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FULL LENGTH ARTICLE

Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco

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Abstract The objective of this research work was to determine the characteristic features of the oil content and composition of nutrients of sesame seeds grown in Morocco. Characteristic features of the seed oil revealed a high degree of unsaturation and as determined by gas chromatography reported herein, the major unsaturated fatty acids were linoleic acid (46.9%) followed by oleic acid (37.4%), while the main saturated fatty acid was palmitic acid (9.1%). Sesame seed oil was also found to be rich in tocopherols with a predominance of γ-tocopherol (90.5%). The phytosterol marker β-sitosterol accounted for 59.9% of total sterols contained in sesame seed oil. This oil, therefore, has a potential for its use in human nutrition or industrial applications. Compositional analysis revealed that the sesame seeds contained considerable amounts of protein (22%) and high amounts of lipids (52%). Nutrient information reported herein illustrates the benefits to public health for consumers of these plant seeds. In terms of oil, sesame seed oil may be considered as a valuable source for new multi-purpose products as industrial, cosmetic, and pharmaceutical uses.

1. Introduction

Sesame seed (*Sesamum indicum* L.) is one of the world's most important and oldest oil seed crops known to man (Abou-Gharbia et al., 2000). The genus sesamum is a member of the family *Pedaliaceae*, which contains 16 genera

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and 60 species (Hassan, 2012). Sesame seed, a rich source of protein, is one of the first crops processed for oil production (Anilakumar et al., 2010), also known as bennissed, benne, sesamum, gingelly, sim–sim and tila (Hassan, 2012). It has been cultivated for centuries, particularly in Asia and Africa specially Sudan, Ethiopia and Nigeria (FAO, 2003). Nearly 70% of the world production is from Asia. Africa grows 26% of the world's sesame, with Sierra Leone, Sudan, Nigeria and Uganda being key producers. Latin America grows 4% of the total world production (Abou-Gharbia et al., 2000). Sesame plays an important role in human nutrition, medicinal, pharmaceutical, industrial and agricultural uses. Sesame seed has many culinary applications in many bakery products and for the oil production (raw or roasted). Sesame seed oil is very rich in polyunsaturated fatty acids used in margarine production and cooking oils. Sesame contains significant amounts of the lignans sesamin and sesamolin. These compounds have beneficial effects on serum lipid levels and liver function and give sesame seed oil a marked antioxidant activity. The lignans are also responsible for the great stability of sesame seed oil to oxidation (Crews et al., 2006). All these substances have been shown to possess cholesterol-lowering effect in humans (Ogawa et al., 1995; Hirata et al., 1996) and to prevent high blood pressure and increase vitamin *E* supplies in animals (Yamashita et al., 1992; Kamal-Eldin et al., 1995). Sesame seeds are an excellent source of copper and calcium. It is also rich in phosphorous, iron, magnesium, manganese, zinc and vitamin B1. Many medicinal properties and health benefits of sesame may be attributed to its mildly laxative, emollient and demulcent (Anilakumar et al., 2010). Sesame seed oil has been found to inhibit the growth of malignant melanoma in vitro and the proliferation of human colon cancer cells (Smith and Salerno, 1992). In the tissues beneath the skin, this oil neutralizes oxygen radicals. It penetrates into the skin quickly and enters the blood stream through the capillaries. Sesame seed oil is a useful natural UV protector. It has been successfully used in the children's hair to kill lice infestations (Anilakumar et al., 2010). Sesamin has bactericide and insecticide activities (Anilakumar et al., 2010). Sesamolin also has insecticidal properties and is used as a synergist for pyrethrum insecticides (Sirato-Yasumoto et al., 2001; Morris, 2002).

The chemical composition of sesame shows that the seed is an important source of oil (50–60%), protein (18–25%), carbohydrates and ash (Sabah El Khier et al., 2008). The oil fraction shows a remarkable stability to oxidation due to the presence of antioxidants (sesamol, sesamolin and sesamin) together with tocopherols. The quantity and quality of the oil contained in the seed have been shown to depend on ecological, genetics and physiological factors such as climate, soil type, cultivars and maturity of plant respectively (Rahman et al., 2007).

For the assessment of the nutritional and economical value of oilseeds the knowledge on the compositional factors is very essential in connection with the properties. Therefore, the main objective of this study was to analyze the physical and chemical investigation on the seed and seed oil of sesame cultivars grown in Morocco and compare their biochemical properties with other countries.

2. Material and methods

2.1. Plant material and chemicals

Cultivation of Sesame seeds was performed in the region of Tadla-Azilal situated in central Morocco (32°20′North 6°21′West). Seeds were harvested in June 2014 in the agricultural province of Tadla (Region of Tadla-Azilal, central Morocco). After harvest, the seeds were stored at 4 °C until processed.

All the reagents were of analytical or HPLC grade. Isooctane and isopropanol used as HPLC mobile phase and cyclohexane used for extinction coefficient determination were purchased from Professional Labo (Casablanca, Morocco).

2.2. Seed analysis

Seed moisture content, expressed as percentage by mass, was determined using 5 g of seeds by adapting the AOAC method 934.06 (AOAC, 1990). A Jouan Quality Systems oven regulated at 105 °C was used. The difference between the results of two last determinations was 0.1 g of moisture per 100 g of sample. Oil yield was calculated following the DIN EN ISO 659 recommendation (ISO 659, 2009).

Nutritional composition of sesame seed oil cake was determined using the recommended methods of the Association of Official Analytical Chemists (AOAC, 2005). Ash content was determined by incinerating 5 g of oil seed at 550 °C in a muffle furnace. Crude protein content was calculated from the nitrogen content measured by the Kjeldah procedure with Gerhardt model Vapodest 20 instrument, using a factor 6.25. Crude fiber was determined according to the gravimetric procedure on defatted samples.

2.3. Sesame seed oil analysis

Oil extraction: Press-extraction was carried out using screwless cold presses (IBG Monforts Oekotec GmbH, Monchengladbach, Germany). Oil samples were stored at 4 °C and protected from sunlight prior analysis.

Fatty acid composition was determined using method ISO 5508 (1990). Before analysis, fatty acids (FAs) were converted to fatty acid methyl esters (FAMEs) by shaking a solution of 60 mg oil and 3 mL of hexane with 0.3 mL of 2 N methanolic potassium hydroxide. FAs were analyzed by gas chromatography using a Varian CP-3800 (Varian Inc.) chromatograph equipped with a FID. The column used was a CP-Wax 52CB column (30 m × 0.25 mm i.d.; Varian Inc., Middelburg, The Netherlands). The carrier gas was helium and the total gas flow rate was 1 mL/min. The initial and final column temperature was 170 °C and 230 °C, respectively, and the temperature was increased by steps of 4 °C/min. The injector and detector temperature was 230 °C. Data were processed using a Varian Star Workstation v 6.30 (Varian Inc., Walnut Creek, CA, USA). Results were expressed as the relative percentage of each individual FA present in the sample.

Sterol composition was determined using method ISO 6799 (1991), after trimethylsilylation of the crude sterol fraction, using a Varian 3800 instrument equipped with a VF-1 ms