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Short Communication

Seed oil content and fatty acid composition of annual halophyte *Suaeda acuminata*: A comparative study on dimorphic seeds

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Suaeda acuminata **produces two morphologically distinct types of seeds on the same plant. This study was conducted to compare oil content and fatty acid composition of the two seed morphs. Though oil characteristics between dimorphic seeds showed statistically significant difference, these differences were relatively small. The seed oil content of this species ranged from 14.3 to 15.5% by dry weight. Both seed morphs contain ca. 90% unsaturated fatty acids, with linoleic (>65%) and oleic acid (>14%) being the most abundant. The results show that oil reserve of *S. acuminata* seeds depends mainly on seed weight rather than seed morphology.**

Key words: *Suaeda acuminata*, fatty acid, linoleic, seed oil.

INTRODUCTION

Seed heteromorphism is the phenomenon in which a single plant produces two or more seed types with different morphology and/or behavior (Mandák, 1997; Imbert, 2002). Seed heteromorphism is common in Asteraceae and Chenopodiaceae (Imbert, 2002), and may be characterized by differences in seed size (Mandák and Pyšek, 2001), dispersal (Sorensen, 1978; Venable and Levin, 1985), and dormancy and germination characteristics (Baskin and Baskin, 1976; Wang et al., 2008, 2011). Many studies have focused on the ecological differences between heteromorphic seeds and its offspring. However, few investigations were conducted to determine biochemical differences between heteromorphic seeds (Williams, 1960; Yao et al., 2010; Siddiqui and Khan, 2011), and there is no study on fatty acid composition of heteromorphic seeds.

Suaeda acuminata is an annual halophyte restricted to central Asia (Delectis Florae Reipublicae Popularis Sinicae Agendae Academiae Sinicae Edita, 1979). In China, *S. acuminata* is found only in the inland saline-alkaline deserts in Xinjiang province (Commissione Redactorum Florae Xinjiangensis, 1994). In Flora of China and Flora Xinjiangensis, only one type of seed (red-brown to black, 0.8 to 1 mm and smooth) was described.

However, we found two types of seeds on each plant of *S. acuminata*: brown with soft coarse seed coat and black with rigid smooth seed coat (Ding et al., 2010). Brown and black seeds had a mean dry mass of 1.28 ± 0.07 and 0.22 ± 0.01 mg, respectively. Germination percentages of brown seeds were significantly higher than those of black seeds in all temperature and light regimes tested (Wang et al., 2011). Brown seeds of *S. acuminata* are non-dormant, whereas black seeds have intermediate physiological dormancy (Wang et al., 2011).

The aim of this study was to compare seed oil content and fatty acid composition of the two seed morphs of *S. acuminata*. Meanwhile, we evaluated the edible value of seed oil of this species.

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Table 1. Fatty acid compositions (% of total fatty acids) of *S. acuminata* seed oils.

Fatty acid	Brown seed	Black seed
Myristic acid (C14: 0)	0.17 ± 0.01[a]	0.09 ± 0.00[b]
Palmitic acid (C16: 0)	6.14 ± 0.06[a]	4.55 ± 0.00[b]
Stearic acid (C18: 0)	1.45 ± 0.02[a]	1.74 ± 0.02[b]
Arachidic acid (C20: 0)	1.07 ± 0.04[a]	0.75 ± 0.01[b]
Behenic acid (C22: 0)	0.45 ± 0.01[a]	0.32 ± 0.01[b]
Lignoceric acid (C24: 0)	0.18 ± 0.01[a]	0.02 ± 0.00[b]
∑SFA	9.54 ± 0.12[a]	7.51 ± 0.05[b]
Palmitoleic acid (C16: 1)	0.18 ± 0.00[a]	0.20 ± 0.00[b]
cis-Palmitoleic acid (C16: 1)	0.22 ± 0.00[a]	0.16 ± 0.00[b]
Oleic acid (C18: 1)	14.36 ± 0.11[a]	17.84 ± 0.09[b]
tra- Elaidic acid (C18: 1)	0.93 ± 0.04[a]	1.02 ± 0.04[a]
Eicosenoic acid (C20: 1)	0.41 ± 0.04[a]	0.13 ± 0.00[b]
cis-Eicosenoic acid (C20: 1)	0.14 ± 0.04[a]	0.32 ± 0.01[b]
∑MUFA	16.24 ± 0.22[a]	19.68 ± 0.11[b]
Linoleic acid (C18: 2)	65.09 ± 0.26[a]	67.91 ± 0.12[b]
g-Linolenic acid (C18: 3)	0.09 ± 0.00[a]	0.13 ± 0.00[b]
r-Linolenic acid (C18: 3)	7.78 ± 0.12[a]	3.98 ± 0.03[b]
cis-Eicosadienoic acid (C20: 2)	0.18 ± 0.00[a]	0.14 ± 0.00[b]
∑PUFA	73.14 ± 0.37[a]	72.16 ± 0.15[a]

Different lower-case letters in each row indicate significant difference ($P<0.05$) between the two seed morphs. Values are means ± s.e ($n = 3$). SFA: Saturated fatty acid; MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid.

MATERIALS AND METHODS

Freshly matured seeds of *S. acuminata* were randomly collected from ca. 200 plants growing in an inland saline desert (87° 46′ 10″ E; 44° 07′ 55″ N; 500 m a.s.l) in Fukang, Northern Xinjiang, China, in October 2010. Seeds were cleaned and air-dried at ambient temperature, and then separated by their color. Dry seeds were stored at room temperature until used.

The oil contents were analyzed with Soxhlet apparatus. In the Soxhlet extraction procedure, 10 g of the crushed seeds was packed in a thimble and the oils were extracted with hexane for 6 h. After extraction, concentrated oil was kept at 80°C for 12 h. The oil was stored at -18°C in sealed tubes prior to analyses.The fatty acid composition was determined by gas chromatography of the fatty acid methyl esters (FAMEs).

The FAMEs were obtained by transesterification with a cold methanolic solution of potassium hydroxide. Oil samples were solubilized in hexane, esterified using potassium methoxide and analyzed on Agilent 6890N gas chromatograph equipped with a flame ionization detector (FID) and a polar capillary column: Supelcowax 10 (0.25 mm internal diameter, 60 m length and 0.25 µm film thickness).

The operational conditions were: oven temperature programme, the column held initially at 100°C for 2 min after injection, then increased to 200°C at the rate of 4°C/min.

The final temperature was increased to 240°C at the rate of 6°C/min, and held for 43 min; injector temperature, 250°C; detector (FID) temperature, 260°C; carrier gas, N_2; inlet pressure, 25 psi; linear gas velocity, 22 cm/s; column flow rate, 1 ml/min; split ratio, 50:1; injected volume, 1 µl. Identification of the components was assigned by comparison of their retention times of FAME with the known standard mixture.

RESULTS AND DISCUSSION

Oil contents of brown and black seeds were 15.51 ± 0.01% and 14.30 ± 0.01%, respectively. There was a significant difference of the oil content between the two types of seeds ($P<0.05$).

Fatty acids for both seed morphs were composed of saturated (7.51 to 9.54%), monounsaturated (16.24 to 19.68%) and polyunsaturated fatty acids (72.16 to 73.14%) (Table 1). The predominant fatty acids were polyunsaturated and their amount was >72% of the total fatty acids. Statistically significant variation was found in saturated fatty acid and monounsaturated fatty acids between brown and black seeds, but the difference was slight. A total of 16 different fatty acids were identified. It contained six saturated, six monounsaturated and four poly-unsaturated fatty acids (Table 1). The predominant fatty acid was linoleic acid (18:2), followed by oleic acid (18:1), r-linolenic acid (18:3), palmitic acid (16:0) (Table 1).

To the best of our knowledge, this is one of the few reports that compare fatty acid (lipid) of heteromorphic seeds (Siddiqui and Khan, 2011). In this study, we showed for *S. acuminata*, that oil content and fatty acid composition between heteromorphic seeds were statistically significant difference, but these differences were relatively small. This study suggests that oil reserve

of *S. acuminata* seeds depends mainly on seed weight rather than seed morphology. In *S. acuminata*, brown seeds were heavier than black seeds (Wang et al., 2011). So, brown seeds have higher oil reserve than black seeds. Differences in seed content could play an important role in germination and seedling growth differences because biochemical and physiological processes are involved in onset of germination and providing of growth materials (Mayer and Poljakoff-Mayer, 1989).

The data presented here clearly indicate the potential to extract high-quality edible oil from seeds of desert halophyte *S. acuminata*. Oil quality is related to its degree of unsaturation (Ariffin et al., 2009). Oil with high unsaturation is considered healthier. The oil of *S. acuminata* seeds was characterized by a high polyunsaturated/saturated ratio of 7.7-9.6, higher than common edible oil. A high ratio of polyunsaturated to saturated is regarded to be favorably for the reduction of serum cholesterol and atherosclerosis and prevention of heart diseases. The present fatty acid composition of seed oil make it desirable in terms of nutrition and it may be used as edible cooking oil and natural sanitarian oil.

The oil of *S. acuminata* seeds could be alternative source of high-quality edible oil due to the presence of high percent of polyunsaturated fatty acids required for human health. It is not necessary to separate seed morphs when producing oil because there is small difference in oil content and fatty acid composition between the two types of seeds.

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