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Comparative phytochemical analysis of mature mango leaves from nineteen cultivars of Murshidabad district, India

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Abstract. *Ghosh B, Majumder S, Acharyya S, Ghosh A, Saha S, Sarkar S, Chakraborty S, Bhattacharya M. 2022. Comparative phytochemical analysis of mature mango leaves from nineteen cultivars of Murshidabad district, India. Asian J Nat Prod Biochem 20: 48-55.* Mango (*Mangifera indica* L.), "the king of fruits," is one of the most popular fruits in tropical regions. This research aimed to qualitatively and quantitatively screen major phytochemical groups present in the leaves of nineteen cultivars of mango tree extracted with three different solvents (petroleum benzene, acetone, methanol) belonging to different polarities and to determine their antibacterial activity against two Gram-positive (*Bacillus subtilis, Staphylococcus aureus*) and two Gram-negative (*Escherichia coli, Klebsiella pneumoniae*) bacteria. The antiradical scavenging activity was performed using a DPPH assay. In addition, total phenol and flavonoids in the leaf extracts were also quantitatively analyzed. Phytochemical investigations showed that mango leaf extracts contain phenol, tannin, protein, coumarin, terpenoid, alkaloid, steroid, and cardiac glycoside. The extracts also contain a variety of total phenols and flavonoids. Antiradical scavenging activity showed that polar solvents (methanol, acetone) are more potent than non-polar (petroleum benzene) extracts. Mango leaf extracts inhibit the growth of *E. coli, K. pneumoniae,* and *S. aureus,* but no inhibition zone against *B. subtilis.* Based on the phytochemical compounds and significant antioxidant and antibacterial properties of mango leaf extracts, mango leaves might be a potential source for developing pharmaceutical formulations and drugs.

Keywords: Antibacterial, antioxidant, mango, morphology, phytochemicals

INTRODUCTION

Mango (*Mangifera indica* L) belonging to the family Anacardiaceae is one among sixty genera and six hundred species (Hannan et al. 2013). It is one of the economically important tropical fruits (Rymbai et al. 2013; Kumar et al. 2021). Mango plantations globally occupy an area of about 4.37 million hectares, and current mango production in the world is nearly 31.5 million metric tons (Rymbai et al. 2013). Mangoes are grown commercially in many countries (more than 111 countries), where India ranks first in both production and plantation area (Rymbai et al. 2013). Other well-known mango-producing countries include China, Thailand, Indonesia, Pakistan, Mexico, Brazil, Bangladesh, Nigeria, and the Philippines (Kumar et al. 2021). Besides fruit, mango leaves can also be used as a food supplement and a good fodder as it has a good amount of minerals, vitamins, and protein (Kumar et al. 2021; Jhaumeer et al. 2018).

Murshidabad is the producer and exporter of mango var. Himsagar. Mango var. Langra originated from Varanasi, Uttar Pradesh. Mango var. Amrapali is grown throughout India. It is a hybrid variety, a cross breed between Dasher and Neelam mangoes, indigenous breeds. Fazli variety is also indigenous to Malda (West Bengal) and Bihar. Gulabkhas variety is most abundant in Bihar, West Bengal, and Jharkhand (https://www.holidify.com). Mango varieties of Anaras, Sarenga, Molamjam, Champa, and Chandankosa are generally produced in Murshidabad (https://www.getbengal.com). Mango varieties of Rani, Champa, and Bhabani are also Murshidabad variety. Rani variety was named by Raja Prasanna Narayan Deb, Dewan of Nizamat Qilla, Murshidabad (Lahiri 2018). Saranga variety was dedicated to the musicians who played the sarangi in Nawab's haveli. Gulabkhas, as the name suggests, has a mild taste of rose (Gulab), while Anaras variety has a pineapple flavor; and Mohanbhog was named by the worshipers of Lord Krishna for some religious belief (https://sundayfarmer.wordpress.com/2020/05/26/). These are some of the examples which may not provide scientific data regarding the origin of mangos but signifies their nomenclature history.

Traditionally, the mango plant has been used to treat gastrointestinal tract infection, diarrhea, dysentery, mouth infection in children, typhoid, sore throat, and scurvy (Hannan et al. 2013). In addition, as a good source of vitamin A, mango can be used to treat blood disorders (Hannan et al. 2013). Mango is an important dietary source of many bioactive compounds responsible for its color and flavor. In addition, the fruit has been reported to possess antioxidant activity and could overcome oxidative stress by neutralizing the overproduction of oxidant species. The collaborative and interdependent effects of the complex mixture of phytochemicals present in mango cannot be

accomplished through micronutrient supplements (Abbasi et al. 2015).

Some parts of the mango plant have been known to have a pharmacological effect. Ground seeds and leaves of mango plants are generally used to treat diabetes. The stem bark of mango has been demonstrated to possess anti-allergic properties. Glucoside-rich mango leaves have been analyzed and contain mangiferin, a potent antiviral and antibacterial agent (Hannan et al. 2013). Mangiferin is a natural miracle biologically active compound against lifestyle-related disorders. Some studies have shown that mangiferin treats COVID-19 (Umar et al. 2021). Mangiferin has a binding affinity for the Mpro of COVID-19. Mpro is a key enzyme that plays a vital role in viral replication and transcription. Therefore, mangiferin can inhibit viral replication and transcription (Umar et al. 2021). Among the many bioactive compounds of mango leaf and fruit, polyphenols are abundant antioxidant compounds that act as anti-mutagenic, antiradical, and anti-carcinogenic agents (Rymbai et al. 2013; Abbasi et al. 2015). They reduce the risk of many chronic diseases by exhibiting varied biological activities due to one or more hydroxyl groups. The high amounts of phenolic acids are present in ripe mangoes, enabling them to play an important role in quenching and neutralizing free radicals to improve human health. Gallic acid, known as an anticancer agent, has also been reported to be in mango (Rymbai et al. 2013; Abbasi et al. 2015). Flavonoids (a group of potent bioactive polyphenols) in mango have been reported to act as an antioxidant and antibacterial agent (Rymbai et al. 2013).

Although several research studies have been conducted to find different uses of mango fruits, peels, juice, and stem bark, there are limited reports on the importance of *Mangifera indica* L. leaves and their uses. Therefore, in this present study, the objective was to determine the presence of bioactive phytochemicals in the leaves of different mango cultivars and their antibacterial activity.

MATERIALS AND METHODS

Sample collection and extraction

Healthy, disease-free leaves of nineteen different cultivars (Table 1) of mango plants were collected from mango plantations of Lalbagh (24.19°N, 88.28°E), a small town in West Bengal's Murshidabad district. Freshly collected leaves were brought to the laboratory and washed with tap water. Leaves were kept in Petri dishes and left at room temperature for drying. Then, the dried leaves were crushed in a mortar pestle using liquid nitrogen. Leaf extracts (100 mg/ml concentration) were prepared by dissolving 1 g of each sample (crushed leaves) into 10 ml of each different solvent (petroleum benzene, acetone, and methanol) for 48 hrs. Solvents were chosen based on a wide range of polarity, i.e., petroleum benzene (hydrocarbon-based highly non-polar), acetone (polar aprotic solvent), and methanol (most polar and protic solvent).

Morphological characteristics

Morphology is a set of important parameters used to study the shape and structure of organisms or organs (in this case, mango leaf) and their specific structural features. Length (cm), width (cm), petiole length (cm), weight (g), length: width ratio, and surface area (cm^2) of leaf were determined to study the morphology of different leaves. A measuring scale in centimeters was used to determine the length and width. Millimeter chart sheets were used for leaf area measurements. Twenty mature leaves of each variety were selected randomly, and mean ± SD was calculated.

Qualitative Biochemical Tests

Qualitative tests for the detection of bioactive groups of molecules (tannin, protein, coumarin, terpenoid, alkaloid, steroid, and cardiac glycosides) in methanolic extracts were conducted following the protocols of Ghosh et al. (2020) and Majumder et al. (2021a).

Antioxidant activity (DPPH assay)

The free radical scavenging capacity of mango leaf extract was determined by the DPPH assay performed on petroleum benzene, acetone, and methanol leaf extract of all nineteen samples, following the protocol of Majumder et al. (2022a) and Ghosh et al. (2020). Results were expressed as the percentage of DPPH inhibition (%) that occurred due to the exposure of samples.

Quantification of total phenol content (TPC)

Quantifying total phenol content was performed by the Folin-Ciocalteu method described by Majumder et al. (2022a) and Sarkar et al. (2021). TPC was measured against the gallic acid standard curve, using the standard curve equation of R^2=0.9975; y=0.0043x-0.1672. Results were expressed as gallic acid equivalent (mg GAE/g).

Table 1. List of *Mangifera indica* varieties used in this study

Name of the variety	Sample code
Mangifera indica L. var Himsagar	S1
Mangifera indica L. var Langra	S2
Mangifera indica L. var Molamjam	S3
Mangifera indica L. var Sorikhas	S4
Mangifera indica L. var Champa	S5
Mangifera indica L. var Gulabkhas	S6
Mangifera indica L. var Rani	S7
Mangifera indica L. var Borosaheb	S8
Mangifera indica L. var Fazli	S9
Mangifera indica L. var Asina-Fazli	S10
Mangifera indica L. var Mohon-bhog	S11
Mangifera indica L. var Amrapali	S12
Mangifera indica L. var Chandankosa	S13
Mangifera indica L. var Daudi	S14
Mangifera indica L. var Bhabani	S15
Mangifera indica L. var Saranga	S16
Mangifera indica L. var Anaras	S17
Mangifera indica L. var Michriganj	S18
Mangifera indica L. var Tarabi	S19

Quantification of flavonoid content

Total flavonoid content was determined following the aluminum chloride method described by Ghosh et al. (2020) and Majumder et al. (2022a). Total flavonoid content was measured against the quercetin standard curve, using the standard curve equation of R^2=0.962; y=0.207x-0.204. Results were expressed as quercetin equivalent (mg QE/g).

Antibacterial test

Antibacterial potentials of each leaf sample against actively growing broth cultures of two Gram-positive (*Staphylococcus aureus* and *Bacillus subtilis)* and two Gram-negative (*Escherichia coli* and *Klebsiella pneumoniae*) bacteria were tested by well diffusion of the method following Ghosh et al. (2020) and Majumder et al. (2022b). A nutrient agar (NA) medium was used for this test. Following the pour plate method, 100 µL of bacterial broth culture was first poured into each sterile Petri dish and then sterilized. The plates were left for a few minutes at room temperature for the media to be solidified. Following solidification, a sterile steel cork borer was used cut out circular wells (8 mm in diameter). Next, 200 µL of each leaf extract sample was poured into the well. This process was done under sterile condition in a laminar airflow cabinet. The plates were then incubated at 37°C for 24 hours in a non-inverted position.

RESULTS AND DISCUSSION

Morphological characteristics

Mangifera indica L. is a large evergreen tree with heavy branches from a stout trunk having dense dome-shaped foliage. The mango tree grows up to a height of 10-45 m. Young leaves are reddish and thinly flaccid and release an aromatic odor when crushed, turning shiny dark green on the upper surface when they mature. The mean results of morphological characteristics of the leaves are present in Table 2. These results refer that the morphological characteristics of mango leaf do not show significant variation to distinguish one cultivar from the others; rather, they exhibit low morphological variation among all the varieties. Table 2 shows that leaf length ranges from 10.86±2.23 cm (S13) to 26.72±3.82 cm (S9). Data for leaf breadth in Table 2 ranged from 3.14±0.29 cm to 7.98±1.35 cm. The highest value was recorded for S9 (7.98±1.35 cm), and the lowest leaf breadth was for S13 (3.14±0.29 cm). The highest petiole length was in S6 (5.35±1.08 cm) and the lowest in S7 (2.13±0.45 cm). The heaviest leaf weight was 2.76±0.85 g for S9, followed by S12 (1.72±0.47 g) and S6 (1.53±0.6 g), while the lightest value was 0.54±0.58 g recorded for S13. The leaf surface area in different mango cultivars demonstrated that the S17 has the lowest leaf surface area of 20 cm^2. In contrast, S6 exhibited the highest leaf surface area with 111.5 cm^2, followed by S9 (104.5 cm^2).

Qualitative analysis of the leaf extract

Results of qualitative analysis of mango leaf extract for tannin, cardiac glycosides, protein, coumarin, terpenoid, steroid, and alkaloid are depicted by a heat map in Figure 1. These phytochemical groups showed their various presence in different mango leaf extracts. A noticeable amount of protein was found in the leaf extract of S17. In contrast, the leaf extract of S1, S3, S6, S8, and S16 showed no indication of the presence of protein. The presence of coumarin, terpenoids, and steroids was indicated in the mango leaf extracts of all the nineteen cultivars. Alkaloids tested positive in all the samples except the leaf extracts of S1, S4, S11, S12, and S19.

Antioxidant activity (DPPH assay)

Responsible reducing agents act as proton donors when free radicals are scavenged. In the DPPH assay, this antiradical activity is calculated from the decreasing absorbance that occurred in the DPPH solution (Majumder et al. 2021b). Nonpolar (petroleum benzene) and polar (acetone and methanol) solvent extracts of nineteen different varieties of mango tree leaf extracts showed the variable potential of DPPH scavenging activity. Leaf extracts of S1 (92.22±1.49%), S7 (91.91±1.30%), S8 (90.76±3.99%), S16 (91.05±1.91%), S18 (90.81±1.55%) showed a significantly high level of DPPH scavenging activity compared to others in their methanol extracts. Whereas acetone extracts of S1 (89.77±1.27%), S4 (90.99±1.38%), S7 (90.38±0.25%), S11 (90.25±1.59%), S18 (91.22±1.13%) also showed a high level of DPPH scavenging activity. So, among the high DPPH scavengers, leaf extracts of S1, S7, and S18 in methanol and acetone showed maximum DPPH scavenging activity. On the other hand, the lowest levels of scavenging activities were observed in petroleum benzene extracts. At the same time, polar solvents (methanol and acetone) showed moderate, high, or very high DPPH scavenging activity. The results of all the nineteen samples are presented in Figure 2.

Quantification of total phenol content (TPC)

Quantifying total phenol was done in petroleum benzene, acetone, and methanol extracts. This quantitative analysis of total phenol revealed that the content of total phenol varies from plant to plant. The quantities of phenols were detected and converted to gallic acid equivalent, represented in Figure 3. The highest concentration of total phenol was quantified in methanol extract of S14 (20.24±1.35 mg GAE/g sample), S18 (20.07±1.07 mg GAE/g sample), S10 (19.11±0.26 mg GAE/g sample), S7 (18.51±0.85 mg GAE/g sample), S4 (17.91±0.85 mg GAE/g sample) and acetone extracts of S8 (18.20±0.14 mg GAE/g sample), S13 (18.17±0.11 mg GAE/g sample), S10 (18.16±0.2 mg GAE/g sample), S9 (16.96±0.2 mg GAE/g sample), S17 (16.77±0.12 mg GAE/g sample). In contrast, all nineteen samples recorded the lowest total phenol concentration in petroleum benzene extracts.

Table 2. Morphological analysis of mango leaves of nineteen different cultivars

Sample	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Weight (g)	Length: breadth (mean)	Mean surface area (cm²)
S1	19.7±2.45	5.71±0.11	4.4±0.45	1.53±0.21	3.45	76.5
S2	21±1.94	5.04±0.14	3.2±1.22	1.13±0.27	4.16	41.5
S3	17.46±1.24	4.04±0.1	3.3±0.79	0.81±0.12	4.31	35.5
S4	21.8±1.47	5.08±0.13	4.2±0.63	1.43±0.21	4.29	77
S5	20±3.3	4.79±0.23	3.42±0.82	0.99±0.35	4.17	69
S6	26.4±4.69	6.15±0.25	5.35±1.08	1.53±0.6	4.29	111.5
S7	12.81±2.75	5.04±0.12	2.13±0.45	0.62±0.28	2.54	55.5
S8	21±3.43	5.08±0.18	4.35±0.57	1.16±0.48	4.13	66.5
S9	26.72±3.82	7.8±1.35	5.68±1.03	2.76±0.85	3.34	104.5
S10	17.1±4.67	4.66±0.26	4±1.33	1.39±0.6	3.66	37.5
S11	16.2±3.96	6.15±0.2	3.1±0.66	1.45±0.6	2.63	50.5
S12	24.37±3.06	4.43±0.13	4.25±0.88	1.72±0.47	5.49	56
S13	10.86±2.23	3.14±0.29	2.2±0.36	0.54±0.58	3.45	31
S14	20.6±5.14	4.52±1.03	3.5±1.35	1.33±0.46	4.55	48
S15	17±1.98	5.25±0.29	3.82±0.73	0.99±0.18	3.23	69
S16	19.81±4.42	4.43±0.18	3.09±1.44	1.05±0.47	4.46	47.5
S17	17.37±3.73	3.25±0.16	3.25±1.03	1.12±0.41	5.34	20
S18	16.4±3.37	4.53±0.19	2.3±0.63	1.07±0.38	3.62	27.5
S19	17.5±1.71	5.68±0.37	3.3±0.82	0.81±0.13	3.08	55.5

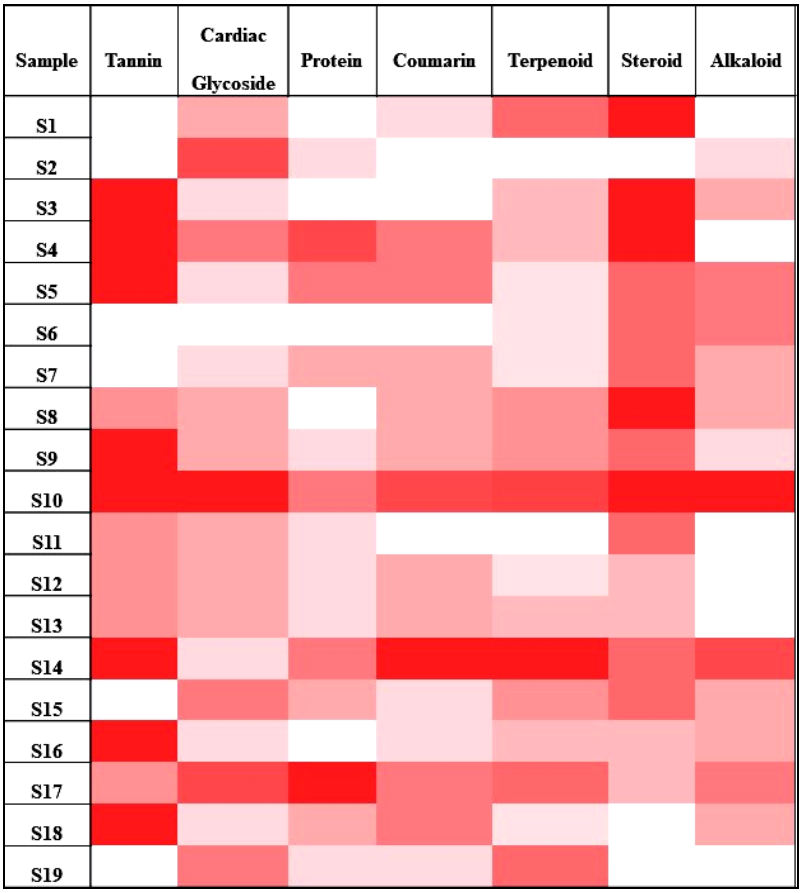

Figure 1. Heat map (red- white = high- low) showing results of phytochemical groups in mango leaf extract

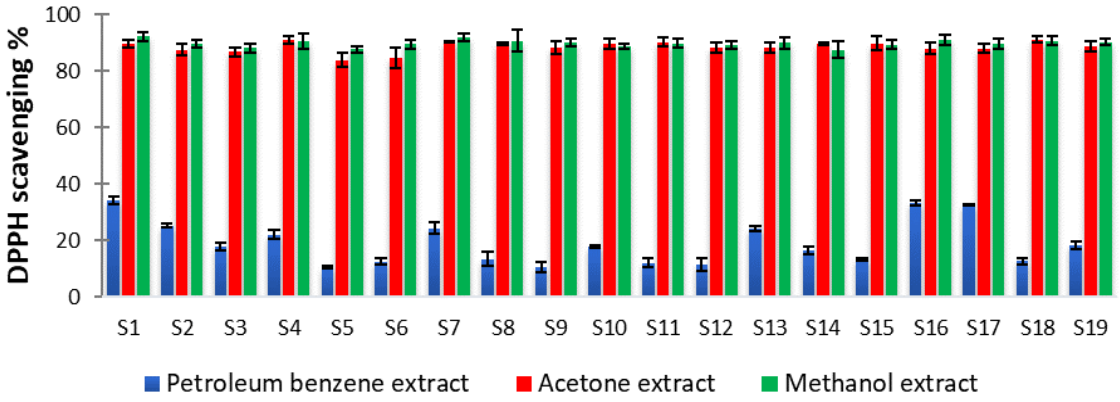

Figure 2. DPPH free radical scavenging (%) activity shown by *Mangifera indica* leaf extracts

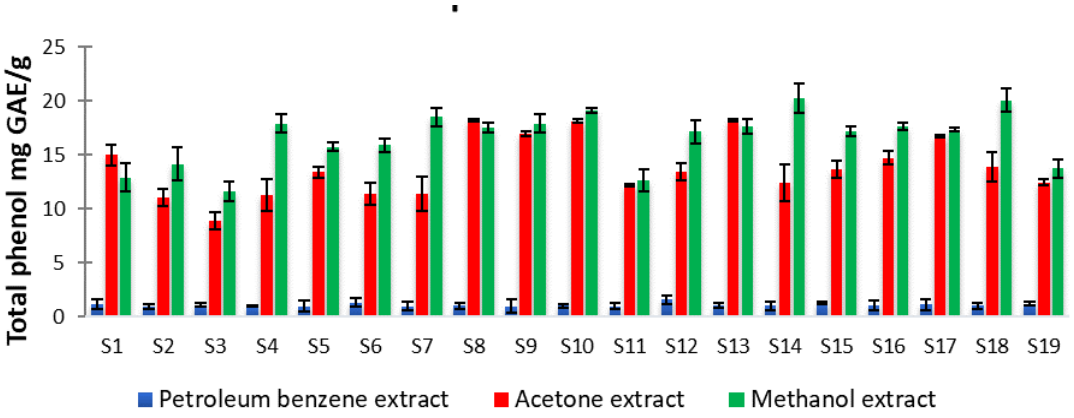

Figure 3. Total phenol content (TPC) as Gallic acid equivalent detected in solvents extracts of different leaves

Quantification of total flavonoid content

Quantifying flavonoids was conducted in petroleum benzene, acetone, and methanol extracts of all the nineteen varieties of a mango leaf. Determination of total flavonoid content was expressed as mg Quercetin equivalent (QE)/g fresh leaves of mango plant extracted by three (petroleum benzene, acetone, methanol) different solvents. The quantities of flavonoids were detected and converted to quercetin equivalent. The results were represented graphically in Figure 4. Methanol leaf extracts of S11 (3.14±0.13 mg QE/g sample), S8 (2.74±0.09 mg QE/g sample), S3 (2.29±0.24 mg QE/g sample), S14 (2.09±0.21 mg QE/g sample), S18 (2.04±0.19 mg QE/g sample) showed the maximum quantity of flavonoids. At the same time, mango leaf extracts in acetone also showed a promising result. Acetone leaf extracts of S1 (3.09±0.07 mg QE/g sample), S5 (2.53±0.17 mg QE/g sample), S11 (2.3±0.25 mg QE/g sample), S2 (2.24±0.19 mg QE/g sample), S13 (2.18±0.08 mg QE/g sample), also exhibited a significant quantity of flavonoids. In contrast, petroleum benzene leaf extracts of all the nineteen samples showed minimum quantities of flavonoids.

Antibacterial activity

Mango leaf extracts showed potent antibacterial activity against Gram-positive and Gram-negative bacteria. Methanol extract of S5 and acetone extract of S7 showed an inhibition zone of 2.5 cm and 2 cm, respectively, against *E. coli*. An inhibition zone of 1.5 cm was also observed against *K. pneumoniae* by acetone extract of S7. There was no zone of inhibition observed against *B. subtilis.* In contrast, acetone extract of S18, S7, and S17 showed a wide inhibition zone of 1.5 cm, 1.2 cm, and 1 cm, respectively, against *S. aureus.*

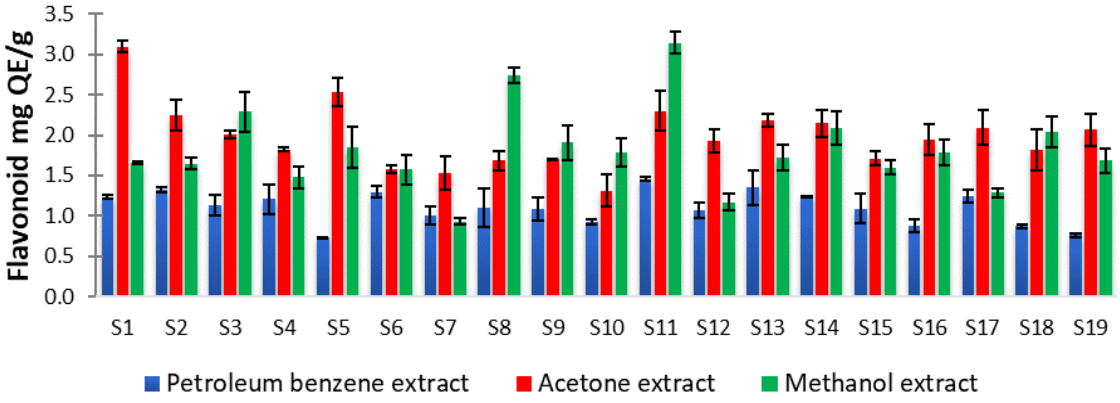

Figure 4. Total flavonoid content as quercetin equivalent detected solvents extracts of different leaves

Discussion

Murshidabad district was once the capital of exotic mango varieties, but nowadays, Murshidabad is missing out on past honors as the district is facing massive genetic erosion of the mango germplasm (Pal 2017; De et al. 2014). Around 250 varieties of mango have been grown in this district (Pal 2017). The origin of mango cultivars used in this research was studied from available literature. The nawabs of Murshidabad had purchased different mango cultivars from different parts of the country and took the initiative to create new varieties through grafting. Till the 1970s and 1980s, some rare varieties were found on the mango plantation of Lalbagh of Murshidabad. Due to climate change and inadequate preservation facilities, farmers are losing interest in producing some varieties (Pal 2017). However, a few exotic mango tree species are still present in the orchards of Lalbagh. Therefore, Lalbagh was chosen for sample collection for this study.

The leaves characters are spirally arranged on branches, lanceolate-elliptical, pointed at both ends and borne on 1-12.5 cm long petioles. Leaves are mostly about 16-30 cm long and 3-8 cm wide on flowering branches, and up to 50cm long on sterile branches (Shah et al. 2010; Igbari et al. 2019). So, the values of morphological analysis for mango leaves of all the nineteen different cultivars depicted in Table 2 fitted perfectly with the ranges mentioned above.

Mangifera indica has attracted to be studied to determine new biomolecules from different parts of plants like fruits, leaves, stems, and seed kernels. Its therapeutic importance is well established and has been used as a traditional remedy for treating several diseases (Jhaumeer et al. 2018). For example, a previous study by Kumar et al. (2021) showed that the leaf extract had cytotoxic activity and oxidative effects on breast cancer cells and was non-invasive against non-carcinogenic cells (Kumar et al. 2021). In addition, several studies have reported that the different parts of mango plants, such as leaves, bark, stems, and seeds, exhibited antimicrobial activity against some multi-drug resistant (MDR) microbes (Kumar et al. 2021; Hannan et al. 2013).

Mango leaves have been reported to contain several beneficial chemical compounds that can be used to treat various diseases such as diabetes, hepatitis, and wound healing. Kumar et al. (2021) stated the major phytochemicals responsible for the antimicrobial activity were phenolics, alkaloids, glycosides, tannins, terpenes, and saponins. Some compounds from mango can be used in the pharmaceutical industry, such as steroids, gallic acid that has antifungal and antiviral activity, flavonoids that have antioxidant activity, and tannin as a diarrhea remedy (Ali et al. 2020). Tannin is an astringent and biosynthesized in plants and can be pharmacologically useful against various diseases (Okuda et al. 1992). In addition, tannin acts as antibacterial (Awosika 1991) by inhibiting bacterial proliferation through the denaturation of enzymes involved in microbial metabolism, further, it precipitates proteins in tissues which are beneficial for wound healing (Tyler et al. 1998). In this research, methanol extract was chosen for the qualitative biochemical tests, as methanol showed a favorable result during DPPH antioxidant assay. Tannin was found in all the samples in moderate quantity. Cardiac glycosides were present in all samples, while a significant amount was found in S2, S10, and S17. Cardiac glycosides are used to treat congestive heart failure and cardiac arrhythmia. Therefore, mango leaf extract might be used for cardiac ailments.

Free radical DPPH scavenger activity indicates the ability of plant extracts to scavenge free radicals and is considered an indicator of antioxidant activity. All leaf extracts showed promising DPPH scavenging activity, although S1, S7, and S18 (methanol and acetone extracts) have higher DPPH scavenging activity. However, their DPPH scavenging activity did not differ significantly from other extracts. (Figure 2). .Mango leaves have been reported to have antioxidant activity mostly from phenolic compounds (Ali et al. 2020). Phenols generally protect plants and human cells from oxidative damage (Ali et al. 2020). Therefore, S7, and S18, which showed the noticeable potential of DPPH antioxidant activity, were also rich in total phenol content. Flavonoids are polyphenols, a group of natural biomolecules with variable phenolic structures available in almost all plant parts. They primarily confer antioxidant properties (Panche et al. 2016) and have antimicrobial, anti-inflammatory, anti-allergic,

and anticancer activity (Balch and Balch 2000). Therefore, the mango leaf is also a good flavonoid source (Ali et al. 2020). S1 and S18 are good DPPH scavengers and exhibit high flavonoid content. This research showed that methanol and acetone leaf extracts possess good phenol and flavonoid content (Figures 3 and 4).

The phytochemical content in the mango leaf extracts is responsible for the antibacterial, anti-inflammatory, and antioxidant activity (Jhaumeer et al. 2018). A previous study by Jhaumeer et al. (2018) showed that crude extracts of mango leave exhibited moderate to good antibacterial activity against some Gram-positive bacteria (*Pseudomonas aeruginosa*, *Bacillus cereus,* and *S. aureus*) and Gram-negative bacteria (*Staphylococcus epidermidis*, *K. pneumoniae,* and *E. coli*). Interestingly, the essential oil of five different Egyptian mango cultivars also showed potential antimicrobial activity (Kumar et al. 2021). This study showed that leaf extract of S5, S7, S17, and S18 showed effective antimicrobial activity. However, there was no inhibitory zone against *B. subtilis*.

Furthermore, several extracts that contain several phytochemical compounds (S10, S14, S1, and S11) were not active as antibacterial. Therefore, further analysis (fractionation and separation of phytochemical) is needed to study the bioactivities in depth. The detailed qualitative phytochemical profiling suggested that mango leaves are a good resource of phytochemicals like flavonoids, tannins, protein, coumarin, terpenoids, alkaloids, steroids, cardiac glycosides, and phenols. Methanol extracts of all mango varieties had good DPPH scavenging activity, total phenol, and flavonoid content. Furthermore, varieties such as Rani, Anaras, Michriganj, and Champa are effective against *E. coli, K. pneumoniae,* and *S. aureus*.

Furthermore, mango leaves exhibit exceptional antioxidant and antibacterial properties. Therefore, the extract of mango leaves might be utilized by pharmaceutical industries to benefit humankind. Results suggest the presence of phytochemicals (cardiac glycosides, polyphenols, tannin, terpenoids, coumarin, etc.) in mango leaf extracts are responsible for their antioxidant and antimicrobial activity. Moreover, variations in results among the cultivars had been considered for the comparative analysis, which will help to choose promising samples for further chromatographic studies to evaluate their bioactivities.

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