Industrial Crops and Products 57 (2014) 150–157

Contents lists available at ScienceDirect

Industrial Crops and Products

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

Total phenolic contents of 33 fruits and their antioxidant capacities before and after *in vitro* digestion

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ARTICLE INFO

Article history:
Received 25 December 2013
Received in revised form 17 March 2014
Accepted 18 March 2014
Available online 17 April 2014

Keywords:
Fruit
Antioxidant
Phenolic content
In vitro digestion

ABSTRACT

In order to provide new information on the antioxidant activities before and after *in vitro* digestion of selected fruits for consumers, nutritionists, and food policy makers, total phenolic contents and antioxidant capacities of 33 fruits were evaluated by Folin–Ciocalteu method, 2,2-diphenyl-1-picrylhydrazyl radical scavenging activity assay (DPPH), Ferric reducing antioxidant power assay (FRAP), and $ABTS^{\bullet+}$ radical cation scavenging activity (ABTS) assay, respectively. The correlations between DPPH, FRAP, ABTS values and total phenolic contents were also evaluated. The results showed that different fruits had diverse antioxidant capacities and the variation was very large. Before the gastric and duodenal phases of *in vitro* digestion, there was a high positive correlation between the DPPH, FRAP, ABTS values, and total phenolic contents. After the digestion, however, the correlations between the results and the total phenolic contents were poor. Four fruits, plum (sanhua) (*Prunus salicina* Lindl), red bayberry (*Myrica rubra* (Lour.)), plum (green) (*P. salicina* Lindl), and mango (shuixian) (*Mangifera indica* Linn) showed the strongest antioxidant activities they were before or after the digestion, which implied that these fruits were important natural sources for preventing oxidative stress diseases.

1. Introduction

Excess reactive oxygen species (ROS) were reported relating to a number of serious diseases, such as cardiovascular disease (Heitzer et al., 2001), neurological decline (Jomova et al., 2010), and cancer (Farombi et al., 2004). When the ROS were imbalanced in a human body, they could cause damage to DNA and protein which would increase the risk of degenerative disease (Wu et al., 2006). In addition, the imbalanced ROS could also lead to cell apoptosis, alteration of gene expression, lipid peroxidation, DNA mutation, and modification of cell signal transduction (Nordberg and Arnér, 2001).

Epidemiological studies indicated that diet played an important role in the prevention of chronic diseases (Bauman, 2004; Parillo and Riccardi, 2004; Willett, 1995). The vegetables, fruits, and grains are rich in phenolics, carotenoids and tocopherols. These compounds could provide chemo-protective effects against oxidative stress in the body, and maintain balance between oxidants and antioxidants to improve human health (Wolfe et al., 2003; Adom and Liu, 2002). Recently, phenolic compounds have attracted increasing attention as potential agents for preventing and treating many oxidative stress-related diseases (Kahkonen et al., 2001; Robards et al., 1999). Many studies determined the total phenolic contents and antioxidant capacities of fruits (Fu et al., 2011; Lim et al., 2007), but the antioxidant activity of the total phenolic in human system was not taken into consideration. Thus, the aim of this study was to determine the total phenolic contents and to study the antioxidation of total phenolic contents by vitro digestion model, and observe that whether it still maintained a high antioxidant capacity after gastric and duodenal digestion and the variation of total phenolic contents in human system.

2. Materials and methods

2.1. Materials

Gallic acid was obtained from National Institutes for Food and Drug Control of China. Porcine pepsin, taurodeoxycholate, taurocholate, and pancreatin were obtained from Amresco (America).

Abbreviations: FRAP, ferric reducing antioxidant power; DPPH, 2,2-diphenyl-1-picrylhydrazyl; ABTS, 2,2-azinobs-(3-ethylbenzothiazoline-6-sulfonic acid).

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http://dx.doi.org/10.1016/j.indcrop.2014.03.018
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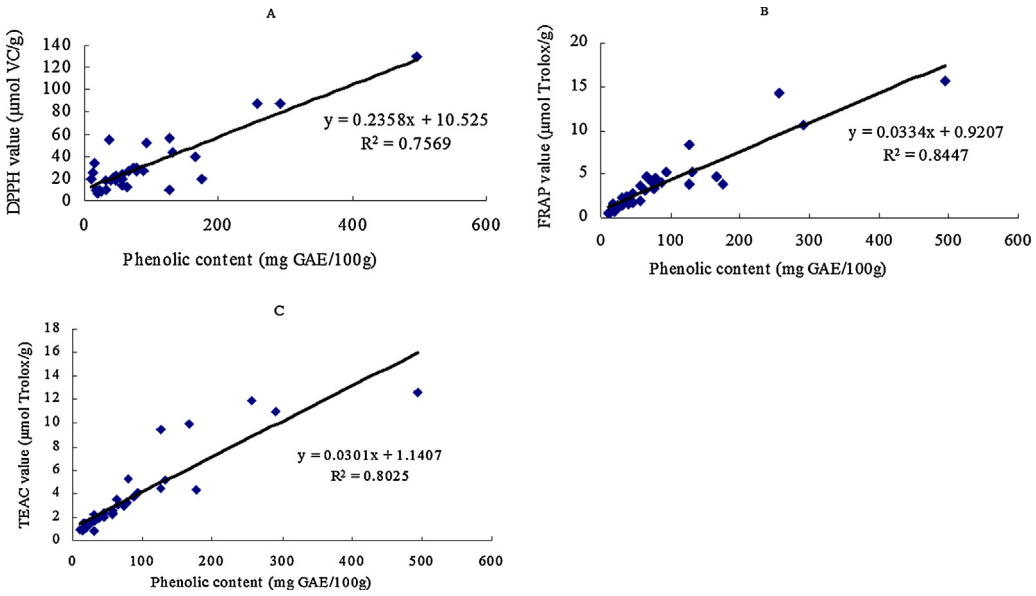

Fig. 1. Correlation between the antioxidant capacities and total phenolic content. Antioxidant capacities were measured by the DPPH assay (A), FRAP assay (B) and TEAC assay (C), respectively. GAE: gallic acid equivalents.

The 2,4,6-Tri(2-pyridyl)-*S*-triazine (TPTZ), and 2,2-azinobis (3-ethylbenothiazoline-6-sulphonic acid) diammonium salt (ABTS) were purchased from Aladdin Industrial Inc. Glycodeoxycholate was purchased from Dibo Chemical Factory (Shanghai, China). Pancreatin was purchased from Toyobo (Osaka, Japan). The 2,2-Diphenyl-1-picrylhydrazyl (DPPH) was purchased from Qiyun Biological Technology Co. Ltd., (Guangzhou, China). The 6-Hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid (Trolox), and the Folin–Ciocalteu's phenol reagent were purchased from Sigma-Aldrich (St. Louis, MO). All chemicals used in the experiments were of analytical grade, and deionized water was used (Figs. 1–3).

Thirty-three fruits were collected from the markets in Zhongshan, China.

2.2. Sample preparation

The fruits were washed with deionized water to remove dirt on their peels, and then were given an airing at room temperature. Edible parts of the fruit were ground into fine particles with a blender. A 1.00 g of these particles was extracted with 9 mL of a mixture of ethanol:water (50:50; v/v) at room temperature for 30 min in a shaking water bath (Fu et al., 2011; Soong and Barlow, 2004). The

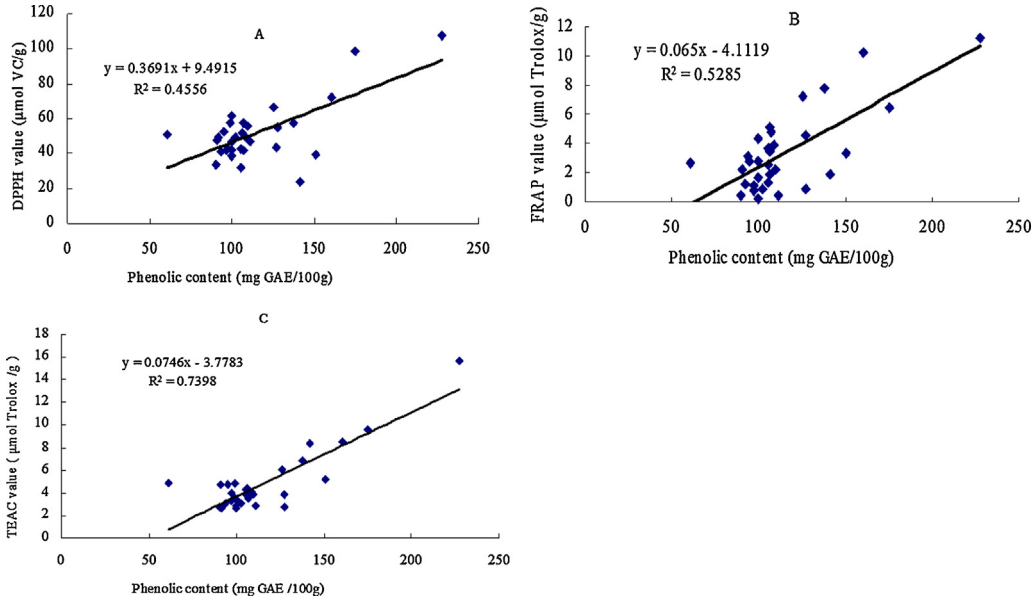

Fig. 2. Correlation between the antioxidant capacities and total phenolic content after the duodenal phase of digestion. Antioxidant capacities were measured by the DPPH assay (A), FRAP assay (B) and TEAC assay (C), respectively. GAE: gallic acid equivalents.