Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/fbio

Chemical composition and quality traits of Chinese chestnuts (*Castanea mollissima*) produced in different ecological regions

Fang Yang[a,1], *Qi Liu*[a,b,1], *Siyi Pan*[b,1], *Can Xu*[a], *Youling L. Xiong*[c,*]

[a]*Key Laboratory for Green Chemical Process of Ministry of Education, Wuhan Institute of Technology, Wuhan 430073, China*

[b]*College of Food Science and Technology, Huazhong Agricultural University, Wuhan 430070, China*

[c]*Department of Animal and Food Sciences, University of Kentucky, Lexington, KY 40546, USA*

ARTICLE INFO

Article history:
Received 4 January 2015
Received in revised form
4 April 2015
Accepted 8 April 2015
Available online 18 April 2015

Chemical compounds studied in this article:
Ascorbic acid (CID: 54670067)
Gallic acid (CID: 370)
Glucose (CID: 5793)
Rutin (CID: 5280805)

Keywords:
Chestnut
Nutritional composition
Polyphenol compounds
Flavonoids
Principal component analysis

ABSTRACT

The aim of this research was to study the chemical composition and processing adaptability of Chinese chestnuts grown in ten different ecological regions. Results, based on the harvest season 2012, showed that geographic locations significantly influenced the nutritional contents and quality traits of Chinese chestnuts. Chestnuts from the central region of China (such as Hubei province) had higher carbohydrate contents than from other regions, those from Guangdong province (deep south) had the highest protein content, and those from Hunan province (south) had the lowest fat content. Moreover, chestnuts from Zhejiang province (south) had the highest polyphenol content and those from Hunan province had the highest flavonoid content. Owing to their high sugar content, Hunan chestnuts were the sweetest. However, principal component analysis indicated that factors other than geographic regions also contributed to compositional and quality variations, indicating the necessity for further investigations.

1. Introduction

Chestnuts are a common tree nut once utilized as an important food resource in northern hemisphere. Today, chestnuts are reemerging as valuable functional food materials due to newly recognized nutritional quality and many potential health benefits. Chestnuts are consumed as a part of gluten-free diets (Pazianas et al., 2005) and they reportedly can prevent cardiovascular disease (Sabaté, Radak, & Brown, 2000). Chestnuts are free of cholesterol and contain considerable amounts of fibers, ascorbic acid, and trace minerals (Gold, Cernusca, & Godsey, 2005; Borges, Gonçalves, Soeiro de Carvalho, Correia, & Silva, 2008). In addition,

*Corresponding author. Tel.: +1 859 257 3822; fax: +1 859 257 5318.
E-mail address: ylxiong@uky.edu (Y.L. Xiong).
[1]Co-first author with equal contribution to this work.

http://dx.doi.org/10.1016/j.fbio.2015.04.004
2212-4292/

they are excellent sources of bioactive substances, including polyphenol compounds (Vasconcelos, Bennett, Rosa, & Cardoso, 2007). Phenolic acids have the beneficial effects of neutralizing free radicals and prooxidative minerals *in situ*, therefore, are capable of promoting human health (Caro & Piga, 2008; Shahidi, Janitha, & Wanasundara, 1992).

Chestnut trees are spread all over the world and used to produce wood and tanning agents (Gonçalves et al., 2010). World chestnut trees include *Castanea mollissima* (Chinese chestnut), *Castanea crenata* (Japanese chestnut), *Castanea dentata* (American chestnut), *Castanea sativa* (European chestnut), and others. In China, chestnut trees have a growing history of over 2000 years where 22 provinces, autonomous regions and municipalities have them as an important economic cultivation (Yang, Jiang, Gu, Yang, & Jiang, 2010). According to the ecological adaptability to different climates, the main chestnut-producing areas in China are divided into six regional groups: Northern, Yangtze River Valley, Southeastern, Southwestern, Northwestern and Northeastern. Furthermore, due to their excellent adaptability and resistance to fungus blight, Chinese chestnut trees have been introduced into the United States (Jaynes, 1979).

Studies have been carried out on the nutritional composition of European chestnuts (Attanasio, Cinquanta, Albanese, & Matteo, 2004; Bellini, Giordani, Marinelli and Perucca, 2005; Sacchetti & Pinnavaia, 2005; Neri, Dimitri, & Sacchetti, 2010). However, it is difficult to describe the chemical characteristics of chestnut varieties; some have different ecotypes with different chemical characteristics linked to the ecological surroundings (Sacchetti & Pinnavaia, 2005) and different clones of the same variety may have different chemical compositions (Pinnavaia, Pizzirani, Severini, & Bassi, 1993). The chestnut composition also shows a dramatic variation between harvesting years (Sacchetti & Pinnavaia, 2005), and the interaction between cultivar and year is significant (Ferreira-Cardoso, Torres-Pereira, & Sequeira, 2005).

Previous studies have mainly focused on the composition of chestnuts, including some bioactive compounds (ascorbic acid, polyphenols, etc.). Fernández-Agulló, Freire, Antorrena, Pereira and González-Álvarez (2014) reported that phenolic extracts from chestnut could inhibit the growth of both gram-positive and gram-negative bacteria but not fungi. Dinis, Oliveira, Almeidac, Costad, and Gomes-Laranjoa (2012) studied the antioxidant properties of different ecotypes of chestnuts (cv. *Judia*), suggesting that the climatic conditions could be a limiting factor for the production of phenolic compounds and, consequently, antioxidant properties of chestnuts. Barreira, Ferreira, Oliveira, and Pereira (2008) compared the antioxidant properties of chestnut extracts (flowers, leaves, skins, and fruits), noting that chestnut skins had the best antioxidant activity.

In spite of the previous studies, information about the nutritional and sensory quality attributes as related to geographic locations of chestnut trees is scant. In particular, the compositional differences between chestnuts grown from different ecological regions in China, one of the largest chestnut-producing countries, have not been examined to our knowledge.

The aim of this study was to investigate the chemical composition, processing adaptability, and sensory properties of Chinese chestnuts, grown in different regions. The contents of main groups of antioxidant compounds (ascorbic acid, polyphenols, flavonoids, and minerals) in chestnuts were also determined to highlight the potential benefits of Chinese chestnuts as a source of natural antioxidants.

2. Materials and methods

2.1. Samples and chemicals

Chinese chestnuts from ten different regions with a 23–41° latitude span (Fig. 1), harvested in the fall of 2012, were used for the study. They were purchased fresh either from local chestnut processors or from local distributors. The chestnuts were confirmed by the suppliers to be within a few days post-harvest and kept in a cooler for no more than 2 weeks if long distance shipment was required. No spoilage was noted for any of the chestnuts received. To ensure only regionally grown chestnuts were collected, the acquisition was done through local contacts (colleagues and collaborators). Hence, chestnut samples were named after their geographic growing locations from north to south in China (Fig. 1): LN (Liaoning province), SD-Y (Yimengshan area of Shandong province), SD-L (Linyi area of Shandong province), HEN (Henan province), HB-S (Suizhou area of Hubei province), HB-L (Luotian area of Hubei province), HUN (Hunan province), JX (Jiangxi province), ZJ (Zhejiang province), and GD (Guangdong province). The average temperatures and precipitations for these regions in the fall season (August–October) in which chestnuts were grown are indicated in Fig. 1.

A pool of five-kilograms of fresh chestnuts per region was used. The chestnuts were cross-cut on the top, slit with a knife, then peeled. Three independent tests (replications) were performed; in each replication, 10–20 shelled nuts were diced into small pieces, and approximately 100 g of the mixture was milled in a Model FW80 high-speed grinder (Teste Instrument Co., Ltd., Tianjin, China) to obtain fine particles. They were placed in sealed plastic bags, kept at 2 °C, and analyzed within seven days.

Chemicals and reagents were of analytical grade obtained from Sigma Chemical (St. Louis, MO, USA) and Sinopharm (Shanghai, China). Phenolic (gallic acid) and flavanoid (rutin) standards were purchased from Sinopharm. Water used in the experiments was ultrapure deionized water.

2.2. Determination of chemical composition

2.2.1. Moisture and ash

The moisture content of chestnuts was determined by the gravimetric method using a drying oven (DHG-9075A,Yiheng, Shanghai, China) at 101 ± 2 °C until a constant weight was obtained (Sacchetti & Pinnavaia, 2005). Total ash content was measured using a Baidian muffle furnace (Shanghai, China) at 525 ± 5 °C according to AOAC 923.03 (AOAC, 2000).

2.2.2. Total protein

Total protein nitrogen was analyzed by the Kjeldahl method AOAC 925.40 (AOAC, 2000). Sample digestion was carried out in a digestion system sealed with a cork, and copper was used