

Identification and Quantification of Phytochemicals in Ethanol Leaf Extract of *Emilia praetermissa*

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/105101>

Original Research Article

Received: 18/06/2023

Accepted: 22/08/2023

Published: 07/09/2023

ABSTRACT

Emilia praetermissa, an erect annual medicinal plant from the family *Asteracea* used in treatment of different illnesses by the local populace was worked on, to determine the phytochemicals responsible for its therapeutic properties. The phytochemicals from the leaves was extracted using ethanol maceration method. The extract was subjected to phytochemical analysis using standard methods of phytochemical analysis which revealed the presence of alkaloids, flavonoids, terpenoids, tannins, saponins, phenol and oxalate. The quantitative confirmation of the phytochemical analysis result using Gas Chromatography Flame Ionization Detector (GC-FID) revealed the presence of these phytochemicals with their concentration: Ammodendrine (5.95%), Phytate (14.50%), Hydroxylupanine (6.74%) Sapogenin (15.65%) Tannin (2.55%), Cardiac glycoside (1.00%), Epihedrine (9.05%), Anthocyanin (9.17%), Flavones (7.97%), Flavonone (5.25%), Proanthocyanidin (5.71%), Cyanogenic glycoside (3.96%) and Narigenin (8.39%). The presence of these phytochemicals on the leaf extract of *Emilia praetermissa* proves the efficacy of this plant as acclaimed ethnomedically.

Keywords: *Emilia praetermissa*; phytochemicals; ethnomedicine; medicinal plant.

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1. INTRODUCTION

“A medicinal plant is any plant which in one or more of its organs contains substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs” [1]. “Our earliest human ancestors found plants to heal wounds, cure diseases, and ease troubled minds. People on all continents have long used hundreds, if not thousands, of indigenous plants, for treatment of various ailments dating back to prehistory. Knowledge about the healing properties or poisonous effects of plants, mineral salts, and herbs accumulated from these earliest times to provide health and predates all other medical treatment” [2]. “Medicinal plants have been used in healthcare since time immemorial, Plant resources have remained an integral part of human society throughout history. After filling the primary needs like food and shelter, man has sought for a suitable remedy among plants for curing various diseases and illness” [3].

Traditional medicine includes diverse health practices, approaches, knowledge and beliefs incorporating plants, animal and/or mineral based medicines, spiritual therapies, manual techniques and exercises applied singularly or in combination to maintain well-being as well as to treat, diagnose or prevent illness. The use of traditional medicine has expanded globally and gained popularity in the last few decades. Specifically, these practices have not only continued to be used for primary care of the poor in developing countries, but have also been used in other countries where conventional medicines are predominant in national health care system. “In the last decades traditional medicines has become popular in developing countries, partly due to long unsustainable economic situation in the countries. The high cost for drugs and increase in drug resistance to common diseases like malaria, bacterial infection and other sexually transmitted diseases has caused the therapeutic approach to alternative traditional medicine as an option for concerted search for new chemical entities” [4]. “Natural medicine is still in use in modern day Africa after hundreds of years of its existence without much reported cases of adverse effects [4].

Among such species or plant use for their beneficial medicinal effect is *Emilia Praetermissa* from the family of *Asteraceac*” [5]. “The plant is documented in ethnomedicine to possess medicinal benefits in treating diarrhoea, night blindness and sore throat , rashes, measles,

inflammatory diseases, fever, stomach tumor, malaria, asthma, liver diseases, eye inflammation, earache and chest pain. In China, the leaves are used for the treatment of dysentery and roundworm infestations, wounds and abscesses, influenza, burns and snake bites. The leaf paste in doses of one spoonful once a day at bed time for about 2-3 months is recommended to treat night blindness. The crushed leaves are used externally to treat breast abscesses among tribal women” [6,7]. “The leaves are rubbed on the forehead to relieve headache. The Africans consume the leaves as vegetable for its laxative property. The plant has been documented in the Nigerian folk medicine for the treatment of epilepsy in infants” [7]. “The use of plants for treating diseases is as old as the human species, popular observations on the use and efficacy of medicinal plant significantly contribute to the disclosure of their therapeutic properties. Medicinal plants have provided mankind a large variety of potent drugs to alleviate or eradicate infections and suffering from diseases in spite of advancement in synthetic drugs, some of the plant-derived drugs still retained their importance and relevance. The use of plant-based drugs all over world is increasing” [8].

2. MATERIALS AND METHODS

2.1 Plant Collection and Identification

Fresh leaf of *Emilia praetermissa* was harvested from uncultivated farm land located in Prefab Aladinma in Owerri Municipal Local Government Area of Imo State Nigeria and was identified by Professor F.N Mbagwu of the Department of Botany Imo State University, Owerri as *Emilia praetermissa* from the family of *Asteraceae*.



Fig. 1. *Emilia praetermissa* plants

2.2 Preparation of the Sample for Analysis

The harvested leaf of *Emilia praetermissa* was washed with water to remove sand and dirt, and then dried at room temperature for two weeks. The plant material after complete dryness was pulverized with new corona mechanical grinder 2013 model, weighed and stored in amber coloured Winchester bottle for analysis.

2.3 Ethanol Extract

300g of the pulverised sample was percolated with 500ml of redistilled ethanol, allowed to stand for 24 hours, filtered using sterile whatmann no 1 filter paper and used for phytochemical analysis using standard procedure by Harborne, to identify the constituents present in the plant [9].

2.4 Qualitative Phytochemical Analysis

Qualitative phytochemical analysis was carried out to identify the phytocompounds present in ethanol leaf extract of *Emilia praetermissa* using standard methods as shown below.

2.5 Test for Alkaloid

Preparation of Wagner's Reagent:

Wagner's Reagent: 1.3g of iodine crystals and 2.0g of KI were dissolved in 100ml volumetric flask made up to the mark with distilled water. Reddish brown colour on the addition of the reagent to the extract indicated the presence of alkaloid [9,10].

2.6 Test for Saponins

0.5g of dried plant powdered sample was extracted with 5ml of 50% aqueous methanol solution. The filtrate was transferred into a test tube and shake vigorously. Observation of persistent froth for 10 minutes was an indication of saponin presence [11].

2.7 Test for Tannin

"0.1g of plant material was measured in a test tube and 3ml of butanol-HCl reagent (95ml of n-butanol and 5ml of concentrated HCl) were added to it. The test tube was plugged with cotton and was heated on boiling water bath for

an hour. Appearance of pink colour indicated the presence of tannin" [11].

2.8 Test for Phenol

Ferric chloride test: "2ml of plant extract was measured in a test tube, 2ml of distilled water added followed by addition of 10% FeCl₃ solution. Bluish black colour indicates the presence of phenol" [11].

2.9 Test for Terpenoids (Salkowski test)

Sulphuric acid Test: 5ml of the crude extract was dissolved in 2ml of chloroform and 2ml of conc. H₂SO₄ was added carefully to form a layer, a reddish-brown coloration at the interphase was formed to show positive results for the presence of terpenoids P [12].

2.10 Test for Steroids

Sulphuric acid Test: To the plant extract 2ml of chloroform was added. 2ml of conc. H₂SO₄ was added by the sides of the test tube and red colour at the lower chloroform layer indicates the presence of steroids [12].

2.11 Test for Flavonoid

To 4ml of extract in a test tube, add 2ml of 50% methanol and warm. 1g of magnesium metal was added, followed by the addition of 5 to 6 drops of concentrated hydrochloric acid. Red coloration confirmed the presence of flavonoids [12].

3. RESULT AND DISCUSSION

The result of qualitative phytochemical analysis were recorded in the table below.

Table 1. Result of qualitative Phytochemical analysis of *Emilia Praetermissa* leaves

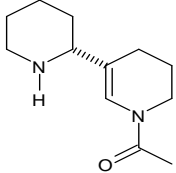
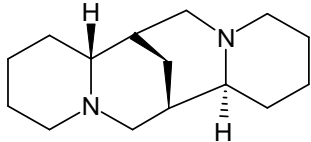
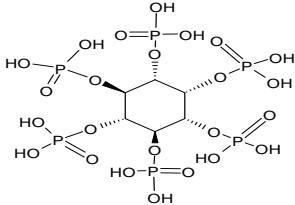
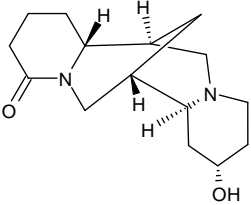
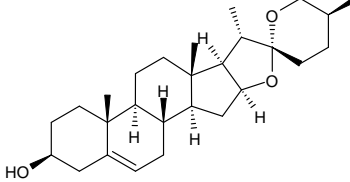
| Phytochemicals | Results |
|--------------------|---------|
| Phenol | + |
| Flavonoids | + |
| Saponin | + |
| Terpenoids | + |
| Alkaloids | + |
| Tannins | + |
| Steroids | + |
| Oxalate | + |
| <i>Present = +</i> | |

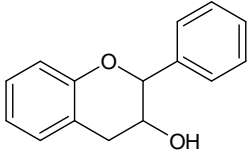
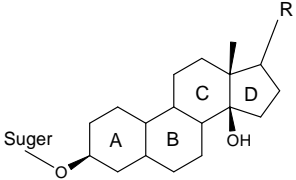
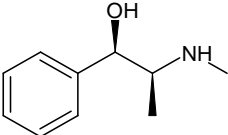
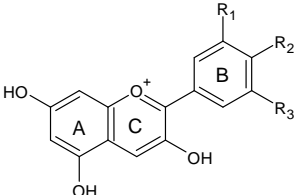
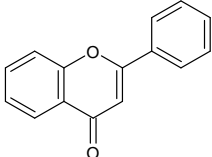
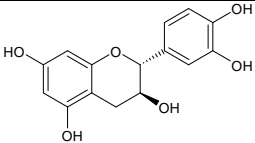
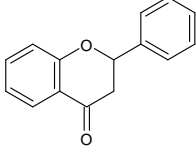
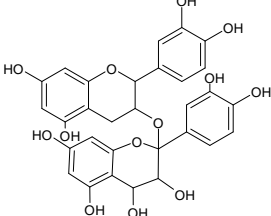
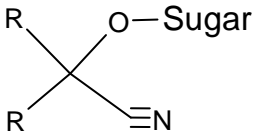
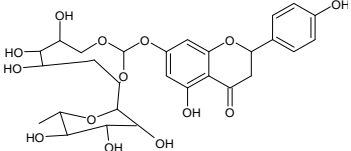
Phytochemical analysis result revealed the "presence of phenol, flavonoids, saponins,

terpenoids, alkaloids, tannins, steroid and oxalate which are known to exhibit medicinal as well as physiological activities. Alkaloids and flavonoids have been linked with antibacterial and antiviral activity, medicinally alkaloid are pharmacologically active compounds used as local anesthetic, stimulants, psychedelics, analgesics, antibacterials, anticancer drugs, antihypertensive agents, cholinomimetics, spasmolysis agents, vasodilators, antiarrhythmia, antiasthma therapeutics, antimalarials, etc” [13,14]. “These compounds are known to show curative activity against several diseases and therefore could explain the plants traditional use for the treatment of wide array of illnesses” [16]. Mamta,(2012) reported that “flavonoids are responsible for the antimicrobial activity associated with some ethnomedicinal plants. These flavanoids have also been reported to possess antioxidant and antiradical properties” [15,17]. “As antioxidants, it can prevent the

oxidative damage caused by the free radicals, interfere with the extraction process by reacting with free radicals, chelating catalytic metals and act as oxygen scavengers. Phenolic and flavonoids compound are widely distributed in plants and have been reported to exert multiple biological effects, including antioxidant, free radical scavenging abilities, anti-inflammatory, anticarcinogenic, etc” [18]. “The result also revealed the presence of terpenoid which was reported to have a broad range biological properties which include cancer chemo-preventive effects, anti tumour, antimicrobial, antifungal, antiviral, anti-hyperglycemic, anti-inflammatory, anti-parasitics activities and memory enhancers [19]. Antimicrobial activities of tannins are well documented, the growth of many fungi, yeasts, bacteria, and viruses were inhibited by tannins” [20,21]. “Even though their concentrations and classes differ in the different fractions of plants, tannins seem to have similar

Table 2. Result of Quantitative phytochemical Screening of ethanol leaf extract of *Emilia praetermissa*

| Phytochemicals | Structure | External Units | Percentage %Concentration |
|-----------------|---|----------------|---------------------------|
| Ammodendrine |  | 10.8252 ppm | 5.95 |
| Sparteine |  | 7.3667 ug/ml | 4.05 |
| Phytate |  | 26.3637 ug/ml | 14.50 |
| Hydroxylupanine |  | 12.2504 ppm | 6.74 |
| Sapogenin |  | 28.4607 ug/ml | 15.65 |

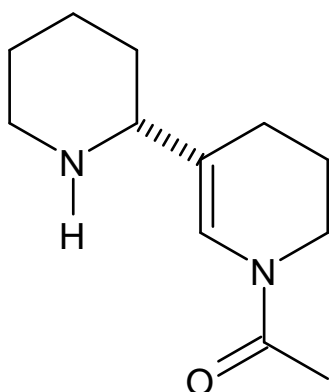
| Phytochemicals | Structure | External Units | Percentage %Concentration |
|----------------------|---|----------------|---------------------------|
| Tannin |  | 4.6310 ppm | 2.55 |
| Cardiac Glycoside |  | 1.8250 ug/ml | 1.00 |
| Ephedrine |  | 16.4623 ug/ml | 9.05 |
| Anthocyanin |  | 16.6731 ug/ml | 9.17 |
| Flavone |  | 14.5350 ug/ml | 7.97 |
| Catechin |  | 0.0000 ppm | 0 |
| Flavonones |  | 9.5471 ppm | 5.25 |
| Proanthocyanidin |  | 10.3853 ug/ml | 5.71 |
| Cyanogenic glycoside |  | 7.2091 ppm | 3.96 |
| Narigenin |  | 15.2624 ug/ml | 8.39 |

properties such as antioxidant, antimicrobial or predator-deterrent (i.e., against helminths or herbivores). It possesses anti-inflammatory, immunomodulatory, antimicrobial, antiviral, and antifungal properties" [22,23]. "Saponin are reported to have Antimicrobial and anti-inflammatory activity, significantly, certain saponins have been identified to drastically enhance the efficacy of many chemotherapeutic agents, including cisplatin, paclitaxel, doxorubicin, docetaxel, mitoxantrone, and cyclophosphamide. Moreover, saponins used in combination therapy enhance the sensitivity of chemoresistant tumor cells to clinically used chemotherapeutic agents" [24]. "Over 50% of all modern clinical drugs are of natural product origin and natural products plays an important role in drug development programme of the pharmaceutical industry. In the continuation of this strategy of new drug discovery, emphasis has been laid on the aerial parts of most plants for their antibacterial and anti-oxidant properties" [25]. These phytochemicals might be responsible for the efficacy of the plant.

Results of quantitative phytochemical screening of *Emilia praetermissa* ethanol leaf extract using Gas Chromatography Flame Ionization Detector (GC-FID) revealed the presence of the following compounds in different concentrations

3.1 Ammodendrine C₁₂H₂₀N₂O

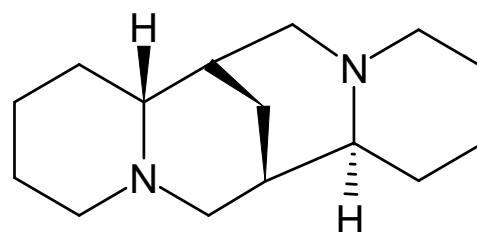
This is a piperidine alkaloid, Ammodendrine has a role as a plant metabolite and as a teratogenic agent, a N-acylpiperidine and a member of acetamides [26].



3.2 Sparteine C₁₅H₂₆N₂

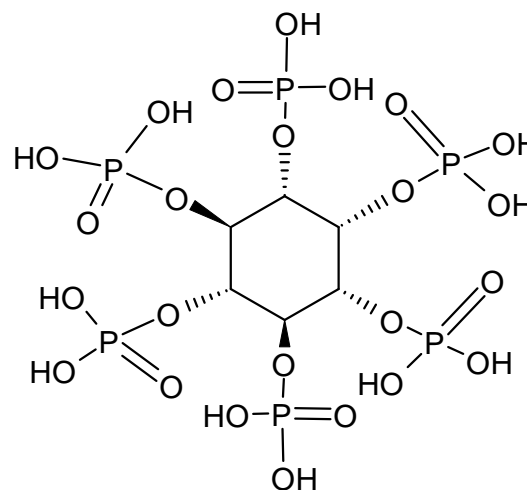
Sparteine is a lupin alkaloid, an antiarrhythmic agent and a sodium channel blocker. It is the predominant alkaloid in *Lupinus mutabilis* and is

thought to chelate the bivalent cations of calcium and magnesium [27]. It has been reported to reduce cardiac conductivity, stimulate uterine motility, circulatory collapse and respiratory arrest. World Health Organization have approved some drugs that contain sparteine like Abatacept, Acebutolol for the treatment of various illnesses [28].



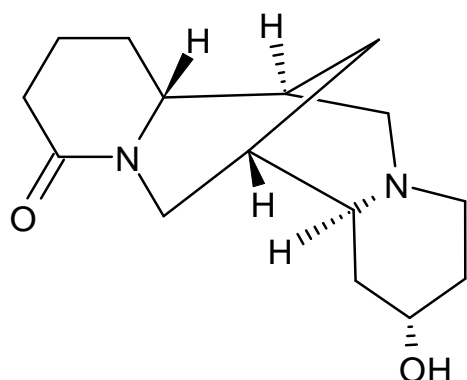
3.3 Phytate C₆H₁₈O₂₄P₆

"Phytate represents the major storage form of phosphorus and inositol in plants and has also been suggested as a storage of trace elements in plants. Phytate has antinutritional activity in human and monogastric animal diets through its strong chelation of Ca, Fe, and Zn. It has a positive nutritional role as an anti-oxidant, through the suppression of Fe-mediated OH formation by Fe, which is complexed by phytate and acts as an anticancer agent" [29].



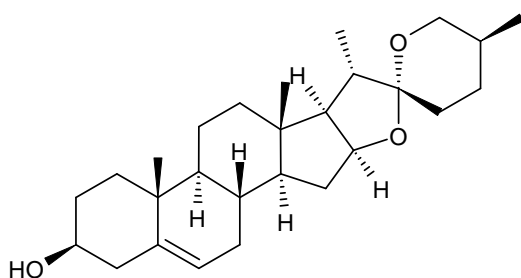
3.4 Hydroxylupanine C₁₅H₂₄N₂O₂

"Hydroxylupanine is a bioactive alkaloid that acts as a ganglionic blocker, it inhibits autonomic activity by interfering with neurotransmission within autonomic ganglia. Hydroxylupanine reduces sympathetic outflow to the heart thereby decreasing cardiac output by decreasing heart rate and conductivity" [30].



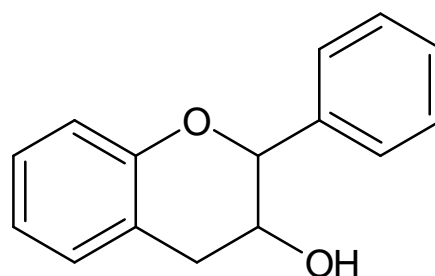
3.5 Sapogenin C₃₀H₅₀O₅

“Sapogenins are lipophilic triterpene derivatives which, similarly to phenol protects plants against microbes, fungi and other hostile organisms. It has several health benefits that is, antioxidant, antitumor and antidiabetic effect” [31]. Sapogenins are important mainly because of their steroid structure. They are precursors for hormones, like corticosteroids. According to findings, steroidal sapogenins are effective candidate for treating fungal and yeast infection in humans and animals. They are reported to be used in the treatment of some disorder like, cardiovascular, urological, respiratory, neurological and other disorder. They reduce the risk of heart disorder in humans who consume a diet rich in legume food [32].



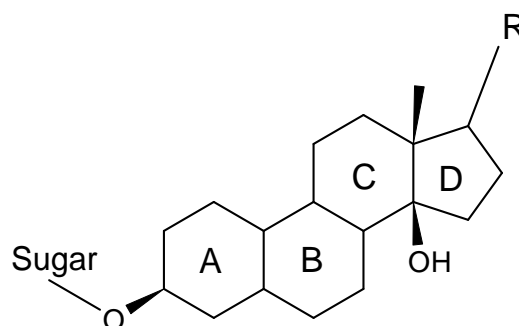
3.6 Tannin C₇₆H₅₂O₄₆

Medically tannins help prevent urinary tract infections in women by reducing the ability of *E.coli* bacteria from adhering to cells lining the urinary tract. Its anti-adhesive property may reduce the ability of *H. pylori*, to cause stomach ulcers. Because of its styptic and astringent properties, tannins have been used to treat tonsillitis, pharyngitis, haemorrhoids, and skin eruptions. It is used as an antidote for metallic, alkaloidal and glycosidic poisons, with which it forms insoluble precipitate [33].



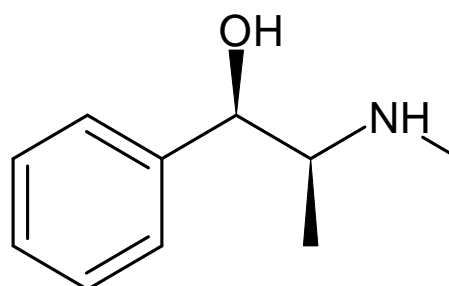
3.7 Cardiac Glycoside

Cardiac glycosides are steroids having the ability to exert specific powerful action on the cardiac muscles. They are chemical compounds responsible for the treatment of congestive heart failure and help to slow down heartbeats that are fast. Cardiac glycoside inhibits the influx of Na⁺ and outflow of K⁺ ATPase enzyme in the heart, and consequently increase the flow of myocardial contraction. They also perform antitumor activity. It is used to treat patients with atrial fibrillation and atrial flutter [34].

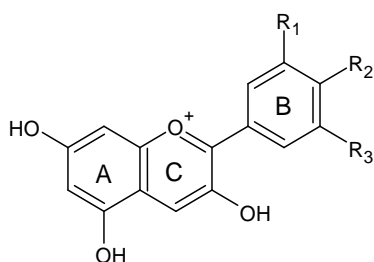


3.8 Epihedrine C₁₀H₁₅NO

Epihedrine is a central nervous system stimulant that is often used to prevent low blood pressure during anesthesia. They are used to treat mild hypertension and bradycardia associated with general or regional anesthesia. In patients with prostatic hypertrophy, epihedrine can produce urinary retention [35].

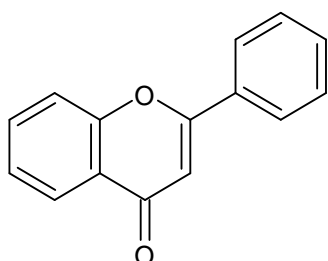


3.9 Anthocyanin C₁₅H₁₁O⁺



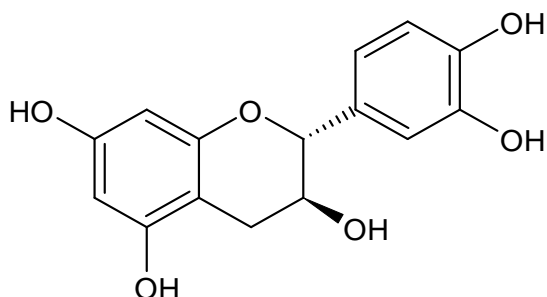
Anthocyanins are important classes of flavonoids that represent a large group of plant secondary metabolites. They play a role in reducing chronic and degenerative diseases. Anthocyanidin are responsible for the blue, purple, red and intermediate colours of many flowers, leaves, vegetables and fruits. It has been recorded to contain anticancer properties, show induce cell apoptosis thus eliminating damaged cells or tumour cells [36].

3.10 Flavones C₁₅H₁₀O₂



Flavones are classes of flavonoids that exhibit inhibitory activity against various human viruses. It can act as a natural pesticide in plants, providing protection against insects and fungi diseases. Flavone helps to resume cardiac functional parameters after ischemia and was associated with lower oxidative injury [37].

3.11 Catechin C₁₅H₁₄O₆

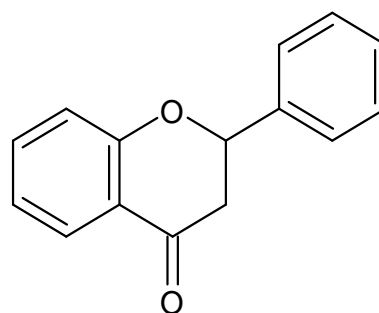


Catechin belongs to a group of polyphenol present in green tea called flavonoid which

ascribed a potent antioxidant activity, it prevent inflammation, reduced platelet clumping, help to reduce the risk of blood clots and heart attack. Its beneficial effect to human health is due to its antioxidant property [38].

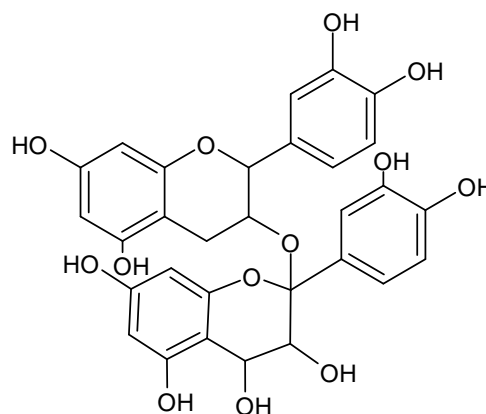
3.12 Flavonones C₁₅H₁₂O₂

FLavonones is an aromatic flavonoid that often occur in plants as glycosides, Flavonone is used as an antioxidant, cholesterol lowering and anti-carcinogenic agents. It can be is used as an anti-ulcer agent, antihypertensive and immune system modulator [39]. They have beneficial effect as antihypertensive, lipid-reducing, insulin-sensitizing, anti-oxidant and anti-inflammatory properties [40].



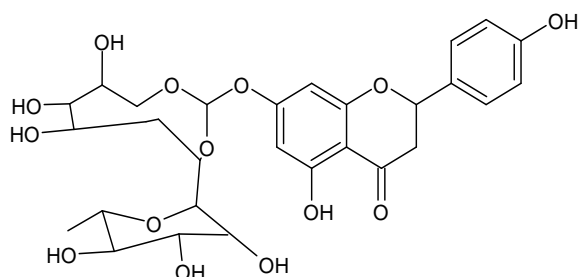
3.13 Proanthocyanidin C₃₁H₂₈O₁₂

They are chemical compound responsible for fruit and flower colour of many plants. They are group of compounds called polyphenol. They have strong antioxidant activity and many contribute to reduction in chronic diseases in human. They inhibit the development of pathogens, provide protection against UV radiation and oxidative stress. Proanthocyanidins contain antioxidative, vasodilatory, anticarcinogenic, antiallegic, anti-inflammatory, cardioprotective and estrogic activities [41].



3.14 Naringenin C₁₅H₁₂O₅

Naringenin is a chemical compound responsible for fruit and flowers of many plants, contributing to their red, blue or purple colours, they help to prevent cancer, they are in group of compounds called polyphenols. Naringenin has many beneficial effects on the human body such as aiding metabolism, acting as an antioxidant, anti-tumour, and anti-inflammatory, as well as preventing cardiovascular diseases, it has been observed in humans that the consumption of naringenin reduces the incidence of brain vascular diseases [42].



4. CONCLUSION

Phytochemical analysis of ethanol leaf extract of *Emilia pratermissa* revealed that it contains different alkaloids which include Ammodendrine, sparteine, hydroxylupanine and ephedrin, flavonoids present include phytate, tannins, anthocyanins, flavone, catechin, flavonones, proanthocyanidin and naringenin. Other phytochemicals present include saponin, cardiac glycoside and cyanogenic glycoside in different concentrations. The use of this plant in treatment of a wide range of illnesses can be attributed to the different phytochemicals present in it; thus, the use of *Emilia pratermissa* in treatment of cardiovascular diseases and as an anti-inflammatory agent is due to the presence of cardiac glycoside, naringenin, sparteine and catechin. The results of this study proved that the plant *Emilia pratermissa* leaf can be used in treatment of various illnesses which include inflammation, cough, rheumatism, fever, dysentery, wounds, tumour, heart-related issues and preventing miscarriage as acclaimed by the local populace ethnomedically may be due to the presence of these secondary metabolites.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

- Okigbo RN, Anuagasi CL, Amadi JE. Advances in selected medicinal and aromatic plants indigenous to Africa, *Journal of Medicinal Plant Research*, 2009; 3(2):86-95.
- Medicinal Botany, US Forest Service. United States Department of Agriculture, fs.usda.gov. Available: <https://www.fs.usda.gov/wildflowers>
- WHO. Traditional Medicine: Growing Needs and Potentials. World Health Organization, Geneva; 2002.
- Fokunang, C.N., Ndikum, V., and Kamsu, K. Traditional Medicine: Past, Present and Future Research and Development Prospects and Integration in the National Health System of Cameroon. Published online; 2011. DOI:10.4314/ajtcam.v8i3.65276
- Kiringe JW. Ecological and Anthropological Threats to Ethno-Medicinal Plant Resources and their Utilization in Maasai Communal Ranches in the Amboseli Region of Kenya: Ethnobotany Research and Application; 2005.
- Edu NE, Ubi GM, Ekpo PB, Ivon E. Efficacy and Phytochemical profiles of leaf extract of yellow tassel (*Emilia sonchifolia*) plant on selected diarrhoeagenic pathogens, *World Journal of Pharmaceutical and Medical Research* 2017;3(7):08-13.
- Ken F. Useful tropical plant database; 2014. Available: <https://tropical.theferm.info.2023-07-24>
- Bhat KP. Medicinal plant information databases. In: Non-Wood Forest Products. Medicinal Plants for Conservation and Health Care, Rome: Food and Agriculture Organization; 1995.
- Harborne JB. Phytochemical methods- a guide to modern techniques of plant analysis. Chapman and Hall, London. 1998;182-190.
- Eluyode OS, Alabi OS. Preliminary Phytochemical Screening of Crude Extract of Commiphora africana on Inflammation and Pain in Rodents. *Asian Journal of Medical Science*. 2007;2(3):811-84.
- Aishz H, Palwasha A, Hasnain N. Detection and Estimation of Alkaloids, Saponins and Tannins in Herbs of Quetta Baluchistan. *American-Eurasian Journal of*

- Agricultural and Environmental Science 2015;15(6):985-990.
12. Rajesh KS, Yadav RN. Qualitative Phytochemical Analysis and Estimation of Total Phenols and Flavonoids in leaf extract of *Sarcochlamys pulcherrima* wed. Global Journal of Bio-Science and Biotechnology. 2015;4(1):81-84.
 13. Heinrich M, Mah J, Amirkia V. Alkaloids Used as Medicines: Structural Phytochemistry Meets Biodiversity-An Update and Forward Look. Molecules. 2021;26(7):1836. DOI: 10.3390/molecules26071836 PMID: 33805869 PMCID: PMC8036335
 14. Kuete V. (J)Health Effects of Alkaloids from African Medicinal Plants, Toxicological Survey of African Medicinal Plants, Elsevier publisher. 2014;21(1):611-634.
 15. Ullah A, Munir S, Badshah SL, Khan N, Ghani L, Poulson BG, Emwas AH, Jaremko M. Important Flavonoids and Their Role as a Therapeutic Agent. Molecules. 2020;25(22):5243. DOI: 10.3390/molecules25225243 PMID: 33187049 PMCID: PMC7697716
 16. Mamta R. Natural antioxidant (Flavone Glycoside) from *Emilia sonchifolia* (L.) DC. and its potential activity. International Journal of Pharmacy and Pharmaceutical Science. 2012;4.
 17. Nakayoma J, Yamada M. Suppression of active oxygen induced cytotoxicity by flavanoids. Biochem. Pharmacol. 1995;45: 265-267.
 18. Miller AL Antioxidant flavanoids: structure, function and clinical usage. Alt. Med. Rev. 199;61:103.
 19. Deepak KD, Chandra KT, Anil KS, Vaibhav T. Revisiting the medicinal value of terpenes and terpenoids; 2022. DOI: 10.5772/intechopen.102612
 20. Koczurkiewicz P, Katarzyna K, Grabowska K, Piska K, Katarzyna R, Katarzyna W, Irma P, Galanty A, Michalik M, Pękala E. Saponins as chemosensitizing substances that improve effectiveness and selectivity of anticancer drug—Minireview of in vitro studies, 2019;33(9):2141-2151.
 21. Fraga-Corral M, Otero P, Cassani L, Echave J, Garcia-Oliveira P, Carpena M, Chamorro F, Lourenço-Lopes C, Prieto MA, Simal-Gandara J. Traditional Applications of Tannin Rich Extracts Supported by Scientific Data: Chemical Composition, Bioavailability and Bioaccessibility. Foods. 2021;10(2):251. DOI: 10.3390/foods10020251 PMID: 33530516 PMCID: PMC7912241
 22. Gouri KD. Traditional Uses, Phytochemical And Pharmacological Aspects Of *Emilia sonchifolia* (L.) DC, International Journal of Research in Ayurveda and Pharmacy; 2015. DOI: 10.7897/2277-4343.064103
 23. Wang J, Chen X, Chen Y, Qin F, Yang H. Pharmacological effects and mechanisms of tannic acid. Biomedicine and Pharmacotherapy. 2022;154:113561. Available: <https://www.sciencedirect.com/science/article/pii/S0753332222009507>
 24. Ahn K. "The worldwide trend of using botanical drugs and strategies for developing global drugs". BMB Reports. 2017;50(3):111–116. DOI:10.5483/BMBRep.2017.50.3.221. PMC 5422022 PMID 27998396
 25. Ghasmzadeh A, Jaafar HZ, Rhamat A. Antioxidant Activities, Total Phenolics and Flavonoids Content in Two varieties of Malaysia Young Ginger, Molecules, 2010;(15):4324-4333.
 26. Wikipedia. Ammodendrine; 2008. Available: www.wikipedia.org. Retrieved 19/05/2023.
 27. Alan RK, Christopher AR, Richard JK. Comprehensive Heterocyclic Chemistry III. Isoquinolizidine Alkaloids; Spartein. Science Direct; 2018. Available: <https://www.sciencedirect.com>.
 28. DrugBank. DrugBank; 2020. Available: <https://go.drugbank.com/drug>.
 29. Khan K, Peter RS. Wheat: Chemistry and Technology. A volume in American Associate of Cereal Chemists International. Fourth edition; 2009.
 30. Bimol. Hydroxylupaine; 2016. Available: www.biomol.com. Retrieval date, 20/07/2022.
 31. Luque de Castro MD, Castillo P. Innovative food processing technologies. Woodhead Publishing Series in Food Science, Technology and Nutrition. 2016;157-160.
 32. Charis MG. Innovations in Traditional Foods. Science Direct; 2019. www.sciencedirect.com.
 33. Melissa P, Michele M, Tikkanen A. Tannin (biochemistry). The editors of Encyclopaedia Britannica; 2021. Available: www.britannica.com

34. Antonella M, Nimmit VP. Cardiac Glycoside: what Are They, What are They Used for, How Do They Work, Side Effects and More; 2021. Available:www.osmosis.org.
35. Hugh CH, Telmage DE. Pharmacology and Physiology for Anaesthesia. Foundation and Clinical Application; 2019. www.sciencedirect.com.
36. Ying L, Yory TC, Schouten RE, Marcelis LF, Richard GF, Arnaud B. Anthocyanidin. Science Direct; 2014.
37. Gregory LH, Robin AR, Steven JS. Flavones; Food Sources, Bioavailability, Metabolism, and Bioactivity. Advances in Nutrition. 2017;8(3):423-435.
38. Catechins; the science behind why tea is good for you. Available:https:// www.senchateabar.com
39. Richa S. Top 4 Examples of Flavanones with Uses; 2021. Available:www.biologydiscussion.com
40. Aar RM, Tanzila IE, Mohd. Fajjanur RS, Asif S, Hossain A, Md. Mosfeq U, Nova R, Rahatul I, Uddin MR, Md. Furkanur RM. Natural flavonols: actions, mechanisms, and potential therapeutic utility for various diseases, Beni-Suef University Journal of Basic and Applied Sciences. 2023;12:Article number: 47.
41. Zuite AS. Proanthocyanidin: chemistry and biology from phenolic compounds to proanthocyanidins, reference module in chemistry, molecular sciences and chemical engineering; 2014.
42. Sayed MN, Ana SS. Non-vitamin and Non-mineral Nutritional Supplements; 2019. Available:www.sciencedirect.com. Retrieval Date: 31/04/2023.

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Peer-review history:
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