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Original Article

Studies on the Phenolic Acid Contents in Different Parts of Raw and Ripe Jackfruit and Their Importance in Human Health

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ABSTRACT

Objective: To assess the phenolic acid content of skin, pulp, covering pulp of seed and seed of raw and ripe jackfruit (*Artocarpus heterophyllus*).

Methods: High Performance Liquid Chromatographic (HPLC) analysis was done of various parts of raw and ripe jackfruits.

Results: Raw fruit skin was rich in gallic (22.73 µg/g) followed by tannic and ferulic acids. In ripe fruit, the skin had high amount of ferulic (13.41 µg/g) and reduced amount of gallic (12.08 µg/g) acids. The level of tannic acid (5.73 µg/g) was the same as that in raw fruit skin. Flesh of raw fruit had three phenolic acids where gallic acid was maximum followed by ferulic and tannic acids. However, flesh of ripe fruit had high amount of gallic (19.31 µg/g) and low amount of ferulic (2.66 µg/g) acids. Tannic acid was slightly high as compared to raw fruit skin. Raw and ripe pulp of the seeds was rich in phenolic acids. The raw pulp showed more phenolic acids than ripe fruit pulp. Raw fruit pulp of seed had three phenolic acids, viz., gallilc, tannic, and ferulic acids. But in ripe fruit the amount and number of phenolic acids were significantly less, e.g., only two phenolic acids, i.e., gallic and ferulic acids were detected. Raw fruit seed showed four phenolic acids, i.e., gallic, tannic, caffeic and ferulic acids. However, in ripe fruit seed only three phenolic acids were found, i.e., gallic, ferulic and tannic acids.

Conclusion: The presence of good amount of phenolic acids in various edible parts of raw and ripe Jackfruit indicates the nutritional value of jackfruits and the likely benefits it can provide to human health.

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam)., belongs to the family Moraceae, along with Ficus spp. (fig), Morus spp. (mulberry), and Maclurapomifera Schneid (osage orange or hedge apple)[1]. It is popularly known as the poor man's food in the eastern and southern parts of India[2]. Ripe fruits are rich source of vitamins A and C along with some minerals[3]. It provides good amount of carbohydrates. Young jackfruits and their seeds are commonly used as vegetables and pickles. The ripe fruits are not liked by some people because of its strong flavour. The ripe fruits are also used in squash and toffee. The skin of the fruits and leaves are excellent cattle food[4]. Changes in primary metabolites during ripening of fruits are reported by some workers [5] but reports about the changes in secondary metabolites in raw and ripe fruits are limited. Szecsko *et al.*[6] reported that the polyphenol oxidase (PPO) and endogenous phenolic acid contents varied from season to season. They also reported that the amounts of phenolic substances act as inhibitors and stimulators of various enzymes, i.e., polyphenol oxidases and peroxidases in the plants during the dormant spell. Seeds of jackfruits are rich source of protein and its amount varies considerably during different growth stages. The mature seeds contain a protein termed as jacalin which possesses diverse biological properties[7]. *A. heterophyllus* is rich source of primary and secondary metabolites having medicinal properties[7,8]. Wetprasit and Chulavatnatol [9] isolated lectin from *A. heterophyllus* which is specific for alpha monomer galectoside with an aromatic residue. Jacalin, a tetrameric two-chain lectin (66,000 Mr) isolated from *A. heterophyllus* seeds is highly specific for the tumor associated T-antigenic disaccharides.

Plants have developed efficient protective defense mechanisms against various diseases where pre-existing and induced secondary metabolites play significant role to protect them against various adverse climatic conditions[10-13]. The biosynthetic pathway of phenolic compounds is derived from the shikimate pathway and the backbone of phenolic compounds are aromatic amino acids [14]. Role of plant phenolics in inducing resistance in plants is well documented in the literature[10,15]. Results of the present experiments reveal the presence of some phenolic acids in different parts of jackfruit. Their role in human health is described here.

MATERIALS AND METHODS

Randomly selected three fruits of the same age at raw and ripe stage were harvested and pooled together to make one sample of each part of the fruit. One gram of freshly harvested fruit parts (skin, pulp, covering pulp of seed and endocarp of seed) were finely crushed with 5-10 ml of ethanol water (80-20; v/v), ultrasonicated (15 minutes at 4^0C) (Branson Sonifier, USA) and centrifuged (15 minutes at 7500 rpm). The supernatant was subjected to charcoal treatment for removal of pigments. Extraction of the residue was done once again, supernatant was pooled with the previous extraction and evaporated under vacuum. The dried samples were re-suspended (in 1.0 ml methanol of HPLC grade), filtered (membrane filter of pore size 0.45 µm, Millipore) and analyzed by HPLC[16]. The HPLC (Shimadzu Corporation, Kyoto, Japan) equipment was comprised a UV-VIS detector (Shimadzu SPD-10 AVP), C-18 reversed phase column (Phenomenex, USA) of 250 X 4.6 mm id with particle size 5 µm, and the samples were run at 25^0C. The mobile phase used was a mixture of methanol-0.4 % aqueous acetic acid (66:34, v/v), flow rate was set at 1 ml/min, injection volume was 5 µl and detection was done at 290 nm. The samples were analyzed thrice and the means of the individual compounds were considered for quantification. Different phenolic compounds such as ferulic, chlorogenic, gallic, tannic, vanillic, caffeic, and cinnamic acids were used as internal and external standards. Qualitative analysis of the phenolic compounds in the samples were done by two methods *viz*., by comparing the retention time (Rt) of standards as well as by co-injection.

RESULTS AND DISCUSSION

Analysis of various parts of raw and ripe jackfruits collected at different stages, showed significant difference in phenolic acids. Raw fruit skin was rich in gallic (22.73 µg/g fresh wt.) followed by tannic (6.70 µg/g) and ferulic (4.635 µg/g) acids but the skin had same phenolic acids in which the amount of ferulic acid (13.41 µg/g) increased but gallic acid (12.08 µg/g) drastically decreased. However, the amount of tannic acid (5.73 µg/g) was the same as compared to raw fruit skin. Flesh of raw fruit also had three phenolic acids, i.e., gallic, ferulic and tannic acids, where gallic acid (9.7 µg/g) was found maximum, followed by ferulic (8.04 µg/g) and tannic (4.87 µg/g) acids. However, in pulp of ripe fruit, the amount of gallic acid (19.31 µg/g) was almost double, while ferulic acid (2.66 µg/g) was drastically reduced but tannic acid (5.24 µg/g) increased a little as compared to raw pulp of fruit skin. Raw and ripe pulp of the seed was rich in phenolics as compared to ripe fruits covering pulp of the seed. Raw fruit pulp of seed had three phenolic acids in which gallic acid (11.05 µg/g) was maximum followed by tannic (2.29 µg/g) and ferulic (2.16 µg/g) acids. However, due to ripening of the fruits the amount and number of phenolic acids were significantly reduced as only two phenolic acids (gallic and ferulic acids) were detected in which maximum (6.26 µg/g) was gallic acid whereas ferulic acid (2.56 µg/g) was slightly moré compared to the raw fruit pulp of seed. Phenolic acid in raw and ripe fruit seeds varied significantly. Four phenolic acids (gallic, tannic, caffeic and ferulic acids) were detected in raw fruit seeds where gallic acid (11.3 µg/g) was maximum followed by tannic (6.59 µg/g), caffeic (2.84 µg/g) and ferulic (2.38 µg/g) acids. However, there was only three phenolic acids (gallilc, ferulic and tannic acids) in which gallic acid (11.3 µg/g) was maximum followed by ferulic (2.71 µg/g) and tannic (2.1 µg/g) acids (Table 1.).

The HPLC analysis of different parts of raw and ripe fruits showed varying number and amount of phenolic acids. Most of the jackfruit samples had gallic and ferulic acids in common. HPLC analysis indicated that phenolic acids are abundantly present in raw fruit which is eaten mostly as vegetables and pickles. Kabir (1995) [7] reported that the low molecular weight of protein, i.e., jacalin, is present in raw fruit seed but totally absent in ripe fruit. Strong anti-inflammatory activity of gallic acid towards zymosan-induced acute food pad swelling was reported in mice[17]. Further, *in vitro* studies revealed that gallic acid interferes with the functioning of polymorphonuclear leukocytes (PMNs) as well as scavenging of superoxide anions and inhibit myeloperoxidase release and activity. Sarma and Singh (2003)[13] and Maurya *et al*. (2007)[18] reported that ferulic acid has potent antimicrobial properties. Strong antioxidant activities of jackfruit pulp extracts was reported earlier[5] and the same is correlated with the total phenolic and flavonoids content in the samples. Soong and Barlow (2004)[19] also reported that the seeds of jackfruit are rich in total phenolic acid content and have strong antioxidant properties. Presence of phenolic compounds in food enhances food quality as they provide various benefits to human health[20]. In this communication we report for the first time the presence of different types of phenolic acids in fruits of raw and ripe stages.

CONCLUSION

The raw and ripe edible parts of jackfruits contain good amount of phenolic acids and thereby it signifies the importance of nutritional value of jackfruit for human health.

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Table 1. HPLC analysis of various phenolic acids in different parts of Jackfruit

Plant Parts	Phenolic acids (µg/g fresh wt.)			
	TA	GA	FA	Caf-A
Raw fruit skin	6.70±0.05	22.73±2.04	4.64±0.02	UDL
Ripe fruit skin	5.73±0.04	12.08±1.03	13.41±1.2	UDL
Raw fruit flesh	4.87±0.05	9.70±0.09	8.04±0.07	UDL
Ripe fruit flesh	5.24±0.06	19.31±1.8	2.66±0.06	UDL
Raw fruit pulp of seed	2.29±0.01	11.05±1.02	2.16±0.05	UDL
Ripe fruit pulp of seed	UDL	6.26±0.04	2.56±0.02	UDL
Raw fruit seed	6.59±0.07	11.3±1.6	2.38±0.01	2.84±0.02
Ripe fruit seed	2.21±0.01	11.30±1.07	2.71±0.01	UDL

± Standard Error, TA: Tannic acid; GA: Gallic acid; FA: Ferulic acid and Caf-A: Caffeic acid; UDL: Under detection limit