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Response of Certain Poly Phenolic Compounds to Sonication in Fresh Pear Juice

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Abstract
The use of non-thermal technologies in fruit and vegetable juice processing is an emerging trend in the food industry. Considering this, the current study was designed to assess the influence of sonication on selected polyphenolic compounds; cholrogenic acid, caechin, caffeic acid, apicatechin and phlodridzin of pear juice. The sonication of fresh pear juice was carried out at amplitude of 70% (500 W) with a constant frequency of 25 kHz for 0, 15, 30, 45 and 60 min at 25 °C. The results showed a significant increase in all the studied phenolic compounds compared to fresh untreated control pear juice samples. Sonication for 60 min revealed better results than the rest of the treatments. It may be inferred that ultrasound processing or sonication may successfully be employed as a quality enhancement tool at industrial scale for producing safe and quality pear juice.
Keywords Pear juice, phenolic compounds, ultrasound, quality.

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China is the largest pear producing country with its share exceeding half of the world production. In 2013, out of 24 million metric tons of world pear production china`s share crossed 17 million metric tons [1].Some recent studies showed that pear is the third most consumed temperate fruit in the world as a whole, both fresh and in fruit products[2, 3]. It also has a history of over 2000 years of being used as a traditional folk medicine due to its anti-inflammatory, anti-hyperglycemic and diuretic qualities [4]. Due to low acidic nature, higher potassium and lesser sodium than apple; pear fruits are popular in baby food formulas and in food products containing high acidic fruits [5].

Phenolic compounds are bioactive chemicals originating from secondary plant metabolism. They are one of the basic constituents in the sensory and nutritional quality of fruits, vegetables and other plant materials [6]. Most of the phytochemicals occurring in plants belong to these groups. Due to a vast range of molecular structures, these compounds play very diverse biological functions. These phenolic compounds may act as attractants for pollinators, antifeedants, and protective agents against UV light, predators and pathogens [7]. These compounds are also mainly responsible for color and sensory characteristics of fruits and vegetables [8]. Over 8000 phenolic compounds, including more than 4000 flavonoids has been identified, and the list is still growing [9]. The retention and availability of these bioactive compounds in the final product are one of the top most priorities in the processing industry.

Highly thermos-sensitive nature of these bioactive compounds has led the researchers to develop processing technologies with lesser heat involvement. During the past two decades, many different innovative processing technologies have been tested in food industry [10]. Ultrasound is one of those emerging food processing technologies that could effectively improve quality and shelf life of the food product while reducing the heat losses of conventional heat processing [11-13]. Some recent studies have illustrated the improvements in antioxidant capacity, ascorbic acid, and cloud values in apple, pear and carrot juices by the use of ultrasound treatment [11, 14, 15]. However, the behavior of individual phenolic compound to ultrasound treatment in fresh pear juice has not been studied yet. Therefore, the current study was designed to evaluate the effect of ultrasound treatment on selected polyphenolic compounds (chlorogenic acid, caffeic acid, catechin, epicatechin and phloridzin) in the fresh pear juice.

The chemicals required for the chemical analysis were purchased from Fluka Chemie GmbH (Buchs, Switzerland), Hanbon Science and Technology (Jiangsu, China) and Sinopharm Chemical Regent Co., Ltd (Shanghai, China). All other reagents and chemicals used were of analytical grade.

Pears (cv. Yali) were bought from a local market in Nanjing, China. The pears were washed, dried and cut into pieces with the help of a stainless steel knife. Seed and stem were discarded and Juice was extracted using a domestic tabletop juice extractor. Coarse particles were removed using double layered pre-sterilized muslin cloth. The obtained juice was divided into 5 similar portions (80 ml each) to be used as control and for sonication treatments.

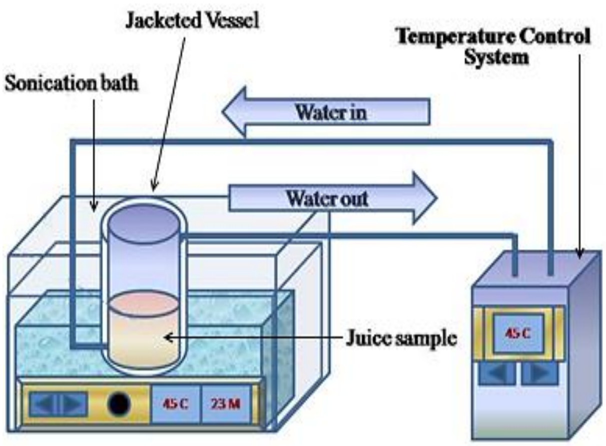

Fig. 1 The schematic diagram of ultrasound exposure system.

The juice samples were sonicated in a 100 ml jacketed vessel at the constant temperature of 25°C, power set at 70% and frequency at 25 kHz for 15, 30, 45 and 60 min using a bath ultrasound cleaner (model) SB-500 DTY from Ningbo Scientz Biotechnology Co., Ltd, Ningbo, China. The dimensions of bath ultrasound cleaner were 30 × 50 × 15 cm (width × length× depth).A continuous circulation of water at a flow rate of 500 ml/min was used to control the temperature of the sample. Fig. 1 shows the schematic diagram of the bath type sonicator. The treated samples were stored at 4°C in sterilized media bottles (100 ml)till further analyses. All treatments were repeated thrice.

The poly phenolic compounds in fresh and treated pear juice were determined using Agilent 1100 series HPLC (Agilent Technologies, USA) as described by Kahle et al. [16] with minor adjustments. The main parts involved in the process included; a G1379A degasser, a G1316A column oven, a G 1311A pump, a G1315B diode array detection (DAD) system and an Agilent Zorbax Eclipse XDB-C18 column (4.6×150 mm, 5 µm). The mobile phase comprised of 0.1% formic acid (v/v) and methanol as A and B, respectively. The gradient was adjusted at 10-90% B in 40 min at a flow rate of 1.0 ml/min. After filtration using 0.45 um diameter filter, 20 µl sample volumes were injected into the system. The peaks were identified by comparing standard reference chemicals. Calibrating wavelength for catechin, epicatechin and phloridzin was 280 nm while for chlorogenic acid and caffeic acid was 320 nm. Standard solutions of chlorogenic acid, caffeic acid, catechin, epicatechin and phloridzin at different concentrations were used to prepare calibration curves and the results were expressed as mg/l for the polyphenolic compounds in pear juice sample.

The statistical significance of treatments effect was determined using one-way ANOVA while Duncan's multiple range test was employed to find differences among treatments at$P<0.05$. Statistix 9.0 software (Analytical Software, Tallahassee, FL, USA) was employed for statistical analyses.

Results representing the effects of sonication treatments on poly phenolic compounds in pear juice are described in the Table 1. A significant increase in all the studied phenolic compounds was observed comparing with control (the untreated pear juice). The increase observed in chlorgenic acid was from 33.47 to 57.90 mg/l, in caffeic acid from 2.38 to 3.56 mg/l, in catechin from 178.93 to 223 .70 mg/l, in epicatechin from 188.01 to 276.43 mg/l and in phloridzin from 73.50 to 149.43 mg/l. Some recent studies have shown a significant increase in chlorogenic acid and certain other phenolic compounds in clear and filtered apple juice under ultra-high pressure homogenization and sonication both being non-thermal processing techniques [17, 18]. Another study described significant improvement in each individual flavanone of orange juice under high pressure treatments [19]. One of the reasons behind this increase in poly phenolic compounds is that sound waves result in the breakdown of cell walls, causing the liberation of bound phenolic compounds into the system [14, 20]. Another reason for this development is that aromatic rings of phenolic compounds are attached with hydroxyl radicals produced during sono-chemical reactions [21]. Some researchers have also reported findings otherwise during ultrasound processing of fruits and vegetables; a significant reduction in flavonol/flavonoid contents [22]. In this study, it was found that the sonication treatment

Table 1 Effects of sonication treatments on polyphenolic compounds of pear juice (mg/L).

Treatments	Chlorogenic acid	Caffeic acid	Catechin	Epicatechin	Phloridzin
Control	33.47 ±0.13d	2.38 ±0.08d	178.93 ±4.68d	188.01 ±1.98d	73.50 ±0.98d
US15	35.74 ±0.12d	2.54 ±0.07d	179.84 ±4.10d	194.07 ±2.33d	80.07 ±1.33d
US30	42.14 ±0.16c	2.91 ±0.07c	197.16 ±4.29c	217.79 ±3.79c	97.79 ±0.79c
US45	51.60 ±0.17b	3.23 ±0.06b	212.76 ±4.76b	254.96 ±3.68b	128.96 ±0.68b
US60	57.90 ±0.16a	3.56 ±0.02a	223.70 ±3.58a	276.43 ±4.66a	149.43 ±0.66a

The results were expressed as mean value ± standard deviation. Values with different letters in the same column are significantly different ($P < 0.05$) from each other. US15, Sonication for 15 min; US30, Sonication for 30 min; US45, Sonication for 45 min; US60, Sonication for 60 min.

increased the polyphenolic compounds that improved the overall quality of pear juice. The ultrasound treatment of fruit juices is an emerging technique that creates a balance between industry and consumer expectations by improving health related compounds and by reducing costs and processing time. However, further studies are required to optimize the fruit juices processing conditions and to better understand the underlying mechanisms.

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