South Asian Journal of Research in Microbiology

7(1): 1-11, 2020; Article no.SAJRM.58042
ISSN: 2582-1989

Evaluation of Phytochemical Contents, Proximate Nutritional Composition and Antimicrobial Activity of the Leaves and Rhizome Extracts of *Cyperus rotundus* Linn. in Uyo, Akwa Ibom State, Nigeria

Ikon, Grace Michael[1], Etang, Ubong Ekerenam[2*], Udoiko, Etima Micah[1] and Ohagim, Ifunanya Promise[3]

[1]Department of Microbiology, Faculty of Science, Obong University, Obong Ntak, Etim Ekpo Local Government Area, Akwa Ibom State, Nigeria.
[2]Department of Medical Microbiology, Faculty of Basic Clinical Sciences, University of Uyo, Uyo, Akwa Ibom State, Nigeria.
[3]Department of Environmental Microbiology, Faculty of Science, Federal University of Technology, Owerri, Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/SAJRM/2020/v7i130159
Editor(s):
(1) Dr. Chamari Hettiarachchi, University of Colombo, Sri Lanka.
Reviewers:
(1) Seema Surendran, India.
(2) Aziz Khan, University of Science and Technology, Bannu, Pakistan.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58042

Original Research Article

Received 07 April 2020
Accepted 12 June 2020
Published 25 June 2020

ABSTRACT

Background: The leaves and rhizome extracts of *Cyperus rotundus* Linn. popularly called "Nut grass" in many Nigerian communities have been extensively used in local food preparation and in treatment purposes.
Aim: This study aimed to evaluate the phytochemical contents, proximate nutritional composition and antimicrobial activity of the leaves and rhizome extracts of *C. rotundus.*
Methodology: The disease-free plant materials were collected from a farm in Uyo, Akwa Ibom State, Nigeria. Preparation of the plant material, methanolic and aqueous extracts; bacterial culture, isolation, microscopy and biochemical identification; phytochemical screening and

**Corresponding author: Email: meetmedicetang@yahoo.com;*

proximate nutritional analysis were done according to standard methods, while screening for antimicrobial activity was done by agar well diffusion technique.
Results: The preliminary phytochemical analysis of the plant extracts showed the presence of bioactive compounds at varying amounts such as glycosides, tannins, reducing sugars, alkaloids, flavonoids, polyphenols, terpenoids, saponins and phlobatannins. The proximate nutritional and elemental analysis of *C. rotundus* extracts showed high presence of B-carotene (164.3 ± 0.02), Vitamin A (109.25 ± 0.01) and carbohydrate (59.0 ± 0.01) with moderate content of lipid (24.25 ± 0.02) and moisture (9.10 ± 0.01) as well as contents of some mineral elements such as Ca, K and P occurring in the range literature values in mg per 100 g dry weight of the plant sample. The methanol and aqueous extracts of *C. rotundus* showed varying diameter of zones of inhibition on the test organism. The observable inhibitory effect of the plant extracts on the test organism was more pronounced with methanol extracts as indicated by the diameter of zones of inhibition in mm in the order of 22.0>14.0>13.0 for *P. mirabilis*, *E. coli* and *S. aureus*, respectively compared to the aqueous extract.
Conclusion: The results of this study have shown the antimicrobial, therapeutic and nutritional potential of the leaves and rhizome extracts of *C. rotundus*. It could possibly find application as a good alternative antibacterial agent, nutraceuticals and dietary supplements.

Keywords: Antimicrobial; Cyperus rotundus; methanol; minerals; phytochemicals.

1. INTRODUCTION

Cyperus rotundus (*C. rotundus*) Linn. is a sedge of the family Cyperaceae and order Cyperales. This plant which grows naturally in tropical, sub-tropical and temperate regions is native to Africa, Southern and Central Europe (North of France and Austria) and Southern Asia [1]. *C. rotundus* is a perennial plant that may reach a height of up to 140 cm (55 inches). As in other Cyperaceae, the leaves sprout in ranks of three from the base of the plant, around 5-20 cm (2-8 inches) long [2].

Cyperus rotundus Linn. is recognized with many local names and synonyms in many places of its existence. In Nigeria, it is known as Nutgrass, coco-grass, purple nut sedge, yellow nut or red nut sedge. In Iraq, it is known as Soad or Al Saad, while in other areas, it is known as Nagarmotha, Nutsedge and others. The rhizome of *C. rotundus* is cylindrical in shape, scaly creeping, bulbous at the base and appears reddish in colour from inside and blackish outside, with a characteristic odour [3,4].

The leaves and rhizome (root) extracts of *C. rotundus* have been extensively studied over the years by many authors [2,5-7] owing to their traditional, nutritional and medicinal use, especially in the treatment of dental caries and bowel disorders which dates back to 300-400AD [2].

Several pharmacologically active substances have been identified in *C. rotundus* that may scientifically explain the folk and alternative medicinal uses. Previous researchers have detected many phytochemical constituents such as flavonoids, alkaloids, cyperol, fatty oils, furochromones, glycerol, linolenic acid, myristic acid, nootkatone, starch, saponins, sesqui-terpenes, sitosterol, stearic acid, terpenoids, polyphenol and novel sesquiterpenoids in the rhizomes and tubers of *C. rotundus* [3,4]. These substances account for the therapeutic, pesticidal, fungicidal and insecticidal properties of the plant.

The widespread medicinal use of *C. rotundus* have been indicated in treatment of nausea and vomiting, dyspepsia, colic, flatulence, diarrhea, dysentery, intestinal parasites, fever, malaria, cough, bronchitis, renal and vesical calculi, urinary tenesmus, skin diseases, wounds, amenorrrhoea, dysmenorrhoea, deficient lactation, loss of memory, insects bites and food poisoning; while the aromatic oils from the plant are used for perfumes and splash [8]. In many parts of Nigeria, the leaves of *C. rotundus* are used as flavouring agents in food, the tubers and rhizomes are used as natural remedies to cure spasms, diarrhea, dysmenorrhoea and menstrual irregularities [9].

There is a growing concern on the health impact of synthetic antioxidants in protecting against free radicals from oxidative DNA damage. This has led to a renewed interest in the use of naturally occurring compounds in plants and herbs with antioxidant properties. Extracts from *C. rotundus* have been shown to possess promising antioxidant potential against free

radical induced oxidative damage [10]. Phytochemical compounds such as polyphenols and flavonoids which are widely distributed in *C. rotundus* have been used to treat many human diseases such as diabetes, cancers and coronary heart diseases. Moreover, flavonoids have been shown to exhibit antiviral, antimicrobial, antiplatelet and antitoxic activities [11].

Several preliminary investigations have shown that the leaves and rhizome extracts of *C. rotundus* possess nutritional constituents and grave antimicrobial activity against a number of microorganisms such as *Candida albicans*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Enterococcus faecalis* and *Salmonella enteritidis* at varying concentrations [12]. At present, a lot of studies have been carried out to unravel the pharmacologically active compounds, phytochemicals, antioxidants and nutritional compounds in the leaves and rhizome extracts of *C. rotundus* [7,12-14]. However, similar studies have not been replicated here in Nigeria to a larger extent, particularly in Uyo, Akwa Ibom State. Hence, there is a dearth of information on the phytochemical, nutritional and antimicrobial activity of *C. rotundus* in the region. Therefore, this study was carried out to investigate the phytochemical properties, nutritional composition and antimicrobial activity of *C. rotundus* collected from a farm in Uyo, Akwa Ibom State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out between March, 2019 and September, 2019 at the Microbiology Laboratory of Obong University, located at Etim Ekpo Local Government Area. Etim Ekpo, created from the former Abak division is one of the Annang-speaking areas with GPS coordinates 5°1'N 7°37'E and time zone UTC +1 (WAT). According to the National Population Commission of Nigeria (web) and the National Bureau Statistics (web), the population statistics of Etim Ekpo is 148, 800 (2016 population census). It is a town situated in Akwa Ibom State, South-South geopolitical zone of Nigeria.

2.2 Collection (Source) and Identification of Plant Material

The disease-free plant materials were collected from a farm in Uyo Akwa Ibom State, Nigeria. They were kept in a dry polythene bag to reduce decomposition and transported in this form to Calabar, where it was properly identified by the forestry department as *Cyperus rotundus* Linn.

2.3 Laboratory Preparation of Plant Materials

The leaves and rhizome (root) of *C. rotundus* were washed to remove sand and other foreign particles which may act as contaminants before they were dried in shade. The dried samples were then pulverized using electric blender to obtain a fine powder. The pulverized sample with characteristic dark green color was sieved (0.2mm) and stored in airtight containers until required for further studies.

2.4 Source of Test Bacteria and Method of Identification

Three bacterial isolates namely: *Staphylococcus aureus, Proteus mirabilis* and *Escherichia coli* obtained from Microbiology laboratory of Obong University were used for the study. Identity of the isolates was confirmed after sub-culturing microscopically by Gram's reaction and biochemically by catalase, oxidase, coagulase, citrate, indole, motility and sugar fermentation tests.

2.5 Preparation of Methanolic Plant Extract

Ethanolic extract of *C. rotundus* was prepared using 75% ethanol. Exactly 10 g of the powdered plant was weighed out into a sterile beaker container containing 100 ml of 75% ethanol, stirred, wrapped with aluminum foil and allowed to stay for 72 hours at room temperature (25°C). After 72 hours, it was filtered and the solvent was heated in a water bath to evaporate completely. The slurry left behind was then stored in McCartney bottles and kept at 4°C until required for use [15,16].

2.6 Preparation of Aqueous Plant Extract

5 g of powdered plant material was soaked in about 50 ml of sterile distilled water, stirred and left overnight. After 24 hours, the suspension was filtered using Whatman No.1 filter and the filtrate was heated in a water bath at 70°C to allow the solvent to evaporate to dryness to eliminate the water. The extract was labeled and stored in the refrigerator until when required for further analysis.

2.7 Preliminary Phytochemical Analysis

Phytochemical tests for the screening and identification of bioactive phytochemical constituents in the extracts of leaves and rhizomes of *C. rotundus* were carried out in two perspectives viz: Qualitative and Quantitative analyses.

2.8 Qualitative Analysis

The extracts were tested for the presence of the following bioactive compounds namely; glycosides, saponins, alkaloids, flavonoids, phenols, phlobatannins, tannins, reducing sugars, anthraquinones and terpenoids using standard methods.

2.8.1 Test for alkaloids (Dragendorff's test)

About 2 mL of the extract was treated with 3-5 drops of Dragendorff's reagent and observed for the formation of an orange precipitate to detect the presence of alkaloids.

2.8.2 Test for saponins (Frothing test)

Two milliliter of (Aqueous and ethanolic separately) extracts was shaken vigorously and observed for a stable persistent froth. The frothing was mixed with few drops of olive oil and shaken vigorously after which it was observed for the formation of an emulsion.

2.8.3 Test for glycosides (Keller-Killiani test)

To 5 mL of the extract, 2 mL of glacial acetic acid was added followed by 1 drop of 5% $FeCl_3$ and then con. H_2SO_4. The appearance of a reddish brown ring at the junction of the two liquid layers indicates the presence of glycosides in the extract.

2.8.4 Test for flavonoids (Alkaline reagent test)

Two milliliter of the extracts was treated with few drops of 20% NaOH solution. Formation of intense yellow colour, which becomes colourless on the addition of dilute HCl, indicates the presence of flavonoids.

2.8.5 Test for polyphenols (Ferric chloride test)

Two milliliter of the extracts were treated with aqueous 5% ferric chloride and observed for formation of deep blue or black colour.

2.8.6 Test for phlobatannins (Precipitate test)

Two milliliter of the extract was boiled with 1 mL of 1% aqueous hydrochloric acid and then shaken. Deposition of a red precipitate was taken as evidence for the presence of phlobatannins.

2.8.7 Test for tannins (Braymer's test)

Two milliliter of the extract was treated with 10% alcoholic ferric chloride solution and observed for formation of blue or greenish colour solution.

2.8.8 Test for anthraquinones

Two milliliter of the plant extract was shaken with 10 mL benzene, filtered and 5 mL of 10% NH_3OH was added. The mixture was shaken and the presence of pink/red or violet coloration in ammonical (lower) phase indicated the presence of free anthraquinones.

2.8.9 Test for terpenoids (Salkowski's test)

One milliliter of chloroform was added to 2 mL of the extracts followed by a few drops of concentrated H_2SO_4. Reddish brown precipitate produced immediately indicated the presence of terpenoids.

2.8.10 Test for reducing compounds

Fehling's Test: 2 mL of the extracts were put in test tubes, 5 mL of Fehling solution added and heated in the water bath for 5 min. The formation of brick-red precipitation or coloration indicated the presence of reducing sugar.

Molisch's Test: To 5 mL of each extract, 2 drops of alcoholic solution of α-naphthol was added and mixed by vigorous stirring. This was followed by the addition of 1 mL of conc. H_2SO_4. The formation of a violet ring in the test tube within few minutes indicated the presence of carbohydrates.

Benedict's Test: 1 mL of Benedict's reagent was added to 2 mL of the extract and heated on a water bath for 2 minutes. The development of a characteristic colored precipitate indicated the presence of sugar.

2.9 Proximate and Nutritional Analyses of *C. rotundus*

Analysis of the proximate compositions of *C. rotundus* was carried out using the official method (dehydration) described by the Association of Analytical Chemists [17] and the DNS colorimetric and Kjeldahl method. Elemental compositions of the plant were

determined by the wet digestion extraction method as described by AOAC [17]. All the calculations were carried out on the dry weight basis of the Nutgrass (*C. rotundus*) and expressed in mg/100 g dry weight. The proximate nutritional compositions were determined by the spectrometric method [17,18,19]. The amount of vitamins and other nutrients present were expressed as mean values ± standard deviation.

2.10 Screening for Antibacterial Activity of *C. rotundus* Extracts by Agar Well Diffusion Assay

Screening for antibacterial activity was done by agar well diffusion technique as described by Adeniyi et al. [20]. Plates of Mueller Hinton Agar (MHA) were inoculated with 0.1 mL of a 24 hr broth culture (equivalent to 0.5 MacFarland turbidity standards) of each bacteria isolate in sterile Petri dish. The seeded plates were rocked to obtain homogenous distribution of the isolates and allowed to set. Holes were bored on the plates with the aid of a sterile cork borer of 5mm diameters and equal volumes of 50 µl of extract were introduced in the wells using a micropipette. The plates were allowed to stand for an hour at room temperature to allow for proper diffusion of the extract, before incubation for 24 hr at 37°C. After incubation, the diameter of zones of inhibition was measured, including the 5 mm diameter of the hole using a digital caliper. The experiments were carried out in triplicates and the mean values were calculated and recorded in millimeter. Antibacterial activity was recorded when the zone of inhibition was greater than 5 mm. A solution of only dimethylsulfoxide (DMSO) and water in equal ratios was used as negative control while Ciprofloxacin antibiotics disc was used as positive control.

3. RESULTS

Table 1 shows the result of the phytochemical screening of the leaves and rhizome extracts of *C. rotundus*. Alkaloids, glycosides, saponin, flavonoids, polyphenols, tannins, terpenoids and reducing compounds were detected in both leaves and rhizome extracts of the solvents. Phlobatannins was detected only in the rhizome extract, while anthraquinones was not detected in any of the plant parts investigated. Comparatively, ethanol extracts of leaves and rhizome yielded more phytochemical compounds than aqueous extracts.

The quantitative phytochemical screening of *C. rotundus* extracts in mg/100 g dry weight of sample is presented in Table 2. The plant extracts exhibited important quantity of alkaloids, glycosides, flavonoids, polyphenols and reducing compounds. The highest content of these compounds was found in methanol extract, with reducing compounds (451 ± 11 mg/100 g) being the most abundant followed by polyphenols (401 ± 11 mg/100 g). The least compound was saponin in aqueous extract with percentage abundance of 42 ± 11 mg/100 g dry weight.

Table 3 shows the proximate nutritional composition of *C. rotundus* expressed in mg per 100g dry weight of the sample. The results showed the plant is high in B-carotene (164.3 ± 0.02), Vitamin A (109.25 ± 0.01), carbohydrate (59.0 ± 0.01) and lipid (24.25 ± 0.02) content but low in Vitamin C, protein, moisture and total ash content.

Table 1. Preliminary phytochemical screening of the leaves and rhizome extracts of *C. rotundus*

Phytochemical constituent	Test	Leaves extracts		Rhizome extracts	
		Aqueous	Ethanol	Aqueous	Ethanol
Alkaloids	Dragendorff's test	+	++	+	+
Glycosides	Keller-Killiani test	++	++	-	+
Saponin	Frothing test	+	++	+	+
Flavonoids	Alkaline reagent test	+	++	+	-
Polyphenols	Ferric chloride test	++	+++	+	+
Phlobatannins	Precipitate test	-	-	+	+
Tannins	Brayer's test	+	+	+	+
Anthraquinones	NH_3OH test	-	-	-	-
Terpenoids	Salkowski's test	-	+	+	+
Reducing compounds	Fehling's test	-	-	-	+
	Molisch's test	+	++	+	+
	Benedict's test	+	+	-	+

Key: - = Absent; + = Present; ++ = Present in moderate amount; +++ = Present in excess

Table 2. Quantitative phytochemical screening (mg/100 g dry weight) of extracts from *C. rotundus*

Phytochemical compounds	Extracts (mg/100 g dry weight	
	Aqueous	Methanol
Alkaloids	274 ± 11	320 ± 11
Glycosides	252 ± 14.5	301 ± 14.5
Saponins	42 ± 8.5	85 ± 8.5
Tannins	46 ± 11	98 ± 11
Flavonoids	280 ± 11	337 ± 11
Polyphenols	381 ± 11	401 ± 11
Reducing compounds	395 ± 11	451 ± 11

Table 3. Proximate nutritional composition of *C. rotundus* (mg/100 g dry weight)

Parameter	Amount (Mean ± SD) in mg/100 g
Moisture content	9.10 ± 0.01
Total ash content	3.40 ± 0.01
Lipid content	24.25 ± 0.02
Protein content	4.71 ± 0.02
Carbohydrate content	59.0 ± 0.01
B-carotene XSEREAWE	164.3 ± 0.02
Vitamin A	109.25 ± 0.01
Vitamin C	3.25 ± 0.02

Each value represents the mean of 3 determination ± SD

Table 4. Mineral composition of the leaves of *C. rotundus* in mg/100 g dry weight

Mineral	Composition	Range of reported literature values
Sodium (Na)	6.4	7.2-14.9 [21]
Potassium (K)	561.5	556.9-845.8 [22]
Calcium (Ca)	22.78	19.09-32.27 [22]
Magnesium (Mg)	102.7	105.5-112.3 [22]
Iron (Fe)	10.12	13.57-15.44 [21]
Zinc (Zn)	1.22	1.88-2.7 [22]
Copper (Cu)	0.46	0.43-0.71 [23]
Phosphorus (P)	234.6	229.6-283.7 [23]

Table 4 shows the mineral composition of the leaves of *C. rotundus* in mg/100 g dry weight. A total of eight (8) mineral elements were detected of which potassium was the most abundant (K = 561.5 mg/100 g dry weight) followed by phosphorus (P = 234.6 mg/100 g dry weight). The least abundant mineral element was copper (Cu = 0.46 mg/100 g dry weight).

Table 5 shows the antimicrobial activity of ethanol and leaves extracts of *C. rotundus* on the test organisms. The results showed the diameter of inhibition zones in mm of extracts for *P. mirabilis*, *E. coli* and *S. aureus* to be 22.0>14.0>13.0 for methanol extract and 19.0>12.0>10.0 for aqueous extract, respectively. However, the diameter of zones of inhibition for the positive control with Ciproflaxacin antibiotics was comparatively higher than that obtained from the two extracts against the test organisms.

4. DISCUSSION

Cyperus rotundus Linn. is a sedge of the family Cyperaceae and order Cyperales that is widely distributed in the Mediterranean basin areas and grows naturally in tropical, sub-tropical and temperate regions. It is widely regarded as a traditional medicine plant due to its potent pharmacological, antioxidant, hepatoprotective and antimicrobial properties; and as a good source of nutraceuticals [6,24]. Increasing trend in antimicrobial resistance of some pathogenic microorganisms such as *S. aureus, P. mirabilis* and *E. coli* to commonly used antibiotics has prompted a rapid search for the use of medicinal plant as alternative source for the development of therapeutics and neutraceuticals [2]. In this study, evaluation of the phytochemical potentials of *C. rotundus* revealed that its aqueous and methanolic extracts contains a number of bioactive compounds such as alkaloids, glycosides, saponin, flavonoids, polyphenols, tannins, terpenoids, reducing compounds and phlobatannins but with iteration in the type of solvent used (Table 1). This result is in accordance with that reported by Karzan et al. [6], Omeman et al. [7], Okuda and Ito [25], but slightly differs from the results of Wangila [12] and Arumugam and Vijisaral [26] who reported the presence of similar phytochemical compounds except flavonoids. The observed difference may be due to the methods adopted for the preliminary screening as the former adopted Shinoda test while the later used alkaline reagents, as used in this study.

The phytochemical compounds in *C. rotundus* possess excellent medicinal values and have been reported to demonstrate good anti-cancer, anti-malarial, hepatoprotective, hypolipidaemic,

Table 5. Antimicrobial activity of ethanol and leaves extracts of *C. rotundus*

Diameter of inhibitions zones in mm of *C. rotundus* extracts				
Test organism	**Aqueous**	**Ethanol**	**-ve control DMSO**	**+ve control Ciprofloxacin**
Escherichia coli	12.0	14.0	-	23.0
Staphylococcus aureus	10.0	13.0	-	17.0
Proteus mirabilis	19.0	22.0	-	25.0

Each value is expressed as mean of three experiments in mm; - indicates no activity

anti-diarrhoeal, analgesic and anti-inflammatory activities [2,24,27]. For instance, polyphenols and flavonoids widely distributed in this plant and present in considerable amounts in leaves and rhizomes (Table 2) have been used to treat human diseases, such as diabetes, cancer and coronary heart diseases [28]. Also, flavonoids have also been shown to exhibit antiviral, antimicrobial, antiplatelet, antitoxic, antioxidative and antigenotoxic activities. These activities are believed to be due to their redox properties. In fact, polyphenols can play important roles in absorbing and neutralizing free radicals, quenching singlet and triplet oxygens, or decomposing peroxides [28]. Other bioactive compounds also detected in the plant extracts such as saponins have been shown to possess hypotensive and cardio depressant properties, while glycosides have been used naturally as cardioactive drugs in the treatment of congestive heart failure and cardiac arrhythmia [29].

Quantitative extraction of the phytochemical compounds in *C. rotundus* was performed in two solvents, with reducing compounds, polyphenols, flavonoids alkaloids and glycosides present in much higher amount in methanol solvent than in aqueous solvent, each value expressed in mg per 100 g dry weight of the sample (Table 2). The only secondary metabolite not detected in both solvents was anthraquinones, while terpenoids was detected only in methanol solvent. This result was in agreement with reports from previous literature [5,6,7,30]. The quantitative estimation may be useful in determining the level of these compounds in the plant sample which may subsequently lead to its deployment by humans either in medicinal formulation or in other areas of relative traditional importance. For instance, *in vivo* studies of the effect of the methanolic extracts of flavonoids and terpenoids in albino rats have indicated their effectiveness in the treatment of inflammatory diseases. Additionally, terpenoids have been found to possess significant antipyretic and analgesic effects similar to salicyclic acid [27]. Also, cytoprotective effects of *C. rotundus* have been indicated in case of ethanol induced gastric damage in albino rats, as well as its significant antidiarrhoel, haemodynamic and hypolipidaemic activities [24].

The proximate nutrient composition in leaves extract of *C. rotundus* was carried out to determine the mean level of food constituents and vitamins as well as the mineral composition in mg/100 g dry weight of the sample (Table 3). Analysis of the proximate nutritional composition of the extract clearly showed that the plant is high in B-carotene (164.3 ± 0.02), Vitamin A (109.25 ± 0.01), carbohydrate (59.0 ± 0.01) and lipid (24.25 ± 0.02). However, the moisture content as well as Vitamin C, protein and total ash contents is considerably low. This result is consistent with the report of Ibrahim et al. [31]. The moisture content of foods and food products to a large extent determines the level of microorganisms and also the degree of spoilage in foods. This perhaps has a direct influence on the physical, chemical, stability and freshness of the food product during long storage. The low moisture content in *C. rotundus* is desirable in terms of durability and edibility of the plant product. This study reports low moisture content of 9.10±0.01 mg/100 g in dry leaves sample of *C. rotundus* which is a little bit higher to the 5.19% moisture content reported by Kabbashi et al. [32]. This study also shows that, *C. rotundus* is rich in protein (4.71 ± 0.02), ash (3.40 ± 0.01), carbohydrate (59.0 ± 0.01), lipid (24.25 ± 0.02) and B-carotene (164.3 ± 0.02). This suggest that the plant contains a high source of energy and its food product such as the tiger nut could serve as excellent food supplement with high nutritive value. These food classes possess satiety values and could help in delays emptying of the stomach [22]. Studies have shown that the presence of beneficial protein in plant can function in lowering blood sugar levels, thus serving as a good nutraceutical for diabetes. The low lipid content in *C. rotundus* could possibly improves blood cholesterol levels, decrease the

risk of cardiovascular disease and promote weight loss. The presence of some vitamins such as Vitamin A, Vitamin C and B-carotene is an indication that *C. rotundus* may play a part in the regulation of bodily functions, because some vitamins require fat for their dissolution into the blood stream and provide nutrients. Also, vitamin A is necessary for enhancement of good vision that can be gotten from *C. rotundus* [33,34].

In this study, the mineral composition of *C. rotundus* include both essential and trace elements such as sodium, potassium, calcium, phosphorus, magnesium, iron, zinc and copper in varying amounts (Table 4). This result is close to that obtained by Ekeanyanwu and Ononogbu [22], Adejuyitan [35] who reported the presence of similar elemental composition in addition to cobalt. Studies have shown the involvement of these elements in the regulation of certain activities in human cells, tissues and organs. The strengthening of heart muscle contraction is aided by increase in Ca^{2+} concentration in cells while Fe^{3+} is plays a role in blood circulation. Also, minerals in diets are solely required for metabolic reactions, transmission of nerve impulses, rigid bone formation and regulation of salt and water balance in the body. These elements are important in proper biochemical function and their presence could improve immunological and physiological processes that can mitigate certain diseases in the body [33]. Previous studies have shown that the leaves and rhizome of *C. rotundus* are edible and have some nutritional value. The Rhizome (root) and tubers are known to contain high amount of carbohydrates and are also good nutritional source of mineral and trace elements [2].

Antimicrobial activity of *C. rotundus* extracts was tested on Gram-negative bacteria, *E. coli* and *P. mirabilis* and Gram-positive bacterium, *S. aureus* using agar well diffusion technique (Table 5). The antimicrobial potential of *C. rotundus* extracts showed their ability to inhibit the growth of these organisms *in vitro* as indicated by the diameter of zones of inhibition in mm of methanol extract in the order of 22.0>14.0>13.0 for *P. mirabilis*, *E. coli* and *S. aureus*, respectively. There was remarkable iteration in the antimicrobial efficacy of the different extracts on the test organisms. In aqueous extract, the diameter of zones of inhibition was found to be in the order of 19.0 mm>12.0 mm>10.0 mm for *P. mirabilis*, *E. coli* and *S. aureus*, respectively. The highest antimicrobial activity of methanol extract was found at 22.0 mm against *P. mirabilis* and lowest at 13.0 mm against *S. aureus*. On aqueous extract, maximum antimicrobial activity was equally recorded for *P. mirabilis* at 19.0 mm and minimum at 10.0 mm for *S. aureus.* This result was similar to that obtained from previous studies [5,7,31]. This may be due to variation in the polarity of the two solvents and the differences in the level of resistance of the test organism vis-à-vis their virulence nature. The Ciprofloxacin (5 µg) disc used as positive control showed greater antimicrobial activity to the test organisms in comparison to the plant extracts with diameter of zones of inhibition at the range of 17– 25 mm. This indicates increased efficacy of the fluoroquinolone antibiotic and confirms the rationale for its widespread use in the treatment of bacterial infections caused by these pathogens in both community and hospital settings [6].

The observable inhibitory effect of the plant extracts on the test organism is not surprising because the active extracts contain flavonoids and other polyphenolic compounds. These families of compound have been reported to play significant role in the prevention of colonization of epithelial, mucosal and enteric surfaces by parasites, bacteria and fungi [7,36]. Preliminary screening for antimicrobial activity of *C. rotundus* and the tested bacteria revealed such activity with methanol and aqueous extracts. The methanol extract contains higher quantities of flavonoids, tannins and polyphenols than the aqueous extract. Thus, their antimicrobial activity is somewhat different [37]. We deduced that, the polyphenolic composition in methanol extract is somewhat different from that of aqueous extract since they are solvents with dissimilar polarities. Phytochemical compounds such as tannins, flavonoids and polyphenols have been reported to contribute to the antimicrobial activity of *C. rotundus* extracts [6,7]. Interestingly, it is known that these phytochemicals can form heavy soluble complexes with proteins, bind to bacterial adhesions and block the activity of certain receptors on the cell surface [38]. Also, tannins which are active compounds in several medicinal plants have been shown to form irreversible complexes with proline-rich proteins resulting in the inhibition of cell wall proteins. This property could elucidate the antimicrobial mechanisms of plant extracts. This explanation also goes further to corroborates reports of several *in vitro* assays demonstrating potentially significant interactions of these bioactive compounds with biological systems such as viruses,

bacteria and molluscs as well as enzyme inhibiting, antioxidant and radical-scavenging properties. Their tendency to interfere with biological systems is partly due to a characteristic ability to form complexes with macromolecules combined with a polyphenolic nature [14,39].

5. CONCLUSION

This study revealed the presence of certain phytochemical compounds and nutritional composition in rhizome and leaves extracts of *C. rotundus* indicating that the plant possesses excellent pharmaceutical and nutraceutical potentials. Antimicrobial activity of the plant extracts on the test organism showed that it has inhibitory effect on some bacterial pathogens which could be exploited as alternative treatment option for certain bacterial infections and in the development of drug in future. The proximate nutritional and mineral composition of the plant extracts is also an indication that it could serve as a good source of food supplement supplying the body with essential elements, vitamins, carbohydrates and proteins.

ACKNOWLEDGEMENTS

The authors would wish to acknowledge the management, staff and students of the Department of Microbiology, Obong University, Etim Ekpo, Akwa Ibom State – Nigeria for providing research facilities, technical assistance and encouragement. Our thanks are also due to Mr. Sunday Michael Ekpo of Biochemistry Department, University of Calabar, Calabar – Nigeria for providing useful information about the plant and identification of the plant sample as *Cyperus rotundus*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Harborne JB, Baxter H, Moss GP. General introduction: Phytochemical dictionary a handbook of bioactive compounds from plants (2nd Ed.). London: Taylor & Francis. 1999;7.
2. Corvallis O. Phytochemicals. Micronutrient Information Center, Linus Pauling Institute, Oregon State University. 2017;1-5.
3. Himaja N, Anitha K, Joshna A, Pooja M. Review article on health benefits of *Cyperus rotundus*. Indian Journal of Drugs. 2014;2(4):136-141.
4. Peerzada AM, Ali HH, Naeem M, Latif AHB, Tanveer A. *Cyperus rotundus* L.: Traditionaluses, phytochemistry and pharmacological activities. Journal of Ethnopharmacology. 2015;174:540-560.
5. Kilani-Jaziri S, Bhouri W, Skandrani I, Limem I, Chekir-Ghedira L, Ghedira K. Phytochemical, antimicrobial, antioxidant and antigenotoxic potentials of *Cyperus rotundus* extracts. South African Journal of Botany. 2011;77:767-776.
6. Karzan K, Shnawa B, Gorony S. Antimicrobial activity of *Cyperus rotundus* Linn. extracts and phytochemical screening. Eurasian Journal of Science and Engineering. 2017;312:82.
7. Omeman A, Edrah SM, Belhaj SM, Alafid F. Evaluation of phytochemical analysis and antibacterial activity of leaves and roots of *Cyperus rotundus*. The Second Annual Conference on Theories and Applications of Basic and Biosciences. 2018;1-11.
8. Yeung HC. Handbook of Chinese herbs and formulas. Institute of Chinese Medicine, Los Angeles; 1985.
9. Sharma SK, Singh AP. Antimicrobial investigations on rhizomes of *Cyperus rotundus* Linn. Der Pharmacia Lettre. 2011;3(3);427-431.
10. Sivapalan SR. Medicinal uses and pharmacological activities of *Cyperus rotundus* Linn- A review. International Journal of Scientific and Research Publication. 2013;3(5):1-8.
11. Bhouri W, Derbel S, Skandrani I, Boubaker J, Bouhlel IB, Sghaier M, Kilani SM, Mariotte A, Dijoux-Franca MG, Ghedira K, Chekir-Ghedira L. Study of genotoxic, antigenotoxic and antioxidant activities of the digallic acid isolated from *Pistacia lentiscus* fruits. Toxicology *in vitro*. 2010;24:509–515.
12. Wangila TP. Phytochemical analysis and antimicrobial activities of *Cyperus rotundus* and *Typha latifolia* reeds plants from Lugari region of Western Kenya. Pharm Anal Chem. 2017;3:128.
13. Raut NA, Gaikwad NJ. Antidiabetic activity of hydro-ethanolic extract of *Cyperus rotundus* in alloxan induced diabetes in rats. Fitoterapia. 2006;77:585–58.

14. Kilani S, Ben-Sghaier M, Limem I, Bouhlel I, Boubaker J, Bhouri W, Skandrani I, Neffatti A, Ben-Ammar R, Dijoux-Franca MG, Ghedira K, Chekir-Ghedira L. *In vitro* evaluation of antibacterial, antioxidant, cytotoxic and apoptotic activities of the tubers infusion and extracts of *Cyperus rotundus*. Bioresour Technol. 2008;99(18): 9004-9008.
15. Ikan R. Natural products: A laboratory guide. Jerusalem: Israel: Israel University Press. International Archives of Applied Immunology. 1969;94:262-265.
16. Harbone JB. Phytochemical methods, a guide to modern techniques in plant analysis; 1973.
17. AOAC. Official method of analysis of the association of analytical chemists. Washington D.C. 2005;223-225.
18. Pearson D. The chemical analysis of foods, 7th Ed. Churchill Livingstone, London. 1976;572.
19. Oseni MO, Oseni A, Amoo IA. Studies on the physiochemical properties of oil, minerials and nutritional composition of nut of nut grass (*Cyperus rotundus*). American Journal of Food Technology. 2011;6(12).
20. Adeniyi BA, Odelola HA, Oso BA. Antimicrobial potentials of *Diospyros mespiliformis* (Ebenaceae). African Journal of Medicine and Medical Sciences. 1999;25:221-224.
21. Bado S, Bazongo P, Son G, Kyaw MT, Forster BP, Nielen S, Lykke AM, Ouedraogo A, Bassole IHN. Physicochemical characteristics and composition of three morphotypes of *Cyperus esculentus* tubers and tuber oils. Journal of Analytical Methods in Chemistry. 2015;1:1-8.
22. Ekeanyanwu RC, Ononogbu CI. Nutritive value of Nigerian tigernut (*Cyperus esculentus* L.). Agricultural Journal. 2010;5(5):297-302.
23. Glew RH, Glew RS, Chuang T. Amino acid, mineral and fatty acid content of pumpkin seeds (*Cucurbita spp*) and *Cyperus esculentus* nuts in the Republic of Niger. Plant Foods for Human Nutrition. 2006;61(2):51-56.
24. Salman K, Ran JC, Dong UL, Yeong SK. Sesquiterpene derivatives isolated from *Cyperus rotundus* L., inflammatory signaling mediated by NFxB. Natural Product Sciences. 2011;17(3):250-225.
25. Okuda T, Ito H. Tannins of constant structure in medicinal and food plants hydrolysable tannins and polyphenols related to tannins. Molecules. 2011;16: 2191-2217.
26. Arumugam S, Vijisaral ED. Phytochemical screening of the various extracts of *Cyperus rotundus.* L. American Journal of Pharm Tech Research. 2014;4(3):1-9.
27. Sundaram MS, Sivakumar T, Balamurugan G. Anti-inflammatory effect of *Cyperus rotundus* Linn leaves on acute and subacute inflammation in experimental rat models. Biomedicine. 2008;28:302-304.
28. Broadhurst CL, Polansky MM, Anderson RA. Insulin-like activity of culinary and medicinal plant aqueous extracts *in vitro*. Journal of Agricultural and Food Chemistry. 2000;48:849–852.
29. Lalitha TP, Jayanthi P. Asian Journal of Plant Science and Research. 2012;2(2): 115-122.
30. Obadoni BO, Ochuko PO. Phytochemical studies and comparative efficacy of the crude extracts of some haemostatic plants in Edo and Delta states of Nigeria. Global J. Pure Applied Sci. 2002;8:203-208.
31. Ibrahim J, Musa DA, Gbodi TA. Comparative nutritive evaluation of *Cyperus esculentus* and *Cyperus rotundus* nuts. Lapai Journal of Applied and Natural Sciences. 2016;1(1):24-28.
32. Kabbashi AS, Mohammed SEA, Almagboul AZ, Ahmed IF. Antimicrobial activity and cytotoxicity of ethanolic extract of *Cyperus rotundus* L. American Journal of Pharmacy and Pharmaceutical Sciences. 2015;2(1):13.
33. Brown D. Medicinal properties of *Pleurotus species* (oyster mushroom): A review. World Journal of Fungal and Plant Biology. 2012;3(1):1-12.
34. Ikon GM, Udobre EA, Etang UE, Ebana RU, Edet UO. Phytochemical screening, proximate composition and antibacterial activity of oyster mushroom *Pleurotus ostreatus* collected from Etim Ekpo in Akwa Ibom State, Nigeria. Asian Food Science Journal. 2019;6(2):1-10.
35. Adejuyitan JA. Tigernut processing: Its food uses and health benefits. American Journal of Food Technology. 2011;6(3): 297-302.
36. Chiang LC, Chiang W, Liu MC, Lin CC. *In vitro* antiviral activities of *Caesalpinia pulcherrima* and its related flavonoids. The

Journal of Antimicrobial Chemotherapy. 2003;52:194–198.

37. Rodriguez Vaquero MJ, Alberto MR, Manca de Nadra MC. Antibacterial effect of phenolic compounds from different wines. Food Control. 2007;18:93–101.
38. Haslam E. Natural polyphenols (vegetable tannins) as drugs: Possible modes of action. Journal of Natural Products. 1996;59:205–215.
39. De Bruyne T, Pieters L, Deelstra H, Vlietinck A. Condensed vegetable tannins: Biodiversity in structure and biological activities. Biochemical Systematics and Ecology. 1999;27:445–459.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/58042