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Snapdragon (*Antirrhinum majus*) seed oil: Characterization of fatty acids, bioactive lipids and radical scavenging potential

Mohamed Fawzy Ramadan[a,*], Hesham El-Shamy[b]

[a] *Agricultural Biochemistry Department, Faculty of Agriculture, Zagazig University, 44519 Zagazig, Egypt*
[b] *Horticulture Department, Faculty of Agriculture, Zagazig University, 44519 Zagazig, Egypt*

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ABSTRACT

Lipid classes, fatty acids, phytosterols and tocopherols composition of snapdragon (*Antirrhinum majus*) seed oil were determined. *A. majus* seeds are a good source of oil (12.3%). The amounts of neutral lipids in the oil were the highest, followed by glycolipids and phospholipids. Linoleic and oleic accounted for 88% of the total fatty acids. Snapdragon seed oil is characterized by a relatively high amount of phytosterols, wherein the sterol marker was β-sitosterol. All tocopherol isomers were present, wherein γ-tocopherol constituted 81% of the total tocopherol content followed be β-tocopherol (*ca.* 14.3%). The radical scavenging activity (RSA) toward 1,1-diphenyl-2-picrylhydrazyl (DPPH) radicals and galvinoxyl radicals of *A. majus* oil were higher than those of extra virgin olive oil. The diverse potential uses of *A. majus* oil may make this plant into significant industrial importance.

1. Introduction

Trend toward natural ingredients and products promoting health is likely to increase. Non-conventional seeds are being considered because their constituents have unique chemical properties and may augment the supply of nutritional and functional products. Owing to their medicinal and healing properties as well as the health-boosting constituents, non-traditional plant oils are used in the healthcare industry (Ramadan et al., 2009).

Snapdragon (*Antirrhinum majus*, Family Plantaginaceae) is a species of plants belonging to the genus *Antirrhinum*. It is herbaceous annual flowering plant (Fig. 1) native to the Mediterranean region (Oyama and Baum, 2004). *A. majus* is propagated easily by seeds and grows nicely in flower beds, borders and containers. *A. majus* is widely used as an ornamental and is one of the model species in genetic regulation research (Mateu-Andres and De Pacol, 2005; David et al., 2006). *A. majus* plants contain four major iridoid compounds, *i.e.* antirrhinoside, antirrhide, 5-glucosyl-antirrhinoside and linarioside (Franzyk et al., 1998; Høgedal and Mølgaard, 2000). The plant has bitter and stimulant properties and the numerous seeds (Fig. 2) yield an oil said to be little inferior to olive oil (Mateu-Andres and De Pacol, 2005; David et al., 2006). However, no data concerning the chemical composition and antioxidant properties of *A. majus* seed oil are yet available.

Natural oils contain, apart from triacylglycerols, a number of bioactive lipophilic compounds with a very diverse chemical makeup. Among the most interesting are the polar lipids, sterols and fat-soluble vitamins. In this work, lipid classes, fatty acids and fat-soluble bioactives of *A. majus* seed oil have been analyzed for the first time. The objective of this investigation was to obtain informative profile about the chemical nature of *A. majus* seed oil which will serve as a basis for further detailed chemical investigation and nutritional evaluation of the *A. majus* seeds. The results, furthermore, will be important as an indication of the potentially nutraceutical and economical utility of *A. majus* seeds as a new source of edible oils.

2. Materials and methods

2.1. Materials

A. majus seeds were collected in 2009 from the experimental garden at Faculty of Agriculture, Zagazig University (Egypt). Neutral lipid **(NL)** standards were from Sigma Chemical Co. (St. Louis, MO, USA). Standards used for glycolipids (GL) identification; monogalactosyldiacylglycerol (MGD), digalactosyldiacylglycerol (DGD), cerebrosides (CER), steryl glucoside (SG) and esterified steryl glucoside (ESG) were of plant origin (plant species unknown) and purchased from Biotrend Chemikalien GmbH (Köln,

* Corresponding author. Tel.: +20 122 9782424/55 2320282; fax: +20 55 2287567/2345452.
E-mail address: hassanienmohamed@yahoo.com (M.F. Ramadan).

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Fig. 1. *Antirrhinum majus* is herbaceous perennial plant growing to 0.5–1 m tall, rarely up to 2 m. The leaves are spirally arranged, broadly lanceolate, 1–7 cm long and 2–2.5 cm broad. The flowers are produced on a tall spike, each flower is 3.5–4.5 cm long, zygomorphic, with two 'lips' closing the corolla tube; wild plants have pink to purple flowers, often with yellow lips. The fruit is an ovoid capsule 10–14 mm diameter, containing numerous small seeds. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of the article.)

Germany). Standards used for phospholipids (PL) identification; phosphatidylserine (PS), phosphatidylethanolamine (PE), phosphatidylinositol (PI) from Bovine liver and phosphatidylcholine (PC) from Soybean were purchased from Sigma (St. Louis, MO, USA). Standards used for sterols (ST) characterization were purchased from Supelco (Bellefonte, PA, USA). Lanosterol (L408, 40–60%) was purchased from Aldrich (St. Louis, MO, USA). 3β-hydroxy-5α-cholestane (dihydrocholesterol) was used as internal standards (ISTD) and was purchased from Sigma (St. Louis, MO, USA). Standards used for vitamin E (α-, β-, γ- and δ-tocopherol) were purchased from Merck (Darmstadt, Germany). Extra virgin olive oil was from a local market (Zagazig, Egypt). The total phenolic compounds content in olive oil as determined by the Folin–Ciocalteu at the beginning of the analyses was 337 mg/kg as gallic acid equivalent.

2.2. Methods

2.2.1. Solvent extraction of total lipids (TL)

Seeds (moisture content 9%) were fine powdered using high-speed mixer, and milled into a fine particle sized (*ca.* 20–50 μm) meal, which was sticky in consistency, then subjected to Soxhlet extraction using *n*-hexane for 14 h. TL recovered were stored at 4 °C for further analysis.

2.2.2. Column chromatography (CC) and thin-layer chromatography (TLC) of lipid classes

TL were separated into different classes by elution with solvents over a glass column (20 mm dia × 30 cm) packed with a slurry of activated silicic acid (70–230 mesh; Merck, Darmstadt, Germany) in chloroform (1:5, w/v). NL was eluted with 3-times the column volume of chloroform. The major portion of GL was eluted with 5-times the column volume of acetone and PL with 4-timed the column volume of methanol. By means of TLC on Silica gel F_{254} plates (thickness = 0.25 mm; Merck, Darmstadt, Germany) a further characterization of GL and PL subclasses was carried out with the following solvent system chloroform/methanol/ammonia solution 25% (65:25:4, v/v/v). For the characterization of NL subclasses TLC plates were developed using *n*-hexane/diethyl ether/acetic acid (60:40:1, v/v/v). For the detection of the lipids, TLC plates were sprayed with the following agents: for the marking of all lipids with sulfuric acid (40%), for the marking of GL with α-naphthol/sulfuric acid and for the marking of PL with the molybdate-blue reagent (Kates, 1986; Ramadan et al., 2006). Each spot was identified with lipid standards as well as their reported retention factor (R_f) values. Individual bands were visualized under UV light, scraped from the plate and recovered by extraction with chloroform/methanol (2:1, v/v).

For the quantitative determination of NL subclasses individual bands were scraped from the plate and recovered by extraction with 10% methanol in diethyl ether, followed by diethyl ether. Data presented are the average of three gravimetrically determinations. For the quantitative estimation of GL subclasses, the acetone fraction obtained from CC was separated by TLC in the above given solvent system. The silica gel regions with the corresponding GL subclasses were scraped out followed by hexose measurement at 485 nm using the phenol/sulfuric acid in acid-hydrolyzed lipids

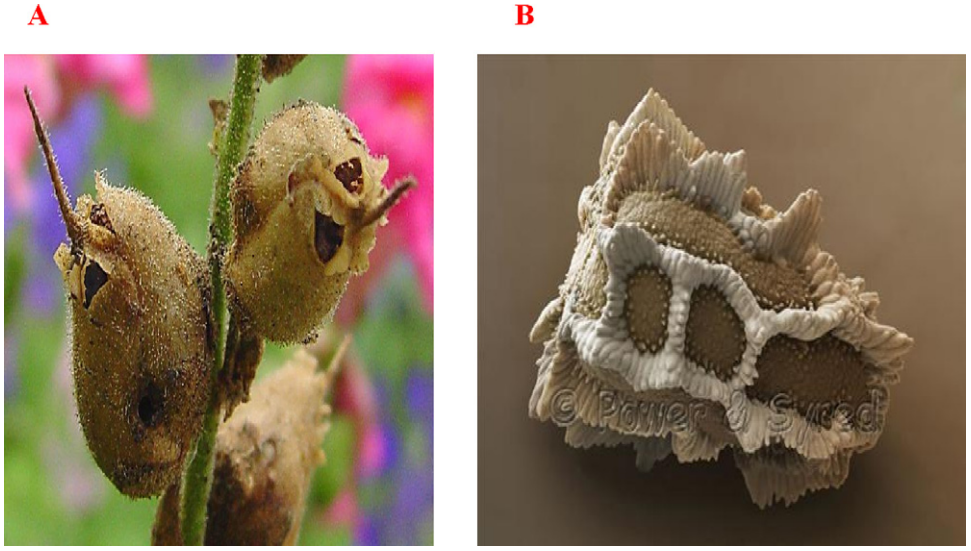

Fig. 2. *A. majus* seedpods (A) full of seeds and scanning electron micrograph (B) of *A. majus* seeds (magnification 134×). Small seeds have very roughly textured coats. The ridges and craters are produced by outgrowths of the integument. Their purpose is to trap small particles of soil, so that when the seed falls to the ground it is anchored and can germinate.