果 树 学 报 2017,34(5):567-575
Journal of Fruit Science

DOI:10.13925/j.cnki.gsxb.20160224

野生樱桃李(*Prunus cerasifera*)果实多酚多样性分析

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摘 要:【目的】分析野生樱桃李资源果实多酚的多样性,以便为其利用和新品种培育提供基本材料。【方法】对收集、保存于辽宁兴城的野生樱桃李(*Prunus cerasifera*)103份高接株系中筛选出的13份优异资源和'晚熟红李'(*Prunus salicina*)成熟果实酚类物质进行分析。【结果】13份野生樱桃李资源多酚质量分数变异幅度为2 597.63~5 802.33 mg·kg^{-1},变异系数为19.51%;绿原酸、原花青素B_1、儿茶素、原花青素B_2、表儿茶素、原花青素C、芦丁、槲皮素-半乳糖、槲皮素-葡萄糖、槲皮素-木糖醇、槲皮素-吡喃阿拉伯糖等组分含量变异系数为30.56%~108.01%,体现出野生樱桃李丰富的多酚含量多样性;野生樱桃李资源与'晚熟红李'主要多酚组分不同,存在丰富的多酚组成多样性。【结论】13份野生樱桃李资源在多酚组成和含量上存在丰富的多样性。野生樱桃李5、野生樱桃李7、野生樱桃9、野生樱桃李10、野生樱桃12等5个株系是原花青素B_1、儿茶素、绿原酸、原花青素B_2、表儿茶素和原花青素C的良好来源,进一步挖掘利用的潜力很大。

关键词:野生樱桃李;果实;HPLC;多酚;多样性

中图分类号:S662.5 **文献标志码**:A **文章编号**:1009-9980(2017)05-0567-09

Diversity analysis of phenolic in wild myrobalan plums (*Prunus cerasifera*)

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Abstract:【Objective】The wild Myrobalan plum (*Prunus cerasifera*) is a type of little arbor or sheepberry which belongs to the *Prunus* genus. As an important species of the wild fruit forests in the Ili river valley of Xinjiang, the wild Myrobalan plum is a type of National and Autonomous Region's key protective species. And just as its phenotypic diversity, strong stress resistance and high nutritional value, the fruits of the Myrobalan plum contain an abundance of organic acids, pectin, mineral elements, all essential amino acids, and are rich in polyphenol, making the wild myrobalan plum a good prospect for utilization and garden breeding. In this study, the diversity of the polyphenol content and composition in ripened fruits of the wild myrobalan plum (*P. cerasifera*) were studied to provide basic materials for sustainable utilization of wild plum resources and breeding of new cultivars, and to widen gene sources of plum breeding.【Methods】In this research, 13 elite and rare resources were chosen from the total collection and conservation of 103 wild myrobalan plum (*P. cerasifera*) and 'Wanshuhongli' (*P. salicina*) in Xingcheng of Liaoning, according to their fruit weight, rate of fruit determined by other pollen, habit, fruit color, soluble solids content and titratable acid content. The plums were collected during the fruit's ripening stage. Since the plum's quality shows variablility within different trees, fruit sampling occurred under the following conditions: middle vigor trees, any parts of the tree. The fruit mass, soluble solids content and titratable acid

收稿日期:2016-07-07 接受日期:2016-09-22

基金项目:中国农业科学院科技创新工程专项经费(CAAS-ASTIP-2015-ZFRI);中央级公益性科研院所基本科研业务费专项(1610182016010);科技基础性科技工作专项(2013FY111700)

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content were measured soon after harvest. The average fruit mass was determined by using an electronic balance, the soluble solids content by using a hand held saccharometer, and the titratable acid content by using the method of acid-base titration. For polyphenolic compounds analyses, the whole fruits were cut directly to liquid nitrogen and crushed by using a laboratory mill for homogeneous powder in liquid nitrogen, and then the samples were stored in a freezer (-70 ℃) until analysis. The total contents of polyphenol were determined using the Folin - Ciocalteau method, Gallic acid was used as a standard, and the total phenolic content was expressed as grams gallic acid per kilogram of fresh weight ($mg \cdot kg^{-1}$). The composition and content of the polyphenol extracts were analyzed using a High Performance Liquid Chromatography (HPLC) system equipped with a photodiode detector (PDA). The separations of the polyphenols were carried out using a Ultimate® LP-C18 column (4.6 mm×250 mm, 5 μm) at 40 ℃, flow rate of 0.8 $mL \cdot min^{-1}$, and the samples (10 μL) were injected. The mobile phase was composed of solvent A (2.0% formic acid) and solvent B (100% of acetonitrile). The ultimate® LP-C18 gradient elution was used at, 0-35 min, 0-30%B; 36-50 min, 30%-45%B; 51-60 min, 0B. 【Results】There were considerable variations in the polyphenol content which revealed rich diversity. The wild myrobalan plum 9 was the richest in the polyphenol content (5 802.33 $mg \cdot kg^{-1}$), was followed by the wild myrobalan plum 2 (5 606.50 $mg \cdot kg^{-1}$), and the polyphenol content in 'Wanshuhongli' was the lowest (1 856.93 $mg \cdot kg^{-1}$). The total phenolic content 13 wild myrobalan plum germplasms ranged from 2 587.10 $mg \cdot kg^{-1}$ to 5 825.00 $mg \cdot kg^{-1}$, and the variation coefficient was 19.51%; the polyphenol content in the wild myrobalan plums was significantly higher than in 'Wanshuhongli'. The results showed that the wild myrobalan plum fruits were rich in polyphenols, a total of 11 polyphenols were identified including chlorogenic acid, catechin, procyanidin B_1, procyanidin B_2, epicatechin, procyanidin C, quercetin rutinoside, quercetin galactoside, quercetin glucoside, quercetin xyloside, and quercetin arabinopyranosyl, but procyanidin C and quercetin galactoside were not detected in the wild myrobalan plum 8. The procyanidin B_1, catechin, chlorogenic acid, procyanidin B_2, epicatechin and procyanidin C were the major phenolics present in the wild myrobalan plums, while quercetin rutinoside and quercetin arabinopyranosyl were the major phenolics present in 'Wanshuhongli', there were significantly higher polyphenol content in wild myrobalan plum germplasms than those in 'Wanshuhongli' (except quercetin rutinoside), the polyphenol content of chlorogenic acid, catechin, procyanidin B_1, procyanidin B_2, epicatechin, procyanidin C, quercetin rutinoside, quercetin galactoside, quercetin glucoside, quercetin xyloside, quercetin arabinopyranosyl were 71.57, 144.65, 64.70, 235.97, 139.81, 51.29, 24.43, 4.42, 31.29, 13.04, 46.99 $mg \cdot kg^{-1}$, respectively. The variation ranges were 20.77-169.18, 36.03-313.47, 14.54-113.50, 45.59-373.04, 39.13-310.61, 0.00-74.98, 9.37-40.72, 0.00-9.15, 4.95-68.89, 1.72-27.77, 9.73-95.37 $mg \cdot kg^{-1}$, respectively. The variation coefficient ranges were from 30.56% to 108.01% which revealed rich genetic diversity. 【Conclusion】There were extensive diversity in the polyphenol content and components in the 13 wild myrobalan plums (*P. cerasifera*), and the 13 germplasms presented significant differences, wild myrobalan plum 5, wild myrobalan plum 7, wild myrobalan plum 9, wild myrobalan plum 10 and wild myrobalan plum 12 represent good natural sources of procyanidin B_1, catechin, chlorogenic acid, procyanidin B_2, epicatechin, and procyanidin C, which have a large potential for further selection.

Key words: Wild myrobalan plum; Fruit; HPLC; Polyphenol; Diversity

野生果树具有丰富的遗传多样性,在长期的进化过程中形成了许多优良特性,是果树育种珍贵的基因库[1]。野生樱桃李(*Prunus cerasifera* Ehrh.)属第三纪孑遗物种,在《中国珍稀濒危保护植物名录》中已将其列为国家Ⅱ级重点保护物种,抗寒、抗旱、抗逆性强[2]。野生樱桃李资源类型复杂,遗传多样性丰