Effects of osmopriming on fatty acid content in three canola (*Brassica napus*) cultivars

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Abstract

Canola production in Iran is growing fast and the area allocated to this crop in the last five years has almost doubled. Water stress is the most common stress in Iran to which canola crop is exposed. Seed priming can lead to better establishment in crops under water stress. Seed priming is a technique of controlled hydration and drying that result in more rapid germination when the seeds are reimbibed. In this study, fatty acid contents of three canola cultivars were measured under various priming treatments. Seeds were primed at two time (12 and 24 hours) and five priming concentrations using polyethylene glycol (PEG) 6000 (0, -10, -12, -14, -16, -18 bar). Contents of palmitic acid, palmitoleic acid, margaric acid, stearic acid, oleic acid, linoleic acid, linolenic acid, arachidic acid, and erucic acid were measured in SLM0496, Okapy, and Licord cultivars. Comparing primed and non-primed seeds, the results showed that at 12 hours of priming the amounts of all fatty acids except palmitoleic acid and stearic acid were reduced. At both intervals (12 and 24 hours), priming increased the levels of palmitoleic and stearic acids. Higher osmotic potential of PEG increased the contents of six fatty acids. This didn't happen for three fatty acids, namely, palmitoleic, margaric and stearic acids. Significant differences were detected between cultivars for all fatty acids except palmitic acid. Averaged over all, for pamitoleic acid, SLMO496 cultivar; and for margaric, steraric, arachidic, erucic, and oleic acid, Okapy cultivar had the highest contents. Licord cultivar exhibited the least fatty acid contents.

Key words: fatty acid, *Brassica napus*, osmopring

Introduction

Traditionally, the fatty acid composition of the oil has been considered to be the main factor defining oil quality. Therefore, grate agronomical and breeding efforts have been devoted to its modification for special purposes, including both food and nonfood uses of the oils. With few exceptions in which significant maternal effects have been reported, fatty acid concentration is determined by the genotype of the developing embryo and environmental factors (Velasco, Perez-Vich and Dernandez-Matinez, 1999). Germination enhancement technologies based on presowing seed hydration have attracted considerable interest in both seed physiological research. In recent years, the meaning of the term priming has evolved from its original specific sense of increased germination synchrony and is now commonly used to describe seed presowing hydration methodologies without discrimination where seeds are imbibed by whatever means (McDonald, 2000). Very few studies have been conducted specifically relating to primed seeds. The purpose of this study was to evaluate the role of osmopriming on accumulation of fatty acid contents which can be used as a marker for priming effects on antioxidant activities in canola seeds.

Materials and Methods

Three canola cultivars, namely, SLM046, Okapy, and Licord were used in this study. For seed priming, canola seeds were treated with polyethyleneglycol (PEG) 6000 at five concentrations -10 (P1), -12 (P2), -14 (P3), -16 (P4), and -18 (P5) bars (Michel and Kaufmann, 1973) for 12 (T1) and 24 (T2) hours. 500 seeds were placed in Petri dishes containing 5 cc of PEG and transferred to germinator at 25±1 and 75% RH. At aforementioned time intervals, 200 seeds were removed from germinator and used for fatty acid evaluation. For fatty acid determination, the method of Metcalfe et al., (1966) was used. Gas Chromatography instrument, model UNICAM 4600, with capillary column BPX70 having 30 cm length was used for fatty acid discrimination.

Results

Priming treatments for 12 hours a -14, -16, and -18 bars reduced the palmitic acid contents in SLM064 cultivar (Table 1). At -18 bar, the content of this acid reduced by almost 60%. However, the responses of other cultivars were not similar. For Okapy cultivar, this reduction was detected at -10 and -12 bars. Comparing to control, in Licord, priming at -10 bar reduced the acid palmitic content by 61%. Except for SLM064, priming at 12 hours did not change the palmitic acid content in other canola cultivars dramatically. Priming for 24 hours at -14 bar reduced the palmitic acid content in SLM064 by 39% (Table 1).

Palmitoleic acid increased in three canola cultivars at all priming treatments (Table 2). However, cultivars did not respond similarly. For Licord cultivar, 12 hours and 24 hours of priming resulted in a various pattern of acid content. Palmitoleic acid content most affected by PEG treatments. The highest concentration of this acid was increased by 84% and 138% for 12 and 24 hours of priming, respectively. Similar to Licord cultivar, priming at 24 hours increased significantly palmitoleic acid content of SLM063 and Okapy cultivars (Table 2).

Table 1.Palmitic acid contents (16:0) of three canola seed cultivars at various priming treatments.

Priming treatment	Cultivar			Mean
	SLM046	Okapy	Licord	
0	8.61def	8.29efg	9.38cde	8.76A
T1P1	9.48cde	4.82h	3.60hi	5.97G
T1P2	9.13cde	2.65i	8.91de	6.90EF
T1P3	6.90g	8.28efg	8.59def	7.92D
T1P4	4.72h	8.27efg	9.72cde	7.57DE
T1P5	3.47hi	7.33fg	9.16cde	6.66FG
T2P1	12a	11.12ab	8.28efg	10.47AB
T2P2	9.27de	12.25a	8.45def	9.99B
T2P3	4.69h	9.86bcd	9.39cde	7.98D
T2P4	12.12a	9.38cde	9.92bcd	10.47AB
T2P5	12.35a	10.59bc	9.40cde	10.78A
Mean	8.43A	8.44A	8062A	

Mean comparison by multiple Duncan range test at 1%.

Table 2. Palmitoleic acid contents (16:1) of three canola seed cultivars at various priming treatments.

Priming treatment	Cultivar			Mean
	SLM046	Okapy	Licord	
0	0o	0o	0o	0H
T1P1	0.55k	0.39i	0.84hi	0.59E
T1P2	0.91gh	0.09no	0.65jk	0.55E
T1P3	0.24m	0.06no	0.76ij	0.35F
T1P4	0.19mn	0.13mno	0.17mn	0.17G
T1P5	1.02efg	0.56k	0.62k	0.73D
T2P1	1.12de	1.89a	0.75ij	1.25B
T2P2	1efg	1.27bc	0.95fgh	1.07C
T2P3	1.38b	1.36b	1.38b	1.37A
T2P4	1.40b	1.09def	0.95fgh	1.15C
T2P5	1.21cd	1efg	1.05efg	1.09C
Mean	0.82A	0.71B	0.74B	

Mean comparison by multiple Duncan range test at 1%.

In SLM064 cultivar, priming for 24 hours at -12 bar was the only treatment which reduced stearci acid content (Table 3). This reduction for Okapy cultivar was detected at 12 hours of -12 bar osmopriming. At this treatment, acid content was reduced by 66%. It seems for Licord cultivar both 12 and 24 hours of priming could reduce the stearic acid content. Moreover, more than one of priming concentrations such as -10, -12, and -16 bar effectively reduced stearic aicd content (Table 3). For Licord cultivar, priming for 12 hours at -10 and -12 bars, reduced stearic acid content by 34 and 45%, respectively. Averaged over all, priming for 12 hours at -12 bar reduced stearic acid content most effectively than other treatments.

Okapy and Licord cultivars for 12 hours and -10 bar resulted in least oleic acid content (Table 4). However, for SLM064 both 12 and 24 hours of priming treatments at -16 and -14 bars, respectively, reduced oleic acid content. For Licord and Okapy cultivars, a short period of priming treatment (T1P1) reduced oleic acid content by 61 and 45%, respectively (Table 4). In all cultivars 24 hours of priming treatment, resulted in higher oleic acid content. Higher PEG concentrations increased oleic acid content of canola cultivars by almost 30%. Averaged overall, SLMo64 exhibited the least while Okapy cultivar had the highest oleic acid content (Table 4).

Table 3. Stearic acid contents (18:0) of three canola seed cultivars at various priming treatments.

Priming treatment	Cultivar			Mean
	SLM046	Okapy	Licord	
0	1.55ijk	2.07fghi	2.31defg	1.98CD
T1P1	2.79cde	1.72hijk	1.52ijk	2.01CD
T1P2	2.67cdef	0.70m	1.27kl	1.54E
T1P3	2.05fghi	3.61a	2.64cdef	2.76A
T1P4	1.68hijk	2.94bcd	1.37jk	1.99CD
T1P5	1.87ghij	2.62cdef	2.95bc	2.48A
T2P1	2.59cdef	2.79cde	1.69hijk	2.36B
T2P2	0.78lm	2.56cdef	2.46cdefg	1.93D
T2P3	1.62ijk	2.86bcde	2.39cdefg	2.29BC
T2P4	2.58cdef	2.39cdefg	2.40cdefg	2.46AB
T2P5	2.26efgh	3.39ab	2.55cdef	2.73A
Mean	2.04B	2.51A	2.14B	

Mean comparison by multiple Duncan range test at 1%.

Table 4. Oleic acid contents (18:1) of three canola seed cultivars at various priming treatments.

Priming treatment	Cultivar			Mean
	SLM046	Okapy	Licord	
0	99.32kl	118.76efgh	111.46ghij	109.85D
T1P1	89.33mn	65.62o	43.03r	65.99H
T1P2	108.68ij	23.79c	97.46lm	76.64G
T1P3	86.50n	121.50ef	88.97mn	89.99E
T1P4	60.58op	104.16jkl	133.22cd	99.32E
T1P5	95.75pq	109.75hij	115.98fghi	90.49F
T2P1	126.54de	106.41ijkl	107.28ijk	113.41D
T2P2	89.51mn	155.90a	110.14hij	118.51C
T2P3	52.95pq	132.22cd	120.05efg	101.74E
T2P4	142.55b	132.22cd	137.24bc	137.34A
T2P5	136.76bc	138.34bc	115.57fghi	130.22B
Mean	94.40C	109.88A	107.31B	

Mean comparison by multiple Duncan range test at 1%.

It seems priming treatments did not affect linoleic acid contents of canola cultivars (Table 5). Priming treatment for 12 hours at -12 bar reduced the linoleic acid content of Okapy by 80%. The highest concentration of linoleic acid content was detected for 24 hours and -12 bar priming treatment. For Licord the least linoleic acid concentration was detected at 12 hours of priming at -10 bar (Table 5). SLM064 was the only cultivar with higher variation of response. Both 12 and 24 hours of priming reduced the linoleic acid content of this cultivar (Table 5). Averaged overall, SLM064 exhibited the least linoleic acid content while Licord had the most.

Table 5. Linoleic acid contents (18:2) of three canola seed cultivars at various priming treatments.

Priming treatment	Cultivar			Mean
	SLM046	Okapy	Licord	
0	29.96hijk	33.90efgh	35.24cdef	33.03B
T1P1	26.52k	18.47l	12.76n	19.25E
T1P2	30.91ghij	6.57o	30.77ghij	22.75D
T1P3	29.56ijk	33.28efghi	27.48jk	30.11C
T1P4	17.17lm	29.56ijk	38.53bcd	28.42C
T1P5	26.19k	30.03hijk	31.81fghi	29.34C
T2P1	36.11cde	33.41efghi	29.67hijk	33.06B
T2P2	26.05k	44.34a	30.76ghij	33.72B
T2P3	13.73mn	39.23bc	38.7bc	30.58C
T2P4	42.08ab	35.64cdef	37.26cde	38.33A
T2P5	34.51def	39.01bc	35.24cdef	36.25A
Mean	28.43B	31.22A	31.66A	

Mean comparison by multiple Duncan range test at 1%.

Discussion

It is widely recognized that toxic oxygen species (AOS) are produced as products of mitochondrial respiration and glyoxysomal lipid degradation, and are removed within plant cells by antioxidative enzymes which scavenge free radicals before they disrupt biomolecules. One major harmful effect of free radical reaction is believed to be the accumulation of free fatty acid and other lipid-degradation products in membrane bilayers, which increase the lipid phase transition temperature and cause the irreversible formation of gel phase domain, which are lethal when the cell is rehydrated (McKersie, 1991). Baily and colleagues (2000) found in sunflower seeds that malondialdehyde (MDA) content, a measure of the deree of lipid degradation, remained unchanged during osmopriming, while activities of superoxide dismutase and catalase increased strongly. Furthermore, although MDA concentrations increased markedly after drying, the declined again during six hours from the start of reimbibition, compared to an increase in control imbibed unprimed seed. This supports the idea that the enzymatic antioxidant dfense system operates efficiently in sunflower seeds to scavenge AOS produced during osmopriming and that the system survives in an enhanced state in dried primed seeds to operate during the first hours after subsequent reimbibition. The results of this study suggest that osompriming of canola cultivar could alter the fatty acid contents of seeds. This reduction could protect these oilseed cultivars after imbibtion and changing the dry phase state of seed.

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