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Kernel characteristics, oil contents, fatty acid compositions and biodiesel properties in developing Siberian apricot (*Prunus sibirica* L.) seeds

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ABSTRACT

Kernel characteristics, oil contents, fatty acid compositions and biodiesel properties were studied in developing Siberian apricot (*Prunus sibirica* L.) seeds, at intervals of 1 week from 3 weeks after anthesis to 10 weeks. Variation of kernel dry biomass, kernel length, kernel breadth and kernel thickness were significant ($P < 0.01$). Oil content increased with maturity and reached the highest point at 8 weeks after anthesis (51.6%). Changes in the content of oleic acid (C18:1) and linoleic acid (C18:2) presented an opposite trend that oleic acid increased, whereas linoleic acid decreased until 7 weeks after anthesis. Siberian apricot methyl esters meet the specifications better in biodiesel standards when seeds were harvested at 8, 9 and 10 weeks after anthesis. Siberian apricot seeds harvested after 8 weeks after anthesis may be suitable for producing biodiesel.

1. Introduction

Siberian apricot (*Prunus sibirica* L.) is a fruit species belongs to the Rosaceae family. The total area of Siberian apricot in China is approximately 1.7 million ha, and the annual seeds harvest is nearly 192,500 tons (Wang, 2011). Siberian apricot is a multipurpose tree species with ecological and economic value. It has a strong adaptability to stress that can be cultivated on marginal land. The trees are not only used to sand control and prevention but also cultivated for fruit or oil purpose (Zhang and Zhang, 2003). Moreover, the seed kernel of Siberian apricot was high in oil content (over 50%) and has been determined to be suitable for biodiesel production (Wang and Yu, 2012). Fatty acid composition and oil content are considered as prominent attributes in oil crops (Were et al., 2006). It also has an effect on productions and fuel properties of biodiesel (Ramos et al., 2009; Knothe, 2009). However, oil content and fatty acid composition change in developing seeds (Slack and Browse, 1984; Cherif et al., 2004; Pavithra et al., 2012). Studies on variation in oil content and fatty acid composition in developing seeds for biodiesel production have been focused on *Calophyllum inophyllum* (Hathurusingha et al., 2011), *Pongamia pinnata* (Pavithra et al., 2012), and Jatropha curcas (Sinha et al., 2015).

Siberian apricot seed oil has been investigated in previous publications for producing biodiesel, but they are concerned about the biodiesel properties of fully matured seeds (Wang and Yu, 2012; Wang, 2012; Wang, 2013; Guo et al., 2015). Information of biodiesel property of Siberian apricot seeds at different stages of development is unavailable. The purpose of this study was to investigate the effect of variation in fatty acid composition and oil accumulation on biodiesel property in developing Siberian apricot seeds. It may provide a schedule for harvesting Siberian apricot seeds with the high quality of biodiesel.

2. Materials and methods

2.1. Materials

Twenty trees of Siberian apricot locating in Liao Ning Province in China were selected and marked in April 2013 (geographical coordinates approximately 122°22′E; 42°43′N). Seeds were collected at intervals of 1 week from 3 weeks after anthesis to 10 weeks (3, 4,

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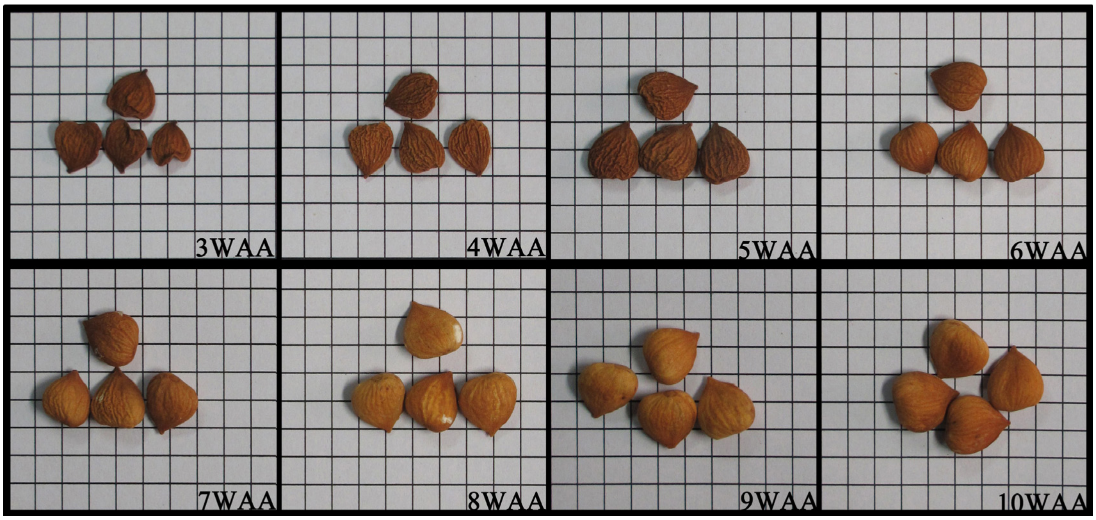

Fig. 1. Changes of kernel morphological in developing Siberian apricot seeds.

Table 1
Variation of kernel dry biomass and characteristic in developing Siberian apricot seeds.

Weeks after anthesis	Kernel dry biomass(g)	Kernel characteristics		
		Kernel Length (mm)	Kernel breadth (mm)	Kernel thickness (mm)
3	0.05 ± 0.03^{d}	9.62 ± 1.59^{c}	7.66 ± 1.29^{c}	1.37 ± 0.23^{d}
4	0.13 ± 0.03^{c}	10.50 ± 0.51^{bc}	7.70 ± 0.47^{c}	3.23 ± 0.47^{c}
5	0.22 ± 0.06^{b}	10.89 ± 1.02^{ab}	8.40 ± 1.64^{ab}	4.28 ± 0.58^{b}
6	0.24 ± 0.07^{b}	10.95 ± 0.83^{ab}	8.85 ± 1.24^{bc}	5.04 ± 0.72^{a}
7	0.25 ± 0.09^{b}	11.01 ± 1.07^{ab}	9.24 ± 1.52^{ab}	5.05 ± 0.69^{ab}
8	0.27 ± 0.05^{ab}	11.28 ± 0.93^{ab}	9.33 ± 0.88^{ab}	5.07 ± 0.65^{a}
9	0.29 ± 0.08^{ab}	11.55 ± 1.18^{ab}	9.68 ± 1.25^{ab}	5.41 ± 0.47^{a}
10	0.34 ± 0.08^{a}	12.19 ± 1.13^{a}	10.52 ± 1.13^{a}	5.59 ± 0.70^{a}
P	**	**	**	**

** $P < 0.01$.

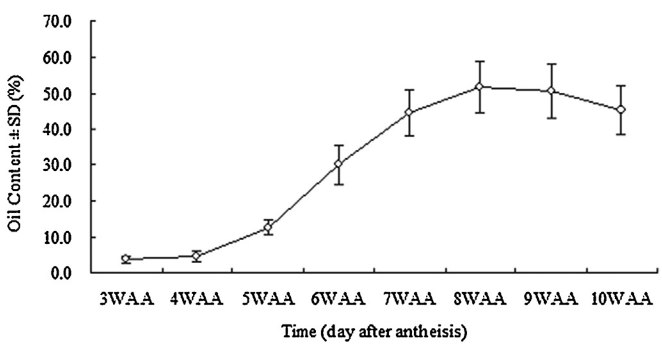

Fig. 2. Variation of kernel oil content in developing Siberian apricot seeds.

5, 6, 7, 8, 9, and 10 weeks) in June–August. One hundred fruits from the 20 trees (Random 5 seeds each tree) were selected each time. The fresh seeds were removed from the flesh and stored at room temperature for 1 week to dry before they were transferred to the laboratory.

2.2. Kernel characteristic

The 800 seeds (8 × 100) of Siberian apricot were dried to constant weight using a hot air oven which the temperature was maintained at 60 °C for 6–7days. Fig. 1 shows the morphological characteristics of dry kernels at different stages of development. The dry kernels of Siberian apricot were obtained using a small hammer by carefully removing the exocarp. And the dry biomass, length, breadth and thickness were measured using electronic balance and vernier caliper. The kernel characteristic values across different development stages were reported as mean ± standard deviation and compared by Duncan Multiple Test (DMRT) using the software SPSS 20.0.

2.3. Kernel oil extraction and trans-esterification

The kernels were crushed and extracted by n-hexane double extraction at 25 °C using a rotary evaporator (LABORTA 4000-efficient, Heidolph, Germany). Oil content was determined by comparing the weight of dry kernel before and after extraction. The determination was performed in triplicate, and data are reported as mean ± standard deviation. Siberian apricot kernel oils were methylated following a trans-esterification method as Wang (2012) described.

2.4. Fatty acid methyl ester analysis

The obtained fatty acid methyl esters (FAMEs) were analysed by gas chromatograph, using the Agilent 6890 (California, USA) equipped with a flame ionization detector (GC–MS). Methyl ester solution (1 µl) was injected into a HP-INNOWax capillary column (inner diameter 0.32 mm, length 30 m, film thickness 0.5 µm, split 1:20). The temperature of injector and detector was 250 and 280 °C. Oven temperatures were programmed from 190 °C for 3 min, with a rise of 5 °C/min to 240 °C for 10 min. The carrier gas was high-purity