Investigation of antioxidant properties of *Morinda citrifolia* leaf and fruit extracts in Sri Lanka

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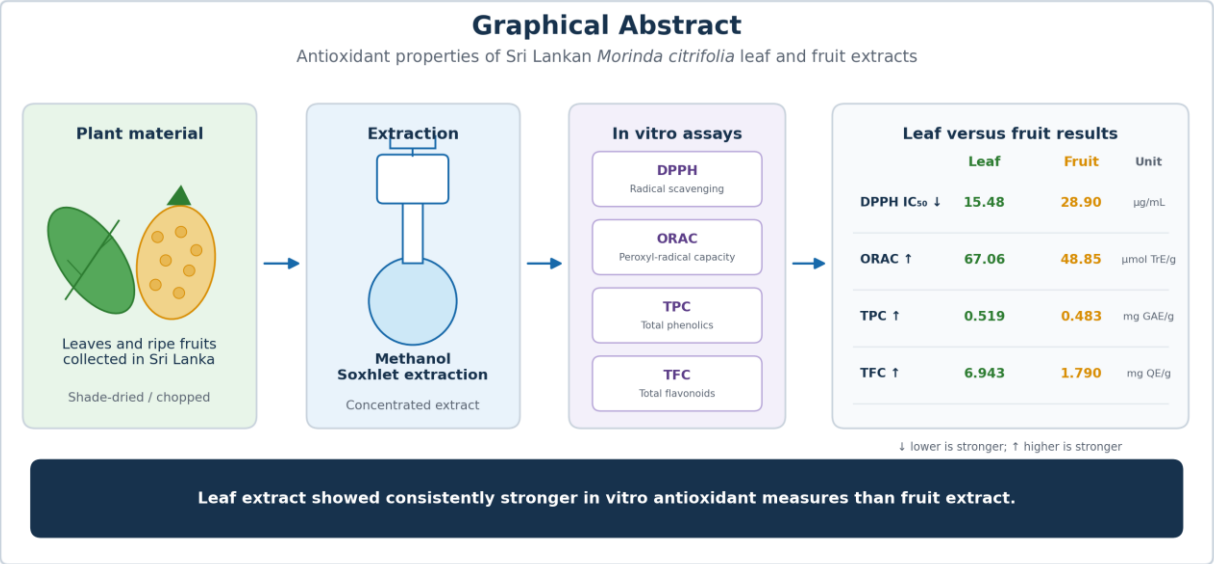

Abstract

Sri Lanka's traditional medicinal system, with a rich history spanning over 3000 years, remains a trusted and widely used form of healthcare among people. Recently, *Morinda citrifolia* (commonly known as Noni) has gained attention in scientific studies for its potential in preventing and treating various illnesses, specifically cancers. In Sri Lanka, however, there have been limited *in vitro* investigations on its composition and antioxidant capacity. This study aimed to explore the antioxidant activity, total phenolic content, and total flavonoid content of methanolic extracts obtained from different parts of the *Morinda citrifolia (M. citrifolia)* plant, specifically the leaves and fruits grown in Sri Lanka. Antioxidant capacity was assessed using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay and the oxygen radical absorbance capacity (ORAC) assay. The Folin-Ciocalteu method and the aluminum chloride colorimetric method were used to quantify total polyphenols and flavonoids, respectively. The findings show that both the leaves and fruits of *M. citrifolia* are rich sources of antioxidants when compared with Trolox as the reference standard. Notably, *M. citrifolia* leaves exhibited higher levels of total phenolic content (0.519 ± 0.09 GAE/g) and total flavonoid content (6.943 ± 1.22 QE/g), along with stronger antioxidant activity as indicated by a lower IC_{50} value (15.48 µg/mL), compared to the fruits, which recorded a total phenolic content of 0.483 ± 1.8 GAE/g, total flavonoid content of 1.79 ± 0.12 QE/g, and a higher IC_{50} value (28.90 µg/mL). Similarly, ORAC assay results confirmed that the leaves have superior antioxidant potential with higher ORAC value (67.06 ± 15.9) relative to the fruits (48.85 ± 9.7). Given these results, promoting the use of *M. citrifolia* products, especially those derived from leaves, could be beneficial in Sri Lanka.

Keywords: *Morinda citrifolia, Methanolic extraction, Antioxidants, Sri Lanka, Total phenolic content*

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1.0 Introduction

Sri Lanka has been recognized as a biodiversity hotspot due to its varied range of plants. However, many of them are unused (Perera et al., 2022). Many wild plants found in Sri Lanka have contributed to the country's unique biodiversity. Traditional medicinal practices continue to play an important role in primary healthcare in Sri Lanka, largely due to the accessibility of plant-based remedies and long-standing indigenous knowledge systems (Waisundara and Watawana, 2014).

Morinda citrifolia, often known as Noni, is a plant that has been utilized for numerous therapeutic purposes in ancient times (Abou Assi et al., 2017). However, its use in Sri Lanka appears to be limited and remains poorly documented in comparison to other commonly used indigenous medicinal plants (Ediriweera, 2010; Waisundara and Watawana, 2014). *M. citrifolia* trees are distinguished by a straight stem, huge, brilliant green, elliptical leaves, white tubular blooms, and ovoid, grenade-like fruit. The fruit can grow to be 12 cm or greater in size, with a rough surface covered by polygonal-shaped sections (Abou Assi et al., 2017). *M. citrifolia* plants may begin to bear tiny flowers and fruits at 9 months to 1 year of age if growing circumstances are favorable. Fruits can be collected at this time, but they are usually small and few.

M. citrifolia has recently piqued the interest of pharmaceutical and food sector experts due to its adaptability and usage of plant structures for various medical uses. *M. citrifolia'*s high nutritional value may elicit therapeutic effects such as antibacterial and antioxidant capabilities. Although *M. citrifolia* products are not widely available in Sri Lanka, many European countries have produced industrial products from this plant, including drinks, dried fruit powder, fermented juice, seed oil, and leaf powders (Almeida et al., 2019).

Traditional medicine is still used for primary health care by an estimated 80% of the world's population. Natural products contain a variety of beneficial chemical components, including antioxidants (Hosseinzadeh et al., 2015). Antioxidants are chemicals that can protect cells from free radical damage. The reactive chemicals known as free radicals contribute to oxidative stress. They cause a variety of diseases, including cardiovascular disease, renal and respiratory disorders, cancer, gastrointestinal diseases, and diabetes. The human body has numerous methods for combating oxidative stress by producing antioxidant molecules, which are either spontaneously produced in situ or given externally in the form of supplements or foods. As a result, antioxidant chemicals can boost immune response and lower the risk of degenerative diseases (Bhatt et al., 2013).

Although numerous studies have evaluated the antioxidant potential of *M. citrifolia* grown in other countries, scientific evidence regarding plants cultivated in Sri Lanka remains limited. Environmental and geographical factors such as climate and soil conditions can influence phytochemical composition and antioxidant capacity. Therefore, findings from other regions cannot be directly extrapolated to Sri Lankan *M. citrifolia*. In addition, comparative data on the antioxidant activity of leaves and fruits under identical experimental conditions are scarce in the Sri Lankan context.

The present study aims to provide a preliminary *in vitro* evaluation of the antioxidant capacity of methanolic extracts of *Morinda citrifolia* leaves and fruits grown in Sri Lanka. Antioxidant activity was assessed using DPPH radical scavenging and oxygen radical absorbance capacity (ORAC) assays using Trolox as the reference standard, while total phenolic content (TPC) and total flavonoid content (TFC) were quantified using established colorimetric methods. This study seeks to generate baseline data to support future, more comprehensive investigations into the bioactive potential of *M. citrifolia* cultivated in Sri Lanka.

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2.0 Methods

Materials

Reagents such as 1,1-diphenyl-2-picrylhydrazyl radical (DPPH), Folin-Ciocalteu's reactive, sodium carbonate (Na_2CO_3), quercetin, azobis (2-amidinopropane) dihydrochloride (AAPH) , fluorescein (FL) were purchased from Merck (Darmstadt, Germany) and gallic acid (GA), AlCl3, methanol (99.9%), 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox), sodium phosphate dibasic heptahydrate ($Na_2HPO_4 \cdot 7H_2O$.), sodium phosphate monobasic dihydrate ($NaH_2PO_4 \cdot 2H_2O$) were purchased from Sigma-Aldrich (St. Louis, USA).

Plant Collection

As the initial step, ripened *M. citrifolia* fruits (maturity stage 4) (Chan-Blanco et al., 2006) and *M. citrifolia* leaves were collected from the western province, from Chillaw and Seeduwa, where the average temperatures were reported 28 °C and 27 °C, respectively, and the soil pH is 5. These plants were identified with the help of the available literature (Abou Assi et al., 2017). Plant materials were then washed separately with fresh water to remove dirty materials. The collected leaves (553 g) were dried in the shade for 10 days. The dried materials were ground into coarse powder by pestle and motor just before the extraction procedure.

Extract Preparation

According to the initial assessment and with the help of available literature, methanol has been identified as the best solvent for the extraction of the *M. citrifolia* plant (Nguyen et al., 2020). As hexane and methanol were used as solvents in many antioxidant studies, the extractions were obtained using hexane and methanol initially. Based on the amount of extract obtained/grams of material, methanol has been chosen for extraction.

The extraction was performed according to (Redfern et al., 2014) using the soxhlet apparatus. The powdered *M. citrifolia* leaves (4.508 g) have filled the thimble made using chromatography paper. Then the powder has subjected to the soxhlet apparatus to get the extract, using methanol (250 ml) for 4 hours. Afterward, the methanol was evaporated using a rotary evaporator, leaving a small yield of extracted plant material (1.8779 g) in the glass bottom flask.

The ripened *M. citrifolia* fruits have chopped into small pieces and 18.036 g were subjected to the Soxhlet apparatus using methanol (200 ml) and the methanol was evaporated using a rotary evaporator, leaving a small yield of extracted plant material (13.130 g) in the glass bottom flask after 4 hours. Then the collected samples have dissolved with methanol (5 ml) separately and transferred to Eppendorf tubes and stored under a refrigerator (-20) until used for further analysis (Nguyen et al., 2020). A higher mass of fruit was used as previous studies report differences in total phenolic content between noni fruits and leaves, where the phenolic profile and levels vary by plant part, which can influence antioxidant extraction yields (Yang et al., 2011). To accommodate these differences and ensure efficient extraction, powdered leaves (4.508 g) and powdered fruits (18.036 g) were each packed into Soxhlet thimbles of the same size, allowing consistent contact with the solvent and optimal extraction efficiency across samples.

Samples were stored at −20 °C until analysis. While stability data were not collected, storage under frozen conditions is expected to minimize antioxidant degradation (Soto et al., 2025).

Total antioxidant activity (2, 2, diphenyl-1-picrylhydrazyl Assay)

The total antioxidant activity was estimated by the 2, 2, diphenyl-1-picrylhydrazyl (DPPH) assay, according to the method Golezar et. al. (2017), with some modifications. Stock solution of the fruit extract was prepared in methanol from which a serial dilution was carried out to obtain concentration of 5 mg/ml, 2.5 mg/ml, 1.25 mg/ml, 0.625 mg/ml and 0.3125 mg/ml. Diluted solutions (50 µl) were added to a 60 µl solution of DPPH then mixed and allowed to stand for 30 minutes for

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the reaction to occur. The absorption of the samples was measured at 517 nm against a blank of methanol without DPPH. The percent inhibitions were plotted against concentration and from the graph IC_{50} was calculated. The experiment was performed two times and average absorption was noted for each concentration. The blank was 99.8% (v/v) methanol. The capability to scavenge the DPPH radical was calculated using the following equation (Rajurkar and Hande, 2011).

$$DPPH\ Scavenged\ (\%) = \frac{A_B - A_A}{A_B} \times 100 \qquad \text{------} \qquad 1$$

where, AB is absorbance of blank at t=0 min; AA is absorbance of the antioxidant at t= 30 min. The antioxidant activity of Noni leaves and fruits was compared to Trolox as a positive control to provide a benchmark for activity levels. A calibration curve was plotted with percentage DPPH scavenged versus concentration of standard antioxidant (Trolox). The results were reported as IC_{50} values and Trolox equivalents (TrE, mg/g) of *M. citrifolia* extracts.

Total antioxidant activity ORAC (oxygen radical absorbance capacity) assay

ORAC evaluation of extracts and isolated compounds follows a method described in a previous study (Ou et al., 2001). 2, 2'-azobis (2-amidino-propane) dihydrochloride (AAPH), fluorescein, and 6-hydroxy-2, 5, 7, 8-tetra-methylchroman-2-carboxylic acid (Trolox) were prepared in 75 mM phosphate buffer with a pH of 7.4. An excitation wavelength of 496 nm and an emission wavelength of 535 nm were applied in the assay, whereby the ORAC value was referred to as the net protective area under the curve of fluorescein in the presence of an antioxidant. The net area under the curve (AUC) of the standard and samples were calculated. The antioxidant capacity (ORAC) related to Trolox was calculated as follows:

$$ORAC\ value = \left[\frac{(AUC_{sample} - AUC_{blank})}{(AUC_{Trolox} - AUC_{blank})}\right] \times [Trolox] \qquad \text{------} \qquad 2$$

The results were evaluated with the aid of MS Excel and expressed as µmol Trolox equivalents (TrE) per gram of sample**.**

Total Phenolic Content (TPC)

The total phenolic content of the extracts was determined by the Folin-Ciocalteau method with some modifications (Qasim et al., 2017). 1 mg/mL samples were made of the fruit and leave extracts was prepared in methanol from which a serial dilution was carried out to obtain concentration of 1 mg/ml, 0.5 mg/ml, 0.25 mg/ml, 0.125 mg/ml and 0.0625 mg/ml. Diluted solutions (20 µl) were added to 110 µl of 10 times diluted Folin-Ciocalteau reagent and placed for 5 minutes and obtained the pre-plate reading. Then 70 µl of 10% Na_2CO_3 was added to the wells and incubated at room temperature for 30 minutes. Absorbance was measured at 765 nm using SpectraMax-Plus-384-Spectrophotometer. Gallic acid (1 mg/mL) was used to produce a standard calibration curve. The total phenolic content was expressed in mg of gallic acid equivalents (GAE)/g of extract.

Total flavonoid content (TFC)

The total flavonoid content was determined using the aluminum trichloride ($AlCl_3$) method (Shraim et al., 2021). 1 mg/mL samples were made of the fruit and leave extracts was prepared in methanol from which a serial dilution was carried out to obtain concentration of 1 mg/ml, 0.5 mg/ml, 0.25 mg/ml, 0.125 mg/ml and 0.0625 mg/ml. 100 µL of 2 % aluminum trichloride ($AlCl_3$) in methanol was mixed with the same volume of the extracted solutions. Absorption readings at 415 nm using SpectraMax-Plus-384-Spectrophotometer, were taken after 10 minutes of incubation against a blank sample consisting of leaf extract solution with 100 µL methanol without $AlCl_3$. The total flavonoid content was determined using a standard curve with Quercetin (1 mg/mL) as the standard. Total flavonoid content is expressed as mg of Quercetin equivalents (QE)/g of extract.

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3.0 Results

Investigation of Antioxidants

DPPH Assay. When antioxidant samples were combined with DPPH reagent solution, the color changed from purple to yellow over time as shown in Figure 1 in leave extracts and Figure 2 in fruit extracts.

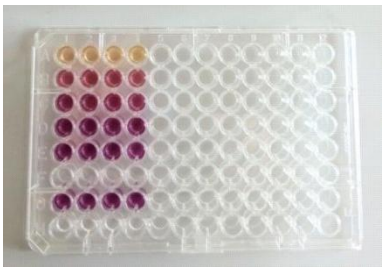

Figure 1: Reduction of DPPH radicals by *Morinda citrifolia* leaf extracts

The color change from purple to yellow indicates scavenging of DPPH free radicals by antioxidant compounds in the extracts. Four replicates were shown (wells 1-4 from left to right), but only first three (1,2,3) were used for quantitative analysis. Blank controls are included in the bottom row. Antioxidant activity was quantified as % DPPH radical scavenged using Equation (1). Data represent mean ± SD of three independent measurements (n = 3). Trolox was used as a positive control. All assays were performed at 25°C, and absorbance was measured at 517 nm after 30 min incubation.

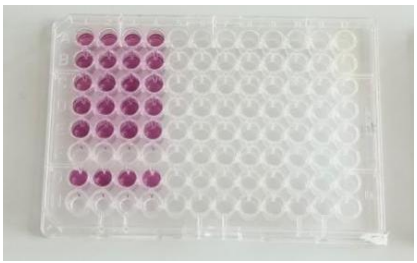

Figure 2: Reduction of DPPH radicals by *Morinda citrifolia* fruit extracts

The change from purple to yellow indicates antioxidant activity. Four replicates were shown (wells 1- 4 from left to right), but only three (1,2,3) were considered for analysis. Blank controls are included in the bottom row. Antioxidant activity was quantified as % DPPH radical scavenged using Equation (1). Data represent mean ± SD of three independent measurements (n = 3). Trolox was used as a positive control. Assays were performed at 25°C, and absorbance was measured at 517 nm after 30 min incubation.

The color shift was evaluated by measuring absorbance at 517 nm with a spectrophotometer. Trolox (6-hydroxy-2, 5, 7, 8-tetramethylchroman-2-carboxylic acid) was utilized as the standard, and the antioxidant activities of the various extracts varied. Trolox's IC_{50} value was 11.01 g/mL. The greater the IC_{50} value, the lower the radical scavenging activity or antioxidant capacity (Sagar B. Kedare and R. P. Singh, 2011). When compared to fruit extracts, leaf extracts showed the highest antioxidant capacity. The IC_{50} value of the fruit extracts was 28.90 g/mL, whereas the IC_{50} value of the leaf extract was 15.48 g/mL. Figure 3 shows the standard curve of Trolox. The results of qualitative analysis of IC_{50} of the samples are shown in Table 1.

Table 1: IC_{50} of the *M. citrifolia* leaves and fruits grown in Sri Lanka 2022

Sample	Trolox	Leave extract	Fruit extract
IC_{50} (µg/mL)	11.01	15.48	28.90

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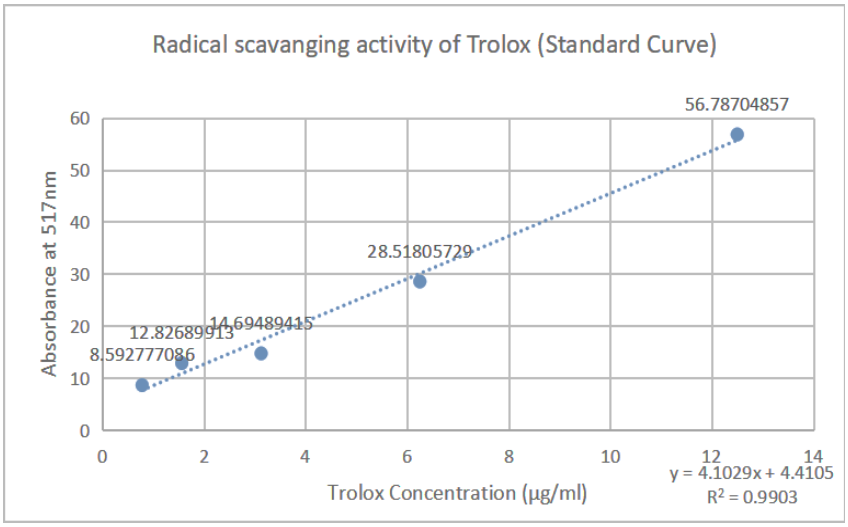

Figure 3: Trolox calibration curve used to determine antioxidant capacity of *Morinda citrifolia* extracts. The curve was prepared using known concentrations of Trolox (µM) as a standard, and fluorescence or absorbance values were measured to generate the linear relationship. This standard curve was used to calculate the ORAC values of leaf and fruit extracts, expressed as µmol Trolox equivalents per gram of sample (µmol TrE/g). All measurements were performed under the same experimental conditions as the sample assays.

Table 2 shows the ORAC value of *M. citrifolia* leaves and fruit extract.

Table 2: ORAC value of *M. citrifolia* leaves and fruit extract

Sample	AUC sample	AUC blank	Net AUC sample	AUC Trolox	net AUC Trolox	ORAC value	SD	Average
Leave extract	5.79	1.46	4.33	2.05	0.59	55.04	15.93	67.06
	5.86	1.66	4.2	2.03	0.37	85.13		
	5.87	1.64	4.23	2.16	0.52	61.01		
Fruit extract	4.51	1.46	3.05	2.05	0.59	38.77	9.72	48.85
	4.53	1.66	2.87	2.03	0.37	58.18		
	5.08	1.64	3.44	2.16	0.52	49.62		

Note: AUC refers to the area under the fluorescence decay curve measured during the ORAC assay. Net AUC values were calculated by subtracting the AUC of the blank from the AUC of the sample. ORAC values were determined by comparing the net AUC of each sample with that of Trolox and are expressed as Trolox equivalents. Values represent the mean of triplicate measurements, and SD indicates standard deviation.

The ORAC assay showed that leaf extracts of *M. citrifolia* had higher antioxidant capacity (mean ORAC = 67.06 ± 15.93) compared to fruit extracts (mean ORAC = 48.85 ± 9.72), suggesting that leaves are richer in compounds capable of scavenging peroxyl radicals. Fruit extracts, while less potent, displayed more consistent measurements across replicates. No data points were excluded, and all assays were performed at 25°C using a calibrated FLUOstar Omega microplate reader. The observed difference between leaves and fruits may be attributed to higher phenolic content in leaves, consistent with previous studies.

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Total Phenolic Content

Table 3 shows the total phenol content of *M.citrifolia* leave and fruit extracts. The leave extract had the highest TPC value at the concentration of 0.125 mg/mL while fruit extract had the highest TPC value at the concentration of 0.5 mg/mL. Leaves extracts had a higher amount of total phenolics than fruit the extract. Figure 4 shows the standard Gallic acid curve and regression equation used to calculate total phenolic content of the extracts. The microplate observed during the assay is shown in Figure 5.

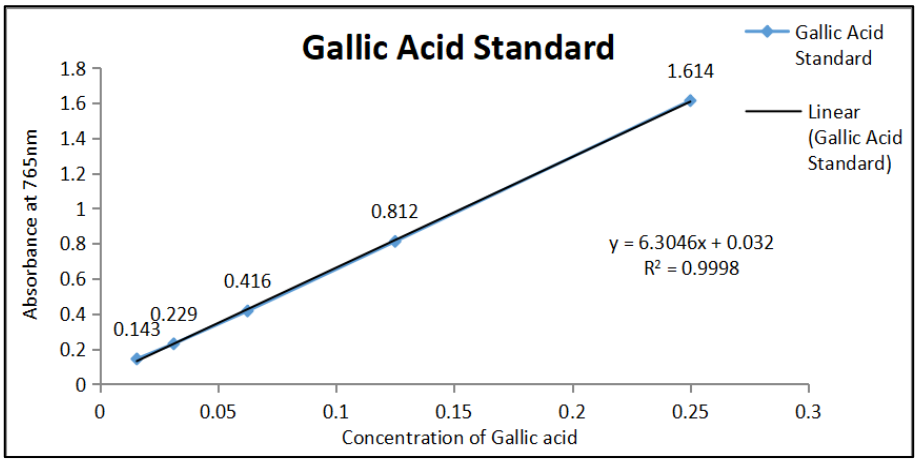

Figure 4: Gallic Acid Standard Curve

Table 3: Total phenol content of *M.citrifolia* leaf and fruit extracts growing in Sri Lanka 2022

Samples	Concentrations					Mean TPC value (GAE/g)
	1mg/mL	0.5mg/mL	0.25mg/mL	0.125mg/mL	0.0625mg/mL	
Leave extract	0.372	0.491	0.678	0.740	0.520	0.519 ± 0.09
Fruit extract	0.593	0.739	0.291	0.291	0.499	0.483± 1.8

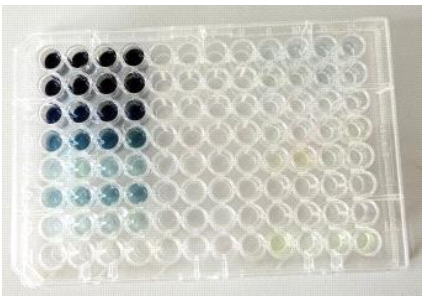

Figure 5: Observed microplate during the total phenolic content (TPC) assay of *Morinda citrifolia* extracts. The color change from light to dark blue indicates the presence of phenolic compounds in the samples. The intensity of the blue color correlates with the concentration of total phenolics, which was quantified spectrophotometrically at 765 nm using a gallic acid standard curve. All assays were performed at 25°C.

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Total Flavonoid Content

Flavonoid concentrations in *M. citrifolia* leaves and fruit extracts were measured quantitatively using aluminum chloride in a colorimetric technique. The data were generated from the calibration curve of quercetin, (y = 0.11.78x-0.0824+, R^2 = 0.9982) as shown in Figure 5. The results are represented in quercetin equivalents (QE) per gram dry extract weight (Table 4). The microplate observed during TFC assay is shown in Figure 6.

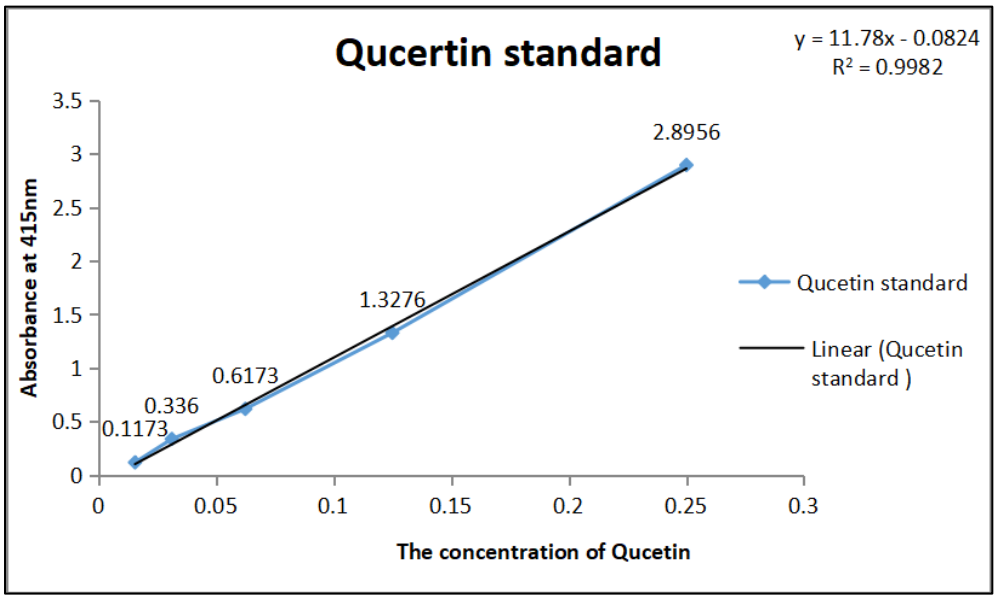

Figure 5: Quercetin standard calibration curve used to determine total flavonoid content (TFC) in *Morinda citrifolia* extracts. The curve was prepared using known concentrations of quercetin (0-100 µg/mL), and absorbance was measured at 415 nm after reaction with aluminum chloride. The resulting linear equation (y = 0.11.78x-0.0824+, R^2 = 0.9982) was used to calculate flavonoid concentrations in leaf and fruit extracts, expressed as quercetin equivalents (QE) per gram of dry extract. Data represent mean ± SD of three independent measurements (n = 3). All measurements were performed under identical experimental conditions as the sample assays.

Table 4: Mean TFC Values of Methanolic Extracts of *M. citrifolia* Leaves and Fruits

Samples	Concentrations					Mean TFC value (QE/g)
	1mg/mL	0.5mg /mL	0.25mg/mL	0.125mg/mL	0.0625mg/mL	
Leave extract	1.227	2.076	4.175	8.306	18.930	6.943 ± 1.22
Fruit extract	0.4714	0.826	1.349	2.386	3.896	1.79 ± 0.12

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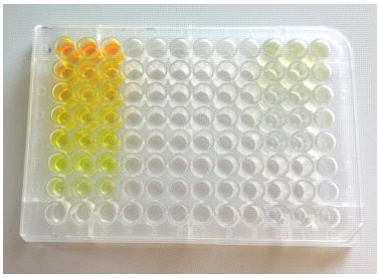

Figure 6: Observed microplate during the total flavonoid content (TFC) assay of *Morinda citrifolia* extracts. Wells 1-3 (left to right) represent leaf extract replicates. Blank controls are included in the bottom row. The yellow coloration produced upon reaction with aluminum chloride indicates the presence of flavonoids, and the intensity of the color correlates with flavonoid concentration. Flavonoid concentrations were quantified spectrophotometrically at 415 nm using a quercetin standard curve as shown in Figure 5 and expressed as quercetin equivalents (QE) per gram of dry extract. Data represent mean ± SD of three independent measurements (n = 3). Assays were performed at 25°C under identical experimental conditions.

4.0 Discussion

Sri Lanka, located in the tropics, contains diverse plant species that have been used for centuries as herbal medicines for the prevention of disease. This traditional medicinal knowledge highlights the relevance of studying native plants, such as *Morinda citrifolia*, for their potential antioxidant properties. While *M. citrifolia* has been used for various ailments globally, scientific data on its leaves and fruits grown in Sri Lanka remain limited.

Oxidative stress, resulting from the accumulation of free radicals, is implicated in numerous diseases, including cardiovascular disorders, cancer, and inflammation. Plant-derived antioxidants can mitigate these effects by scavenging free radicals, making the study of Noni's antioxidant potential particularly relevant (Akar et al., 2017). *Morinda citrifolia Linn* is a member of the Rubiaceae family. This plant is known as Indian Mulberry or Nuna in India, whereas it is known as Ahu in Sri Lanka. *M. citrifolia* is a tiny evergreen tree that grows in open coastal locations at sea level and forest areas up to around 1300 feet above sea level (Samarasiri et al., 2019). Previous studies indicate that Noni exhibits diverse bioactivities, including antioxidant, anti-inflammatory, and immunomodulatory effects. However, these studies primarily focus on fruits from other countries, highlighting the need for region-specific evaluation in Sri Lanka (Algenstaedt et al., 2018).

This study evaluated the antioxidant properties of *Morinda citrifolia* (Noni) leaves and fruits grown in Sri Lanka. The results indicate that leaves have higher antioxidant activity than fruits across all assays, consistent with their higher flavonoid and phenolic content. Flavonoids and polyphenolic compounds are major contributors to antioxidant activity due to their electron-donating and free radical-scavenging abilities (Saeed et al., 2012).

The DPPH survey showed that leaves achieved the highest radical scavenging activity of 56.58%, while fruits reached 44.23%. The IC_{50} values further highlight this difference, with leaves requiring a lower concentration (15.48 µg/mL) to inhibit 50% of radicals compared to fruits (28.9 µg/mL). These findings correlate with the measured flavonoid (leaves: 6.943 ± 1.22 mg QE/g; fruits: 1.79 ± 0.12 mg QE/g) and phenolic content (leaves: 0.519 ± 0.09 mg GAE/g; fruits: 0.483 ± 0.018 mg GAE/g), supporting the well-established relationship between phytochemical content and antioxidant activity (Konieczynski et al., 2016).

ORAC values provided complementary evidence of higher antioxidant potential in leaves (67.06 µM Trolox equivalents/g) compared to fruits (48.85 µM TrE/g). While these differences suggest that leaves are a richer source of antioxidants, no statistical analyses were performed; therefore, the significance of these differences cannot be confirmed. Future studies should include replicates and statistical comparisons to strengthen these findings.

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The higher antioxidant activity observed in leaves may be explained by their greater exposure to environmental stressors, such as UV radiation, which often induces secondary metabolite production, including flavonoids and polyphenols. Fruits, on the other hand, may allocate resources primarily to growth and reproduction, resulting in lower concentrations of these compounds. This biochemical difference aligns with findings from other countries where *M cirtifolia* leaves consistently exhibit higher antioxidant potential than fruits (Shoeb et al., 2016; Samarasiri et al., 2019).

While *in vitro* assays like DPPH and ORAC are useful for screening antioxidant capacity, it is important to recognize that these results do not directly translate to in vivo health benefits. Factors such as bioavailability, metabolism, and interactions with other dietary compounds can influence the biological effect of antioxidants. Therefore, these findings should be interpreted as preliminary, and further in vivo studies are needed.

The results also have implications for the use of Noni in traditional medicine in Sri Lanka. Leaves, with their higher flavonoid and phenolic content, may provide stronger antioxidant effects when used in herbal preparations. This study contributes to documenting the biochemical diversity of Sri Lankan Noni, supporting its potential role in primary healthcare and highlighting the importance of conserving local biodiversity.

This study is limited by the absence of statistical analysis to determine whether the observed differences between leaf and fruit extracts are significant. Only total phenolic and flavonoid contents were measured, without identification or quantification of individual bioactive compounds. Extraction optimization and stability testing were not performed, which may affect the reproducibility and robustness of the results. While stability data were not collected, previous studies have highlighted the importance of storage and handling conditions in preserving antioxidant activity (Nguyen et al., 2020).

This study demonstrates that Sri Lankan *M. citrifolia* leaves exhibit higher *in vitro* antioxidant activity than fruits, likely due to higher flavonoid and phenolic content. These findings provide a foundation for future studies, including bioactive compound characterization, in vivo antioxidant evaluation, and exploration of potential therapeutic applications.

5.0 Conclusions

This study demonstrates that *Morinda citrifolia* leaves and fruits grown in Sri Lanka are sources of polyphenols and possess *in vitro* antioxidant activity. Based on IC_{50} values from the DPPH assay, leaves (IC_{50} = 15.48 µg/mL) showed higher antioxidant potential than fruits (IC_{50} = 28.90 µg/mL). However, as no statistical tests were performed, the results should be interpreted as a relative indication of antioxidant capacity between leaves and fruits rather than absolute “high” activity.

Further studies are recommended to isolate and identify bioactive compounds using advanced analytical techniques such as column chromatography, fractionation, and mass spectrometry. These findings provide a foundation for future research on the phytochemical composition and potential health applications of Sri Lankan Noni, while emphasizing the need for caution when extrapolating in vitro results to therapeutic outcomes.

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