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Phytochemical profiles of plant species used in the management of erectile dysfunction in Bayelsa State, Nigeria

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Abstract

Erectile dysfunction (ED) remains a significant global health concern, necessitating the exploration of alternative therapeutic approaches, particularly from plants with documented ethnobotanical relevance. This study evaluates the phytochemical profiles of 19 plant species traditionally utilized for ED management in Bayelsa State, Nigeria. Qualitative phytochemical analysis on the sections of interest revealed a widespread presence of bioactive compounds, including flavonoids, alkaloids, steroids, terpenoids, and saponins, which are associated with key physiological processes such as testosterone modulation, circulatory enhancement, and libido stimulation. Predominantly, *A. melegueta, A. vogelii, C. lutea, E. guineensis, E. marginata, E. senegalensis,* and *G. mannii* exhibited the highest phytochemical diversity, suggesting broad pharmacological potential. Quantitative analysis further revealed substantial variations in bioactive compound concentrations, *with E. guineensis, C. prostrata, and A. melegueta* emerging as the most phytochemically rich species. High concentrations of alkaloids in *P. guineense* (10.6 ± 0.21 mg/g), flavonoids in *A. melegueta* (13.3 ± 0.42 mg/g), terpenoids in *C. prostrata* (10.8 ± 0.06 mg/g), and phenolic compounds in *E. senegalensis* (17.1 ± 0.01 mg/g) suggest potential mechanisms of action in improving erectile function. These results validate the therapeutic potential of the plant species, aligning with their documented ethnomedicinal applications

Keywords: Erectile Dysfunction; Plant species; Phytochemical Analysis; Bayelsa State

1. Introduction

The intricate relationship between humans and plants for healing has been a focal point of medicinal plant research, particularly in understanding the impact of plant resources on traditional remedies. Medicinal plant has played a pivotal role in shaping modern medicine, with numerous pharmaceutical drugs tracing their origins to traditional remedies. Grounded in natural treatments, spiritual healing, and local traditions, it explores the significance of plants in human health: both as medicinal resources and cultural symbols (Lar, 2006; Ihinmikaiye and Ajagunla, 2020). Its relevance extends to integrative medicine, where traditional healing practices are combined with modern medical approaches to enhance treatment outcomes. Traditionally, some plant species serve as indispensable resources in providing raw materials essential for well-being (Malan et al. 2015; Kayode et al., 2015). This dependency is especially evident in Africa, where indigenous knowledge of plant species and their applications remains integral to both traditional and modern healthcare systems. In Nigeria, plants are deeply embedded in the socio-cultural fabric, as indigenous populations possess extensive knowledge of their surrounding flora and rely on them for primary healthcare (Sani and Aliyu,2011; Obafemi, 2021).

The transmission of ethnomedicinal knowledge has historically been an oral tradition, passed down through generations by local priests, herbalists, and traditional healers. This accumulated wisdom has significantly contributed

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to the global pharmacopoeia, with many modern drugs originating from plant-based compounds (Suchita, 2019; Junsongduang *et al*., 2020). Despite variations in medicplant usage among ethnic groups, their knowledge systems have evolved through centuries of observation, experimentation, and adaptation to environmental conditions (Arwa et al., 2010). The World Health Organization estimates that approximately 3.5 billion people in developing countries rely on botanical medicine as a primary healthcare source, with nearly 80% of the global population depending on plant-derived treatments (Smith-Hall et al. 2012; Nasim et al., 2022). The therapeutic efficacy of medicinal plants is attributed to their bioactive phytochemical constituents, which exert specific physiological effects on the human body (Dipak et al., 2010). These phytochemicals form the basis for the development of conventional pharmaceuticals, playing a crucial role in disease prevention and health maintenance (Jayakumar, 2020; Chihomvu et al.2024).

Bayelsa State, located in southern Nigeria, is home to some of the earliest indigenous populations, who have historically depended on plant resources for both medicinal and economic purposes. Traditional medicine remains a vital component of healthcare within the state, with many plant species utilized in the treatment of numerous ailments (Ihinmikaiye and Ajagunla, 2020). One such condition frequently managed through ethnomedicinal practices is erectile dysfunction (ED), a prevalent male health issue with significant socio-economic implications. Ihinmikaiye et al. (2021) compiled a checklist of plant species used in ED management within Bayelsa State. However, there remains a critical gap in research regarding the phytochemical constituents responsible for their therapeutic efficacy. To address this, the present study aims to evaluate the bioactive compounds in these plants, thereby enhancing their potential for pharmaceutical applications.

2. Materials and methods

The knowledge of the plant species used in the management of erectile dysfunction (ED) in Bayelsa State, has been previously described by Ihinmikaiye et al. (2021).

2.1. Collection and Processing of the Plant Materials

Fresh samples of various plant section of interest: leaves, stems, seeds, roots, and flowers were collected from their natural habitats in the Otuoke and Emeyal communities, located in Ogbia Local Government Area (LGA). The collected specimens were subsequently processed and air-dried at Jacz Global Services Laboratory in Port Harcourt, Rivers State. The dried plant materials were then crushed using a mortar and further pulverized with a dry, clean automatic electric blender (Model MS-223, China). The resulting powders were stored in airtight containers and utilized for subsequent analyses.

2.2. Hot Water (Aqueous) Extraction

A total of 10 g of each powdered sample was suspended in 100 mL of distilled water at room temperature in a conical flask, sealed with cotton wool, and subjected to boiling. The mixture was filtered sequentially through cotton wool and Whatman No.1 filter paper into a beaker. The resulting filtrates were subsequently analysed for their phytochemical constituents.

2.3. Phytochemical Screening of the Extracts

2.3.1. Qualitative Phytochemical Analysis

The qualitative phytochemical analysis of the aqueous extracts was conducted using standard procedures as described by Harborne (1994), Sofowora (1993), Trease and Evans (1989), and Iweala and Okeke (2005). The following tests were carried out to detect the presence of key bioactive compounds:

2.3.2. Test for Glycosides

A 2mL aliquot of each extract was transferred into labelled test tubes. 2mL of Morris reagent was added as 2% solution of 3,5 dinitrosalicylic acid, and followed by the addition of 2mL of 4% NaOH. The formation of a brown ring indicated the presence of glycosides.

2.3.3. Test for Saponins

2 mL of each extract were placed in labelled test tubes and heated for 1min, followed by the addition of 1 mL of distilled water. The mixture was shaken vigorously, and the formation of a stable, persistent froth indicated the presence of saponins. Three drops of olive oil resulted in the emulsion of the froth persistence.

2.3.4. Test for Tannins

Three drops of 0.1% ferric chloride were added to 2mL of the extract diluted in 20 mL of distilled water, the pH reaction was maintained at 5.0 using acetate buffer. The appearance of a blue-black coloration confirmed the presence of tannins.

2.3.5. Test for Steroids

Two millilitres of acetic anhydride were added to 2 mL of each extract, followed by the careful addition of 2 mL of concentrated H_2SO_4, and subsequent shaking for uniformity. A colour change from violet to blue or green confirmed the presence of steroids.

2.3.6. Test for Alkaloids

One millilitre of each extract was mixed with 5 mL of 2% HCl and heated in a steam bath. The mixture was filtered, and 0.1 mL of the filtrate was treated with Wagner's reagent (iodine in potassium iodide solution). The formation of a reddish-brown precipitate indicated the presence of alkaloids.

2.3.7. Test for Terpenoid

2mL of each extract were mixed each with 2mL chloroform in test tubes, then 3mL concentrated sulfuric acid were carefully added down the side of the test tubes to form a layer. A reddish-brown interface indicates terpenoids.

2.3.8. Test for Phenols

The ferric chloride test was used. Few drops of 5% $FeCl_3$ solution were added to each extract in test tube and shaken. The development of a blue, green or purple coloration after 1minute, indicates the presence of phenols

2.3.9. Test for Flavonoids

1g of powdered sample was placed in labelled test tubes. 2% concentrated hydrochloric acid was added, and parafilm were used to prevent evaporation. After allowing the mixture to stand for 10 minutes, it was then filtered through filter paper, and 1 mL of 0.1 M NaOH was added to 2 mL of the filtrate. The development of a yellow coloration confirmed the presence of flavonoids.

2.4. Quantitative Phytochemical Analysis

2.4.1. Determination of saponins

The test extract was dissolved in 80% ethanol, and 2 mL of vanillin dissolved in ethanol was added and mixed thoroughly. Subsequently, 2 mL of 77% sulfuric acid was introduced, and the mixture was heated in a water bath at 60°C for 25 minutes. The absorbance of the resulting complex was measured at 540 nm using a reagent blank prepared without the extract for baseline correction. Quantification was achieved by comparing absorbance values against a diosgenin standard curve, and the results was expressed as diosgenin equivalents.

2.4.2. Alkaloid Determination Using Bromocresol Green Method

1mL of the test extract was mixed with 5 mL of pH 4.7 phosphate buffer and 5 mL of bromocresol green (BCG) solution. Prior to this, the extract was dissolved in 2 N HCl and filtered. The resulting solution was vigorously shaken with 4 mL of chloroform to extract the alkaloid–BCG complex into the organic layer. This extraction step was repeated three times, and the chloroform layers were pooled. The combined chloroform extract was diluted to a final volume of 10 mL with chloroform and analysed spectrophotometrically at 470 nm. A blank solution, prepared in the same manner but without the test extract, was used as the reference. For recovery validation, the extract was spiked with 10 µg/mL atropine, yielding a recovery rate of 98%. Alkaloid content was quantified using an atropine standard calibration curve and expressed as atropine equivalents.

2.4.3. Determination of Total phenolic Content

100mg of the extract was dissolved in 100mL of triple-distilled water. From this stock solution, 1 mL was taken and mixed with 0.5mL of 2 N Folin–Ciocalteu reagent, followed by the addition of 1.5 mL of 20% sodium carbonate solution. The total volume was adjusted to 8 mL with distilled water, and the mixture was thoroughly shaken. The reaction mixture was allowed to stand at room temperature for 2hrs to develop color. Absorbance was then measured at 765nm using a UV–Vis spectrophotometer. The total phenolic content was calculated from a gallic acid standard calibration curve and expressed as gallic acid equivalents (GAE).

2.4.4. Determination of total flavonoids

A 100µL aliquot of methanolic extract (10 mg/mL) was mixed with 100µL of 20% aluminium chloride solution and a drop of acetic acid. The mixture was then diluted to 5 mL with methanol and incubated at room temperature for 35min. to allow the formation of the flavonoid–aluminium complex. Absorbance was measured at 415nm using a spectrophotometer, with a blank prepared in the same manner but omitting aluminium chloride. Spike recovery tests were conducted at a 100% spiking level. Total flavonoid content was determined using a rutin standard calibration curve and expressed as rutin equivalents.

2.4.5. Determination of tannin Content

A 500mg portion of the *P. pinnata* sample was extracted by shaking with 50mL of distilled water for 1 hour at room temperature. The mixture was filtered and the filtrate was adjusted to a final vol. of 50 mL with distilled water. A 5 mL aliquot of this extract was then mixed with 2mL of 0.1 M ferric chloride (prepared in 0.1 N hydrochloric acid) and 2mL of 0.008M potassium ferrocyanide solution. The absorbance of the resulting blue-green complex was measured at 720nm within 10 min. of mixing. Tannin content was determined based on a suitable standard curve and expressed accordingly.

2.4.6. Determination of Glycoside

The method described by El-Olemy et al. (1994) was followed with slight modifications. A 2g portion of the powdered extract was soaked in 15mL of 70% ethanol for 2hrs at room temperature. The mixture was then filtered, and the filtrate was purified using lead acetate and sodium hydrogen phosphate solutions. After purification, Baljet's reagent was added to the extract, and the mixture was allowed to stand for 1hr at room temperature. Absorbance was measured at 495 nm using a UV-Vis spectrophotometer. A standard calibration curve was prepared using digoxin, covering the expected sample concentration range. Glycoside content was calculated from the curve and expressed as digoxin equivalents. Spike recovery tests were performed to validate accuracy, with recovery rates targeted at approximately 100%.

2.4.7. Determination of Terpenoid

The method of Indumathi et al. (2014) was used, with modifications to suit the present study. 5g of each powdered plant sample is weighed. Each sample is then macerated in 50mL of absolute ethanol in a beaker, to ensure the sample is fully submerged. The mixture is allowed to stand at room temperature for 24hrs. After this, the ethanol is evaporated using a rotary evaporator at 40°C to concentrate the extract. The concentrated extract is resuspended in 20 mL of distilled water to create a polar phase, which ensures proper phase separation during liquid-liquid extraction (LLE). The aqueous mixture is transferred to a 100mL separating funnel, 10mL of petroleum ether is added and the funnel shaken vigorously for 2min. It is then clamped and left undisturbed for 15min. The upper petroleum ether layer, which contains the terpenoids, is collected into a labelled beaker. The LLE process is repeated twice more with fresh petroleum ether to maximize terpenoid recovery. All the petroleum ether extracts are combined and evaporated using a rotary evaporator at 40°C until dryness. Subsequently the terpenoid content is quantified by weighing the residue using an analytical balance. The percentage of terpenoids is calculated as: Terpenoid % = weight of residue/weight of sample x 100.

2.4.8. Determination of Steroid Content

Steroid content was quantified using a colorimetric method adapted from Harborne (1973) and Madhu et al. (2016). Plant extracts were reacted sequentially with sulfuric acid, iron (III) chloride, and potassium hexacyanoferrate (III) under heating at 70 °C for 30 min. the resulting complex was measured spectrophotometrically at an absorbance of 780 nm. The intensity of the colour developed was directly proportional to the standard steroid solution, diosgenin concentration present in the sample and measurement was taken under in less than 10mins.

2.4.9. Data analysis

Colorimetric changes were recorded upon the addition of test reagents to the phytochemical extracts. Results were noted as either positive (+) or negative (-) based on the observed reactions. All experiments were performed in triplicate to ensure reproducibility. The data obtained were analysed using descriptive statistics Analysis of Variance (ANOVA) was employed to compare the mean values of the phytochemical constituents among the plant samples.

3. Results

Table 1 shows the 19 plant species utilized in the management of erectile dysfunction (ED) in Bayelsa State (Ihinmikaiye et al., 2021)

Table 1 Plant Species Used for Managing Erectile Dysfunction in Bayelsa State

Botanical name	1.	***Ageratum conyzoids L.***	***2.***	***Anthocleista vogelii Planch.***
Common/ local name		Goat weed / Oboye		Cabbage tree/ Osuo
Flora parts used		Inflorescence & leaves		Roots
Preparation/ Administration:		The inflorescence & alligator pepper (*Aframomum melegueta*) when chewed together, in parallel with local drink (gin) yields firm & stiff penile erection.		The roots infusion arouses sexual desire.
Botanical name	3.	*Carpolobia lutea* G. Don	4.	*Cyathula prostrata* (L.)
Common/ local name		ingolongolo		Oborikorigha/Pasture weed
Flora parts used		Roots		The leaves & inflorescence are squashed & mixed with native oil
Preparation/ Administration:		The roots infusion in gin & a spoon full of honey stimulates the penis & yield erection.		Treats, restores erection & cure venereal diseases
Botanical name:	5.	*Elaeis guineensis* Jacq.	6.	*Elytraria marginata* (Vahl)
Common/ local name		Palm tree / Lugu-tin		Elytraria / Kenibuotien,
Flora parts used		The base of the seedling		Inflorescence & leave
Preparation/ Administration:		Chew the base of the seedling regularly to treat ED, & for firm erection.		A decoction of the species in local gin cures ED when taken orally, and administer routinely on daily basis
Botanical name	7.	*Erythrina senagalensis* A.DC.	8.	*Glyphaea brevis* (Spreng.) Monach.
Common/ local names		Coral tree/Ugurizi		Masquerade stick/ Itolo
Flora parts used		Stem bark		Stem bark/twig
Preparation/ administration		The stem decoction in local gin arouse penis		Decoctions of the Stem/twig in local gin restores erection
Botanical name	9.	*Mallotus oppositifolius* (Geisel.) Mull. Arg.	10.	Microdesmis puberula (Hook. f. ex Planch)
Common/local names		Indian kamila/Furu-ipain		Microdesmis, Akpalata, Ingolongolo
Flora parts used		Roots		Fruits, bark & leaves
Preparation/ administration		A decoction of the roots in local gin serves as aphrodisiac.		Eat the fruits; A decoction of its bark, leaves, & the root of Carpolobia lutea in gin cures ED.
Botanical name	11.	*Sabicea calycina* (Benth)	12.	*Sacoglottis gabonensis* (Baill.) Urb.
Common/local names		Sabicea / Kalakumu		Bitter bark tree/Tala
Flora parts used		Stem bark		Stem bark

Preparation/ administration		Swallow the juice while using the tiny stem as chewing stick		Use the stem bark decoction & Piper guineense in local gin to stimulates penis
Botanical name	13.	*Sansevieria trifasciata* (Prain)	14.	*Struchium sparganophora* (L.) Kuntze
Common/local names		Snake plant		Boukiriologbo/Bush bitter leaf
Flora parts used		Leaves		leaves
Preparation/ administration		Leaves decoction & Piper guineense water decoction cures weak erection		Eat the sp. as leafy vegetable in soup to manage ED.
Botanical name	15.	*Spathandra blakeoides* (G. Don)	16.	*Urera rigida* (Benth.) Keay
Common/local names		Barakori-tin		Owei-ombi
Flora parts used		Entire part		leaves
Preparation/ administration		A decoction of the plant, seeds of *Piper guineense* & the root of *Garcina mannii* in gin cures ED.		A blend of the leaves and black pepper roots decoction treats ED

Source: Ihinmikaiye et al. (2021)

The results of the qualitative phytochemical analysis of the 19 plant species are presented in Table 2. The table reveals that most of the plant species contain multiple bioactive compounds with medicinal properties, indicating their therapeutic potential in managing erectile dysfunction (ED). Flavonoids were detected in nearly all species except *M. puberula and S. trifasciata*. Similarly, steroids and alkaloids were prevalent across most species, except for *S. blakeoides* (lacking steroids) and *C. prostrata* (lacking alkaloids).

The table also show that *A. melegueta, A. vogelii, C. lutea, E. guineensis, E. marginata, E. senegalensis*, and *G. mannii* exhibited the highest phytochemical diversity, suggesting a broader therapeutic potential. The widespread presence of flavonoids, alkaloids, and terpenoids further reinforces their role in vascular health. The predominance of alkaloids, flavonoids, and steroids across the tested plant species suggests their possibility in libido stimulation. Moreover, the presence of terpenoids and saponins supports their aphrodisiac properties, and the diverse range of phytochemicals detected in the plant species stresses their strong potential as herbal remedies for ED, either individually or in synergistic formulations.

Table 2 Qualitative Analysis of the Phytochemicals in the Plant Species Used for ED Management in Bayelsa

Botanical name	Glycoside	Saponin	Tannin	Steroids	Alkaloid	Terpenoid	Phenol	Flavonoid
A. conyzoids	-	-	-	+	+	+	-	+
A. melegueta	+	+	+	+	+	+	+	+
A. vogelii	+	+	+	+	+	+	+	+
C. lutea	+	+	+	+	+	+	+	+
C. prostrata	+	+	+	+	-	+	+	+
E. guineensis	+	+	+	+	+	+	+	+
E. marginata	+	+	+	+	+	+	+	+
E. senagalensis	+	+	+	+	+	+	+	+
G. mannii	+	+	+	+	+	+	+	+
G. brevis	+	+	-	+	+	-	+	+
M. puberula	+	+	-	+	+	+	+	-

M. oppositifolius	+	+	+	+	+	+	-	+
P. guineense	+	+	+	+	+	-	+	+
S. calycina	+	+	+	+	+	-	+	+
S. blakeoides	-	-	+	-	+	-	+	+
S. gabonensis	-	+	+	+	+	-	+	+
S. trifasciata	+	-	+	+	+	+	+	-
S. sparganophora	+	+	+	+	+	-	+	+
U. rigida	+	+	+	+	+	+	-	+
Key: + =Present, - = Absent								

The quantitative estimation of the phytochemical profiles of each plant species is presented in Table 2. The table reveals significant variations in bioactive compounds across the plants used for erectile dysfunction (ED), and offer insights into their potential mechanisms of action. Alkaloids are present in most of the plants, with the highest concentration observed in *P. guineense* (10.6±0.21mg/g), *E. guineensis* (9.9±0.10mg/g), and *S. trifasciata* (9.8±0.60mg/g). Flavonoids were most abundant in *A. melegueta* (13.3±0.42mg/g), *A. vogelii* (12.2±0.74mg/g), and *E. senegalensis* (12.1±0.48mg/g). Significant amounts of Terpenoids were found in *A. melegueta* (12.2±0.21mg/g), *C. prostrata* (10.8±0.06mg/g), and *M. puberula* (10.5±0.46 mg/g), while Saponins were most concentrated in *E. guineensis* (12.3 mg/g) and *M. puberula* (11.0 mg/g).

Table 3 Quantitative Proximate Analysis (mg/g) Hot Aqueous extraction of the plant species

Botanical name	**Glycosides**	**Saponins**	**Tannins**	**Steroids**	**Alkaloids**	**Terpenoids**	**Phenols**	**Flavonoids**
A. conyzoids	–	–	–	1.1±0.22	14.9±0.40	3.0±0.10	–	9.2±0.10
A. melegueta	6.6±0.52	7.2±0.77	1.6±0.52	2.0 ±0.10	2.2±0.37	12.2±0.21	1.2±0.14	13.3±0.42
A. vogelii	4.4±0.40	9.1±0.30	1.3±0.12	3.2±0.72	3.2±0.42	10.0±0.05	5.1±0.08	12.2±0.74
C. lutea	3.0±0.21	8.4±0.14	7.1±0.08	8.2±0.40	8.1±0.3	1.9±0.90	3.7±0.14	7.0±0.51
C. prostrata	10.3±0.70	9.0±0.04	7.0±0.30	8.3±0.20	–	10.8±0.06	9.8±0.01	11.7±0.22
E. guineensis	9.2±0.80	12.3±0.15	11.4±0.30	9.5±0.10	9.9±0.10	9.0±0.31	15.9±0.23	4.1±0.18
E. marginata	4.2±0.41	3.1±0.10	1.0±0.010	3.4±0.40	2.8±0.03	2.9±0.01	10.7±0.31	4.0±0.21
E.senagalensis	4.2±0.20	9.5±0.77	3.1±0.41	3.0±0.27	8.2±0.11	7.9±0.11	17.1±0.01	12.1±0.48
G. mannii	3.2±0.04	2.3±0.92	2.4±0.40	3.2±0.60	9.5±0.90	4.1±0.01	12.1±0.26	3.9±0.22
G. brevis	4.8±0.41	4.1±0.30	–	3.0±0.21	4.1±0.21	–	2.7±0.05	12.0±1.02
M. puberula	3.6±0.70	11.0±1.30	–	2.60±0.21	4.3±0.42	10.5±0.46	3.8±0.43	–
M. oppositifolius	3.2±0.80	0.4±0.01	4.0±0.22	3.7±0.50	5.5±0.07	5.4±0.05	–	3.1±0.60
P. guineense	5.05±1.21	9.9±1.50	3.8±0.40	5.5±0.91	10.6±0.21	–	6.2±1.4	6.3±0.12
S. calycina	4.7±0.40	4.1±0.51	6.1±0.10	4.6±0.50	5.7±0.45	–	10.4±0.10	2.3±0.48
S. blakeoides	–	–	4.7±0.92	–	1.1±0.21	–	7.4±0.32	5.5±0.13
S. gabonensis	–	4.1±0.70	6.3±0.30	6.2±030	7.0±0.01	–	4.8±0.43	4.8±0.32
S. trifasciata	7.1±0.10	–	5.1±0.71	3.0±0.22	9.8±0.60	5.9±0.61	2.3±0.01	–
S. sparganophora	2.3±0.02	4.0±090	9.2±0.10	1.6±0.30	5.2±0.41	–	12.1±0.73	11.0±0.04
U. rigida	3.2±0.51	9.8±0.90	9.3±0.71	1.2±0.72	2.9±0.24	2.7±0.02	–	2.4±0.31

"– "= Below detection limit (BDL), Each value is a mean of triplicate estimation ±SD

Phenolic compounds are highest in *E. senegalensis* (17.1±0.01 mg/g), *E. guineensis* (15.9±0.23mg/g), and *C. prostrata* (9.8±0.01mg/g). High tannin content is observed in *E. guineensis* (11.4±0.30mg/g), *U. rigida* (9.31±0.71mg/g), and *S. sparganophora* (9.2±0.10mg/g). Steroid was highest in *E. guineensis* (9.5±0.10mg/g) and *C. prostrata* (8.3±0.20mg/g). The table further shows that *E. guineensis, C. Prostrata* and *A. melegueta* were the richest sources of bioactive compounds. *E. guineensis* exhibited high levels of phenols, steroids, tannins, saponins, and alkaloids. *C. prostrata* was abundant in glycosides, flavonoids, phenols, tannins, and terpenoids; while *A. melegueta* contained high concentrations of flavonoids, terpenoids, saponins, and steroids. Suggesting that the species may be particularly effective in managing ED due to their diverse phytochemical composition.

4. Discussion

The phytochemical profiles of the studied plant species provide substantial evidence supporting their traditional use in managing erectile dysfunction (ED). The presence of alkaloids, flavonoids, saponins, terpenoids, steroids, and phenols suggests multiple therapeutic mechanisms, which is consistent with the previous findings of Adimoelja (2000); Aboua et al. (2014) and Wink, (2014). These compounds are likely contributors to the medicinal relevance of these species in ED treatment. Among the identified constituents, flavonoids were particularly abundant in several of the species, notably *A. melegueta*, *A. vogelii*, and *E. senegalense*. This is noteworthy given the established role of flavonoids in enhancing endothelial function through modulation of nitric oxide (NO) bioavailability, which facilitates vasodilation and improves penile blood flow, critical for erectile function (Martin and Touaibia, 2020; Sagır et al., 2025). The high levels of flavonoid observed in these species are consistent with the findings of Wahyuni et al. (2023), further substantiating their potential therapeutic relevance.

Similarly, significant concentrations of alkaloids were identified in *P. guineense*, *E. guineensis*, and *S. trifasciata*. Omojokun et al. (2019) posited that alkaloids may enhance erectile performance by increasing cyclic guanosine monophosphate (cGMP) levels and inhibiting phosphodiesterase-5 (PDE-5) activity, similar to those of conventional PDE-5 inhibitors used in ED therapy (Kunjiappan et al., 2023). The present of steroidal compounds in the plant species sections of interest, particularly in *E. guineensis* and *C. prostrata* may also contribute to sexual health. This is consistent with the previous studies of Eacker et al. (2008) and Nwidu et al. (2015) which emphasized the role of steroids in androgenic activity, especially testosterone biosynthesis, essential for libido and erectile function. The contribution of phytosterols to hormonal balance further supports the pharmacological importance of steroid-rich species in ED management (Olayinka et al., 2019). Saponins, found in several of the species notably *E. guineensis* and *M. puberula*, have been associated with enhanced libido and sexual behaviour, primarily through the stimulation of luteinizing hormone (LH) secretion and consequent testosterone production (Ajayi and Omodele, 2021). Chomini et al. (2020) opined that saponin-rich extracts of A. melegueta exhibit strong antioxidant and neuroprotective effects, which could further support sexual health. The coexistence of multiple bioactive compounds within individual plant species suggests potential synergistic interaction that could enhance therapeutic efficacy. This is consistent with the previous studies of Omojokun et al. (2019) and, Martin and Touaibia (2024) who posited that flavonoids and alkaloids act synergistically to regulate nitric oxide levels, support vascular tone, and protect penile tissue from oxidative stress. Likewise, Ikpe et al. (2020) averred that saponins and steroids in *A. vogelii* may enhance hormonal balance and boost libido.

5. Conclusion

While this study provides valuable phytochemical evidence in support of the plants' traditional use in ED management, further research is necessary. Specifically, *in vivo* and clinical investigations to elucidate pharmacokinetics, establish clinical efficacy and assess safety profiles. Such studies will be instrumental in translating these preliminary findings into safe and effective clinical applications for ED treatment.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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