Influence of dielectric heating on quality of rape and sunflower seeds

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Dedicated to the hearts of my mother Badeah, my father Schehadeh,
and my sisters Montada and Edrak

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Abbreviations

DM	dry matter
Mill. ha	million hectare
Mill. t	million ton
APX	ascorbate peroxidase enzyme
SOD	super oxide dismutase enzyme
PLD	phospholipase enzyme
LOX	lipoxygenase enzyme
POX	peroxidase enzyme
CAT	catalase
O_2^-	superoxide radical
$OH^\cdot$	hydroxyl radical
H_2O_2	hydrogen peroxide

1. Introduction

1.1. Importance of oilseeds

An increased interest has been recently developed in the quality of oilseeds and their main product oil, due to their nutritional values, which play an essential role in a healthy balanced diet (McKevith, 2005). Oil crops and their products are considered as a critical part of the food supply of the world and they present the second most valuable commodity in the world trade (Abulude et al., 2007). In 2008, the world oilseeds production accounted 391.5 mill. t (USDA, 2008), while their oil consumption accounted 125.8 mill. t (USDA, 2008).

Nutritional properties of oilseeds depend on their chemical characteristics, mainly fatty acid composition, oil content, proteins, tocopherols as well as anti-nutritional components, e.g. glucosinolates and polyphenolic compounds (Bartkowiak-Broda, 2006; Bomb et al., 2007; Yaqoob, 2010). Oilseeds such as soybean, cotton, rape, sunflower and peanut are the main sources of vegetable oils (Gunstone, 2002; USDA, 2008). They are one of the main food ingredients, which represent a major source of natural plant antioxidants (Wanasundara et al., 1997; Shahidi, 2000). Additionally, oilseeds are dense energy foods and they can provide approximately 37672.2 joule of energy per gram as a fat (McKevith, 2005).

Oilseeds contain several non-fat nutritive constituents such as protein, fiber, plant sterols, and minerals such as phosphorus, iron, copper and magnesium (Rainey and Nyquist, 1997; McKevith, 2005). Furthermore, oils are the main carrier of fat–soluble vitamins E, D, K and A (McKevith, 2005), and they are recognized as one of the main sources of essential fatty acids (McKevith, 2005; Latif, 2009).

1.1.1. Oilseed rape (*Brassica napus L.*)

Brassica napus L. (Rapeseed, oilseed rape) belongs to the Cruciferous (Brassicaceae) family. Due to its high content of oil, and the high nutritional value as a main source of the non-fat nutritive constituents such as crude protein and fiber (Tab. 1), rapeseed represents the se-

cond important agricultural oilseed crop with 12 % of the world oilseed production (Fig. 1, USDA, 2008). In addition, it is the third important source of consumed vegetable oil with 15 % of the world oil consumption (Fig. 2, USDA, 2008).

The seeds of conventional Brassica species are characterized by their high content of erucic and eicosenoic acids (Becker et al., 1999). Erucic and eicosenoic are the main very long chain fatty acids, and they account together 45 – 60 % of the total fatty acid content of rapeseed oil (Nath et al., 2009). In addition, rapeseed contains a high content of glucosinolates, which are found in all parts of the plant (Hom, 2004).

Due to the undesirable taste and risks of erucic acid and glucosinolates for the health, new varieties of rapeseed are hybridized to be low in erucic acid content in the seed oil with a low content of glucosinolates in the seeds (Hom, 2004; Nath et al., 2009). These varieties contain less than 2 % erucic acid as a percentage of the total fatty acid content of the oil and less than 25 µmol/g glucosinolates in air-dried seeds (Hom, 2004).

The genetically modification of oilseed rape made it sufficient to be a major source of a valuable oil for human nutrition, with a high quality and a suitable fatty acid composition, which is rich in the mono-unsaturated fatty acid oleic as well as the essential poly-unsaturated fatty acids linoleic and linolenic (Hom, 2004; Nath et al., 2009).

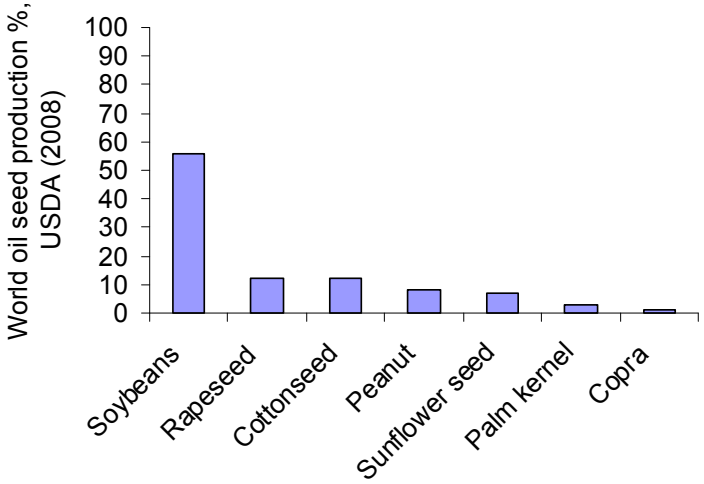

Fig. 1: World oil seed production %, USDA (2008)

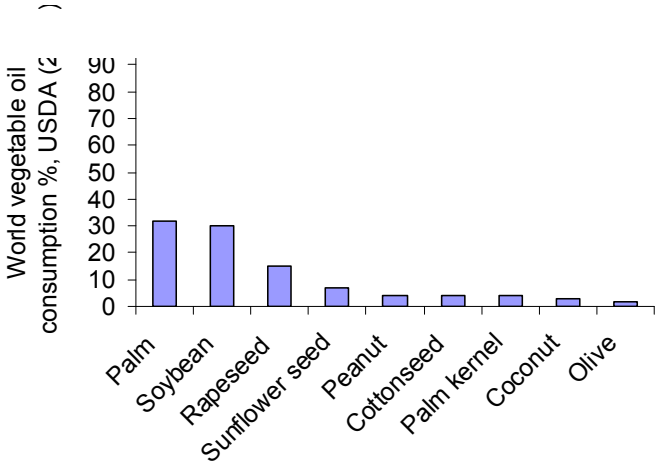

Fig. 2: World vegetable oil consumption %, USDA (2008)

1.1.2. Sunflower (*Helianthus annuus* L.)

Sunflower is a member of the Compositae family (Asteraceae). Sunflower seeds are an excellent source of oil, protein, minerals and dietary fiber (Tab. 1). In addition, sunflower oil, in comparison to any other vegetable oil, is the main supplier of tocopherols that are the most powerful natural fat-soluble antioxidants, which account 534 to 1858 mg/kg oil of sunflower seeds (Dolde et al., 1999). Thus, sunflower seeds are used in food industry as a main source of the oil in the world and mainly in Europe (Verhoog, 2002; McKevith, 2005). Sunflower represents the fifth place with 7 % of world oilseeds production (Fig. 1, USDA, 2008), and the fourth place with 7 % of world oil consumption (Fig. 2, USDA, 2008). It is cultivated in a region of 23 mill. ha in 40 countries of the world (Radić et al., 2009).

The oils of native sunflower varieties are rich in linoleic fatty acid, as a ratio of their total fatty acid content, which give them higher nutritional values; thus, they are used exclusively for human nutrition (Santalla and Mascheroni, 2003; Baydar and Erbas, 2005).

Genetically modification of sunflower varieties was applied to increase levels of oleic fatty acid in their oils up to 85 % of the total fatty acid content with lower proportion of saturated fatty acids in comparison to linoleic sunflower oil (Santalla and Mascheroni, 2003; Baydar and Erbas, 2005). Nowadays the hybridized of high oleic sunflower is widespread and it is considered as a special type of oilseed with high nutri-

tional properties (Santalla and Mascheroni, 2003; Baydar and Erbas, 2005).

Tab. 1: Chemical composition of whole rape and sunflower seeds (% DM)

	Rape seed	Sunflower seed
Dry matter	91.9	92.8
Oil	47.7	48.61
Crude protein	21.8	16.7
Crude fiber	8.1	17.3
Ash	4.7	3.5

Source: www.sustoil.org; Visited Date: 4th, July. 2011

1.2. Fatty acid composition of rape and sunflower seeds

The main components of oilseeds are the oil bodies or oleosomes. Their structure consisting of the storage lipids, triacylglycerols, with a percentage of 94 – 98 % of the dry weight surrounded by a monolayer of the membrane lipids, phospholipids, and bounded with oleosins and some minor proteins of higher molecular mass (Virginie et al., 2008). Triacylglycerols are defined as the glycerol molecule backbones with three fatty acid molecules branched off them (Suriyong, 2007). They represent almost 100 % of the weight of vegetables oils (Yoshida et al., 2001). Furthermore, they are main sources of acyl groups composing 90 % of cell membrane lipids in oilseeds (Suriyong, 2007). Natural oils are a mixture of triacylglycerols of saturated and unsaturated fatty acids (Terigar, 2010). The percentages of saturated and unsaturated fatty acid content of oilseeds oils differ considerably depending on the genotypes (Codex standard, 1999; Baydar and Erbas, 2005; Kavera, 2008).

Low erucic rapeseed oil is rich in the essential unsaturated fatty acids, with 51 – 70 % oleic acid, 15 – 30 % linoleic acid, and 5 – 14 % linolenic acid, as a percentage of its total fatty acid content (Tab. 2). Saturated fatty acids mainly palmitic, stearic and arachidic acids represent a low proportion of total fatty acid content of rapeseed oil (Tab. 2).

Native sunflower oils are rich in linoleic acid, with 48.3 – 74.0 % of the total fatty acid content, whereas the content of oleic acid ranges from