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Evaluation of Phytochemical, Nutritional and Antioxidant Activity of Indigenously Grown Jackfruit (*Artocarpus heterophyllus* Lam)

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Abstract

The aim of present investigation was to explore dietary and health benefits of *Artocarpus heterophyllus* Lam (jackfruit). The nutritional profile of dried ripened jackfruit showed that it is a rich source of carbohydrates (13.08± 0.31%) as well as considerable amount of crude fiber (6.32±0.72 %), crude fat (5.63±0.18 %) and protein (1.48±0.11%) were found. The moisture value and ash content of ripened jackfruit pulp was 71.60±0.75% and 1.89±0.19%, respectively. Among the extracts of ripened jackfruit, in five different solvent systems, methanolic extract exhibited the highest total phenolic (239.87± 0.2 mg GAE/100g dry wt) and flavonoid content (109.94±2.16 mg QE /100g dry wt). Maximum ascorbic acid value (22.47±1.95 mg/100g of dry fruit) was observed in acetone extract of ripened jackfruit pulp. The antioxidant activity of extracts was assessed through DPPH radical scavenging assay. The acetone extract showed higher radical scavenging activity (89.31±0.78%) than remaining extracts. Results of present study enlighten that *A. heterophyllus* comprising significant nutritional value and high antioxidant potential may be utilized as functional food with towering therapeutic benefits.

Keywords: Antioxidant activity; Ascorbic acid content; Jack fruit; Total flavonoid content; Total phenolic content.

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1. Introduction

Oxidative stress has been associated with the progress of chronic diseases. Antioxidants are assumed to have protective effects to mitigate the oxidative stress [1]. The exploration of natural antioxidants has become an emerging area of research during recent years. Phenolic complexes, commonly found in fruits and vegetables, act as antioxidants that scavenge free radicals, chelate metals, and prevent lipid peroxidation [2]. Studies show that polyphenols present in the daily ration may improve health and also help to mitigate diseases like, diabetes, cancer and cardiovascular issues etc. [3]. *Artocarpus heterophyllus*

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Lam, commonly known as the jackfruit belongs to family Moraceae, is indigenous to India and is widely grown in Bangladesh, Burma, Sri Lanka and other countries including Pakistan [4]. Jackfruit tree is an evergreen plant, yields more than any other fruit tree species and bears the largest edible fruit which may vary in size from 2.0-49 Kg [5,6]. In Pakistan, the size of ripe jackfruit varies from 0.3 to 1.5 Kg. The fruits are of dietary importance having high nutritional value while consumed as a vegetable in the unripe stage, salted as a pickle and also as a fruit when ripe [7-9]. The pulp is used in various ways; it can be eaten raw or processed into cans, jams and chutneys or dried [10,11]. The leaves and stem barks have been used to treat anemia, asthma, dermatosis, diarrhea, cough and as an expectorant [12]. A considerable amount of phytochemicals, variety of carbohydrates, free sugars and fatty acids in the pulp of ripe jackfruit has been reported [13,14]. The beneficial physiological effects of jackfruit may also have preventive/curative application in a variety of pathologies [15]. The jackfruit seeds are also rich source of carbohydrates, proteins, fiber and vitamins. Chemical composition and mineral contents of jackfruit seeds have been explored [16]. People in Pakistan are not fully aware of health giving benefits associated with this inimitable fruit. Scientific information regarding jackfruit grown in Pakistan is also scarcely available. Therefore, present study was planned to investigate the nutritional value and phytochemicals of locally grown jackfruit in order to understand the effect of local soils and growing conditions on dietetic status and chemical composition of jackfruit.

2. Material and Methods

2.1. *Fruit sample*

The ripe jackfruit (*A. heterophyllius* Lam) was obtained from botanical garden of Pakistan Council Scientific and Industrial Research (PCSIR), Lahore, Pakistan. The fruits were cleaned and separated into pulp and seeds. The pulp of jackfruit (edible part of fruit) was used for further investigation.

2.2. *Proximate composition of fruit*

Moisture, total ash, protein, fat and crude fiber content of the jackfruit were analyzed according to AOAC [17]. Carbohydrate content was determined by difference:
Total carbohydrates (% dry weight) = {100- moisture (%) - protein content (% dry weight) - crude fat (% dry weight) – total ash (% dry weight)}.

2.3. *Phytochemical analysis*

An appropriate amount of crushed jack fruit pulp was extracted in different solvent systems including methanol, ethyl acetate, ethyl acetate + methanol (1:1), acetone and water. Extraction was carried out on an orbital shaker for 24 h at room temperature. Solvents were evaporated under vacuum, resulting extracts were resupended in DMSO

and stored in ambered colored bottles at 4°C in refrigerator for phytochemical investigations.

2.3.1. *Total phenolic content (TPC)*

Total phenolic content of jackfruit extracts were determined by colorimetric method as reported by Wojdylo *et al.* [18] with slight modification. Appropriate quantity of each sample extract was mixed with 0.2 mL of Folin Ciocalteu reagent, 2mL of distilled water and then incubated for 3 min at room temperature. Following the addition of 7% sodium carbonate the mixture allowed to stand for 30 min at room temperature. The absorbance of the developed blue colour was measured at 765 nm by a UV-visible spectrophotometer (Nicolet, Evlution-300, Germany). Quantification was carried out through the standard curve of gallic acid ($r2 = 0.9972$). The results were expressed in terms of µg gallic acid equivalents (GAE)/100 g of dry extract. All determinations were performed in triplicate ($n = 3$).

2.3.2. *Total flavonoid content (TFC)*

Total Flavonoid content was determined using aluminum chloride colorimetric method [19]. Each sample extract was mixed with appropriate amount of methanol, 10% aluminium chloride and 1 M potassium acetate. It was kept at room temperature for 30 min. After the completion of incubation period, the absorbance of the reaction mixture was measured at 415 nm by UV-visible spectrophotometer. Quantification of respective samples were determined through quercetin standard curve ($r2 = 0.9985$) and expressed in terms of µg quercetin equivalents (QE) /100 g of dry extract. All determinations were performed in triplicate ($n = 3$).

2.3.3. *Estimation of ascorbic acid*

Ascorbic acid (AA) content in jackfruit extracts was determined by using UV-VIS spectrophotometer according to the method of Bajaj *et al.* [20]. The reduction of ammonium molybdate with L. ascorbic acid in the presence of sulphuric acid and metaphosphoric acid-acetic acid resulted the development of molybedenum blue complex. Absorbance of the colored product was recorded at 760 nm and expressed in terms of mg ascorbic acid /100 g of dry extract.

2.3.4. *In vitro antioxidant activity:*

1, 1-Diphenyl-2-picrylhydrazyl radical scavenging activity:
In the present study the hydrogen atoms or electron-donating ability of the jackfruit extracts was determined through DPPH (1, 1-Diphenyl-2-picrylhydrazyl) (Alfa Aesar, Germany) free radical assay described by Brand-Williams *et al.* [21] with slight modification. Each extract was mixed with ethanol in appropriate amounts to prepare

ethanolic test solutions of 20, 40, 60, 80 and 100%. The tested ethanolic dilutions of the extract (100 µL each) were mixed with DPPH (0.1mM) solution. Butylated hydroxytoluene (BHT) was used as a positive control. The mixtures were shaken vigorously and left to stand for 30 min in dark at room temperature. The absorbance of the resulting solution was measured at 517 nm using UV-visible spectrophotometer. Triplicate measurements were made and radical scavenging activity is given as percentage inhibition, which is calculated through the following equation:

DPPH scavenging effect (%) = $\{(OD_{blank} - OD_{sample})/OD_{blank}\} \times 100$

2.4. *Statistical data*

All data is presented as mean ± SD. The mean values were calculated based on the data taken from at least three independent experiments. Analysis of Variance (ANOVA) [22] was performed to see the significant difference among results. A probability of $P<0.05$ was considered to be statistically significant.

3. Results and Discussion

In recent years, the use of fruits and vegetables in daily diet has been highlighted for their miraculous benefits towards lowering the risk of many life threatening diseases. These benefits are due to the presence of polyphenols, flavonoids, carotenoids, and vitamins [23]. The pulp of ripe jackfruit is eaten fresh and used in fruit salads.

3.1. *Determination of nutritional attributes*

Nutritional attributes of locally grown jackfruit were assessed (Fig. 1). In the present study, significant moisture content of ripe jackfruit was found 71.6±0.75%. Various researchers reported that moisture content of jackfruit was ranged between 60 to 90% [16,24]. The ash content of ripe jackfruit pulp was determined as 1.89±0.19%. Ripe jackfruit pulp was found to be rich in carbohydrates (13.08± 0.31%) and protein (1.48±0.11%). Swami *et al.* [15] reported that every 100 g of ripe jackfruit pulp contained 18.9 g carbohydrate, 1.9 g protein, 0.1 g fat, 77% moisture, 1.1 g fiber, 0.8 g total mineral matter, 20 mg calcium, 30 mg phosphorus, 500 mg iron, 540 I.U. vitamin A, 30 mg thiamin, and 84 calories of energy. Present results of protein content (1.49±0.11 %) in ripe jackfruit pulp are in conformation to the reported values [25]. Considerable amount of crude fat (5.63±0.18%) and crude fiber (6.32±0.72%) were also dogged in present investigation.

3.2. *Phytochemical analysis*

3.2.1. *Total phenolics content (TPC)*

Total phenolics content of analyzed ripe jackfruit pulp extracts shown in Fig. 2 illustrated that high phenolics content is present in the methanolic extract (239.87± 0.2 mg gallic acid equivalent (GAE)/100g dry wt), followed by the aqueous extract (84.86±0.57 mg GAE/100g dry wt), ethyl acetate+ methanol extract (30.96±0.08 mg GAE /100g dry wt.) and acetone extract (19.83±0.53mg GAE/100g dry wt). However ethyl acetate extract showed the minimum phenolics content (5.53±0.36 mg GAE/100g). Phenolic compounds in fruits and vegetables have been suggested to be a major source of bioactive compounds for health benefits [26]. Phenolic compounds are also known to play an important role in stabilizing lipids against peroxidation and inhibiting various types of oxidizing enzymes [27,28]. Gupta *et al.* [16] reported the TPC 145±0.007 mg in acetone extract of jackfruit seeds, respectively.

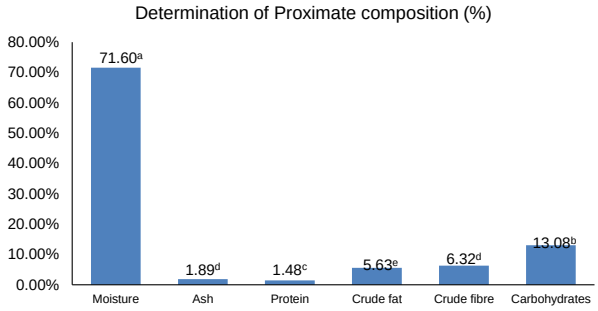

Fig. 1. Proximate composition of *Artocarpus heterophyllus* Lam fruit. Numbers with different letters [a, b, c, d, e] are statistically significant (P<0.05).

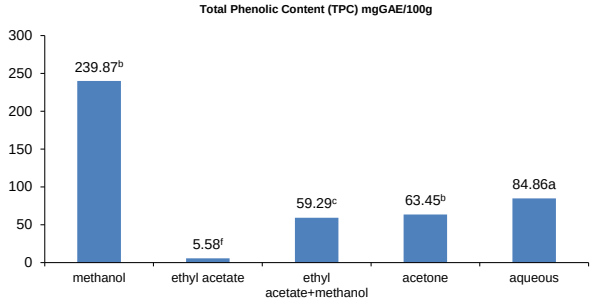

Fig. 2. Estimation of total phenolics content of extracts of *Artocarpus heterophyllus* Lam.

3.2.2. *Total flavonoids content (TFC)*

The results of total flavonoids content in different solvent extracts of jackfruit pulp are depicted in Fig. 3. The highest amount of flavonoids content was found in the methanolic

extract (109.94±2.16 mg quercetin acid equivalent (QE)/100g dry wt), followed by aqueous (44.72± 1.03 mg quercetin acid equivalent (QE)/100g dry wt), ethyl acetate+ methanol (30.96±0.08 mg quercetin acid equivalent (QE)/100 g dry wt), acetone (19.83±0.53 mg quercetin acid equivalent (QE)/100g dry wt) and ethyl acetate (13.12±1.49 mg quercetin equivalent (QE)/100g dry wt). The differences in the flavonoid structures and their substitutions influence the phenoxy radical stability, thereby affect the antioxidant properties of the flavonoids [18].

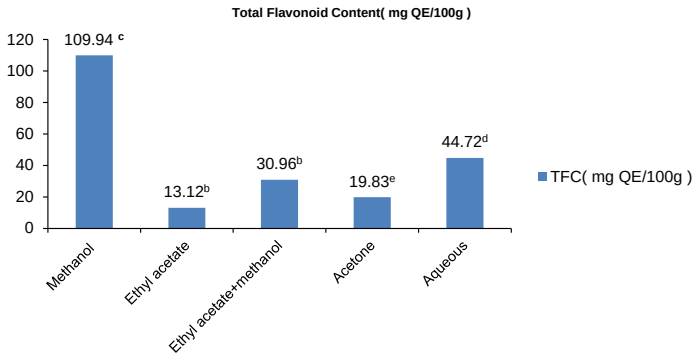

Fig. 3. Determination of total flavonoids content of extracts of *Artocarpus heterophyllus* Lam. fruit.

3.2.3. *Estimation of ascorbic acid*

As can be seen in Fig. 4, acetone extract of ripe jackfruit pulp exhibits the maximum ascorbic acid content of 22.47±1.95 mg/100g of dry extract, followed by methanol (16.13±1.03 mg/100 g of dry extract), aqueous (14.05±1.29 mg/100 g of dry extract), ethyl acetate + methanol extract (13.76±1.01 mg /100 g of dry extract) and ethyl acetate (12.44± 0.57 mg /100 g of dry extract). The human body does not make vitamin C naturally so we have to eat food that contains vitamin C so as to harvest its health benefits [28]. The eating benefits of Jackfruit is a good source of vitamin C that work as antioxidant, protects the body against free radicals, aid in improving skin health, strengthen the immune system and mitigate periodontal diseases [29]. In the current study, the highest value of ascorbic acid was estimated from acetone extract (22.47±1.95 mg/100 g dry wt.) which is in corroboration to kumar *et al.* [30]. Jackfruit was found to be rich of chemical compounds acting as antioxidant able to delay, retard, or prevent the oxidation process [31,32].

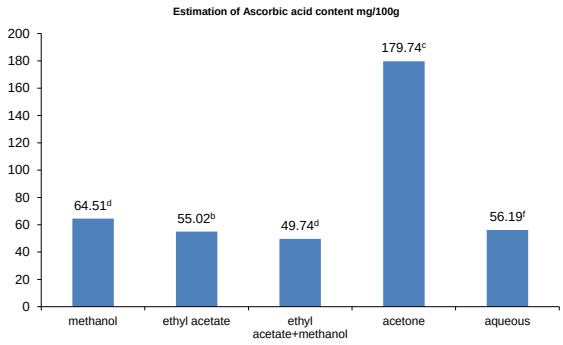

Fig. 4. Ascorbic acid content determination from different extracts of *Artocarpus heterophyllus* Lam. fruit.

3.2.4. *In vitro antioxidant activity*

Antioxidant activity was evaluated by measuring the DPPH radical scavenging activity of different extracts of the *A. heterophyllus*. Fig. 5 shows the percentage inhibition of DPPH radicals by jackfruit extracts. The acetone extract showed higher radical scavenging activity (89.31±0.64%) than remaining extracts followed by methanol extract (87.56±0.47%), aqueous extract (86.54±0.77%), ethyl acetate + methanol extract (85.09± 0.69%), and ethyl acetate extract (17.71±0.97%). DPPH is a free radical generating compound and has been widely used to evaluate the free radical scavenging ability of various antioxidants [16]. In the present study, maximum antioxidant activity was found from acetone extract (89.31±0.78 %) even it showed higher scavenging activity as compared to the standard BHA and ascorbic acid (Fig. 4). High antioxidant activity of the acetone extract may be related to elevated vitamin C value.

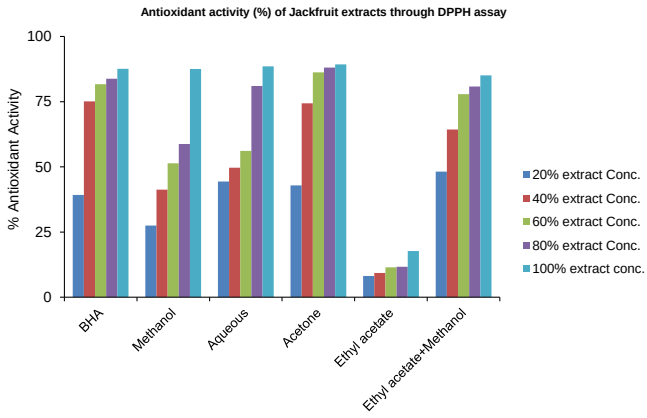

Fig. 5. Assessment of free radical scavenging activity (%) of *Artocarpus heterophyllus* Lam fruit extracts in different solvent systems in comparison with BHA through DPPH assay.

4. Conclusion

Present study provides information on phenoilcs and ascorbic acid contents in jackfruit which are in significant amount and because of this jackfruit can be utilized as antioxidant rich fruit for the development of functional foods having therapeutic benefits.

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