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Investigating the Phytochemicals and Antimicrobial Properties of Three Sedge (Cyperaceae) Species

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Abstract: In order to evaluate the medicinal value of notorious sedge weeds, three species: *Cyperus esculentus*, *Cyperus rotundus* and *Mariscus alternifolius* were investigated for their phytochemical constituents and antimicrobial properties. Preliminary qualitative phytochemical constituents and *in vitro* antimicrobial activities were evaluated against four fungi species *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium chrysogenum* and *Candida albicans* and three bacteria species *Escherichia coli*, *Salmonella typhi* and *Staphylococcus aureus*. Two solvents, water and ethanol were used to produce the extracts and screened for their antimicrobial activity. Antimicrobial activity evaluation of extracts against the pathogens was carried out at 100 mg mL^{-1} concentration by Disc Diffusion Method for fungi and Disc Diffusion and Agar Well Diffusion Methods for bacteria. Observed activities were related to standard antibiotics fulcin (antifungal), tetracycline (antibacterial) and Ciprofloxacin (antibacterial) which served as controls. Phytochemically, the plant extracts showed the presence of carbohydrates, flavonoids, ketose sugars, steroids, reducing sugars and tannins. The ethanolic extract of *C. rotundus* exhibited highest activity against *A. niger*, *E. coli* and *S. aureus*. No extract was active against *C. albicans*. From these findings, *C. rotundus* is a potential source of bioactive compounds for new drugs upon isolation and purification for treating infections caused by these pathogens.

Key words: *Cyperus esculentus*, *Cyperus rotundus*, *Mariscus alternifolius*, phytochemicals, antimicrobial properties, plant extracts, sedges

INTRODUCTION

Nearly 80% of the world population depends upon traditional system of health care (Ganesan *et al*., 2004). The indigenous traditional knowledge of medicinal plants of various ethnic communities where it has been transmitted orally for centuries is fast disappearing from the face of the earth due to the advent of modern technology and transformation of traditional culture (Ganesan *et al*., 2004). However, during the last few decades there has been an increasing interest in the study of medicinal plants and their traditional uses in different parts of the world. This led to major pioneering works such as the isolation of quinine from *Cinchona* sp. (bark extracts), reserpine from *Rauvolfia serpentine* serpent wood (root extracts) and diosgenin from *Dioscorea* sp. (tuber extracts) (Joy *et al*., 2001). Consequently, the level of awareness of phyto-medicine in Nigeria is very large. It is estimated that >80% of the Nigerian population use herbal remedies in one form or the other because <35% of the population has access to modern health care facilities (Awosika, 1993). Thus, medicinal plants form the basis of primary health care for majority of the people living in the rural and remote areas in Nigeria (Awosika, 1993). Most recently, the efforts of some newspaper columnists in raising awareness over herbal medicine efficacy in curing diseases cannot be over-simplified. The availability of many of these herbal plants make them more readily affordable to the rural and even urban dwellers. Of particular significance in herbal medicine are common weeds around homes and waste-lands as well as farmlands where sedges form important components.

Among these common weeds is the family Cyperaceae which are ubiquitous but may be difficult to recognize because of their closeness to the grass family except their triangular shaped stems that are characteristic. Lowe and Stanfield (1974) remarked that about four-fifths of the species grow in damp or wet places (including a few submerged aquatics) while one-fifth is found in drier situations such as savannah grassland and sandy places including sand-dunes.

Cyperus esculentus L. (Family: Cyperaceae, Common Name: Tiger nut, Nigerian local names: Yoruba: Ofio, Hausa: Ayaya and Igbo: Akiausa). It is found in all tropical and warm-temperate regions except Malaysia,

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Australia and Oceania. It is a weed found in cultivated areas in moist places and waste-lands (Burkill, 1985). In Nigeria, it is found across the country. It is 24-55 cm tall, producing rhizomes from the base which are 2 mm thick and bear tubers. Stem is triangular with sides approximately 2 mm wide. Leaves are fairly numerous at the base of the stem, reaching 30 cm long and 8 mm wide but often narrower. Inflorescence subtended by approximately four bracts, the longest approximately 20 cm long and 5 mm wide usually tapering to a fine point. Inflorescence is a simple umbel when small or a compound umbel when larger with primary rays 4-9 cm long, secondary rays if present 2 cm long. Branches ending in spikes 1-3 cm long, composed of 6-25 golden-yellow spikelets, each 7-15 mm long, 1-1.5 mm broad with 3-8 glumes along each side. Glumes approximately 3 mm long with a fairly prominent midrib and with a papery edge. They are occasionally viviparous (Lowe and Stanfield, 1974). Medicinally, they are used in healing menstrual discomforts and stomach troubles (Burkill, 1985).

Cyperus rotundus L. (Family: Cyperaceae, Common Name: Nut grass, Nigerian local names: Hausa: Giragiri, Fulfude: Ayaare and Yoruba: Danda). It is found in pan-tropical and sub-tropical regions in West Africa and other damp places. Its distribution ranges from Mali to Niger and towards Nigeria, Ghana and Sierra Leone. It is also found in warm temperate regions often as a rice-field weed (Burkill, 1985). In Nigeria it is found across the country (Lowe and Stanfield, 1974). Its rhizome is fairly narrow with fibrous brown scales. Stems are 20-40 cm high, 1-2 mm thick with a swollen tuberous base. Leaves vary in length from half as long as the stem to equal the length of the stem in some cases; leaves are sometimes few (6) and narrow (2 mm); sometimes numerous (14) and broader (5 mm). Inflorescence is 3-8 cm long often rather narrow with sub-erect spikelets, subtended by approximately 3 bracts similar to the leaves and from 1/2 to 1 ½ times as long as the inflorescence. Inflorescence usually with a few primary rays 2-5 cm long, ending in a short spike of 3-10 spikelets, sometimes with 1 or 2 short secondary rays at the base of the spike. Spikelets are rather long and flat, generally reddish-brown, 12-20 cm long, 1.5-2 mm broad with 5-10 glumes along each side. Glumes with a green keel and red-brown sides, 3-4 mm long (Lowe and Stanfield, 1974). In medicine, tubers have been reported to be used in treating diarrhea and dysentery; as genital stimulants or depressants; treatment of kidney troubles, stomach troubles and as diuretics (Burkill, 1985). The tubers also possess aromatic substances used as insecticides and arachnicides (Burkill, 1985). The presence of polyphenol, flavonol glycoside, saponin, vitamin C, sesquiterpenoids and essential oil from phytochemical investigation of *C. rotundus* rhizomes was reported by Nagulendran *et al.* (2007).

Mariscus alternifolius Vahl. (Family: Cyperaceae, Common Name: Mariscus, Nigerian local names: Hausa: Ayaa, Yoruba: Alubosa eranko and Igbo: Ataku mainya). It is pan-tropical and common in damp grassy places in Togo, Gambia, Nigeria, Liberia, Ivory Coast, Ghana, Gambia, Guinea and Cameroon (Burkill, 1985). It is found across Nigeria (Lowe and Stanfield, 1974). Mariscus is perhaps the commonest species of sedge in Nigeria, except the far North. An extremely variable plant, forming shoots often thickened or almost bulb-like at the base, sometimes from a short woody rhizome with numerous fibrous roots. May be very slender or may reach 1 m tall with leaves 8 mm wide. Leaf sheaths are purplish-red. Stems rounded to triangular. Inflorescence is simple umbel with few to many rays, the longest approximately 10 cm long and subtended by leafy bracts. Spikelets always densely crowded into heads which may be almost globose and approximately 5 mm diameter or elongated into spikes 3 cm long and 1 cm wide. In young inflorescences, the heads are almost sessile but stalks (i.e., the rays of the inflorescence) soon develop to various lengths. Spikelets usually under 5 mm long with 1 or 2 ribbed glumes showing but in some specimens there may be spikelets over 5 mm long with 2 or 3 glumes visible (Lowe and Stanfield, 1974). The chewed stem bandaged on a cut or wound for at least three days is reported to have a healing effect. The swollen stem base after washing, ground in a mortar and then mixed into some honey is a treatment for gonorrhea (Burkill, 1985).

MATERIALS AND METHODS

Plant collection: Plant samples were collected from the University of Lagos Campus, Akoka, Lagos State and neighbouring surroundings. The plants were collected wholly with roots, shoots and inflorescences. The plants were confirmed in the Herbarium of the Department of Botany, University of Lagos. The collected plants are *Cyperus esculentus*, *C. rotundus* and *Mariscus alternifolius*.

Test microorganisms: The test bacteria: *Escherichia coli*, *Staphylococcus aureus* and *Salmonella typhi* were obtained from Lagos University Teaching Hospital, Idi-Araba, Lagos and the test fungi: *Aspergillus niger* and *Aspergillus fumigatus* were obtained from Microbiology Department, University of Lagos. However, *Candida albicans* and

Penicillium chrysogenum were obtained from the Nigerian Institute for Medical Research, Yaba, Lagos. The bacteria strains were maintained on Nutrient Agar while the fungi were maintained on Potato Dextrose Agar at 4°C in a refrigerator.

Preparation of plant extracts: The plant materials were cut into pieces and air-dried for a week in an oven. Dried samples were ground into powder with a grinding machine. For the aqueous extraction, 50 g of each powdered plant sample was soaked in 500 mL of cold distilled water in a conical flask and left undisturbed for 48 h. Thereafter, the extracts were filtered off using Whatman No. 1 filter paper. The filtrate was concentrated under vacuum below 40°C using a rotary evaporator (Bag *et al*., 2009). For organic solvent extraction, 50 g of air-dried powder was soaked in 500 mL of ethanol in a conical flask and left undisturbed for 48 h. Thereafter, the extract was filtered off using Whatman No. 1 filter paper. The filtered extract was concentrated under vacuum below 40°C using a rotary evaporator (Bag *et al*., 2009). The extracts thus obtained were stored in well-labeled sterile bottles and kept in the freezer at 4°C until further use for the screening of antimicrobial activity.

Preparation of solid media: Commercially produced Potato Dextrose Agar (PDA) and Nutrient Agar (NA) were used for isolation of fungi and bacteria, respectively. To prepare 1 L of PDA, 40 g of PDA was dissolved in 1 L of distilled water in a sterile conical flask. The mouth of the flask was plugged with cotton wool wrapped in aluminum foil. The conical flask was gently shaken to avoid air bubbles and then heated in a water bath to homogenize the agar at about 100°C, the medium was then sterilized in an autoclave at 121°C for 15 min and allowed to cool before use. To prepare 1 L of NA, 28 g of NA was dissolved in 1 L of distilled water in a sterile conical flask. The mouth of the flask was plugged with cotton wool wrapped in aluminum foil. The conical flask was gently shaken to avoid air bubbles and then heated in a water bath to homogenize the agar at about 100°C. The medium was then sterilized in an autoclave at 121°C for 15 min and allowed to cool before use.

Antimicrobial assay

Antifungal activity test of plant extracts: This was done using the Agar Diffusion Test Method of Irobi and Daramola (1993). The 10 mL of Potato Dextrose Agar (PDA) was poured into petri dishes and allowed to solidify. Liquid inoculum was prepared by pouring cooled sterile distilled water on already grown fungal plates. The suspension was transferred into a test tube. This allowed for fungal spores to be easily removed from the pure culture. A drop pipette was used to transfer two drops of fungal inoculum into each of the agar plates. A sterile glass rod was used for even spreading. To prepare discs, Whatman No. 1 filter paper was perforated using a paper punch to form paper discs 6 mm in diameter. The discs were wrapped in aluminum foil and sterilized in an autoclave at 121°C for 15 min. After sterilization, the discs were dropped in each extract (100 mg mL^{-1}). Two controls were used: sterile distilled water and Fulcin. Fulcin control was prepared by dissolving 12.5 g of fulcin powder in 10 mL of sterile distilled water. Four of the discs from each of the three extracts, antibiotic and water controls were aseptically placed with the aid of a sterile forceps on PDA and inoculums in petri dishes. For each fungus, two replicates were produced by repeating the above processes. This is to reduce experimental errors by calculating the average of the values obtained. All the plates containing the extracts and fungi were incubated at 25°C. The zones of inhibition were measured after 48 h of incubation and the results analyzed statistically.

Antibacterial activity test of plant extracts

Disc diffusion assay: This was done using the Agar Diffusion Test Method of Bauer *et al*. (1966). The 10 mL of Nutrient Agar (NA) was poured into petri dishes and allowed to solidify. Petri dishes were inoculated by streaking bacteria over their surfaces with the aid of an inoculating loop. To prepare discs, Whatman No. 1 filter paper was perforated using a paper punch to form paper discs of 6 mm in diameter. The discs were wrapped in aluminum foil and sterilized in an autoclave at 121°C for 15 min. After sterilization, they were dropped in each extract (100 mg mL^{-1}). Two controls were used: sterilized distilled water and Tetracycline an antibiotic. Tetracycline control was prepared by dissolving 12.5 g of tetracycline powder in 10 mL of sterile distilled water. Four of the discs from each extract, antibiotic and water control were then aseptically placed with the aid of sterile forceps on petri dishes with NA and inocula. For each bacterium, the experiment was performed in duplicates. All the plates containing the extracts and bacteria were then incubated at 37°C. The zones of inhibition around the disc were measured after 24 h of incubation and the results analyzed statistically.

Agar well diffusion assay: The Agar Diffusion Test Method of Aneja and Joshi (2009) was applied. The 10 mL of Nutrient Agar (NA) was poured into petri dishes and allowed to solidify. The medium was inoculated with bacteria by Streak Plate Method. Wells were prepared in the plates with a cup-borer (0.85 cm) and 100 μL of the test

compound was pipetted directly into the well. This was repeated for all the extracts and controls. Two controls were used; sterilized distilled water and Ciprofloxacin. Ciprofloxacin control was prepared by dissolving 12.5 g of ciprofloxacin powder in 10 mL of sterile distilled water. Prior to incubation at 37°C for 24 h, the Petri dishes were kept at room temperature for 15 min in order to promote diffusion of the extracts into the agar. All the tests were made in duplicates and the mean diameter of the inhibition zones were analyzed statistically.

Phytochemical screening: Phytochemical screenings of the plant samples were carried out qualitatively using the method described by Harborne (1998). These screenings are: Fehling's Solution test for reducing sugars, Molisch test for carbohydrate sugars, Barfoed's test for monosaccharides, Resorcinolt test (or Seliwanoff's test) for keto-sugars, Phloroglucinol test for pentose sugars, test for Alkaloids, general test for glycosides, tests for saponin, tannins, anthraquinones, flavonoids, steroids and terpenoids.

Statistical analysis: Tests were carried out in duplicate for the three separate experiments. Analysis of the standard error was used for comparison between the mean values of the studies parameters.

RESULTS AND DISCUSSION

Antimicrobial results: Ethanolic and aqueous extracts of the three species of sedges tested showed varying degrees of microbial inhibition. *Cyperus rotundus* was the most active plant extract. Its aqueous was active against *A. fumigatus* and its ethanolic extract was active against *A. niger*. Their activities against other tested pathogens were relatively insignificant. Ethanolic extract of *C. esculentus* was less effective with fairly high action against *A. fumigatus* and *P. chrysogenum* while the water extract was insignificant on other pathogens except *P. chrysogenum*. Although, *M. alternifolius* was the least effective, its ethanolic action on *P. chrysogenum* was relatively high and highest among all pathogens. With respect to bacteria, ethanolic extract of *C. rotundus* had the only significant action against *E. coli*. Other extracts recorded mild actions (Table 1-3).

Phytochemical results: *Cyperus esculentus* contained the highest number of phytochemicals; *C. rotundus* contained tannins and reducing sugars while *M. alternifolius* contained relatively the least number of phytochemicals (only reducing sugars). Alkaloids, saponins, anthraquinones and terpenoids were not found in the three sedges (Table 4).

Burkill (1985) observed that nuts of *Cyperus esculentus* and *C. rotundus* have medicinal properties which have been harnessed by traditional medicine practitioners but only a few of these properties have been proven scientifically. However, in this present study, only the shoots, roots and inflorescence of *Cyperus esculentus* and *C. rotundus* were utilized. This was done to further assess other floral parts for their medicinal importance due to their fast growth rate which make them more readily available for use since the tubers take a longer time to develop. Traditional medicine practitioners make use of water primarily as a solvent but studies have shown that alcohol extracts of plants are much better and powerful. This may be due to the better solubility of the active components in organic solvent (De Boer *et al*., 2005). The two extracts (ethanolic and aqueous) used in this study showed either inhibitory or no activities against the different species of fungi and bacteria tested. *A. niger* is one of the most common species of Aspergillus that causes aspergillosis in humans. Aspergillosis develops in the lungs of humans who are immuno-compromised and results in symptoms such as cough, fever, chest pains and breathing difficulties. In plants, *Aspergillus niger* causes black mould of onion bulbs. Due to the high potency of *Cyperus rotundus* (ethanolic extract) against *A. niger*, it can be suggested that isolation of the bioactive compounds responsible for the inhibitory activity and the purification of this compound may provide another reliable antimicrobial just like fulcin which will be used specifically for controlling *A. niger*-related infections in humans and plants.

Table 1: Effects of water and ethanolic extracts of sedges on fungi

	Inhibition zones of fungi (cm)			
Extracts	*A. niger*	*A. fumigatus*	*P. chrysogenum*	*C. albicans*
C. esculentus (water extract)	NA	1.00±0.34	4.00±0.85	NA
C. esculentus (ethanol extract)	NA	4.63±1.18	6.13±1.22	NA
C. rotundus (water extract)	NA	7.88±1.73	0.88±0.74	NA
C. rotundus (ethanol extract)	9.38±0.98	NA	2.38±1.08	NA
M. alternifolius (water extract)	NA	4.88±1.39	2.38±0.71	NA
M. alternifolius (ethanol extract)	NA	NA	6.75±0.94	NA
Fulcin	10.00±0.33	13.88±0.72	11.63±0.38	20.00±0.42
Water	NA	NA	NA	NA

*NA = Not Active; data are presented as the mean±SD of each triplicate test

Table 2: Effects of water and ethanolic extracts of sedges on bacteria (Disc Method)

	Inhibition zones of bacteria (cm)		
Extracts	*E. coli*	*S. aureus*	*S. typhi*
C. esculentus (water extract)	2.13±0.79	0.75±0.41	0.75±0.49
C. esculentus (ethanol extract)	1.38±0.80	1.25±0.49	0.25±0.16
C. rotundus (water extract)	2.00±0.68	0.50±0.19	0.50±0.50
C. rotundus (ethanol extract)	6.75±0.77	2.25±0.56	NA
M. alternifolius (water extract)	0.63±0.38	0.50±0.38	1.00±0.57
M. alternifolius (ethanol extract)	0.50±0.33	1.00±0.50	0.13±0.13
Tetracycline	19.75±0.98	31.00±1.13	20.00±0.87
Water	NA	NA	NA

Table 3: Effects of water and ethanolic extracts of sedges on bacteria (Well Method)

	Inhibition zones of bacteria (cm)		
Extracts	*E. coli*	*S. aureus*	*S. typhi*
C. esculentus (water extract)	2.13±0.79	0.75±0.41	0.75±0.49
C. esculentus (ethanol extract)	1.38±0.80	1.25±0.49	0.25±0.16
C. rotundus (water extract)	2.00±0.68	0.50±0.19	0.50±0.50
C. rotundus (ethanol extract)	6.75±0.77	2.25±0.56	NA
M. alternifolius (water extract)	0.63±0.38	0.50±0.38	1.00±0.57
M. alternifolius (ethanol extract)	0.50±0.33	1.00±0.50	0.13±0.13
Tetracycline	19.75±0.98	31.00±1.13	20.00±0.87
Water	NA	NA	NA

*NA = Not Active; data are presented as the mean±SD of each duplicate test

Table 4: Phytochemical screening of sedges extracts

	Sedges		
Tests	*C. esculentus*	*C. rotundus*	*M. alternifolius*
Fehling's	-	+	+
Molisch	+	-	-
Barfoed's	-	-	-
Resorcinol	+	-	-
Phloroglucinol	-	-	-
Alkaloids (Dragendoff's)	-	-	-
Saponin	-	-	-
Tannins	+	+	-
Anthraquinones	-	-	-
Flavonoids	+	-	-
Steroids	+	-	-
Terpenoids	-	-	-

Inference of the test is indicated in parenthesis: '+' indicates present; '-' indicates absent

The inactivity of *C. rotundus* (ethanolic extract) against *A. fumigatus* and its potency against *A. niger* may be attributed to the fact that both species produce different mycotoxins. *Aspergillus fumigatus* produces a mycotoxin known as gliotoxin which is different from ochratoxin produced by *A. niger*. *Aspergillus fumigatus* is the most stubborn and most common cause of aspergillosis in the lungs of immuno-compromised humans. Its effectiveness is as a result of the mycotoxin-gliotoxin which is genotoxic and cytotoxic (Nieminen *et al*., 2002). Aqueous extract of *C. rotundus* was the most effective plant extract against the fungus (7.88±1.73 cm). This suggests that further isolation and purification of the bioactive compounds responsible for the inhibitory activity may lead to the development of effective drugs which can be used as a combination therapy with Fulcin against the fungus.

Penicillium chrysogenum is a wonderful source of antibiotic-penicillin; it causes no diseases in humans except few cases of allergies but may cause mould on plant stored products. All plant extracts showed relatively mild inhibitory activities against *Penicillium chrysogenum* compared to the antifungal control Fulcin (Table 1). This is probably due to the fact that the fungus itself produces an antibiotic contributing to its weak potency and susceptibility. The resistance of *Candida albicans* (Table 1) to most antimicrobial agents was clearly demonstrated in this study as no extract showed inhibitory activity against the yeast-like fungus. *Candida albicans* is the causative agent of candidiasis: an opportunistic infection very difficult to control in immuno-compromised patients but easily cured in patients not immuno-compromised. According to Awodele *et al*. (2007), the use of some common disinfectants such as savlon and jik against *C. albicans* revealed that unless 100% concentration of these substances are used, *C. albicans* cannot be controlled.

The ethanolic extract of *C. rotundus* was the most active plant extract against *E. coli* (6.75±0.77 cm) and this probably supports the reported use of the plant by traditional medicine practitioners in treating diarrhoea and other stomach troubles. Isolation and purification of the bioactive compounds responsible for this inhibitory activity are necessary to produce more antibiotics which can be used effectively against *E. coli*. *Cyperus rotundus* ethanolic extract also showed the highest inhibitory action against *S. aureus* (2.25±0.56 cm). This further enunciates the anti-microbial potency of this plant extract. The relatively low inhibitory activities of the plant extracts against *Salmonella typhi* compared to the antibiotic control tetracycline demonstrates the difficulty involved in controlling *Salmonella typhi*.

Mariscus alternifolius ethanolic extract was the most active against *E. coli* and it showed similar results to *C. rotundus*. Researchers are not aware of any reported use of *Mariscus alternifolius* in treating stomach troubles or diarrhoea. Further, purification and isolation of the active compounds in this extract are required for pharmacological evaluation. This plant may be a potential source of a new type of antibiotic. The ethanolic and aqueous extracts of *C. rotundus* showed the highest inhibitory activities against *S. aureus* compared to the other four plant extracts. This result again further illustrates the high potency of *C. rotundus* against micro-organisms. The result also supports that obtained from the Disc Diffusion Method except that the zone of inhibition was greater (Table 2). The ethanol extract of *C. esculentus* was the most active against *Salmonella typhi* and the result was similar to that

obtained from the antibiotic control ciprofloxacin. This indicates the high potency of the plant extract. Isolating and purifying the bioactive compounds may lead to the development of another suitable antibiotic against *S. typhi.*

The observed mild inhibitory activities of most of the tested extracts on the growth of the microbes possibly suggest that the use of these extracts at higher concentrations may be very effective. This is indicated by their use by the traditional medicine practitioners. Amongst the Gram-positive and Gram-negative bacteria, the Gram-positive bacterium (*Staphylococcus aureus*) was more susceptible to the extracts with 100% susceptibility as compared to the Gram-negative bacteria (*Salmonella typhi* and *Escherichia coli*) 66.7 and 91.8% susceptibility, respectively. This observation agrees with earlier research that plant extracts are more active against Gram-positive bacteria than Gram-negative bacteria (Vlietinck *et al*., 1995; Rabe and van Staden, 1997).

The result of phytochemical screening showed that *C. esculentus* contained higher number of variety of phytochemicals than *C. rotundus* and *Mariscus alternifolius*. *C. esculentus* had a record of five phytochemicals (carbohydrates, ketose sugars, tannins, flavonoids and steroids), *C. rotundus* and *Mariscus alternifolius* had two (tannins and reducing sugars) and one (reducing sugars), respectively (Table 4). According to the antimicrobial assays, it can be suggested that most of the phytochemicals in *C. esculentus* do not possess bioactive forms except against *S. typhi.* The steroids, carbohydrates and ketose sugars may be responsible for this activity because these compounds are used in the production of phytoalexins in plants. Phytoalexins are antimicrobial substances synthesized by plants that accumulate rapidly at areas of incompatible pathogen infection (Kodera *et al*., 2002). The presence of tannins and flavonoids suggests that the class of tannins present in this plant is made up of non-hydrolysable or condensed tannins which are effective anti-infective compounds (Okigbo *et al*., 2009). Further, research needs to be conducted in this area to determine the phytoalexins and tannins present in this plant through their isolation and purification. *C. rotundus* contained reducing sugars and tannins. The class of tannins may be responsible for the anti-diarrhoeal potential of the plant (Akiyama *et al*., 2001). Also, the combination of the reducing sugars constitute a building block for the production of phytoalexins and this may be responsible for the high antimicrobial potency of the plant (Kodera *et al*., 2002). *Mariscus alternifolius* contained only reducing sugars. This phytochemical is probably responsible for the plants' high inhibitory activity against *E. coli*. Also, further research needs to be done on this plant to exploit its antimicrobial potential. None of the plant extracts contained alkaloids, anthraquinones, saponins and terpenoids which have been reported in other plants with anti-microbial properties (Opara *et al*., 2012) suggesting the diversity of possible anti-microbial drugs. These sedge species particularly *C. rotundus* are potential sources of bioactive compounds needed in the synthesis of antibiotics against the tested pathogens.

CONCLUSION

To verify the claimed and reported medicinal uses of some sedges, the antimicrobial properties and phytochemicals present in the extracts of *Cyperus esculentus*, Cyperus rotundus and *Mariscus alternifolius* were investigated.

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