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Full Length Research Paper

Localization and composition of seed oils of *Crithmum maritimum* L. (Apiaceae)

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The use of some halophytes for rehabilitation of salt affected area has been reported. *Crithmum maritimum* L. halophyte and apiaceae can tolerate high levels of salt. Their seed was endospermic and had a suitable size for oil extraction. The aim of this report is to localize the lipids in the seed and determine their oils composition. The results showed that the lipids were accumulated in endosperm tissue as oil globoids. The percentage of oils was 44.4% dry weight basis. The *C. maritimum* L. seed oil was rich with oleic acid (78.6%), low level of palmitic acid (4.8%) and non negligible amount of linoleic acid (15.4%). This composition is similar to olive oil and canola oil. These results confirmed the good quality of *C. maritimum* L. seed oils.

Keys word: Halophytes; *Crithmum maritimum* L.; seed oils.

INTRODUCTION

Recently, the demand of vegetable oil has been on the increase (Weber et al., 2007). Similarly, salt affected area is on the increase in the arid and semi-arid regions (FAO, 2005). Most conventional crops do not survive in saline soils, only some halophytes can support these conditions. The use of halophytes for rehabilitation of affected area, economic production (Reddy et al., 2008a) and food sourc-es have been reported (Gallaghar, 1985; Weber et al., 2007; Ruan et al., 2008). Thus, an approach based on halophytes domestication may constitute an alternative solution for salt affected area.

Seed of many halophytes contain appreciable amount of edible oils (Weete et al., 1970; Glenn et al., 1991; Weber et al., 2001; Weber et al., 2007). For instance, seeds of *Batis maritima* contain 25% of oil with high quantities of essential fatty acids (Marcone, 2003). The seed oils of other halophytes also have good quality. This was shown in *Salicornia bigelovii* (Weete et al., 1970), *Suaeda moquinii* (Weber et al., 2001), *Suaeda salsa*, *Kosteletzkya virginica* (He et al., 2003) and *Chenopodium glaucum* (Yajun et al., 2003). Thus, the exploration of economically important halophytes species may constitute an alternative source of edible oil.

Crithmum maritimum L. is a typical halophyte of coastal ecosystems (Abdelly et al., 2006). This species show high salt tolerance during vegetative growth (Ben Amor et al., 2005). Recently, it was shown that its seed is endospermic and contain high amount of nutriments (Atia et al., 2009, unpublished data). Here investigation on the localization and the seed oils composition of this halophyte was carried out.

MATERIALS AND METHODS

Fruit collection

Mature fruits were collected in December 2007 from plants in the natural population growing in the rocky coast of Tabarka (N 36° 57' 12" E 08° 45' 18"), located in N-W of Tunisia. The spongy coat was removed and seeds were used.

Microscopic localisation of lipids

Free hand sections of fruits or seeds were prepared, then were stained with malachite green as general stain or stained with sau-

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dan red to localise lipids. Then the sections were mounted in slide and observed under light microscope (type, Olympus DX41).

Oil extraction and analysis

Seeds were weighted and the oil was extracted based on the method of Allen and Good, (1971). To inactivate lipase, seed samples (0.5 g) were boiled in water for 5 min and then ground manually using a mortar and pestle. For total lipid extraction, a chloroform/methanol mixture (2:1 v/v) was used. After centrifugation at 3000 g for 10 min, the organic layer containing total lipids was aspired and dried under a nitrogen stream. Total fatty acids (TFA) were methylated using sodium methoxide solution (Sigma, Aldrich) according to Cecchi et al. (1985). Methyl heptadecanoate (C17:0) was used as an internal standard and fatty acids methyl esters obtained were analyzed. The fatty acid methyl esters were analyzed on a HP 6890 gas chromatograph (GC) equipped with a flame ionization detector (FID).

RESULTS

Seed description

The seed of *C. maritimum* L. was endospermic. It measured about 3.5 mm in length and 1 mm in width. The mean seed weight of ten seeds was 20 mg and contained about 444 mg/g of lipids (dry weight basis) (Table 1).

Table 1. Characteristics of *C. maritimum* L. seed. * means seed weight of ten seeds.

Seed description	Mean ± SD	Number
Length (mm)	3.53 ± 0.24	12
Width (mm)	1 ± 0	12
Mass (mg)	20.82 ± 1.10	4
Lipids content (mg/g)	444 ± 18.96	3

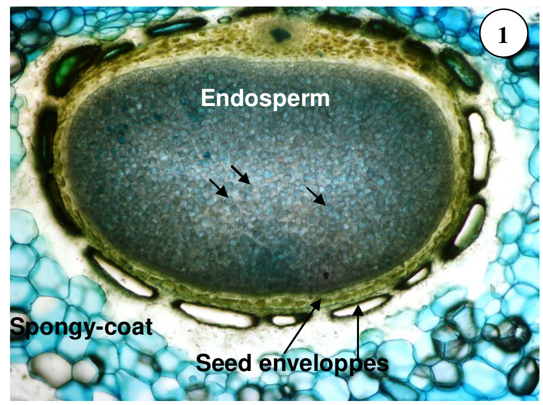

Figure 1. Micrograph of free hand section showing the seed within the fruit. Noted the high number of reserves globoids in endosperm tissue (arrows).

Lipids localization in seeds endosperm

The microscopic observation of transversal sections of *C. maritimum* L. seed showed that it was surrounded by a spongy-coat envelope and secretory envelope layers (Figure 1). The endosperm contained high amount of reserve globoids (Figure 1). The coloration of seed sections with saudan red, a specific dye of lipids, showed several oil globoids that accumulated in endosperm seeds (Figure 2).

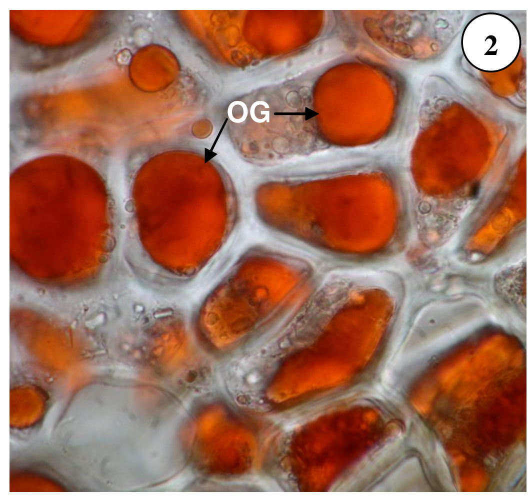

Figure 2. Micrograph by light microscope showing the accumulation of large oil globoids (OG) that appeared red orange after coloration with saudan red.

Oil composition

The results of GC oil analysis showed the presence of palmitic, palmitoleic, stearic, oleic, linoleic and linolenic acids in *C. maritimum* L. seed oils. Oleic acid represented 78.6%. Thus, this was the major component of *C. maritimum* L. seed oils. Palmitic acid represented 4.8%, linoleic acid represented 15.4% while the arachidic acid existed as trace (Table 2). The percentage of saturated fatty acids (SFA), mono-saturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) was 5.5, 78.8 and 15.7%, respectively (Table 2). Among PUFA, the major one was linoleic acid.

DISCUSSION

The average percentage of *C. maritimum* L. oils to seeds weight was 44.4 %. In the other halophyte seeds, the percentage of oils was 41% in *Salvadora persica* (Reddy et al., 2008), 20% in *K. virginica* (Ruan et al., 2008b), 30% in *Salicornia brachiata* and varied between 22 and 25% in *Arthrocnemum indicum*, *Alhaji maurorum*, *Cressa critica*, *Halopyrum mucronatum*, *Haloxylon stocksii*, *Suaeda*

Table 2. Fatty acid compositions of *C. maritimum* L. seed oils

Fatty acid	Means	SE
Palmitic acid (C16:0)	4.8	± 0.14
Stearic acid (C18:0)	0.7	± 0.02
Arachidic acid (C20:0)	Trace	-
∑SFA	5.5	± 0.16
Palmitoleic acid (C16:1)	0.2	± 0.02
Oleic acid (C18:1)	78.6	± 0.23
∑MUFA	78.8	± 0.25
Linoleic acid (C18:2)	15.4	± 0.16
Linolenic acid (C18:3)	0.3	± 0.08
∑PUFA	15.7	± 0.24

Table 3. Fatty acid compositions of seed oils of some halophytes

Species	C16:0	C18:0	C16:1	C18:1	C18:2	C18:3
Crithmum maritimum L.	4.8	0.7	0.2	78.6	15.4	0.3
Arthrocnemum macrostachyum	26.93	3.17	0.9	-	63.02	-
Batis maritima	5.5	1.2	1.1	17.8	73.0	1.4
Alhagi maurorum	29.38	11.01	0.23	-	53.28	-
Kosteletzkya virginica	27.31	2.51	0.46	23.62	37.53	5.53
Salicornia bigelovii	trace	13.6	trace	67.8	3.6	1.8

fruticosa (Weber et al., 2007) and *B. maritima* (Marcone, 2003). The *C. maritimum* L. seed oil was rich with oleic acid which constituted 78.6%. This composition was similar to olive oil. In other halophytes the oleic acid reached 67.8% in *Salicornia bigelovii* seed oil (Weete et al., 1970) and 23.62% in *K. virginica* (Ruan et al., 2008) seed oil. In contrast, *A. maurorum* seed oils contained a trace of oleic acid (Weber et al., 2007) (Table 3). Furthermore, in *C. maritimum* L. seeds, the average of linoleic and linolenic acids reached 15.7%. They constituted the essential fatty acids (EFA). They are required but cannot be synthesized by body. Thus, the external origin of these fatty acids is necessary (Ariffin et al., 2009). In the other halophytes, the percentage of linoleic acids varied between 53% in *A. maurorum* and 62% in *C. critica* (Weber et al., 2007) and was 73% of seed oil of *B. maritima* (Marcone, 2003) (Table 3). Thus, the halophytes seed oils can constitute a sources of oleic acids and essential fatty acids, that is, linoleic and linolenic acids. The oil of *C. maritimum* L. seeds showed high level of oleic acid (C18:1) 78.6% but had a low level of palmitic acid (C16:0) 4.8%. This composition is similar to olive and canola oils. In contrast, the oils of the most other halophytes were rich with linoleic acid (C18:2) and thus were comparable to sunflower and cotton oils (Weber et al., 2007).

These data suggested that the halophyte *C. maritimum* L. could be used as a valuable oil seed crop in semiarid saline soils. In fact, the salt affected soils were not favorable for the cultivation of habitual oil seeds crop but could be utilized for growing some halophytes species such as *C. maritimum* L.. Thus, other studies that consider field conditions are required to test its productivity.

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