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Phytochemical and Essential Oil Quantification of the Aerial Parts of *Commelina diffusa*

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ABSTRACT

There are numerous medicinal plants in Southern and Eastern Nigeria, which are widely exploited in the Nigerian traditional system of medicine for the treatment of countless of illnesses. These plants are very rich in bioactive source of drugs, modern medicines, nutraceuticals, food supplements, pharmaceutical intermediates, and chemical entities for synthetic drugs, which has not been characterized. *Commelina diffusa* is widely utilized in folklore medicine for the treatment of several bacterial infections. This paper focused on the phytochemical and essential quantification of the aerial parts of *Commelina diffusa*. Phytochemical and essential oil quantification were carried out using high performance liquid chromatography and gas chromatography. Analysis of the aerial parts of Commelina diffusa for phytochemicals revealed the presence of eleven flavonoids with a total 133.41 mg/100g, seven terpenoids (45.72 mg/100g), nine phenolic acids (199.76 mg/100g), seven cyanogenic glycoside (194.99 mg/100g), twelve glycosides (128.57 mg/100g), fourteen alkaloids (35.48 mg/100g), fourteen lignans (265.7 mg/100g), eighteen saponins (82.9 mg/100g), twelve anthocyanins (57.22 mg/100g), thirteen anthraquinones (168.66 mg/100g), thirteen sterols (45.67 mg/100g), and essential oils (100%). Our unearthing recommends *Commelina diffusa* is a magnificent birthplace for essential oils, terpenoids, saponins, alkaloids, anthraquinones, anthocyanins, phenolic acid, sterols, cyanogenic glycoside, glycosides, and flavonoids. This investigation personify and demonstrate the rudimentary identification for tactfulness or nomination of *Commelina diffusa* prospective source of novel therapies for the treatment of multitudinous diseases.

Keywords**:** High performance liquid chromatography, Gas chromatography, Commelina diffusa, phytochemicals, essential oils

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1. INTRODUCTION

In recent years, plant's aerial parts have emerged to elicit different medicament efficacies that have attracted great attention globally [1]. Medicinal plants have become crucial in modern therapeutics [2], folk medicine, pharmaceutical ingredients [3], nutraceuticals, food supplementation, and chemical constituents of synthetic drugs, due to the fact that they are naturally endowed with countless of thousands of bioactive compounds called phytochemicals and essential oils [4, 5]. Dietary phytochemical is one of the clinical chemopreventive measures of fighting against fast growing cells [6]. For instance, in experimental animal models, capsaicin has been demonstrated to yield chemopreventive potential, tumor suppression, radiosentization capacity, and anti-malignant effect [7-9].

Essential oils are organic molecules that represent volatile liquids garnered from various medicinal plants through steam purification [10]. Essential oils are products of aromatic materials or as combination of fragrant and odorless substances. These substances are principally of lipophilic and highly volatile secondary plant metabolites, mainly mono-sesquiterpenes, allyl and isoallyl phenols [11]. Medicinal plants are known to be endowed with different types of essential oil which possess other phytochemical constituents that are of immensely therapeutic application. For example, essential oil in medicinal plants are said to contain alkaloids, tannins, steroids, glycosides, resins, phenols, volatile oils, and flavonoids [12, 13]. Many varieties of essential oils have become very popular unaffected or genuine replacement to synthetic antioxidants used to ameliorate the adverse setbacks of synthetic antioxidants that pose toxic reverberations on clients/patients and afterwards results in the development of cancers of different types.

Commelina diffusa fall into the family of plant called Commelinaceae which have been subjected to several screening and evaluations due to the diverse therapeutic efficacies of the plant. *Commelina diffusa* is a medicinal plant found in tropical and subtropical areas worldwide and it is used in traditional system of medicine as a diuretic agent, blood coagulant, antidote and cardiovascular tonic to enhance heart electrocardiogram [14]. In Africa and America, the leaf, stem, and aerial parts *Commelina diffusa* used for the treatment of urinary/respiratory tract infections, diarrhea, hemorrhoids, enteritis, and eye deficits such as phthalmia, and conjunctivitis [15, 16], but complete characterization of the bioactive compounds present in the plant is still under study. For this reason, in order to bolster and improve client's health and bring into being food security, new and economical provenance of natural antioxidants are progressively obtainable. The study provides the quantitative phytochemical and essential oil constituents of *Commelina diffusa*

2. MATERIALS AND METHODS

2. 1. Materials

HPLC (1200 DAD System, Agilent Technology, Ericino, Califonia, USA), GC (Model 8610C-SRI), Soxhlet machine (S-1829, Soxhlet-Giant, USA), centrifuge, borosilicate glass flask, screw-capped test-tube, Stopperd flask, Whatzman filter paper1 (542 mm), Spectrophotometer (Spectrumlab 752 S) water bath (PURA 22 JULABO USA, Allenntown, PA18109), magnetic rod, round bottom flask, aqueous ammonia (NH_3), chloroform ($CHCl_3$), hydrochloric acid, hexane, sulphoric acid, petroleum ethers, potassium hydroxide(KOH), benzene, ethanol, methanol, deionized water, paraffin oil, nitrogen steam, potassium permanganate ($KMnO_4$), sodium hydroxide (NaOH), chromatography autosampler vials, phenolic acid standard and ethyl acetate, dichloromethane, disposable pipette tips (D-T USA), Vortex mixer (VM-USA), Polypropylene and microcentrifuge tubes.

2. 2. Harvesting and preparation of Plant Material

The aerial parts of *Commelina diffusa* were harvested from Toru-Orua community in Sagbama Local Government Area of Bayelsa State. The fresh aerial parts of *Commelina diffusa* were harvested, thoroughly washed using slow running tap water and were air dried under shade. The dried aerial parts were pulverized into coarse powder , which weighed 217g.

2. 3. Extraction of Flavonoids

The flavonoids constituents in the plant sample were extracted and characterized by adopting the method described by Alim *et al*. [17]. In this method and procedure, 30.5 g of the powdered sample was weighed and delivered into a Stopard flask and treated using 30.5 ml of ethanol until the powder was fully soaked. The content of flask was shook for one hourly, was kept aside and shook after twenty four (24) hours. This was repeated for three days and the mixture was filtered to form the extract. The extract was then collected and evaporated using nitrogen steam to form a concentrate weighing 0.5 g. Exactly, 1.5 g of the extract was then transferred into a 200 ml conical flask containing 80 ml of deionized water and boiled for 10 minutes. The flavonoid extract were obtained by pouring 80 ml of the boiling methanol in the ratio 70:300 v/v onto the material. The mixture was then was allowed to macerate for about four (4) hours and then filtered through filter (Whatman No.1). The filtrate was derivatized for volatility through gas chromatography analysis. The mixture was finally concentrated to 2 ml in Agilent through vial for gas chromatography.

2. 4. Extraction of Terpenoids

The terpenoid constituents in the plant sample were extracted and characterized based on Chemat *et al*. [18] modified by Wellington *et al*. [10]. In this modified method, the sub-terpenoid members were extracted and redistilled with chloroform at an inlet temperature of 150 °C. The terpenoids were removed with 10 ml of chloroform for fifteen (15) minutes. The mixture was then filtered and concentrated to 1 ml in vial for gas chromatography analysis and 1 µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 150 °C for the determination of the chromatograms of the different terpenoids present in the aerial parts of the plant.

2. 5. Extraction of Alkaloids

The alkaloid constituents in the aerial parts of the plant sample were extracted and quantified using the modified method and procedure presented by Rahman *et al*. [19]. In this modified method, 10.0 g of the pulverized plant sample was macerated in 30 ml of hexane for seven two (72) hours. The mixture was filtered and the residue was air-dried. The air-dried residues were treated with 10 % of aqueous NH3 which was macerated into trichloromethane ($CHCl_3$) for twenty four (24) hours. The mixture was filtered an evaporated at a temperature of 250 °C in a water bath. The resultant mixture was again treated with 5 % of aqueous 10 ml hydrochloric acid (HCl) while the aqueous phase was made alkaline with aqueous NH_3.

However, the mixture was extracted thrice with $CHCl_3$ while the extract was poured into the round bottom flask of the rotatory evaporator which properly arranged. The crude extract was then concentrated to 2 ml in the borosilicate vial for the gas chromatography analysis; 1.0 µl was injected into the injection port of the gas chromatograph at a temperature of 250 °C for the determination of the chromatograms of all the different alkaloids present in the plant expressed in mg/100 g.

2. 6. Extraction of Cyanogenic Glycosides

The cyanogenic glycoside constituents in the aerial parts of the plant sample were extracted and quantified based on Vitaglione *et al.* [20] method as modified by Wellington *et al.* (2022). In these methods and procedure, 1.0 g of the pulverized plant sample was soaked for two (2) hours with 10 ml of 50 % alcohol. The mixture was filtered and concentrated to 0.8 g. Exactly, 1 ml of redistilled hexane was added to the extract and further concentrated to 1 ml in vial for Gas chromatography analysis. More so, 1 µl of the extract was injected into the injection port of the Gas chromatography at a temperature of 250 °C for the determination of the chromatograms of the different cyanogenic glycoside present in the sample.

3. RESULTS

3. 1. Quantitative Flavonoid Contents in the Aerial Parts of *Commelina diffusa*

Table 1 shows the flavonoid contents of the aerial parts of Commelina diffusa. Quantitative analysis of the aerial parts of the plant for flavonoids showed the presence of eleven flavonoids namely: (-)-epigallocatechin, kaemferol, daidzin, baicalein, apigenin, abzelin, coumesterol, (+)-epigallocatechin, and rutin (Table 1). Acetylcholinesterase (AChE) is a key enzyme in the central nervous system and inhibition of it leads to increases of neural acetylcholine levels which is one of the therapies for symptomatic relief of mild to moderate Alzheimer's disease (Perry *et al.,* [21]. Hence the inhibition of cholinesterases is one of the central focus for drug development to combat. Meanwhile, several of flavonoids such as quercetin, rutin, kaempferol, 3-O-β-d-galactoside and macluraxanthone showed that quercetin and macluraxanthone possess a concentration-dependent inhibition ability against Aaetylcholinesterase (AChE). In this study, (+)-catechin was observed to be highest followed by quercetin, kaemferol, rutin, (-)-epigallocatechin, (+)-epigallocatechin, apigenin, coumesterol, abzelin, while the least was baicalein (Table 1). COX (made up of COX-1 and COX-2 isoforms) is an endogenous enzyme which catalyses the conversion of arachidonic acid into prostaglandins and thromboxanes [22]. COX-1 is a constitutive enzyme and is responsible for the supply of prostaglandins which maintain the integrity of the gastric mucosa and provide adequate vascular homeostasis whereas COX-2 is an inducible enzyme and is expressed only after an inflammatory stimulus [23]. Meanwhile, flavonoids like silbinin, galangin, scopoletin, hesperitin, genistein, daidzein, esculatin, taxifolin, naringenin and celecoxib have been evaluated to elicit COX-inhibitory activity [24].

The degree of the presence of rutin, daidzin, kaempferol, and quercetin noticed in the aerial parts of *Commelina diffusa* is suggestive that the aerial parts of the plant could be a potent source of medicaments that could used to relief mild to moderate Alzheimer's disease and gastrointestinal disorders , since they have been reported to possess inhibition ability against Aaetylcholinesterase and maintain the integrity of the gastric mucosa.

Table 1. Quantitative flavonoid contents of the aerial parts of *Commelina diffusa*

Flavonoids	Concentration (mg/100g)
(-)-epigallocatechin	14.37
Kaemferol	19.41
Daidzin	1.93
Quercetin	21.01
(+)-catechin	35.31
Baicalein	1.73
Apigenin	3.72
Abzelin	2.50
Coumesterol	3.10
(+)-epigallocatechin	13.28
Rutin	17.05
Total	133.41

3. 2. Quantitative Terpenoid Contents in the Aerial Parts of *Commelina diffusa*

Table 2. Quantitative terpenoid contents of the aerial parts of *Commelina diffusa*

Terpenoids	Concentration (mg/100g)
Bauerenol	3.41
Beta-amyrin	15.05
Ajugoside	1.73
Taraxerone	1.58
Euphorbioside-B	1.92
Ephaginol	1.94
Clovandiol	2.05
Total	45.73

Table 2 indicates the terpenoid contents in the aerial parts of *Commelina diffusa*. Quantitative analysis of the aerial parts of the plants revealed the presence of seven terpenoids in which Beta-amyrin was observed to be highest in concentration followed by bauerenol, clovanol, Ephaginol, euphorbioside-B, ajugoside, while the least was Taraxerone (Table 2). Terpenoids constitute the larges group of naturally occurring compounds and they form the major constituent of essential oils from plants. Many terpenoids elicit antiplasmodial, antiviral, anticancer, anti-inflammatory, antioxidant, antiseptic, and antidiabetic activities [25]. Bauerenol exhibited growth inhibitory and apoptosis inducing potential against HepG2 cancer cells [26]. β-amyrin is reported to elicit antitumor [27], anti-inflammatory [28], and hepatoprotective [29, 28] effects. The Beta-amyrin and bauerol contents observed in this study is suggestive that it aerial parts of the plant could serve as a source of herbal therapy against cancer, inflammatory disorders, and diabetes, since these two terpenoids have been reported in literature to yield these pharmacological efficacies. However, the Beta-amyrin, bauerenol, Ephaginol, and euphorbioside-B characterized from the aerial parts of *Commelina diffusa* (Table 2) are higher in concentrations than those quantified by Wellington *et al.* [4] in the aerial parts of *Euphorbia heterophylla.*

3. 3. Quantitative Phenolic acid Contents in the Aerial Parts of *Commelina diffusa*

Table 3 indicates the phenolic acid contents in the aerial parts of *Commelina diffusa*. Quantitative analysis of the aerial parts of the plants revealed the presence of nine in which chlorogenic acid was observed to be highest in concentration followed by cichoric acid, O-coumaric acid, salycicylic acid, 4-hydroxybenzoic acid, ferulic acid, vanillic acid, protacatechuic acid, while the least was sinapinic acid (Table 3). Phenolic acids are regarded as key class of dietary polyphenols, natural antioxidants, which yield numerous variety of functions including plant growth, development, and defense. Phenolic acids serve as precursors of other significant bioactive molecules regularly used for therapeutic, cosmetics, and food industries.

The tremendous dietary antioxidant nature of phenolic acids shield against growth in pathological conditions arise from oxidative stress [30]. Ferulic acid has been demonstrated to possesses divers physiological functions such as anti-inflammatory, antioxidant, antimicrobial activity, anticancer, and antidiabetic effect). It has been widely used in the pharmaceutical, food, and cosmetics industry [31]. Cichoric acid is reported to yield anti-inflammatory, antioxidant, and anti-aging properties, and against digestive system diseases [32]. Medicinal plants rich in ferulic and Cichoric acids could be said to be a good source of anti-inflammatory, antioxidant, antimicrobial, anticancer, and antidiabetic therapy. In this study, the concentration of ferulic and Cichoric acids in the aerial parts of *Commelina diffusa* were 17.71 mg/100g and 25.83 mg/100g respectively, hence the aerial parts of the plant could considered as a novel source of all the pharmacological efficacies mentioned above.

Deniz *et al.* [33] showed that chlorogenic acid could elicit strong immunomodulatory effects, which might represent a promising approach for inflammatory disease management, metabolites of chlorogenic acid are actively involved in inflammation and related disorders arising from dysregulation of NF-κB, inhibits the synthesis of other mediators, such as IL-1β, interferon-γ, monocyte chemotactic protein-1, and macrophage inflammatory protein-1α [34], produced protective potential in neurodegenerative inflammatory disease models, hence could serve as a viable treatment for Alzheimer’s disease or other degenerative diseases. Salicylic acid produced anti-inflammatory effects through suppression of transcription of genes for cyclooxygenase, which is not a consequence of direct inhibition of cyclooxygenase activity. Salicylic acid is capable of binding iron and this necessitates and yield antioxidative effect of salicylic acid because iron has an important function in the course of lipid peroxidation [35].

The chlorogenic and salicylic acids characterized in this study were 31.83 mg/100g and 25.66 mg/100g respectively, thus could be sources of herbal agents that could used for the management of Alzheimer's and neurodegenerative inflammatory diseases. O-Coumaric acid was demonstrated to elicit dose-dependent cytotoxic effect on fast growing cells and ameliorated the proliferation of cells in animal models [36] while protacatechuic acid has been indicated to yield anti-inflammatory, antihyperglycemic and antiapoptotic, and antiproliferativ activities, hence inhibit chemical carcinogenesis [37].

The chemotherapeutic drug called Adriamycin (ADM) is the mostly adopted drug in the treatment of clinical breast cancer. Meanwhile, strong defiance to ADM reduces its clinical potency.

Deregulation of histone deacetylase 6 (HDAC6) activity is connected to numerous diseases including cancer leading to accumulating interest for developing HDAC6 inhibitors. Xu-Na *et al.* [38] demonstrated how 4-Hydroxybenzoic acid enhances the sensitivity of MCF-7/ADM to ADM-induced apoptosis. 4-Hydroxybenzoic acid induces apoptosis in breast cancer cell lines. 4-Hydroxybenzoic acid induces cell cycle arrest in G2/M phase.

In this present investigation, the levels of O-Coumaric and 4-hydroxybenzoic acids in aerial parts of Commelina diffusa were 27.35 mg/100g and 21.17 mg/100g respectively, indicating that the plant could be a medium for designing and profiling new herbal medicament that could cause deregulation of histone deacetylase 6 (HDAC6) activity, induce apoptosis in breast cancer lines, and cause in G2/M phase.

Table 3. Quantitative phenolic acid contents of the aerial parts of *Commelina diffusa*

Phenolic acids	Concentration (mg/100 g)
Ferulic acid	17.11
Cichoric acid	31.83
Chlorogenic acid	39.02
Salycicylic acid	25.66
O-Coumaric acid	27.35
Protacatechuic acid	16.12
4-hydroxybenzoic acid	21.17
Sinapinic acid	5.24
Vanillic acid	16.26
Total	199.76

3. 4. Quantitative Cyanogenic Glycoside Contents in the Aerial Parts of *Commelina diffusa*

Table 4 presents the quantitative cyanogenic glycoside contents in the aerial parts of *Commelina diffusa*. Quantitative phytochemical characterization of the aerial parts of *Commelina diffusa* for cyanogenic glycoside contents revealed the presence seven cyanogenic glycosides, in which verbacoside was noticed to be highest in concentration followed by galliridoside, layandulifoside, amygdalin, O-rutoside, 7-chloro-6-Desoxy-Haraoagide while the least was taraxacoside (Table 4). Cyanogenic glycosides are water-soluble natural phytotoxins [39], that play critical role in the defense mechanism, regulation of the cell signaling and growth [40]. Amygdalin derived from apple seeds has been reported to possess the ability to stop the growth of two Gram-positive bacteria species including; *Staphylococcus aureus* and *Streptococcus pyogenes* as well as two Gram-negative species such as *Escherichia coli* and *Pseudomonas aeruginosa*.

The zone of activity inhibition was highlighted with increasing concentration of undiluted extract [41]. Nwankwo *et al*. [42] demonstrated that Citrus lanatus seed extract which possessed cyanogenic glycosides elicited antibacterial activity against *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Proteus mirabilis* and *Streptococcus pyogenes* taraxacoside, galliridoside, o-rutoside, verbacoside, 7-chloro-6-Desoxy-Haraoagide, and amygdalin produced anticancer, antimalarial [43], antibacterial [44], antifungal and antiparasitic, antiparasitic activities [45].

In this study, the cyanogenic glycosides such as verbacoside was 54.05 mg/100g, galliridoside (41.63 mg/100g), lavandulifoside (37.20 mg/100g), 7-chloro-6-Desoxy-Haraoagide (13.82 mg/100g), amygdalina (26.02 mg/100g), and taraxacoside (5.08 mg/100g).

The values of these cyanogenic glycosides present in the aerial parts of *Commelina diffusa* is indicative that the aerial parts of the plant could be a potent novel sources of therapies against antimicrobial activities, parasitization, malaria, and cancers of many types when exploited.

Table 4. Quantitative cyanogenic glycoside contents of the Aerial Parts of *Commelina diffusa*

Cyanogenic glycosides	Concentration (mg/100 g)
Taraxacoside	5.08
Galliridoside	41.63
O-Rutoside	16.19
Lavandulifoside	37.20
Verbacoside	54.05
7-chloro-6-Desoxy-Haraoagide	13.82
Amygdalin	26.02
Total	194.99

3. 5. Quantitative Glycoside Contents in the Aerial Parts of *Commelina diffusa*

Table 5 presents the quantitative glycoside contents in the aerial parts of *Commelina diffusa*. Quantitative phytochemical characterization of the aerial parts of *Commelina diffusa* for glycoside contents revealed the presence twelve glycosides in which linamarin was highest in concentration (28.52 mg/100g) followed by curburbitin (21.63 mg/100g), digoxin (19.38 mg/100g), salicin (16.03 mg/100g), arbutin (11.52 mg/100g), lotaustralin (7.29 mg/100g), artemetin (6.01 mg/100g), amygdalina (19.93 mg/100g), linamarin (3.82 mg/100g) while the least was ouabain (1.12 mg/100g) (Table 5). Park *et al.* [46], langenhan *et al.* [47], reported the anticancer activity of Ouabain, digoxin, digitoxin, digitoxigenin, and lotaustralin, glycosides, which has attracted lots of attention not only due to an increase of solubility and distribution in the body. These glycoside may possess and elicit marked cytotoxicity against human fast growing cell lines, chronic myelogenous leukemia and human gastric cancer cells with IC50 values of 0.026 and 0.027 μg/mL respectively if exploited.

Table 5. Quantitative glycoside contents of the aerial parts of *Commelina diffusa*

Glycosides	Concentration (mg/100 g)
Salicin	16.03
Curburbitin	21.63
Arbutin	11.52
Prunasin	5.61
Digoxin	19.38
Ouabain	1.12
Artemetin	6.01
Lotaustralin	7.29
Linamarin	28.52
Digitoxin	3.82
Amygdalina	4.38
Methyl Linamarin	3.26
Total	128.57

3. 6. Quantitative Alkaloid Contents in the Aerial Parts of *Commelina diffusa*

Table 6 presents the quantitative glycoside contents in the aerial parts of *Commelina diffusa*. Quantitative phytochemical characterization of the aerial parts of *Commelina diffusa* for alkaloid contents revealed the presence Fourteen alkaloid sub-members, wherein alpha

9-Octadecenamide was seen to be highest in concentration followed by allocryptopine, starchdrine, galloylquinic acid, sparteine, starchdrine, euphorbin-D, euphorbin-A, tannic acid, coptisine, euphorbin-E, 9-octadecenamide, nitidine, while the least was augustamine (Table 6).

Smith (2000) showed that alkaloids possess and yield strong biological effects on animal and human organisms in very small doses and are present in both food and drinks. While Beata *et al*. [48] said that alkaloids such as 9-Octadecenamide, tetrahydrocoptisine, and alpha allocryptopine serve as stimulant drugs and elicit anti-inflammatory, anticancer, analgesics, local anesthetic and pain relief, neuropharmacologic, antimicrobial, antifungal, and many other activities. The alpha 9-Octadecenamide, allocryptopine, starchdrine, galloylquinic acid, sparteine, starchdrine, euphorbin-D, euphorbin-A, tannic acid, coptisine, euphorbin-E, 9-octadecenamide, nitidine, and augustamine characterized in the aerial parts of *Commelina diffusa* is suggestive that the aerial parts of the plant could serve as a source of herbal based medicaments for the treatment of inflammatory, neurological, malarial, and fast growing cells of any part of the human body if exploited.

Table 6. Quantitative alkaloid contents of the aerial parts of *Commelina diffusa*

Alkaloids	Concentration (mg/100 g)
Euphorbin-D	1.92
Nitidine	0.94
Euphorbin-E	1.42
Tannic acid	1.75
Alpha allocryptopine	6.01
Euphorbin-A	1.82
9-Octadecenamide	6.13
Indicine-N-oxide	1.27
Augustamine	0.57
Sparteine	2.84
Coptisine	1.48
Galloylquinic acid	3.81
Starchdrine	4.26
Starchdrine	1.83
Total	35.48

3. 7. Quantitative Lignans Contents in the Aerial Parts of *Commelina diffusa*

Lignans are as a class of secondary metabolites, Gotten from the oxidative dimerization of two or more phenylpropanoid units, which are well-known to exhibit a range of potent biological activities [49]. Pereira *et al.* [50] showed that lignans from *Diphylleia cymosa* and *Podophyllum hexandrum* elicited antibacterial, anticholinesterasic, antioxidant, and cytotoxic activities. Szopa *et al.* [51] demonstrated that lignans isolated from *S. rubriflora* extract, yielded anti-inflammatory activity through inhibition of 15-lipooxygenase (15-LOX), phospholipases A2 (sPLA2), cyclooxygenase 1 and 2 (COX-1; COX-2) enzyme activities. lignans have also been reported to be endowed with the capacity to lower the risk of heart disease, menopausal symptoms, osteoporosis, and breast cancer and that dietary intake of lignan-rich foods could be a useful way to bolster the prevention of chronic illness, such as certain types of cancers and cardiovascular disease [49, 52]. Analysis of the aerial parts of *Commelina diffusa* for lignans contents indicated the presence of fourteen lignans such as galgravin (7.0351 mg/100g), pinoresinol (11.7351 mg/100g), matairesinol (21.7151 mg/100g), sakuranin (26.3751 mg/100g), retusin (11.6251 mg/100g), apigenin (29.0551mg/100g), lariciresinol (19.5251 mg/100g), seroisolariresinol (22.7351 mg/100g), epieudesmin (23.9151 mg/100g), dehydroabietic acid (1.8451 mg/100g), viridissimaol (41.0451 mg/100g), arctigenin (21.6351 mg/100g), diarctigenin (37.2651 mg/100g), and arctiin (27.1 mg/100g) (Table 7). Galgravin and pinoresinol, Isolated from medicinal plants caused suppression NF-κB and IL-6 activation in LPS-activated RAW 264.7 macrophages without causing significant cytotoxicity, in which proinflammatory molecules like TNF-α, IL-6, iNOS, and COX-2 were downregulated, implying its potential application in inflammation diseases [53, 54]. Matairesinol, sakuranin and apigenin, has been reported to induces mitochondrial dysfunction and exerts synergistic anticancer effects, cell cycle arrest, apoptosis, anti-inflammatory, and antioxidant function [55, 56]. The presence of these lignans in the aerial parts of *Commelina diffusa* is suggestive that the aerial parts of the plant could be a novel source of therapies against cancer, inflammatory disorders, and oxidative stress-induced diseases.

Table 7. Quantitative Lignan contents of the aerial parts of *Commelina diffusa*

Lignans	Concentration (mg/100g)
Galgravin	7.03
Pinoresinol	11.73
Matairesinol	21.71
Sakuranin	26.37
Retusin	11.62
Apigenin	29.05
Lariciresinol	19.52
Seroisolariresinol	22.73

Epieudesmin	23.91
Dehydroabietic acid	1.84
Viridissimaol	41.05
Arctigenin	21.63
Diarctigenin	37.26
Arctiin	27.51
Total	265.7

3. 8. Quantitative Saponin Contents of the Aerial Parts of *Commelina diffusa*

Saponins such as sapogenins reported in fenugreek include yamogenin, diosgenin, smilagenin, sarsasapogenin, tigogenin, neotigogenin, gitogenin, neogitogenin, yuccagenin, and saponaretin, characterized in the roots, stems, leaves, and aerial parts of diverse medicinal plants are reported to yield numerous medicament potential such as antimicrobial, hypocholesterolaemic, immune-stimulation, and anti-inflammatory efficacies [57-59]. In this study, analysis of the aerial parts of *Commelina diffusa* for saponins revealed the presence of eighteen saponins including hecogenin (3.04 mg/100g), sapogenin (1.94 mg/100g), hesperetin (3.39 mg/100g), conyzorgin (1.06 mg/100g), naringenin (14.50 mg/100g), rutinose (3.71 mg/100g), yanogenin (4.18 mg/100g), tokorogenin (1.83 mg/100g), narthogenin (1.73 mg/100g), tribuloin (0.48 mg/100g), tiggenin (13.62 mg/100g), tigogenin (17.03 mg/100g), medicagenin (1.40 mg/100g), hecogenin (2.41 mg/100g), diosgenin (5.02 mg/100g), sarsasapogenin (1.82 mg/100g), neotigogenin (5.01 mg/100g), and neochlorogenin (1.53 mg/100g) as shown in Table 8. The presence of these eighteen saponins in the aerial parts of *Commelina diffusa* points to it as a source of therapies against inflammatory disorders, hyperlipidemia, fungal infection, and immune suppression which is similar to the report of Wellington *et al*. [10] on the phytochemical and essential oil characterization of the aerial parts of *Leonurus cardiaca* (Motherworth).

Table 8. Quantitative saponin contents of the aerial parts of *Commelina diffusa*

Saponins	Concentration (mg/100g)
Hecogenin	3.04
Sapogenin	1.94
Hesperetin	3.39
Conyzorgin	1.06
Naringenin	14.50

Rutinose	3.71
Yanogenin	4.18
Tokorogenin	1.03
Narthogenin	1.73
Tribuloin	0.48
Tiggenin	13.62
Tigogenin	17.03
Medicagenin	1.40
Hecogenin	2.41
Diosgenin	5.02
Sarsasapogenin	1.82
Neotigogenin	5.01
Neochlorogenin	1.53
Total	82.9

3. 9. Quantitative Anthocyanin and Anthraquinone Contents of the Aerial parts of *Commelina diffusa*

Anthocyanins and anthraquinones are known for their been colored water-soluble pigments compounds which belong to the phenolic acid group and occurs as glycosylated pigments [60]. The multifarious colorations such as purple, red, and bluishness seen in most fruits, grapes, and vegetables are defined mainly by the presence of anthocyanins in those food substances [61]. The application of anthocyanin-based colorants in yogurts and some mixed fruit juice has gained popularity in recent times [62]. Meanwhile, some food industrial companies utilize synthetic dyes in their products. Huitrón-Reséndiz *et al.* [63] reported that acylated anthocyanins are adopted as food colorants in food manufacturing industries due to their high stability over nonacylated anthocyanins. For Huitrón-Reséndiz *et al.* [63], colored pigments are potent nutraceutical or pharmaceutical ingredients and anthocyanin is one of the recognized organic nutraceutical and it is traditionally used as a phytopharmaceutical, appetite stimulant, choleretic agent, and for treatment of many other diseases.

Twelve anthocyanins including p-hydroxybenzolated (peonidin-3-sphoroside (2.17 mg/100g), pelargonidin (1.72 mg/100g), cyanidin-3-glucoside (6.13 mg/100g), cyaniding (14.06 mg/100g), delphinidin (2.69 mg/100g), caffeolated (cyaniding-3-sophoroside-5-glucoside (2.81 mg/100g), malyvidin (12.04 mg/100g), p-hydroxybenzolated(petunidin-shoroside) (7.24 mg/100g), p-hydroxybenzolated (cyanidine-3-sophoroside (12.06 mg/100g), pelargonidin-3-glucoside (1.62 mg/100g), peonidin-3-sophoroside-5-glycoside (3.28

mg/100g), and petunidin (6.27 mg/100g) as presented in Table 9. While Thirteen antraquinones such as Soranjidiol (2.82 mg/100), Damnacanthol (12.42 mg/100g), 6-methoxyquinolin-1-oxide (43.18 mg/100g), 1-hydroxy-4-methyl (21.02 mg/100g), Heterophylline (27.81 mg/100g), 5, 8-dimethoxy-2, 3, 10(16.32 mg/100g), 9-dione and a steroid (31.03 mg/100g), Androst-5-ene-3 (1.93 mg/100g), 10a-tetrahydro-1H (2.71 mg/100g), 4aH-phenanthrene-4 (1.05 mg/100g), 6-methoxyquinolin-1-oxide (1.25 mg/100g), 2,6-dimethoxybenzoquinone (3.51 mg/100g), and 10a-tetrahydro-1H-phenanthrene-4 (2.61 mg/100g) (Table 10). The presence of these anthocyanins and anthrquinones in the aerial parts of *Commelina diffusa* is suggestive of the plant being an excellent natural source food colorants, phytopharmaceutical, and appetite stimulant.

Table 9. Quantitative anthocyanin contents of the aerial parts of *Commelina diffusa*

Anthocyanins	Concentration (mg/100g)
p-hydroxybenzolated (Peonidin-3-sphoroside	2.17
Pelargonidin	1.72
Cyanidin-3-glucoside	6.13
Cyanidin	14.06
Delphinidin	2.69
Caffeolated (cyaniding-3-sophoroside-5-glucoside	2.81
Malvidin	12.04
p-hydroxybenzolated(petunidin-shoroside)	7.24
p-hydroxybenzolated (cyanidine-3-sophoroside	12.06
Pelargonidin-3-glucoside	1.62
Peonidin-3-sophoroside-5-glycoside	3.28
Petunidin	6.27
Total	57.22

Table 10. Anthraquinone contents of the aerial parts of *Commelina diffusa*

Anthraquinones	Concentration (mg/100g)
Soranjidiol	3.82
Damnacanthol	12.42

6-methoxyquinolin-1-oxide	43.18
1-hydroxy-4-methyl	21.02
Heterophylline	27.81
5, 8-dimethoxy-2, 3, 10	16.32
9-dione and a steroid	31.03
Androst-5-ene-3	1.93
10a-tetrahydro-1H	2.71
4aH-phenanthrene-4	1.05
6-methoxyquinolin-1-oxide	1.25
2,6-dimethoxybenzoquinone	3.51
10a-tetrahydro-1H-phenanthrene-4	2.61
Total	168.66

3. 10. Quantitative Sterols Contents of the Aerial parts of *Commelina diffusa*

Sterols derived from medicinal plants have been demonstrated as one of the safest potential alternative methods in lowering blood cholesterol levels, particularly, they significantly reduce plasma total and LDL cholesterol [64]. Plant sterols are reported to produce inhibition of intestinal cholesterol absorption, enhances cholesterol acyltransferase activity, bile acid synthesis, oxidation and uptake of lipoproteins, stimulation of hepatic and lipoprotein lipase activities [64].

In this study, beta-sitosterol (2.71 mg/100g), savenasterol (5.71 mg/100g), brassicasterol (2.34 mg/100g), cholestanol (3.51 mg/100g), sitostanol (1.63 mg/100g), campesterol (1.93 mg/100g), cholesterol (3.07 mg/100g), gramisterol (1.04 mg/100g), sitosterol (6.02 mg/100g), spinesterol (2.18 mg/100g), ergosterol (4.27 mg/100g), schottenol (7.25 mg/100g), and stigmasterol (2.61 mg/100g) were characterized from the aerial parts of *Commelina diffusa* (Table 11).

Stigmasterol, Campesterol,and Gramisterol have been reported to elicit anticancer, anti-osteoarthritis, anti-inflammatory, anti-diabetic, immunomodulatory, antiparasitic, antifungal, antibacterial, antioxidant, and neuroprotective properties [65]. Brassicasterol which is a phytosterol In this work, was shown by Sherif *et al*. [66] to exerts a therapeutic utility in an in vitro setting against herpes simplex virus type 1 (HSV-1) and *Mycobacterium tuberculosis* (MTB) as well as a considerable inhibitory property against human angiotensin-converting enzyme (ACE) that plays a dynamic role in regulating blood pressure.

The sterol constituents quantified from the aerial parts of Commelina diffusa indicates that the aerial parts of the plant could be a source of novel drugs that could used for the treatment of high blood pressure, diabetic mellitus, bacterial infection, immunomodulatory diseases, and cancers.

Table 11. Quantitative sterol contents of the aerial parts of *Commelina diffusa*

Sterol	Concentration (mg/100g)
Beta-sitosterol	3.71
Savenasterol	5.11
Brassicasterol	2.34
Cholestanol	3.51
Sitostanol	1.63
Campesterol	1.93
Cholesterol	3.07
Gramisterol	1.04
Sitosterol	6.02
Spinesterol	2.18
Ergosterol	4.27
Schottenol	7.25
Stigmasterol	2.61
Total	45.67

3. 11. Quantitative Essential Oils Contents of the Aerial parts of *Commelina diffusa*

Essential oils (EOs) are very vital organic compounds that have potential applicability in the field of medicine, food, cosmetics, and the agriculture industry [67]. Essential oils represent vaporescent compounds with an infinitesimal molecular weight and biological activities produced in different flowers, buds, leaves, branches, stems, seeds, fruits, woods, and roots of medicinal plants [68]. Essential are known to yield antibacterial activities are strongly in connection to particular form present in the substrates [69]. Analysis of the aerial parts of *Commelina diffusa* for essential oil constituents revealed the presence of Thirty two (32) essential oil including; Beta-elemene, hexadecanoic acid, terpinen-4-ol, tetracosane, beta-bisabolene, hexadecanoic acid methylester, xylene (o,m,p), alpha, alpha-dimethyl-14-benzenedimeti, phytol, beta–caryophyllene, tetracosane, heptacosane, gama-cadinene, 13-octadecenal, ethyl cinnamate, dodecanoic acid, 2,6,10,15-tetramethylheptadecane, linalool, trans-decahyronaphthalene, B-cadinene, alpha pinene, alpha humulene, benzyl benzoate, ascaridole, fenchone, limonene, nerol, borneol, pregeijerene, trans-alpha-bergamotene, isoartemisia, and geranial (Table 12). Meanwhile, intraperitoneal administration of 16.40 mg/kg of β-elemene derived from the traditional Chinese medicine *Curcuma wenyujin* for 21 days was reported to relieved apared nerve injury (SNI)-induced mechanical allodynia as well as exerted antioxidative effects by increasing the levels of SOD and GSH-PX and decreasing the level of MDA [70]. Hexadecanoic acid, and Beta-caryophyllene were shown to elicit anti-inflammatory, cancerpreventive, hepatoprotective, antiarthritic, and anticoronary properties [71, 72] while De-Sen *et al*. [73] showed that β-bisabolene possessing essential oils produced antimicrobial and antioxidant activities in experimental animal models. Min *et al*. [74] reported that dodecanoic acid induced apoptotic cell death and inhibited the expression of diverse tumorigenic proteins and attenuated tumor growth as well as lung metastasis in the HCC mouse model. β-elemene, gama-cadinene, ethyl cinnamate, hexadecanoic acid, and beta-caryophyllene characterized in the aerial parts of *Commelina diffusa* is suggestive that the aerial parts of the plant is rich in essential oils and could serve as a herbal-based therapies for the treatment of cancers, arthritis, coronary heart failure, inflammatory disorders, and hepatic damage.

Table 12. Essential oil concentration of the aerial parts of *Commelina diffusa*

Essential Oil	Percentage (%)
Beta-elemene	0.05
Hexadecanoic acid	12.62
Terpinen-4-ol	0.04
Tetracosane	17.83
Beta bisabolene	2.00
Hexadecanoic acid methylester	16.06
Xylene (o,m,p)	1.41
Alpha, alpha-dimethyl-14-benzenedimeti	0.31
Phytol	1.04
Beta –caryophyllene	3.06
Tetracosane	6.01
Heptacosane	0.62
Gama-cadinene	0.04
13-Octadecenal	4.11
Ethyl cinnamate	0.91
Dodecanoic acid	5.01
2,6,10,15-tetramethylheptadecane	0.11

Linalool	0.71
Trans-decahyronaphthalene	0.63
Alpha pinene	2.00
Alpha humulene	6.51
Beta cardinene	1.93
Benzyl benzoate	1.04
Ascaridole	0.03
Fenchone	0.17
Limonene	3.07
Nerol	1.07
Borneol	0.15
Pregeijerene	3.14
Trans-alpha-bergamotene	5.29
Isoartemisia	1.06
Geranial	1.97

4. CONCLUSION

The healing agreeableness of medicinal plants bestowed in chemical structure that leads an ultimate physiological action on the human body. The unconditional prevalence of bio-organic ingredients of plants are alkaloids, tannins, flavonoids, and phenolic compounds. Our unearthing specify Commelina diffusa is an magnificent birthplace of phenolic acids, flavonoids, alkaloids, terpenoids, anthocyanins, saponins, anthraquinones, sterols, cyanogenic glycoside, glycosides, and essential oils. This investigation personify and demonstrate the rudimentary identification for tactfulness or nomination of *Commelina diffusa* prospective source of novel therapies for the treatment of multitudinous diseases.

Disclaimer

The products used for this study were commonly and preponderantly adopt products in our area of research and country. There is unreservedly no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any legal proceeding(s) but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by idiosyncratic endeavors of the authors.

Note

This study highlighted the effectiveness of "traditional medicine" which is an ancient tradition practiced in some parts of India. This ancient concept should be carefully investigated in the light of modern clinical science and can be adopted partially if considered appropriate.

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