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Volatile profiling of two pear genotypes with different potential for white pear aroma improvement

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ABSTRACT

Chinese white pear (*Pyrus bretschneideri*) is sweet, juicy and crispy, but not fragrant. The two pears 'Xiang-Mian Li' ('XML') and 'Mu-Tou Su' ('MTS') with fragrant and large fruits were noted recently from pear germplasm screening. Their volatile profiles were compared with those of typical white pear 'Dang-Shan Suli' ('DSS') (*P. bretschneideri*) and fragrant pear 'Nan-Guo Li' ('NGL') (*P. ussuriensis*) in this study for a better understanding the chemistry of the differences among the tested cultivars. Headspace solid phase microextraction (HS-SPME) coupled to gas chromatography–mass spectrum (GC–MS) was used for sensitive intact fruit volatile profiling while a static headspace GC–MS system was employed for accurate volatile quantification. The rank of the tested intact fruits based on detected volatile numbers and total odor active values was 'NGL' > 'XML' > 'MTS' > 'DSS'. Among many detected volatiles, ethyl 2-methylbutyrate and ethyl hexanoate were the most potent and pleasant odorants from the intact fruit and fruit pulp of 'XML' and 'NGL', but not from 'MTS' pulp. They were identified as the most important contributors to the volatile profile variance among the tested pear fruits. Our study indicated that compared to 'MTS', 'XML' had much more intense aroma and this genotype had potential for Chinese white pear aroma improvement.

1. Introduction

Flavor and texture as well as fruit size are the key determinants of fruit quality and have a great impact on consumer satisfaction. Different pear species exhibit characteristic fruit flavors and textures. Chinese white pear (*Pyrus bretschneideri* Reld) is popular for its sweet and juicy with a crispy texture, big edible fruit part and long shelf life (Chen et al., 2006; Teng and Tanabe, 2004). However, Chinese white pear is still weak in aroma quality as it has only faint odor. On the contrary, the European pear (*P. communis* L.) has an intense aroma (Rapparini and Predieri, 2003). *P. ussuriensis* is similar to *P. communis*, and has a strong aroma after post-harvest maturation (Qin et al., 2012). Esters are the dominant volatiles in *P. ussuriensis*, *P. serotina* and *P. communis* (Li et al., 2014a,b; Qin et al., 2012). Aldehydes, alcohols and esters are the prevailing compounds in *P. pyrifolia* (Katayama et al., 2013). Distinct profiles of odorous compounds have been shown to exist among different cultivars within the same species. For example, esters or hydrocarbons are dominant in some varieties of *P. ussuriensis*, while aldehydes are plentiful in others (Katayama et al., 2013; Qin et al., 2012). These findings indicate that the diversity of pear cultivar odor profiles is a fundamental consequence of genetic diversity among pear cultivars and groups.

Owing to a long history of pear cultivation and active inter-specific hybridization of *Pyrus* (Jiang et al., 2015; Zheng et al.,

Abbreviations: DSS, Dang-Shan Suli; FPP, farnesyl pyrophosphate; FW, fresh weight; GC–MS, gas chromatsography–mass spectrometry; GPP, geranyl pyrophosphate; GGPP, geranylgeranyl pyrophosphate; HS-SPME, headspace solid phase microextraction; LOX pathway, lipoxygenase pathway; MEP pathway, the methylerythritol phosphate pathway; MTS, Mu-Tou Su; MVA pathway, the mevalonic acid pathway; NGL, Nan-Guo Li; OAV, odor active value; OPLS-DA, orthogonal partial least-squares discriminant analysis; VIP, variables of importance; XML, Xiang-Mian Li.

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2014), numerous pear cultivars or landraces with diverse characteristics provide great opportunities for pear breeding to improve fruit flavor quality, e.g. fruit odor. This will, in turn, stimulate new demands in both the production and consumption of pear cultivars. Two pear genotypes 'Xiang-Mian Li' ('XML') and 'Mu-Tou Su' ('MTS'), were found after germplasm screening due to their significant aromas and quite large edible fruit part (average fruit weight 300.0 ± 40.0 g and 230 ± 30.0 g, respectively). Genetic analysis indicated that 'MTS' is belonged to Chinese white pear while 'XML' is a hybrid of Chinese white pear (Zhu et al., 2009). The pear cultivars such as 'XML' and 'MTS' are often desired to be used in a breeding program leading to a new Chinese white pear cultivar maintaining its typical fruit characteristics plus intense aroma. However, no detailed reports have been publicized on the volatile profiles of the two cultivars.

In this paper, the aroma characteristics of both intact fruit and fruit pulp were analyzed and compared with a faint odor typical white pear cultivar 'DSS' and a typical strong odor *P. ussuriensis* control cultivar 'Nan-Guo Li' ('NGL'). The odor active value (OAV) of the compounds were used to evaluate their contributions to fruit aroma quality. Our fruit volatile profiling and clustering suggested that 'XML' and 'MTS' were closely related to Chinese white pear and revealed that both cultivars have great potential for genetic improvement of Chinese white pear aroma.

2. Materials and methods

2.1. Materials

Mature fruits of 'XML', 'MTS', and 'DSS' were collected from the Center of Pear Germplasm Collection (34°16′39″N, 116°29′38″E), Anhui, China. 'NGL' was collected from Xingcheng, Liaoning, China. All four pear fruits prior- and post-harvest were shown in Fig. 1. Fruit maturity was determined by starch staining (0.88% potassium iodide, 0.22% iodine, w/v) and fruit with maturity indices of 7–8 were selected for further assays (Blanpied and Silsby, 2010).

Authentic standards were purchased form Sigma-Aldrich (Shanghai, China): α-farnesene, 2-ethoxyethanol, nonanal, 3-nonanone, ethyl 2-methylbutyrate and ethyl hexanoate.

2.2. Volatile collection and gas chromatography–mass spectrometry (GC–MS) analysis

For volatiles emitted from the intact pear fruit, headspace solid-phase microextraction (HS-SPME) was employed. A fiber coated with polydimethylsiloxane-divinylbenzene (65 μm PDMS/DVB, Supelco, USA) was exposed to the headspace of the fruit sample kept in a 500 mL glass beaker for 30 min at room temperature. The fiber was then maintained in the injection port for 5 min at 250 °C for analyte desorption.

For volatiles from fruit flesh without peel and fruit core, a static headspace GC–MS system was employed for accurate quantitative analysis. Flesh homogenate was prepared in liquid nitrogen and moved to a vial (20 mL, Restek, USA) according to Bruno et al. (2004), and the vial was cleaned by heating for 2 h at 80 °C before usage. 1 mL gaseous sample was collected from the vial headspace using the Agilent 7697A static headspace sampler. The samples were incubated for 30 min at an oven temperature of 40 °C; the temperature of the transfer line connecting the sampler and GC column was 50 °C.

Volatile compounds were analyzed using an Agilent 7890A gas chromatograph coupled to an Agilent 5973 B mass spectrometer. The split injection mode (1:1) was employed, and GC separations were performed on a DB-5 capillary column (30 m × 0.25 mm i.d. × 0.25 μm film thickness, Agilent) with helium as the carrier

Fig 1. Fruits of 'Xiang-Mian Li' ('XML') (A, B), 'Mu-Tou Su' ('MTS') (C, D), 'Dang-Shan Suli' ('DSS') (E, F), and 'Nan-Guo Li' ('NGL') (G, H). Bars = 1 cm.