Specialty Journal of Pharmacognosy, Phytochemistry, and Biotechnology
ISSN: 3062-441X
2021, Volume 1, Page No: 7-10

Available online at: www.galaxypub.co/page/journals

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Evaluation of Phenolic Content and Antioxidant Potential in Edible Plant Leaves from Southern Nigeria

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Received: 12 December 2020; **Revised:** 28 February 2021; **Accepted:** 03 March 2021

ABSTRACT

In recent times, there has been a growing interest in natural foods enriched with phenolic compounds and flavonoids due to their antioxidant properties. This study investigated the phenolic content of leaves from several plant species—*Vernonia amygdalina*, *Mangifera indica*, *Dennettia tripetala*, *Azadirachta indica*, *Citrus sinensis*, *Chromolaena odorata*, *Anacardium occidentale*, and *Telfairia occidentalis*—collected from southern Nigeria. Phenolic content was determined through absorbance readings at 750 nm using a spectrophotometer, with the Folin-Ciocalteu reagent facilitating the analysis. The findings highlighted that *Mangifera indica* contained the highest phenolic concentration of 31.49 mg/g gallic acid equivalent (GAE), demonstrating significant antioxidant potential. In contrast, the lowest concentration was observed in *Dennettia tripetala*, with a value of 3 mg/g GAE. These results suggest that edible leaves with elevated phenolic levels can serve as vital sources of natural antioxidants, which may help mitigate oxidative damage. Such plants hold potential for the development of nutraceuticals and therapeutic agents aimed at managing free radical-associated illnesses.

Keywords: Phenolic compounds, Antioxidants, Gallic acid equivalent, Oxidative stress

How to Cite This Article: Elefe RG. Evaluation of Phenolic Content and Antioxidant Potential in Edible Plant Leaves from Southern Nigeria. Spec J Pharmacogn Phytochem Biotechnol. 2021;1:7-10. https://doi.org/10.51847/DJTHLLW8sm

Introduction

Medicinal plants are known to produce various secondary metabolites, which play an essential role in pharmaceutical production [1, 2]. These include compounds such as phenols, flavonoids, saponins, tannins, alkaloids, and sterols, with their composition and concentration differing significantly between different plant parts [3, 4].

Phenolic and flavonoid compounds, characterized by aromatic rings with at least one hydroxyl group, are among the most important secondary metabolites found in plants [5, 6]. Their antioxidant potential is linked to their electron-donating ability, which allows them to combat oxidative stress [6]. Studies have highlighted the role of phenolic compounds in inhibiting free radicals, breaking down peroxides, deactivating metals, and scavenging oxygen, all of which contribute to reducing oxidative disease burden [6, 7].

Natural foods rich in phenolics and flavonoids have recently drawn significant interest within nutrition and food science due to their health benefits [6, 8]. Phenolics are particularly valued for their antioxidant properties, which not only support plant health but also benefit human well-being. Plants containing higher phenolic levels have shown strong antioxidant activity, often attributed to these compounds' redox properties [4, 9-11].

Plant-derived antioxidants neutralize harmful free radicals in the body, preventing their accumulation and mitigating damage associated with aging and pathological conditions [4]. This study focuses on analyzing the phenolic content and antioxidant potential of edible leaves from plants such as *Vernonia amygdalina*, *Mangifera indica*, *Dennettia tripetala*, *Azadirachta indica*, *Citrus sinensis*, *Chromolaena odorata*, *Anacardium occidentale*, and *Telfairia occidentalis*, all of which were collected from southern Nigeria.

Materials and Methods

Plant samples

The study utilized leaves from *Vernonia amygdalina*, *Mangifera indica*, *Dennettia tripetala*, *Azadirachta indica*, *Citrus sinensis*, *Chromolaena odorata*, *Anacardium occidentale*, and *Telfairia occidentalis*. The botanical and common names for these plants are provided in **Table 1**.

Table 1. Plants Botanical and Common Names

Botanical names	Common names
Vernonia amygdalina	Bitter leaf
Mangifera indica	Mango
Dennettia tripetala	Pepper fruit
Azadirachta indica	Neem (Dogoyaro)
Citrus sinensis	Orange
Chromolaena odorata	Awolowo
Anacardium occidentale	Cashew
Telfairia occidentalis	Pumpkin

Reagents

The reagents used in this study included methanol, gallic acid, distilled water, Folin-Ciocalteu reagent, and sodium carbonate (Na_2CO_3). All chemicals and solvents were of analytical-grade quality.

Sample collection

Fresh leaves from the selected plant species were collected in various locations within Esan West Local Government Area, Edo State, Nigeria. A botanist from the Department of Botany at the University of Nigeria, Nsukka, verified the identification of these samples.

Sample preparation

Five grams of leaves from each plant species were weighed and ground into a paste. Each paste was placed in a separate container with 100 ml of methanol added. The mixture was stirred thoroughly for even distribution and left to stand for 24 hours to enable proper extraction. The extracts were then filtered using filter paper and funnels. From the filtrate, 0.1 ml was transferred into two test tubes using a pipette. These test tubes were heated above boiling water to evaporate the methanol, leaving a concentrated extract in each test tube.

Preparation of reagents

Pre-prepared solutions of gallic acid and Folin-Ciocalteu reagent were used. A 7% sodium carbonate solution was prepared by dissolving 7 g of Na_2CO_3 in 100 ml of distilled water. Distilled water was also utilized for diluting the blank and control samples.

Gallic acid served as a standard to measure phenolic content, while the Folin-Ciocalteu reagent and Na_2CO_3 were employed to quantify total phenolics.

Analysis

Each plant extract was tested using eight test tubes. Two tubes contained the plant extract (X1 and X2), while six tubes served as blanks or controls. Different concentrations of gallic acid (1 mg/ml) were added to the blank test tubes in volumes of 0, 0.1, 0.2, 0.3, 0.4, and 0.5 ml, respectively. No gallic acid was added to the extract tubes.

All test tubes were brought to a total volume of 3.6 ml using distilled water. This dilution created varying concentrations of gallic acid for the control tubes, calculated as 0.0, 0.2, 0.4, 0.6, 0.8, and 1.0 mg/ml.

Subsequently, 0.4 ml of Folin-Ciocalteu reagent was added to each tube. After a 5-minute incubation period, 4 ml of 7% Na_2CO_3 was introduced into the tubes. The mixtures were left to stand for 90 minutes. Absorbance readings for each sample were recorded at 750 nm using a spectrophotometer (Shimadzu Double Beam UV-210A).

The phenolic content of the plant extracts was determined through duplicate tests, with results calculated using a gallic acid calibration curve.

Results and Discussion

The absorbance values for varying concentrations of gallic acid, along with the phenolic content of the plant samples, are displayed in **Tables 2 and 3**.

Table 2. Concentration of gallic acid after dilution and corresponding absorbance values

Test tube	Concentration (mg/ml)	Absorbance
1	0.0	0.000
2	0.2	0.284
3	0.4	0.494
4	0.6	0.715
5	0.8	0.962
6	1.0	1.138

Table 3. Total phenolic content in plant samples (mg/ml and mg/g)

Plant sample	X1	X2	Extract (mg/ml)	Sample (mg/g)
Mangifera indica	1.567	1.582	1.575	31.49
Vernonia amygdalina	0.145	0.967	0.556	11.12
Dennettia tripetala	0.160	0.140	0.150	3.0
Azadirachta indica	0.457	0.539	0.498	9.96
Citrus sinensis	0.40	0.427	0.414	8.27
Chromolaena odorata	0.525	0.500	0.513	10.25
Telfairia occidentalis	0.183	0.199	0.191	3.82

The total phenolic content (TPC) of the analyzed plant samples was determined using the Folin-Ciocalteu method, which measures phenolics based on their redox properties [12, 13]. Among the studied plants, *Mangifera indica* displayed the highest TPC, recording 31.49 mg/g gallic acid equivalent (GAE), signifying its strong antioxidant potential.

Vernonia amygdalina, *Chromolaena odorata*, and *Azadirachta indica* followed with values of 11.12, 10.25, and 9.96 mg/g GAE, respectively. Moderate phenolic levels were observed in *Citrus sinensis* (8.27 mg/g GAE), while *Telfairia occidentalis* (3.82 mg/g GAE) and *Dennettia tripetala* (3.0 mg/g GAE) showed the lowest concentrations among the plant samples. *Anacardium occidentale* was excluded from the analysis due to measurement constraints.

The observed trends in TPC align with findings in earlier studies. For instance, Johnson *et al*. reported a TPC of 14.9 mg/g for *Vernonia amygdalina*, 10.80 mg/g for *Azadirachta indica*, and between 20.80 mg/100 g to 107.29 mg/100 g for crude stem extracts [14-16]. Additionally, Rao *et al*. documented 242.2 mg/g TPC for *Chromolaena odorata* chloroform extracts [17].

The high TPC of *Mangifera indica* underscores its potential as a natural antioxidant source. This capability may be useful in mitigating oxidative damage, reducing the risk of diseases linked to free radicals, and delaying aging.

Conclusion

This study revealed that among the analyzed plants, *Mangifera indica* had the highest total phenolic content, with a concentration of 31.49 mg/g gallic acid equivalent (GAE), indicating its superior antioxidant potential. Other plants such as *Vernonia amygdalina*, *Chromolaena odorata*, and *Azadirachta indica* also demonstrated significant phenolic content, while *Dennettia tripetala* recorded the lowest.

The findings suggest that edible leaves with high phenolic concentrations, like those of *Mangifera indica*, can serve as valuable sources of natural antioxidants. Such plants have potential applications in nutraceuticals and therapeutic products for managing diseases associated with oxidative stress. Future research should focus on isolating specific antioxidant compounds from these plants and understanding their mechanisms of action, which could enhance their potential for clinical or industrial applications.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: None

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