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Phytochemical Screening and Antioxidant Evaluation of Methanolic Peel Extracts from Selected Bangladeshi Fruits and Vegetables

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Abstract

Background: Plant pericarps, often seen as agricultural waste, are rich in phytochemicals that provide medicinal benefits. Traditionally used in indigenous medicine, fruit and vegetable peels contain bioactive compounds like polyphenols, flavonoids, and tannins, which offer antioxidant, antimicrobial, and anti-inflammatory effects. However, scientific research on these components, particularly in Bangladesh, remains limited. **Objective:** The study aimed to perform phytochemical screening and assess the in vitro antioxidant activity of methanolic extracts from the pericarps of fourteen fruit and vegetable varieties developed in Bangladesh. **Materials and Methods:** Fourteen fruit and vegetable varieties were collected, dried, and ground. Methanolic extracts were prepared through 31-day maceration, followed by filtration and evaporation. Phytochemical profiling measured total phenolic content (TPC), total flavonoid content (TFC), and total tannin content (TTC) using UV-visible spectrophotometry. Antioxidant activity was assessed via the DPPH scavenging assay, with IC_{50} values calculated to evaluate efficacy. **Results:** Significant variability was observed among samples. *Mangifera indica* (Fazli) had the highest TPC (481.65 ± 1.165 mg GAE/g), *M. indica* (Khirsha Pati) had the highest TFC (248.075 ± 0.475 mg QE/g), and *Luffa cylindrica* showed the highest TTC (266.335 ± 1.335 mg GAE/g). The strongest antioxidant activity was found in *Litchi sinensis* (Deshi) with the lowest IC_{50} (3.69 ± 0.625 µg/mL), while *Citrus limon* exhibited the weakest activity (66.28 ± 0.35 µg/mL). **Conclusion:** The study emphasizes the significant phytochemical and antioxidant potential of fruit and vegetable peels, particularly those from mangoes, lychees, and cucurbits. These often-underutilized pericarps could be valuable in functional foods, nutraceuticals, and pharmaceuticals, supporting the sustainable use of agricultural byproducts. Additionally, further compound-specific studies and *in vivo* evaluations are recommended.

Keywords: Phytochemical screening; Antioxidant activity; Methanolic extract; Fruit and vegetable peels; Total phenolic content; DPPH assay

INTRODUCTION

Plants have been an essential source of nutrition and traditional medicine over the centuries, with different parts of plants being used in traditional healing practices across cultures. Among these, fruit and vegetable pericarps (outer layers) have played a crucial role in indigenous medicine due to their presence of bioactive components [1]. Historical records indicate that various civilizations, including those of ancient China, India, and the Middle East, utilized plant pericarps in treating diseases and preserving food [2]. Phytoconstituents are plant-derived secondary metabolites that play a significant role in plant defense mechanisms and contribute to their medicinal value. This therapeutic potential of fruit and vegetable pericarps is largely attributed to their rich phytochemical composition [3]. Recent pharmacological studies have validated many traditional uses by demonstrating that these pericarps contain bioactive compounds with potent antioxidant, antimicrobial, anti-inflammatory, and anticancer properties [4,5]. Among the key phytochemicals found in fruit and vegetable pericarps, polyphenols, flavonoids, tannins, alkaloids, and terpenoids have been extensively studied for their pharmacological activities which exhibit strong antioxidant activity by scavenging free radicals and reducing oxidative stress, which is a major contributor to chronic diseases including cardiovascular diseases, diabetes, and cancer [6-8].

The pericarp of *Litchi sinensis* is known for its high flavonoid content, particularly proanthocyanidins, which exhibit strong antioxidant activity and contribute to cardiovascular health [9,10]. The mango pericarp is a rich source of mangiferin, a polyphenolic compound with notable antimicrobial, anti-inflammatory, and anticancer properties [11,12]. Similarly, papaya pericarp contains papain and chymopapain, proteolytic enzymes that aid digestion and possess antimicrobial activities [13]. The citrus pericarp, particularly from *Citrus aurantiifolia*, is loaded with flavonoids and essential oils such as limonene, which have been reported to exhibit antimicrobial and anti-inflammatory effects [14]. Vegetable pericarps also contain an array of bioactive compounds that contribute to their medicinal properties. *Luffa acutangula* and *Luffa cylindrica* pericarps contain cucurbitacins and flavonoids, known for their hepatoprotective and anti-inflammatory effects [15,16]. *Trichosanthes dioica* and *Trichosanthes cucumerina* have been reported to possess anti-diabetic and hypoglycemic properties due to their high flavonoid content [17]. *Lagenaria siceraria* contains saponins and alkaloids, which contribute to its cardioprotective and diuretic effects [18]. *Benincasa hispida* pericarp is rich in polysaccharides and phenolics, known for their immunomodulatory effects, while *Cucurbita pepo* pericarp has been studied for its potential role in wound healing and anti-inflammatory applications [19]. However, Flavonoids, present in large amounts in citrus, mango, and lychee pericarps, contribute to anti-inflammatory and antimicrobial properties, making them valuable in treating infectious diseases. Tannins, found in various fruit and vegetable rinds, possess astringent and antimicrobial properties that support wound healing and gut health. Alkaloids present in *Lagenaria siceraria* and *Trichosanthes cucumerina* have been associated with hypoglycemic and anti-inflammatory effects, beneficial for diabetic patients [20,21]. Terpenoids, commonly found in citrus pericarps, contribute to their antimicrobial and insecticidal properties, making them useful in food preservation and pharmaceutical formulations [22].

Despite the rich traditional use and promising pharmacological potential of fruit and vegetable pericarps, scientific research on their bioactivity remains limited, particularly in Bangladesh. Most studies focus on the edible portions of fruits and vegetables, while the pericarps, often discarded as agricultural waste remain underutilized. There is a need for comprehensive phytochemical screening and biological evaluation to identify their full therapeutic potential [7]. This research focuses on examining the antioxidant and antimicrobial properties of specific fruit and vegetable pericarps. It conducts comparative analyses of multiple varieties, systematically evaluating the phytochemical composition of methanolic crude extracts from various fruit and vegetable pericarps found in Bangladesh. The findings will contribute to the growing body of knowledge on plant-based bioactive compounds and highlight the potential for developing value-added products from agricultural byproducts. By exploring the medicinal potential of these pericarps, this study may also offer insights for their application in the pharmaceutical and food industries, thereby promoting the sustainable utilization of plant resources.

MATERIALS AND METHODS

Chemicals and Reagents

All reagents used in the experiments were of analytical grade. The reagents included methanol (MERCK, Germany, 99.99%), ethanol (MERCK, Germany, 99.5%), gallic acid (Sigma, USA), quercetin (Sigma, USA), ascorbic acid (MERCK, Germany), 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical (Sigma, USA), aluminum chloride ($AlCl_3$) (Loba, India), sodium hydroxide (NaOH) (Loba, India), sodium carbonate (Na_2CO_3) (Loba, India), and Folin-Ciocalteu (FC) reagent (Sigma Chemical Co. Ltd) .

Collection and Processing of sample

A total of fourteen varieties of fruits and vegetables were collected from the Awtapara fruit and vegetable garden, located in Pabna Sadar Upazila, Pabna District, Bangladesh. The identification of each plant was performed by a scientific officer from the Bangladesh National Herbarium in Mirpur, Dhaka. After collection, each sample was rinsed to eliminate dust and soil. Subsequently, all the samples were sun-dried before being ground using a grinder machine. To prevent any cross-contamination, the grinder machine was thoroughly cleaned before proceeding with the grinding process for individual samples.

Preparation of extract

At first, each 150 g powdered sample was soaked in methanol (99.99%) for 31 days. Then, the mixture was shaken gently at a regular interval to mix the samples properly with the solvent. A clear filtrate was collected through filtration of the extract with cotton, which was subsequently filtered by filter paper (Whatman no 1) to eliminate any powdered particles. For the complete evaporation of solvent, a rotary solvent evaporator was used. Finally, the dried extract was preserved in a dry condition for subsequent analysis. The weight of different dried crude extracts of fruit (*Mangifera indica* Including Fazli and Khirsha, *Citrus limon/aurantifolia*, *Litchi Sinesis* including Deshi and Bomby, and *Carica papaya*) and vegetable *(Lagenaria siceraria, Luffa acutangular, Luffa cylindrica, Cucurbita pepo, Trichosanthes cucumerina, Trichosanthes dioica, Benincasa hispida*) were 5.34 g, 5.02 g, 5.06 g, 5.89 g, 6 g, 6.06 g, 4.89 g, 5.103g, 5.079g, 4.84g, 4.65g, 4.75g, 4.3 g, 5.1 g, and 5.80 g respectively.

Investigation of Phytochemicals

Quantification of Total Phenolic Content (TPC)

TPC of sample extracts was quantified according to Folin-Ciocalteu method with respect to standard gallic acid [23]. 5 mL of 10% (v/v) aqueous Folin-Ciocalteu reagent was mixed separately with sample solution (0.5 mL) and standard solution having range of concentration from 0.02 to 0.15 (mg/mL) in extraction solvent (methanol). After that, an equivalent of 4 mL of 7.5% (w/v) Na_2CO_3 solution poured to each mixture. After homogenizing the mixtures in the individual test tubes for 15 seconds with a vortex, incubated at 40 °C for 30 minutes. Simultaneously, a blank solution was made using all of the reagents without including sample extract or standard (gallic acid). By using UV spectrophotometer (set wavelength λ =765nm), absorbance of reaction mixture was recorded against a blank. TPC was demonstrated as (mg of GAE/gm of dry extracts) by using calibration curve of gallic acid.

Quantification of Total Flavonoid Content (TFC)

TFC of sample extracts was quantified by following the aluminium chloride colorimetric method, where quercetin was used as a standard [24]. At first, 1 mL of ethanolic sample solution, 4 mL of distilled water, and 0.3 mL of 5% (w/v) $NaNO_3$ solution were mixed thoroughly. After 5 minutes, 0.3 mL of 10% (w/v) $AlCl_3$ was poured to the previous mixture and left for 1 minute. The volume of the final solution was adjusted up to 10 mL by the addition of 2 mL NaOH solution (1M) and distilled water. Subsequently, homogenization of the mixture was conducted for 15 seconds before being left to react for another 30 minutes. By using a UV spectrophotometer (set wavelength λ =510nm), the absorbance of the reaction mixture was recorded against a blank. The standard calibration curve was created using different doses of quercetin (0-1.0 mg/mL) to determine TFC, which was demonstrated as (mg of QE/gm of dry extracts) by using the standard quercetin calibration curve.

Quantification of Total Tannin Content (TTC)

TTC of sample extracts was quantified by using the Folin-Ciocalteu method concerning standard gallic acid with slight modification [25]. In brief, 0.1 mL of ethanolic gallic acid solution (31.25, 62.5, 125, 250, and 500 mg/mL) and sample extract solution (0.1 mL) were poured individually in separate test tubes, and 7.5 mL of distilled water was added to dilute the mixture. Thereafter, 1 mL 35% Na_2CO_3 and 0.5 mL FC reagent (10%) were poured to each test tube, and the volume of the final mixture was adjusted up to 10mL by the addition of distilled water. Simultaneously, a blank solution was prepared by using all reagents except the sample or standard. For homogenization, all the test tubes were jerked with the help of vortexed for 15 seconds before being kept for 30 minutes for proper reaction. By using a UV spectrophotometer (set wavelength λ =725nm), the absorbance of the reaction mixture was recorded against a blank. TTC was demonstrated as (mg of GAE/gm of dry extracts) by using calibration curve of gallic acid.

Analysis of Antioxidant Activity

DPPH (2,2-Diphenyl-1-picrylhydrazyl) free radical scavenging assay

The quantitative antioxidant capacity was assessed using the DPPH (2,2-Diphenyl-1-picrylhydrazyl) free radical scavenging assay method, with minor modifications [26,27]. Different concentrations of sample extracts (100 - 1.5625 µg/mL) and ascorbic acid used as positive controls (100 - 1.5625 µg/mL) were prepared through serial dilution. For each concentration of the sample extract, 2 mL (2000 µL) was combined with 3 mL (3000 µL) of DPPH solution in methanol. This mixture was then incubated at room temperature (25 °C) in the absence of light for 30 minutes. The absorbance of the reaction mixture was measured using a Thermo Scientific Multiskan Ex microplate photometer set at a wavelength of 517nm, with measurements taken against a blank. A calibration curve plotting log concentration versus the percentage of scavenging activity was constructed from the absorbance readings. The scavenging activity is denoted as SC_{50}, which refers to the concentration required to scavenge 50% of free radicals. The inhibition of DPPH radicals by the samples was calculated using the following equation:

$$\text{Percentage of (\%) Scavenging} = \left\{1 - \left(\frac{A_{Sample}}{A_{DPPH}}\right)\right\} \times 100$$

Here,
A_{Sample} = Absorbance of the Sample.
A_{DPPH} = Absorbance of the DPPH.

RESULTS

Investigation of Phytochemicals (TPC, TFC, TTC)

The present study evaluated the total phenolic content (TPC), total flavonoid content (TFC), and total tannin content (TTC) across 14 different vegetable and fruit plant varieties. Significant variability was observed among the samples.

Table 2 demonstrates that TPC values ranged from 128.485 ± 0.735 mg in *Trichosanthes cucumerina* to 481.65 ± 1.165 mg in *Mangifera indica* (Fazli). *Luffa cylindrica* and *Lagenaria siceraria* also showed high phenolic content, with 465.25 ± 0.75 mg and 436.625 ± 1.375 mg, respectively. In contrast, *Cucurbita pepo* and *Litchi sinensis* (Bombai) exhibited the lowest TPC levels. TFC values were highest in *Mangifera indica* (Khirsha pati), with 248.075 ± 0.475 mg, followed by *Citrus limon* (171.016 ± 1.0165 mg) and *Litchi sinensis* (Deshi) (170.9 ± 0.1 mg). The lowest TFC content was found in *Trichosanthes dioica* (39.325 ± 0.675 mg) and *Lagenaria siceraria* (41.21 ± 1.21 mg). TTC levels varied widely among the samples. The highest TTC was recorded in Luffa cylindrica (266.335 ± 1.335 mg), followed by *Lagenaria siceraria* (235.775 ± 0.775 mg) and *Trichosanthes dioica* (195.935 ± 0.935 mg). On the lower end, *Carica papaya* and *Cucurbita pepo* showed the least TTC values at 48.9975 ± 0.5475 mg and 58.18 ± 1.18 mg, respectively.

Overall, *Mangifera indica* (Fazli and Khirsha pati), *Luffa cylindrica*, and *Lagenaria siceraria* demonstrated comparatively higher (Figure 3) phytochemical compound concentrations. The marked differences among varieties suggest that both species and cultivar types significantly influence the accumulation of phenolic, flavonoid, and tannin compounds.

Analysis of Antioxidant Activity (DPPH (2,2-Diphenyl-1-picrylhydrazyl) free radical scavenging assay)

The antioxidant activity of the selected plant samples was evaluated using IC_{50} values (mean ± SEM), and statistical significance was determined by corresponding p-values. The results revealed considerable variation among the different varieties.

Among all the tested samples, *Litchi sinensis* (Deshi) exhibited the lowest IC_{50} value at 3.69 ± 0.625 µg/mL ($P < 0.05$) compared to standard quercetin at 5.197 ± 0.65, indicating strong antioxidant activity as shown in Table 3 and Figure 4. This was followed by *Luffa acutangula* and *Litchi sinensis* (Bombai), with IC_{50} values of 18.21 ± 1.095 µg/mL and 18.61 ± 0.498 µg/mL, respectively, which are highly statistically significant ($P < 0.01$). *Citrus aurantifolia* and *Mangifera indica* (Khirsha pati) also demonstrated very significant ($P < 0.001$) relatively low IC_{50} values, recorded at 31.33 ± 0.89 µg/mL and 31.68 ± 0.615 µg/mL, respectively.

Carica papaya showed an IC_{50} value of 32.98 ± 0.365 µg/mL, while *Trichosanthes dioica* and *Cucurbita pepo* recorded values of 49.13 ± 0.19 µg/mL and 48.8 ± 0.6 µg/mL, respectively. *Luffa cylindrica* presented an IC_{50} of 52.21 ± 0.471 µg/mL, whereas *Mangifera indica* (Fazli) and *Benincasa hispida* demonstrated similar antioxidant activities with IC_{50} values of 57.72 ± 0.51 µg/mL and 57.77 ± 0.55 µg/mL, respectively. *Lagenaria siceraria* exhibited an IC_{50} of 60.75 ± 0.495 µg/mL, and Trichosanthes cucumerina followed with an IC_{50} of 64.43 ± 0.875 µg/mL. The highest IC_{50} value was observed in *Citrus limon*, with 66.28 ± 0.35 µg/mL, indicating the lowest antioxidant activity among the tested samples. All samples showed statistically significant results ($P<0.001$), confirming the reliability of the observed antioxidant activities.

Figure 1: Schematic representation of dried outer layer of several fruits and vegetables

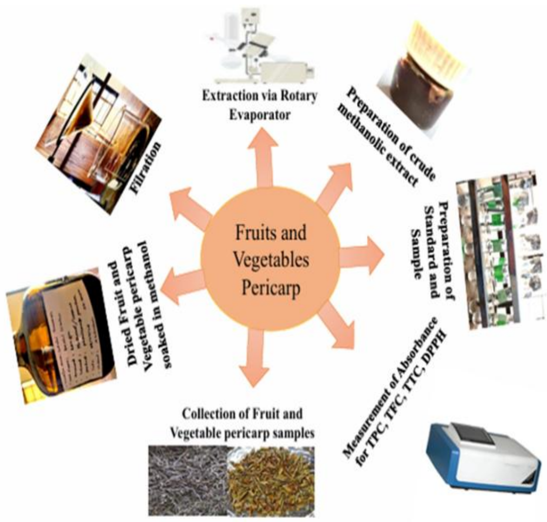

Figure 2: Schematic representation of phytochemical screening and *in vitro* evaluation of the antioxidant activity of methanolic crude extracts of fruits and vegetables

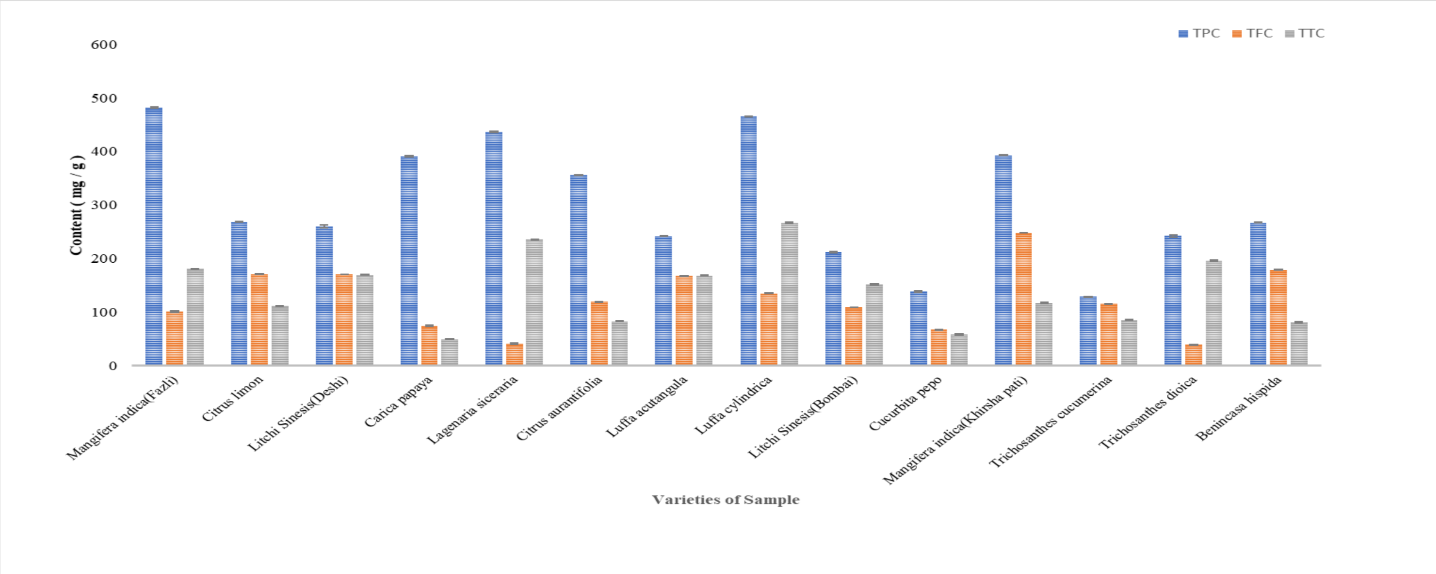

Figure 3. Graphical presentation total phenolic, flavonoid, and tannin contents of different varieties of fruit and vegetables

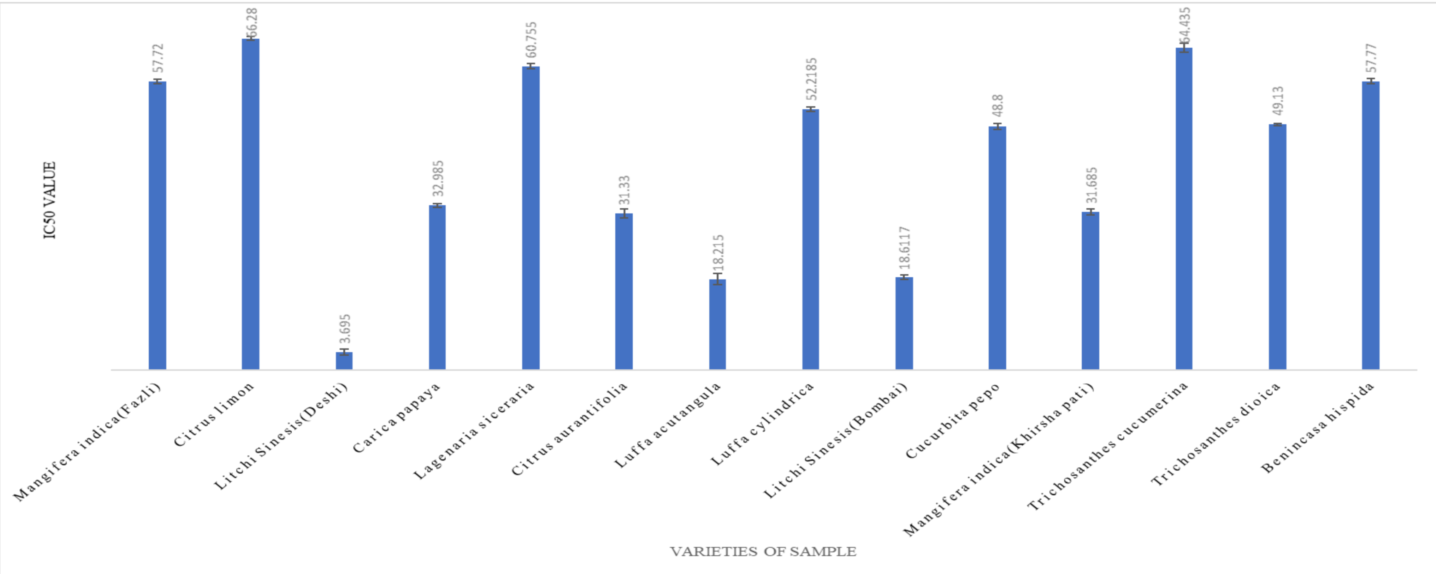

Figure 4. Graphical presentation of DPPH free radical scavenging activity of different varieties of fruits and vegetable

Table 1: Several names of fourteen varieties of fruits and vegetables

Common name	Bangali Name	Scientific name
Mango	Fazli	*Mangifera indica*
Lemon	Pati lebu	*Citrus limon*
Litchi	Deshi litchu	*Litchi Sinesis*
Papaya	Pepe	*Carica papaya*
Calabash gourd	Lau	*Lagenaria siceraria*
Lemon	Kagozi lebu	*Citrus aurantifolia*
Ridged gourd	Jinga	*Luffa acutangula*
Sponge gourd	Dhundul	*Luffa cylindrica*
Litchi	Bombai litchu	*Litchi Sinesis*
Pumpkin	Misti Kumra	*Cucurbita pepo*
Mango	Khirsha pati	*Mangifera indica*
Snake Gourd	Chicinga	*Trichosanthes cucumerina*

Table 2: Total phenolic, flavonoid, and tannin contents of different varieties of fruit and vegetables

Varieties of Samples	TPC ± SEM	TFC ± SEM	TTC± SEM
Mangifera indica (Fazli)	481.65 ± 1.165	101.15 ± 1.15	180.625 ± 0.625
Citrus limon	268.4 ± 0.6	171.016 ± 1.0165	111.33 ± 0.67
Litchi Sinesis (Deshi)	260 ± 2.325	170.9 ± 0.1	169.83 ± 0.5
Carica papaya	391.045 ± 1.045	73.98 ± 0.98	48.9975 ± 0.5475
Lagenaria siceraria	436.625 ± 1.375	41.21 ±1.21	235.775 ± 0.775
Citrus aurantifolia	355.825 ± 1.0855	119.13 ± 0.53	82.775 ± 1.145
Luffa acutangula	241.8250.825	167.55 ± 0.75	168.36 ± 0.97
Luffa cylindrica	465.25 ± 0.75	134.845 ± 0.845	266.335 ± 1.335
Litchi Sinesis (Bombai)	211.325 ± 1.325	108.955 ±0.375	151.525 ± 1.525
Cucurbita pepo	138.115 ± 1.115	67.115 ± 1.115	58.18 ± 1.18
Mangifera indica (Khirsha pati)	392.745 ± 0.945	248.075 ± 0.475	117.12 ± 0.78
Trichosanthes cucumerina	128.485 ± 0.735	115.165 ± 1.165	85.035 ± 0.615
Trichosanthes dioica	242.04 ± 1.54	39.325 ± 0.675	195.935 ± 0.935
Benincasa hispida	267.15 ± 1.05	178.825 ± 0.825	81.015 ± 1.015

Table 3: IC_{50} values of different varieties of Fruit and vegetables in comparison with standard

Varieties of Samples	IC_{50} ± SEM (standard)	IC_{50} ± SEM (sample)	P value
Mangifera indica (Fazli)	5.197±0.65	57.72 ± 0.51	0.0001
Citrus limon		66.28 ± 0.35	0.0005
Litchi Sinesis (Deshi)		3.69 ± 0.625	0.004
Carica papaya		32.98 ± 0.365	0.0003
Lagenaria siceraria		60.75 ± 0.495	0.0001
Citrus aurantifolia		31.33 ± 0.89	0.001
Luffa acutangula		18.21 ± 1.095	0.008
Luffa cylindrica		52.21 ± 0.471	0.001
Litchi Sinesis (Bombai)		18.61 ± 0.498	0.002
Cucurbita pepo		48.8 ± 0.6	0.0002
Mangifera indica (Khirsha pati)		31.68 ± 0.615	0.0007
Trichosanthes cucumerina		64.43 ± 0.875	0.0002
Trichosanthes dioica		49.13± 0.19	0.0001
Benincasa hispida		57.77 ± 0.55	0.0001

DISCUSSION

This study evaluated the antioxidant potential and phytochemical composition of methanolic peel extracts from 14 different plant varieties, revealing significant variability in total phenolic content (TPC), total flavonoid content (TFC), total tannin content (TTC), and free radical scavenging activity (IC_{50}). The results reflect the complex biochemical diversity inherent to different plant species and cultivars and support the increasing recognition of fruit and vegetable peels as rich sources of bioactive compounds with potential health benefits.

Among the analyzed samples, *Mangifera indica* (Fazli) peel extract exhibited the highest phenolic content (481.65 ± 1.165 mg GAE/g), aligning with previous findings that mango peels are phenolic-rich and possess strong antioxidant capacities due to the presence of gallic acid, mangiferin, and quercetin derivatives [28,29]. Similarly, *Luffa cylindrica* and *Lagenaria siceraria* demonstrated high TPC values, which correlate with earlier reports suggesting that cucurbit peels contain substantial polyphenolic compounds that contribute to their antioxidant activities [23]. In contrast, *Trichosanthes cucumerina* and *Litchi sinensis* (Bombai) had the lowest phenolic levels, indicating possible cultivar-specific limitations in secondary metabolite accumulation.

Flavonoid concentrations followed a different pattern, with *Mangifera indica* (Khirsha pati) peel extract showing the highest TFC (248.075 ± 0.475 mg QE/g), supporting literature evidence that mango peels can accumulate high levels of flavonoids such as catechins and rutin, which are influenced by genetic and environmental factors [11,28]. Notably, while *Lagenaria siceraria* had high TPC and TTC, it showed one of the lowest flavonoid levels, suggesting a differential distribution of polyphenolic subclasses. Such diversity in phytochemical profiles has been attributed to plant metabolism being directed toward specific biosynthetic pathways depending on stress response, developmental stage, and cultivar genetics [21, 30,31].

The tannin content varied considerably, with *Luffa cylindrica* registering the highest TTC (266.335 ± 1.335 mg TAE/g). Tannins, known for their protein-binding and antioxidant properties, are increasingly recognized in peels as functional food components [32]. The high tannin content in certain cucurbit peels may enhance their astringency and bioactivity, potentially supporting their use in therapeutic or nutraceutical applications.

The IC_{50} values derived from DPPH radical scavenging assays illustrated the functional significance of these phytochemicals. *Litchi sinensis* (Deshi) showed the lowest IC_{50} (3.69 ± 0.625 µg/mL), indicating the strongest antioxidant capacity among the tested peels, despite not having the highest phenolic or flavonoid content. This supports the idea that antioxidant efficacy is not solely dependent on concentration but also on the chemical structure and synergistic interactions among the compounds [33]. Peels of *Luffa acutangula*, *Litchi sinensis* (Bombai), and *Mangifera indica* (Khirsha pati) also demonstrated potent antioxidant activity, further emphasizing the nutraceutical potential of these often-discarded plant parts [27,34]. On the other hand, *Citrus limon* peel extract had the highest IC_{50} (66.28 ± 0.35 µg/mL), indicating the weakest radical-scavenging activity, which may be due to a lower concentration of active hydroxyl-rich compounds or antagonistic effects among phytochemicals [35].

Overall, the observed phytochemical and antioxidant diversity among these methanolic peel extracts reinforces the notion that plant peels, particularly those of mango, litchi, and certain cucurbits, represent underutilized sources of health-promoting compounds. Their inclusion in functional foods or pharmaceuticals could reduce agricultural waste while adding nutritional and therapeutic value. Future research should investigate compound-specific profiles using LC-MS or HPLC and evaluate bioavailability and *in vivo* efficacy to better harness the full potential of these natural antioxidants.

CONCLUSION

This study thoroughly examined the phytochemical composition and antioxidant capacity of methanolic crude extracts from the peels of fourteen varieties of fruits and vegetables grown in Bangladesh. The results revealed significant differences in the levels of total phenolics, flavonoids, and tannins among various species and cultivars. Notably, *Mangifera indica* (Fazli and Khirsha Pati), *Luffa cylindrica*, and *Lagenaria siceraria* demonstrated high concentrations of bioactive compounds. The antioxidant activity, measured using the DPPH radical scavenging assay, was highest in *Litchi sinensis* (Deshi), indicating a strong ability to neutralize free radicals. These findings highlight the rich diversity of phytochemicals and the health benefits associated with the peels of fruits and vegetables, many of which are typically discarded. The close relationship between phytochemical levels and antioxidant activity suggests their potential use in developing natural antioxidants, functional foods, and nutraceuticals. Furthermore, utilizing these peels supports sustainable practices by reducing agricultural waste. Future research should focus on identifying specific active compounds, evaluating their bioavailability, and confirming their health effects through *in vivo* testing to better understand their therapeutic potential.

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Author Contribution

Md. Abdullah: Writing of the main manuscript, data analysis, methodology, visualization, reviewing, and editing. Md. Sahadat Hossain: Writing the result and the discussion part. Md. Jakaria Sajib: formatting of the table and graph. Md. Moktazim Alam: Data curation. Tamanna Khatun, Md. Ripon Sheikh, Md. Raju Hossain, Mst. Jannatul Ferdous Shurovy and Md. Al Amin are responsible for reviewing the main manuscript and assisting in laboratory work. Abdul Ali Bhuiyan: formal analysis, reviewing, and editing. Dr. Shariful Haque: Design, project administration, resources, supervision, conceptualization, and methodology. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

There is no conflict of interest.

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