economically sustainable. Although there is no recognised worldwide standard for organic agriculture, a number of international organisations have developed basic frameworks against which organic production methods can be measured. The International Federation of Organic Agriculture Movements (IFOAM) has established standards for organic production, labelling, and certification procedures to be enforced by national organic associations (Australian Certified Organic, 2006). The Food and Agriculture Organization (FAO)/World Health Organization (WHO) (1999) Codex Alimentarius Commission has produced guidelines as a first step towards official international harmonisation of the requirements for organic products in terms of production and marketing standards, inspection arrangements and labelling requirements.

Consumer studies indicate that one of the primary reasons for purchasing organic food is the perception that it conveys nutritional advantages over conventional products (Bourn & Prescott, 2002; Magkos, Arvaniti, & Zampelas, 2003; Shepherd, Magnusson, & Sjödén, 2005; Williams, 2002). Reviews of the literature, however, have demonstrated few and inconsistent differences in the nutrient composition of organically produced foods compared to foods that have been produced by conventional methods (Bourn

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& Prescott, 2002; Magkos et al., 2003; Woese, Lange, Boess, & Bögl, 1997). Comparisons between studies are made difficult by the large variability in study design and methodology (Woese et al., 1997; Worthington, 2001). Nonetheless, there are indications that many organic food varieties have a lower nitrate content (Bourn & Prescott, 2002; Magkos, Arvaniti, & Zampelas, 2006; Siderer, Maquet, & Anklam, 2005; Worthington, 2001) and a higher vitamin C content (Magkos et al., 2003; Williams, 2002; Worthington, 2001) than their conventional counterparts.

A small number of studies have reported on the effect of agricultural methods on the fatty acid composition of meat and dairy products. Milk produced through organic practices has been shown in some instances to contain higher amounts of alpha-linolenic acid (ALA) (Bergamo, Fedele, Iannibelli, & Marzillo, 2003; Ellis et al., 2006; Fievez & Vlaeminck, 2006; Jahreis, Fritsche, & Steinhart, 1996) and conjugated linoleic acid (CLA) (Bergamo et al., 2003; Fievez & Vlaeminck, 2006; Jahreis et al., 1996); while other reports demonstrated no clear effect of local management practices on the presence of ALA (Toledo, Andrén, & Björck, 2002) or CLA (Ellis et al., 2006; Toledo et al., 2002). Organic milk has been found to contain a lower $n-6$:$n-3$ fatty acid ratio when compared with conventional milk (Ellis et al., 2006; Wong, Ahmad, Phuyal, & Samman, 2006). The fat quality of lamb is reported to reflect differences in the fatty acid composition of the animal feed rather than a specific metabolic impact of the production method (Nürnberg et al., 2006) and steers raised by organic or conventional methods showed no difference in the fatty acid composition of muscle tissue (Walshe, Sheehan, Delahunty, Morrissey, & Kerry, 2006). Organic chicken breast, based on a sample of 2 chickens, is reported to have lower ALA and higher linoleic acid (LA) compared to 2 conventionally produced chickens (Jahan, Paterson, & Spickett, 2004).

There is limited research comparing the effect of production methods on the fatty acid composition of edible oils. Perretti, Finotti, Adamuccio, Della Sera, and Montanari (2004) reported that the fatty acid composition of sunflower seed oil was unaffected by the method of production, whereas Gutierrez, Arnaud, and Albi (1999) found that the oleic acid concentration tended to be higher and the level of LA lower in organic compared to conventional virgin olive oil. The objective of the present analysis is to compare the fatty acid composition of a range of commercially available certified organic and conventionally produced edible oils.

2. Materials and methods

2.1. Sample collection

During the period from August to September 2006, samples of commercially available certified organic oil products were purchased from supermarkets, organic retail outlets and health food stores in the Sydney metropolitan region. The selected products were certified organic by accredited certifying organisations. Conventional products were purchased for comparison with their organic counterparts based on criteria that included, wherever possible, the description of the production methods, the labelled total fat content, brand name, and the country of origin. A total of 59 organic and 53 conventional samples were obtained of 10 different types of oil, comprising 51 organic-conventional pairs and 10 unpaired oils (8 organic and 2 conventional).

2.2. Lipid extraction and analysis

Lipids were extracted from duplicate samples of oil by chloroform/methanol (Bligh & Dyer, 1959). Fatty acid methyl esters (FAME) were prepared by direct transesterification (Lepage & Roy, 1986), and analysed by gas chromatography (Agilent 6850 series, Santa Clara, CA) with flame ionisation detection. FAME were analysed using a fused carbon–silica capillary column (phase: cyanopropylphenol, 25 μm; column: 30 m × 0.25 mm; type: DB-225, J & W Scientific, Folsom, CA). The flow rate of the hydrogen carrier gas was 1.0 ml/min, at a pressure of 500 kPa. The injector port and detector temperature were maintained at 300 °C. The oven temperature was programmed to maintain a temperature of 170 °C for 2 min, then rise to 190 °C at 10 °C/min and maintain for 1 min, before rising to a plateau of 220 °C at a rate of 5 °C/min. The total run time for one cycle was 25 min. Hewlett–Packard Chem Station Software (v 4.0.1.1) was used to calculate peak areas and retention times. FAME were identified by comparing retention times with a commercial standard mixture of 19 FAME (GLC 68, Nu-Check Prep, Elysian, MN).

2.3. Statistical comparison

The organic and conventional samples were compared with respect to classes of fatty acids (SFA, MUFA, PUFA) using an analysis of variance model with type of oil and method of production (organic or conventional) as fixed factors, and sample pair as a random factor. Preliminary analyses confirmed that fatty acid components were very different in terms of type of oil, but also different in terms of method and the interaction of type with method. Further analyses were conducted for each oil type separately. For those oils with a small number of pairs (that is, all except olive oil), non-parametric versions of the analyses were also conducted, and these results were preferred when they differed from the parametric versions: oils with fewer than three pairs were not compared statistically. All formal analyses were carried out using SPSS version 14 (Chicago, USA).

3. Results

A total of 59 certified organic and 53 conventional samples were available for analysis in the present study. Valid comparisons between organic and conventional products