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Comparative analysis of antioxidant activities of different varieties of mangos with some selected fruits

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Natural antioxidants and secondary metabolites found in vegetables and fruits play significant role in human health. The juices obtained from fruits and vegetables are more convenient to consume than fresh vegetables and fruits. In the current study, the total phenolic, vitamin C, total carotene and B-carotene content and antioxidant activity of fruits and vegetables juices were determined by 1,1-diphenyl-2picryl hydrazyl (DPPH) scavenging, 2,2–azinobis3-ethylbenzothiazoline-6-sulfonic acid (ABTS), and reducing power (RP) assays. Various fruits juices such as Chinese mango juice (Ao mango, Ao flim package, Xiangya mango) and among (Apple, Orange, Tomato, Carrot) juices were compared. Among the fruits, the highest amount of total phenolic (328.18 mg/100 g) and vitamin C (46.8 mg/100 g) content was found in orange juice among all the other fresh juices. Among different mango juices, the highest amount of total phenolic (145.52 mg/100 g) and vitamin C (16.4 mg/100 g) content was found in Xiangya mango as compared to Ao mango and Ao (flim package) mango. While Ao (flim package) mango contained the highest amount of total carotene (2771 µg/100 g) and B-carotene (1.955 mg/100 g), as compared Ao mango and Xiangya mango. The highest amount of total carotene (6062 µg/100 g) and B-carotene 5.398 mg/100 g was found in carrots as compared to the fruit and vegetable juices. However, the lowest content of total phenolic 15.1 mg/100 g and vitamin C (1.87 mg/100 g) was found in carrots as compared to other fruits and vegetable juices. The highest antioxidant activity was recorded in Xiangya mangoes and oranges juice through DPPH, ABTS, and RP scavenging assays as compared to other Juices. However, the lowest antioxidant activity was recorded in carrot juice. The present study demonstrates the potential value of fruit juice as their placement of fresh fruit.

Key words: Chinese mango, phenolic compounds, B-carotene, antioxidant activity.

INTRODUCTION

China is one of the leading mangoes exporting countries in the world with potential local as well as internal markets. The climatic environment permits the cultivation of mangoes throughout the year by the use of stimulation

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techniques particular flower. It is believed that factors like cultivar, agronomic conditions, post-harvest manipulation and stage of ripeness significantly affect the antioxidant properties of mangoes (Lemmens et al., 2013). Mango (*Mangifera indica* L.) is regarded as the king of all fruits, possessing rich dietary source, antioxidants, such as vitamin C, vitamin E, as well as carotenoids and phenolic compounds, which have shown various health effects on the human body (Barbosa et al., 2017; Liu et al., 2014). Recent study showed that the mango juice has possibility as a functional food that is capable of reducing metabolic risk for obesity associated with adiposity and inflammation (Natal et al., 2017). Mango is considered as one of the most popular and economically important fruits due to its admirable sensorial characteristics (sweet taste, bright color, and delicious flavor), as well as nutritional composition (carbohydrate such as abundant glucose, fructose and sucrose, vitamins, minerals, fiber, and photochemical (Barbosa et al., 2017). Mangoes provide excellent quantity of antioxidant activity and bioactive compounds, playing a beneficial role in human health. These bioactive compounds are helpful in preventing different pathological conditions like cardiovascular disease and decreasing the risk of various types of cancers and atherosclerosis (Nemec et al., 2017; Ulla et al., 2017). The antioxidant potential of different vegetable and fruits is associated with their carotenoids composition, and/or total phenolic content (Liu et al., 2014). Although, total phenolic compounds and antioxidant activity of mangoes and other fruits have been extensively studied; however, there is still lack of information regarding composition and changes in these phenolic compounds and their antioxidant potential during the ripening period (Lee and Hwang, 2017). The literature available on this reveals that these phenolic compounds have varied antioxidant potential, depending upon the number of hydroxyl groups and their distribution in the structure (Heo et al., 2007). It is well known that reactive oxygen species (ROS), like superoxide anion radical, hydroxyl radical and hydrogen peroxide are formed in the human body through enzymatic systems during oxygen utilization (Ahmed et al., 2017). A small quantity of these ROS is thought to be favorable for the body performing different vital roles such as transfer of neuro signal from one location to another (Afifa et al., 2014) and also in growth regulator (Carlis et al., 2014). Nevertheless, huge quantity of ROS are known to be involved in causing different pathologic conditions in the human bodies, such as cancer, cardio vascular diseases (CVD), aging and neurodegenerative diseases (Lauricella et al., 2016). Therefore, the firm capacity of exogenous antioxidants is continually required to sustain a sufficient amount of antioxidants in order to stabilize the ROS. Similarly, mangoes have particularly rich source of polyphenols, which are a various group of natural micronutrients present in plants having specific health benefits, that is, mangiferin is antioxidant compounds which may encourage metabolism and scrap diabetes and quercetin, which can decrease inflammation and hypertension as well as reduce cancer growth (Nemec et al., 2017). However, because of different mechanisms of reaction characteristics occupied, one analysis is capable of perfecting all the analysis of antioxidants in a miscellaneous or complex system. Therefore, in order to evaluate a full profile of the potential antioxidant, various assays capacity of antioxidant may be compulsory. In this context, different technique has been applied to determine antioxidants in biological fluids, food materials, nutraceuticals, and dietary supplements (Emoke et al., 2010). Among these methods, reducing power, 2, 2-azino- di-(3-ethylbenzothialozine-sulphonic acid) (ABTS assay), 2, 2-diphenyl-1-picrylhydrazyl (DPPH assay), and hydroxyl radical scavenger activity are the commonly used antioxidant capacity assays. These methods are different from everyone both in conditions of their evaluation roles as well as experimental situation. The main aim of this study is to evaluate the antioxidant properties of different varieties of mangos and compare them with some selected fruits.

MATERIALS AND METHODS

Chemicals and reagents

DPPH, ABTS, potassium peroxy-di-salfate ($K_2S_2O_8$), ascorbic acid, potassium ferricyanide, trichloroacetic acid, ferric chloride, phosphate buffer solution (PBS), gallic acid, Folin-Ciocalteu's, ascorbic acid, methanol, acetone, methylene chloride and ethanol were purchased from Sino Pharma-Chemical Reagents Co, Ltd. (Shanghai, China). All the chemicals used were of analytical grade and were used without further purification.

Preparation of fruit juices

Mangoes were purchased from Hainan province, and the other fruits were purchased from the local supermarket of Huazhong Agricultural University, Wuhan, Hubei province, China. Mangoes, other selected fruits (apple, orange, tomato) and vegetable (carrot) were washed with tap water and dried, followed by cutting into small pieces separating pulp from peel. Afterward, pulp and fruit juice were extracted by using juice extractor (AUX-PB953).

Determination of Brix, pH, and acidity

Brix was measured using WYT-80 hand refractometer (Quanzhou Wander Experimental Instrument Co., Ltd., Quanzhou, China). The pH was measured using a digital pH meter (Delta 320 pH meter, Metller Toledo Instruments Co., Ltd., Shanghai, China), while titratable acidity was measured according to the method suggested by the "Association of Official Analytical Chemists" (AOAC, 2000). The samples were titrated with N/10 NaOH solution using titration kit, where phenolphthalein (3-5 drops) was used as an indicator. The volume of alkali used was noted and calculation was made using the following formula:

Titratable acidity (%) = Quantity of N/10 NaOH used × 0.009 / Volume of sample taken

Determination of total phenols content

To determine the total phenols content, 100 µL sample was mixed with 0.4 mL distilled water (ddH_2O) and 0.5 mL diluted Folin-Ciocalteu reagent. The samples were incubated for 5 min and then 1 mL 7.5% sodium carbonate (w/v) was added. The absorbance was measured at 765 nm using spectrophotometer. The results were obtained as mg of gallic acid equivalents/100 g of fresh sample (Musa et al., 2011).

Determination of vitamin C

Vitamin C content for the fruit juices were determined using protocol of Dashman et al. (1996) with some modifications. About 20 µL of sample was pipetted into a 100-mL volumetric flask. Then 2 mL (10%) tetra-chloro-acetic acid solution was added. The solution was diluted up to 100 mL with distilled water. The sample was poured into a conical flask, swirled gently for 1 min and left to stand for 1 min, and filtered through a Whatman filter (No. 542). One milliliter of the sample or standard solution (3 mg ascorbic acid in 1 mL distilled water) was pipetted into a test tube, followed by the addition of 3 mL distilled water and 0.4 mL of Folin-Ciocalteu reagent. Afterward the samples were incubated at room temperature for 10 min. The absorbance was measured at 760 nm using the Unico™ UV-2100 spectrophotometer. The results were expressed as mg/100 g fresh weight (FW).

Determination of total carotenoids

Total carotenoids were determined using the method of Ranganna et al. (1999). Approximately, 5 g of sample was added to 20 ml of acetone and maintained in the dark for 10 to 15 min. Afterwards, the contents were filtered through a sintered funnel under suction. About 20 ml of acetone was added twice and then 20 ml of hexane was added to extract the pigment completely. The mixed solutions were transferred to a separating funnel. After 5 min, the upper aqueous layer was completely discarded. However, the lower hexane layer was transferred to 250-ml volumetric flask. The volume of flask was filled up to the mark with hexane. Slight amount of anhydrous sodium sulfate was added and the absorbance was measured at 450 nm against hexane as a blank. The carotenoid content of each sample was estimated according to the following equation:

Absorbance × 250 × 1000 × 100 / 250 × Weight of the sample.

The carotene was expressed as µg/100 mL.

Determination of β-carotene

HPLC method was used for determination of β-carotene according to the method of Hymavathi et al. (2005). Sample (15 g) was added to 30 mL acetone. The samples were sonicated for 30 min followed by centrifugation at 9000 rpm at 4°C for 15 min. The procedure was repeated twice to ensure the maximum extraction. The extracts were collected and made up to final volume of 100 mL by adding distilled water. After that, 50 mL of methanolic KOH (10%) was added to the extracts for saponification at 45°C water-bath for 1 h. Then, the extracts were transferred to 100 mL petroleum ether, and the organic layer was dried by passing through an anhydrous sodium sulphate column and evaporated to dryness. The dried residue was dissolved in hexane and filtered through a 0.45 µm membrane filter. The filtrate was analyzed with the RF-10AXL HPLC system (Shimadzu Co., Ltd., Japan) carried out at 445 nm at 30°C. The analytical column was a Sunfire™ C18 (4.6×250 mm i.d., 5 µm particle size) from waters. The mobile phase was acetonitrile: methanol: methylene chloride (6:2:2, v/v/v), with isocratic flow at a rate of 1.0 mL/min. The concentration was calculated using β-carotene as external standard and expressed as microgram β-carotene per 100 g of FW.

DPPH radical scavenging activity assay

The DPPH free radical scavenging activity was observed according to the method described by Mendes et al. (2011). Briefly, 7 mg of DPPH was dissolved in 100 mL ethanol (95%). Different concentrations of each sample (mg/mL) were used from which 2 mL was mixed with 2 mL DPPH solution. Control was prepared by mixing 2 mL DPPH and 2 mL distilled water, whereas blank sample was prepared by mixing 2 mL sample with 2 mL ethanol. Then, samples were kept in the dark for 30 min. The absorption was measured at 517 nm. The samples were taken in triplicate and the results were expressed as means and standard deviation. The results were calculated for IC_{50} value.

ABTS radical scavenging activity

The ABTS free radical antioxidant activity was observed according to the method described by Re et al. (1999) with some modifications. Briefly, 6 mg ABTS and 2 mg potassium peroxi-disulfate ($K_2S_2O_8$) were dissolved in 1.47 and 2.86 mL distilled water, respectively. Then 1 mL of each ABTS and potassium peroxi-disulfate solutions were mixed together. The mixture was kept at dark for 12 h. Then 2 mL of mature was dissolved in 80 mL of 95% ethanol. From different concentrations of juice sample used (mg/mL), 150 µL of sample was mixed with 2.85 mL mixture solution. Control was prepared by mixing 150 µL distilled water and 2.85 mL mixture solution while blank mango by mixing 150 µL sample and 2.85 mL ethanol. The mixture was kept at 25°C for 5 min to ensure maximum reaction. The absorbance of each sample was measured at 734 nm. The samples were measured in triplicate and the results were expressed as mean ± standard deviation (SD). The results were calculated for IC_{50} value.

Reducing power

The reducing power was observed according to the method described by Lidia et al. (2011) with some modification. Different concentrations of sample extracts (1 mL) were mixed with 2.5 mL of 200 mM/L sodium phosphate buffer (pH 6.6) and 2.5 mL of 1% potassium ferricyanide. The mixture was incubated at 50°C for 20 min. The 2.5 mL of 10% trichloroacetic acid (w/v) was added and the mixture was centrifuged at 1000 rpm for 8 min in a refrigerated centrifuge (5805 AN 562248). Then 2.5 mL upper layer of each sample was mixed with 2.5 mL of deionized water and 0.5 mL of 0.1% of ferric chloride. The absorbance was measured at 700 nm by using Unico™ UV-2100 spectrophotometer.

Statistical analysis

The SPSS statistical package (IBM Statistics version 20) was used to analyze the results and determining significant difference. The results are presented as the mean value with the standard deviation (Mean ± SD). The significant difference was found using analysis of variance (ANOVA).

RESULTS

Brix, pH, and acidity

Table 1 results shows that the brix, pH, and acidity of

Table 1. pH, brix, titratable acidity, polyphenol, vitamin C, total carotene , B-carotene and lutenin content of mango and other fruits.

Name of fruits	pH	Brix	Titratable acidity (%)	Total polyphenol (mg GAE/100 g FW)	Vitamin C (mg/100g)	Total carotene (µg/100 g)	β-carotene mg/100 g	Lutein mg/100 g
Ao mango	4.86 ± 0.02^{b}	15.5 ±0.25^{a}	0.18 ± 0.01^{d}	102.7 ± 3.85^{d}	15.8 ±1.09^{c}	578 ± 14.4^{d}	0.467±0.11^{d}	0.111±0.03^{d}
Ao mango (film package)	4.78 ± 0.01^{b}	14.3 ± 0.12^{b}	0.18 ± 0.01^{d}	129.5 ± 3.75^{c}	15.8 ± 1.02^{c}	2771 ± 25.18^{b}	1.955±0.22^{b}	0.816±0.13^{a}
Xiang ya mango	4.72 ± 0.01^{b}	12.2 ±0.14^{c}	0.18 ± 0.01^{d}	145.52 ± 6.86^{b}	16.4 ± 0.97^{c}	1050 ± 29.03^{c}	0.672 ±0.15^{c}	0.378±0.08^{c}
Orange	3.54± 0.03^{e}	8.2 ± 0.08^{e}	0.82 ± 0.01^{a}	328.18 ± 7.91^{a}	46.8 ± 4.07^{a}	75 ± 9.01^{f}	0.075 ±0.02^{f}	-
Apple	3.98 ± 0.02^{d}	10.1 ± 0.12^{d}	0.54 ± 0.01^{b}	137.45± 11.9^{e}	18.6 ± 3.07^{c}	39 ± 6.40^{g}	0.034±0.03^{f}	0.005±0.01^{e}
Tomato	4.53± 0.01^{c}	2.4 ± 0.01^{g}	0.36 ± 0.01^{c}	75.66 ± 3.63^{f}	23.68 ± 3.6^{b}	247 ± 18.4^{e}	0.247±0.08^{e}	-
Carrot	6.8 ± 0.03^{a}	4.1 ± 0.02^{f}	0.09 ± 0.01^{e}	15.1 ± 0.19^{g}	1.87 ± 0.02^{d}	6062 ± 47.28^{a}	5.398 ±0.37^{a}	0.664±0.12^{b}

*Each value represents the means ± SEM. Triplicates in three independents experiments. Different letters within the column represents the significant difference (005).

"Ao" mango (15.5, 4.86 and 0.18), "AO" mango film (14.3, 4.78 and 0.18), Xiang-Ya" mango (12.2, 4.72 and 0.18), orange (8.2, 3.54 and 0.82), apple (10.1, 3.98 and 0.54), carrot (2.4, 4.53 and 0.36), and tomato (4.1, 6.8 and 0.09). The results indicated that "Ao" mango showed the highest brix value in all the experimental samples.

Spectrophotometric analysis of antioxidants compounds

Total polyphenol

Polyphenol compounds are very important fruit constituents due to their antioxidant activities, their chelation of redox-active metal ions, and inactivation of lipid free radical chains and prevention of hydroperoxide conversion into reactive oxyradicals (Cabral et al., 2009). Phenolic content can be used as an important indicator of antioxidant capacity and can be used as a preliminary screen for any product when intended to be used as a natural source of antioxidants in functional foods (Viuda et al., 2011). Total phenolic contents of fruits and vegetables juices are shown in Table 1. The highest quantity of phenolic contents (328.18 mg/100 g) was found in orange juice. However, carrots contain the lowest quantity of phenolic content (15.1 mg/100 g). Among the mango juices, the highest amount of polyphenol content (145.52 mg/100 g) was found in xiangya mango juice as compared to Ao mango and Ao (film package) mango juice.

Vitamin C

Vitamin C is a major antioxidant ingredient in must melon (Hoyle and Santos, 2010). Mango (*Mangifera indica* L.) being one of most consumed tropic fruit is rich in dietary antioxidants such as ascorbic acid, carotenoids and phenolic compounds. These compounds are involved in the protection of human against various diseases (Ribeiro et al., 2007).

Vitamin C content was found to be variable among the fruit and vegetable juices. Total vitamin C contents of various fruit and vegetable juices are shown in Table 1. The highest contents of vitamin C contents were found in 46.8 mg/100 g in fresh orange juice among all the test fruit and vegetable juices. However, carrot juice contains the lowest vitamin C content (1.87 mg/100 g) as compared to other fruit and vegetable juices. Vitamin C contents of mango juice of three varieties were also found to be highly variable. Among the mango varieties, the highest amount of vitamin C (16.4 mg/100 g) was found in xiangya mango when compared with the juices of Ao mango and Ao (film package) mango varieties.

Quantification of carotenoids by spectrophotometry and HPLC

Total carotene

Carotene specialized natural pigments and delivers colors such as yellow, orange and red (Perera and Yen, 2007). Apart from the spectacular colors in fruits and vegetables, these carotenoids in the diets are associated with the reduction of the diseases. Recent studies showed that diets high in carotenoids are important for health of human. Among the carotenoids the diets high in β-carotene and α-carotene are involved in the reduction of reduction of the incidence of type 2 diabetes (Sluijs et al., 2015).

Total carotene content in fruit and vegetable Juices are shown in Table 1. The highest of

carotene (6062 µg/100 g) was measured in carrot juices among all the test fruit and vegetable juices. Lowest total carotene content (75 µg/100 g) was measured in apple juices. Surprisingly among the different mango varieties juices, the highest amount of carotene contents (578 µg/100 g) was measured in the fresh Ao (flim package) mango as compared to Ao mango and xiangya mango juice. B-carotene content was found to be highly variable among the fruits and vegetable juices shown in Table 1. The highest amount of B-carotene (6.062 mg/100 g) was recorded in carrots whereas the lowest amount of B-carotene (0.034 mg/100 g) was recorded in apple juice. Among the mango verities juices, the highest amount of B-carotene content (1.955 mg/100 g) was recorded in fresh Ao (flim package) followed by Ao mango and xiangya mango juice.

DPPH

DPPH method is a quick method to analyze the free radical activity of natural compounds (Shahzor et al., 2015). The antioxidant activity of a substance can be expressed as its ability to scavenge the DPPH free radical. The DPPH scavenging activity of fresh fruit and vegetable juices is related to phenolic contents. With the increasing IC_{50} value, the decreasing trend of antioxidant activity was found in fruit and vegetable juices and vice-versa (Figure 1). The highest IC_{50} value (0.440 mg/ml) with the lowest antioxidant activity was found in fresh carrot juice as compared to other fruits juices. However, among the mango juices, the highest IC_{50} value (0.032 mg/ml) with the lowest antioxidant activity was recorded in Ao mango juice when compared with the Ao mango (flim package) and Xiangya mango juices.

ABTS

ABTS is a technique to determine the antioxidant activity of hydrogen donating antioxidants and of chain breaking antioxidants and commonly used to estimate the total antioxidant power of single compounds and also in the extracts of different plants (Leong et al., 2002). The ABTS scavenging activity of fresh fruit and vegetable juices are as shown in Figure 1. Among the fresh fruit and vegetable juices, the highest IC_{50} value (0.114 mg/ml) with the lowest antioxidant activity was determined in carrot juice. Among the different mango varieties juices, the highest IC50 value (0.032 mg/ml) with the lowest antioxidant activity was recorded in AO mango juice followed by Ao mango (flim package) and Xiangya mango juices.

Reducing power

The reducing power is an important indicator therefore to determine the potential antioxidant activity. The reducing power of test samples and their actions are usually monitored by the formation of Perl's Prussian blue at 700 nm (Shahzor et al., 2015). The reducing power of fresh fruit and vegetable juices are as shown in Figure 1. The reducing power with the highest EC_{50} value (0.114 mg/ml) and lowest antioxidant activity was recorded in carrot juices as compared to other fruit and vegetable juices. Among the mango varieties juices, the reducing power activity with the highest EC_{50} value (0.032 mg/ml) and lowest antioxidant activity was found in AO mango as compared to Ao mango (film package) and Xiangya mango juice.

DISCUSSION

The attraction of consumers toward food materials have recently increased due to their richness in natural substances. These natural substances are major source for human health (Micha et al., 2017). Antioxidants are one of those natural substances which are involved in inhibition of the oxidation of biomolecules such as lipids, proteins and nucleic acids. Antioxidants have been categorized into two major groups, that is, enzymatic and on-enzymatic antioxidants. Free radical scavenging enzymes such as superoxide dismutase and glutathione reductase are enzymatic antioxidants whereas water soluble compounds such as vitamin C and polyphenol and lipid soluble compounds such as vitamin E and pre-vitamin A are non-enzymatic antioxidants (Barbosa et al., 2017). Numerous redoxactive antioxidants such as polyphenol, tocopherols, carotenoids and ascorbic acids are also found in food materials (Liu et al., 2014). These antioxidants have numerous human health benefits such as they protect from the neurodegeneratives disorders, coronary diseases and cardiovascular diseases (Nemec et al*.,* 2017). High consumption of fruits has been linked due to their refreshing tastes and presence of antioxidants compounds. Apples are significant source of phenolic compounds and are commonly consumed in Europe and North American diets (Hua et al., 2016). Remarkably high antioxidant capacity of guava fruit (*Psidium guajava*) due to the presence of high level of phenolic compounds, therefore occupies a distinct position among tropical fruits (Verma et al., 2018). Musk lime (*Citrus microcarpa*) is commonly used to flavor food and beverages. Moreover, musk lime can also be eaten as fresh fruit. Vitamin C is a major antioxidant ingredient in must melon (Hoyle and Santos, 2010). Mango (*M. indica* L.) being one of most consumed tropic fruit is rich in dietary antioxidants such as ascorbic acid, carotenoids and phenolic compounds. These compounds are involved in the protection of human against various diseases (Barbosa et al., 2017; Liu et al., 2014). Citrus fruits contain wide variety of vitamins and nutrients. For example oranges are rich in compounds such as

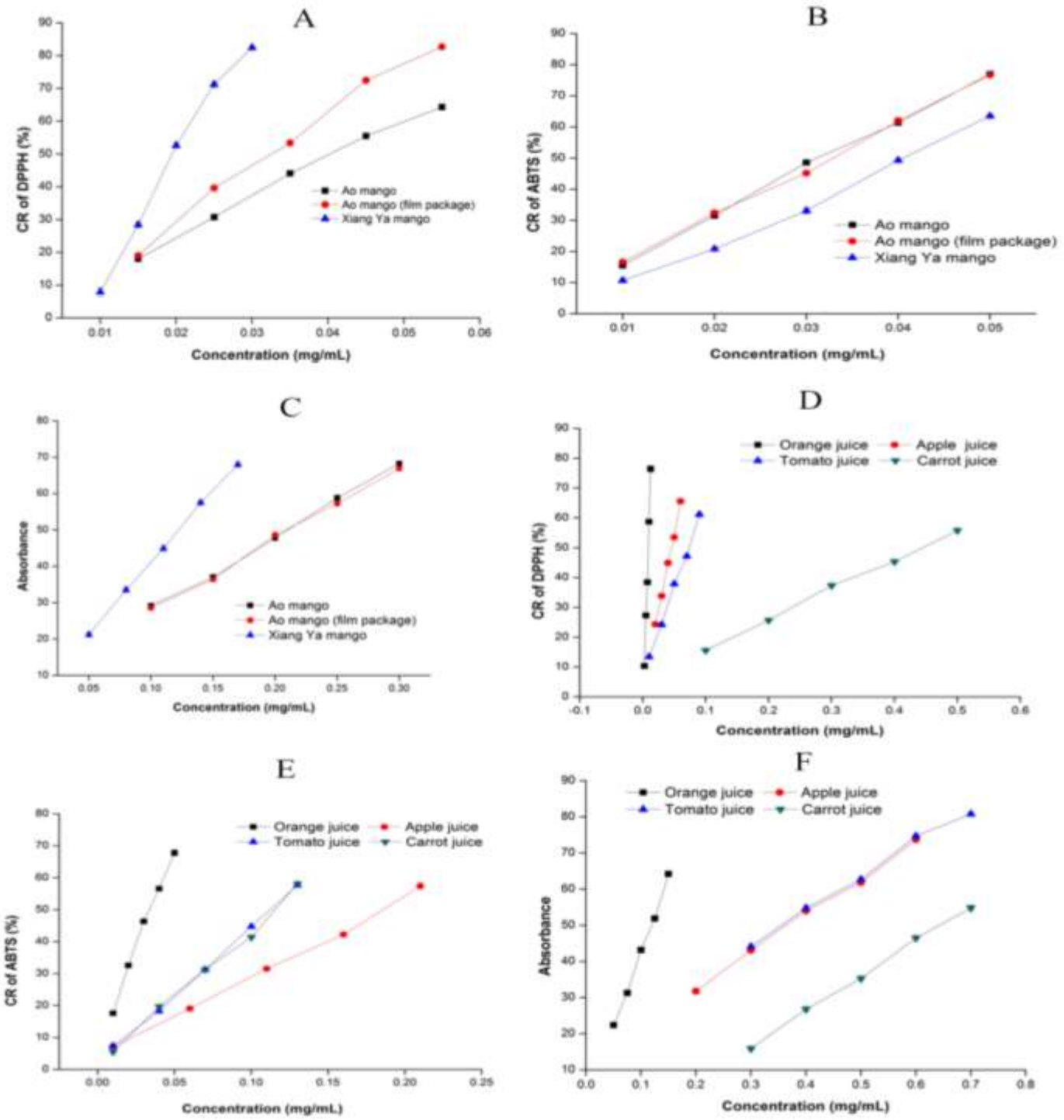

Figure 1. Comparison of DPPH three mangoes (AO, film packaging, Xiangya) (A), Comparison of ABTS of three mangoes (AO, film packaging, Xiangya) (B), Comparison of reducing power of three mangoes (AO, film packaging, Xiangya) (C), Comparison of DPPH of orange, apple, carrot and tomato juices (D), Comparison of ABTS of orange, apple, carrot and tomato juices (E), Reducing power of orange, apple, carrot and tomato juices (F).

limonoids which is bitter in taste and vitamins such as vitamin C. Moreover, oranges also supply carotenoids, folates and phenolic compounds. Since the mentioned oranges are rich in vitamin C, however, the antioxidant activity of orange Juices greatly depends on their phenolic compounds rather than their vitamin contents (Chanalia et al., 2018). In food industries, fruit juices are subjected to evaporation to remove majority of the water

to provide better condition for storage. Transport and preservation of liquid food materials with the lowest handling cost is very important. In addition to evaporation, heating also plays a significant role to increase the phenolic contents through the extra extraction step. Therefore, fruit juice concentrate or commercial fruit juice that reconstitute from the concentrate was believed to be good source of functional food which can easily replace the carbonated soft-drink (Al-Juhaimi and Ghafoor, 2013). Shikmate and phenyl propanois pathways play an important role in the production of phenolic compounds. These phenolic compounds having aromatic ring and bearing one or more hydroxyl groups consists of significant amount of secondary metabolites (Barbosa Gamez et al., 2017). In a previous research, high correlation was found between the content of polyphenols and antioxidant capacity of natural food (Liu et al., 2014). Vitamins such as vitamins C, E and pro-vitamin A have numerous health benefits, however long term clinical studies have revealed that these vitamins cannot reduce the risk of various stress related strokes and cardiovascular diseases. As antioxidants, the phenolic compounds have profound health benefits than vitamins (Nemec et al*.,* 2017). In the present research, the amount of phenolic compounds of both fresh and commercial fruit juices is considerably low, since the daily polyphenol compounds of the diet was estimated to range between 150 mg and 1 g/day (Ribeiro et al., 2007). The daily intake of 100 ml of commercial fruit juice (with 5% or 5 g of fruit concentrate) only contributes to maximum 65 mg of phenolic compounds (13 mg of phenolic compound in 1 g of mango juice). These results revealed that dependence on either fruit or commercial fruit juices does not reflect sufficient daily phenolic compounds intake. In the present study, the fresh apple and guava were blended because peel was previously found to contain additional flavonoids which were not reported in the flesh of fruits (Wolfe et al., 2003). Interesting, these blending method, fail to preserve the antioxidant and phenolic content of fresh apple juices. Among all the fresh fruits the phenolic compounds of fresh apples were comparatively the lowest as compared to all other tested fresh fruit juices. Nevertheless, additional antioxidant capacity may be achieved by keeping peel of the guava. The reason is fresh guava contains the highest amount of polyphenol content. Moreover, the polyphenol contents of fresh guava have potential to inhibit DPPH scavenging activity with the lowest inhibition concentration. Folin-Ciocalteu test showed that the antioxidant activity of the tested fruit juice in DPPH scavenging assay was correlated with the phenolic compounds of fruit juices. This result suggested that phenolic content plays an important role in the antioxidant capacity of various fruits. However, major vitamins (such as vitamin C, vitamin E and pro vitamin A) are not playing significant role in the antioxidant capacity of various fruits. Among the citrus fruits, orange and lime were found to have high amounts of vitamin C contents and phenolic compounds. In the present research the antioxidant capacity of both fresh orange and lime juices were found to be similar in both phenolic quantification and DPPH scavenging test. This result suggested that both citrus fruits may contain similar bioactive compounds which play role in their antioxidant capacity. The decline in the antioxidant activity in commercial fruit juice might be due to long term storage of raw fruit or fruit concentrate before the production and packaging of ready to drink fruit juice. Increase of oxygen, pH and temperature during storage of fruits are involved in the reduction of antioxidant activity of the fruit concentrates (Moon et al., 2018). Moreover, short term *in-vivo* consumption of orange juice lost the potential to affect the oxidation stress that is related to cardiovascular risk (Jae et al., 2014). The reason could be inadequate amount of daily phenolic compounds intake since the phenolic compounds concentration was significantly low. The whitening effect of all of the freeze dried fruit juices is also linked to antioxidant activity. The present research clearly revealed the potential value of fruit juices which are substitute for fresh fruit. The study further revealed that among the various fruit tested each fruit has different level of antioxidant capacity and total phenolic contents. Commercially produced orange and mango juices contain significant amount of phenolic content and antioxidant capacity as compared to fresh mango and orange blend. Therefore, fresh fruit juices can be considered a good source of natural antioxidants besides fresh fruit. However, fresh fruit still contain much higher phenolic content and antioxidant capacity. From the present study, it can be concluded that fruit juices though expensive than the fresh fruits however should be considered as the secondary choice of dietary fruits when fresh fruits are not reachable.

Conclusion

Fresh produced orange and mango juices contain significant amount of phenolic content and antioxidant capacity as compared to fresh mango and orange blend. Therefore, fresh fruit juices can be considered a good source of natural antioxidants besides fresh fruit. However, fresh fruit still contain much higher phenolic content and antioxidant capacity. From the present study, it can be concluded that fruit juices though expensive than the fresh fruits however should be considered as the secondary choice of dietary fruits when fresh fruits are not reachable.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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