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Research Article

COMPARATIVE PHYTOCHEMICAL AND NUTRITIONAL ANALYSIS OF *CYPERUS ESCULENTUS* L. AND *CYPERUS ROTUNDUS* L. (*CYPERACEAE*)

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ABSTRACT

Background to the study: The provision of adequate and sufficient nutrition is of paramount importance, especially in developing nations. Thus to ensure the provision of proper and adequate nutrition to such populations, exploitation of underutilized food varieties is crucial; however, *Cyperus esculentus* is widely consumed in Nigeria but its close relative *Cyperus rotundus* is sparingly eaten.

Materials and Methods: The phytochemical and nutritional compositions of two *Cyperus* species, namely, *C. rotundus* (nutsedge) and *C. esculentus* (tiger nut) of *Cyperaceae* were evaluated using high-performance liquid chromatography.

Results: The phytochemical analysis reveals total alkaloids, flavonoids, phenolics, and glycoside concentrations (g/100 g) of 14.14, 35.55, 29.23, and 14.74, respectively, in tiger nut while that of nutsedge is 16.44, 38.68, 23.23, and 13.26, respectively. Tiger nut vitamin composition includes Vit. B1 3.00%, Vit. B2 0.72%, Vit. B3 0.042%, Vit. B6 0.93%, Vit. B12 4.00%, Vit. C 0.07%, and Vit. E 0.05% while that of nut sedge includes Vit. B1 1.00%, Vit. B2 0.0.97%, Vit. B3 0.05%, Vit. B6 1.00%, Vit. B12 3.00%, Vit. C 0.10%, and Vit. E 0.03%. The concentration of these vitamins (Vit.) in both species was relatively low compared to Vit. A with 19.02% in tiger nut and 15.02% in nutsedge. Other phytochemicals detected include saponins (5.00 ppm for tiger nut and 7.00 ppm for nutsedge), tannins (6.00 ppm for tiger nut and 8.00 ppm for nutsedge), oxalate (4.01 ppm for tiger nut and 3.01 ppm for nut edge), and phytates (6.04 ppm for tiger nut and 7.05 ppm for nutsedge).

Conclusion: The presence of these phytochemicals confirms the medicinal abilities of these two *Cyperus* species.

Keywords: Phytochemicals, *Cyperus*, Vitamin, Tiger nut, Nutsedge.

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INTRODUCTION

The provision of adequate and sufficient nutrition is of paramount importance, especially in developing nations (FAO, 2013). Thus to ensure the provision of proper and adequate nutrition to such populations, exploitation of underutilized food varieties is crucial (Enujiugha and Agbede, 2000). *Cyperaceae* family is a group of monocotyledonous flowering plants known as sedges. The family is large with up to 5000 species separated into about 90 genera (Christenhusz and Byng, 2016). Common genera include *Carex* being the largest with about 2000 species, followed by *Cyperus*, *Kyllinga*, *Eriophorum*, *Cladium*, *Lepidosperma*, etc. These species are widely distributed with many occurring in Tropical Africa, Asia, and South America. Perennial herbs are propagated by rhizomes or tubers.

Cyperus belongs to the family *Cyperaceae* which includes approximately 3000 species of which about 220 species are identified as weeds and of which 42% of these are in the genus *Cyperus* (Bendixen *et al*., 1987; Srivastava *et al*., 2013). The names "nut grass" and "nutsedge" (shared with the related species *Cyperus esculentus* L.) are derived from its tubers that somewhat resemble nuts, although, botanically, they have nothing to do with nuts (Singh *et al*., 2016). In Asia, particularly India and China, it is also considered as one of the most important medicinal plants which are traditionally in use for the cure of different ailments (Muhammad *et al.,* 2020; Baloch *et al.,* 2015). *Cyperus rotundus* was used for stomach disorders, nausea, vomiting, intestinal parasites, food poisoning, indigestion, and irritation of the bowel (Al-Snafi, 2015). The whole plant extract is used as anti-nociceptive (Imam, 2014) and as a tonic for the liver and heart, a digestion stimulant, and aid against hypertension (Bhaskar *et al*., 2015). The foliage parts and seeds of *C. rotundus* L. are rich in oily substances which are useful for the cure of different ailments of the digestive system (Nima, 2008). It has been reported that the oil gotten from *C. rotundus* has bacteriocidal and fungicidal properties. Hexane extracts of the tubers were effective at all doses when screened as a mosquito vector repellant (Singh *et al*., 2016). The tuber portion is used as antimalarial (Thebtaranonth *et al*., 1995). The leaves were found to potentiate the sleeping time induced by standard hypnotics (Pal *et al.,* 2009) as a food flavor, especially in the Middle East and Southeast Asia (Bhaskar *et al*., 2015). It is suggested that the plants have the ability to inhibit *Streptococcus mutans*, a bacteria that cause tooth decay (ScienceDaily, 2014). A relative to *C. rotundus,* it is popularly known in Nigeria as "*Aya*" in Hausa,"*Ofio*" in Yoruba, and "*Akiawusa*" in Igbo where these varieties (black, brown, and yellow) are cultivated (Umerie *et al*., 1997; Defelice, 2002), also as rush nut, yellow nutsedge, *Chufa* in Spain, Chufa sedge, Earth almond, and edible *Cyperus*. The nuts are often eaten raw as an unprocessed snack due to their rich flavor and texture. It is a tuber that grows freely and is consumed widely in Nigeria, other parts of West Africa, East Africa, and parts of Europe, particularly Spain as well as in the Arabian Peninsula (Abaejoh *et al*., 2006). Because of its ecological plasticity and its invasive capacity, this plant is considered a weed or a crop depending on the context (De Castro *et al*., 2015).

Many sedges are used as foods, food additives, drinks, fibers, animal poisons and in the manufacturing of items including paper, perfumes, medicines, mats, boats, shoes, ropes, and clothing (Charles and Richards, 2008). They have excellent nutritional qualities with a fat composition similar to olives and a rich mineral content. *Lepidosperma gladiatum* and *Lepidosperma viscidum* were investigated and found to be active against a range of Gram-positive bacteria (Panche *et al*., 2016). *Kyllinga nemoralis* was found to have analgesic, antidiabetes, anticancer, antioxidant, and antimalarial properties (Raju *et al*., 2011). Tubers of edible *Cyperus* species are used in the treatment of fever,

arthritis, treatment of diarrhea, and blood disorders. These species are able to carry out vast pharmacological functions due to their chemical constituents. Plant synthesized products known as secondary metabolites that have been proven to be essential in the treatment of many diseases and serve many health functions to man. They also provide protective effects against viruses, bacteria, and protozoan parasites (Gallego-Marin *et al.*, 2018). These metabolites are classified into alkaloids, saponins, cardiac glycosides, flavonoids, and phenolic acids. Many alkaloids are used in medicine as analgesics, anticancer agents, suppressants, and sedatives. Phenols have antimicrobial, antiviral, and anti-inflammatory properties. They also act as oxidants. Terpenoids are known to be of commercial importance to the cosmetic and fragrance industry. Glycosides are important plant products used in the treatment of cardiovascular problems. Edible tubers of the *Cyperaceae* family are known to contain high vitamin and mineral value. *Eleocharis dulcis* has an energy value of up to 406 kJ, high amounts of Vitamin A, Vitamin B, and Vitamin C. Vitamins are necessary as they help in normal cell function, growth, and development.

Species of the *Cyperaceae* family have been known as weeds but have also been used as food and medicine for ages (Abaejoh *et al*., 2006; Charles and Richards, 2008; Nima, 2008; Baloch *et al*., 2015; Bhaskar *et al*., 2015). However, *C. esculentus* is widely consumed in Nigeria but its close relative *C. rotundus* is sparingly eaten because of a lack of knowledge of its nutritional composition. This study is carried out to analyze the inherent phytochemical contents and essential vitamins of the species *C. esculentus* and C*. rotundus,* two common species in the Niger Delta region of Nigeria.

MATERIALS AND METHODS

Collection of plant material

C. rotundus were collected from the Niger Delta Development Commission (NDDC) hostel in the University of Port Harcourt while *C. esculentus* was sourced from the Mile 1 market, Port Harcourt. They were authenticated by the Curator in the Department of Plant Science and Biotechnology Herbarium. The fresh nuts were washed with distilled water and used for the phytochemical analysis using high-performance liquid chromatography (HPLC) and vitamin content analysis.

Phytochemical methods

Alkaloids determination

A 5 g of the defated nut was weighed into a flask. A 100 ml of 12% alcohol was added, shaken, and filtered. This was thereafter washed with 20 ml of industrial alcohol. The extracted residue was washed into flasks with 50 ml of ammonia-water (i.e., use ultrapure water), heated in boiling water for 20 min, and cooled. A 0.1 g of diastase (+water) was added and the temperature was maintained at 50–55°C for 2 h. At the expiration of 2 h, the sample was allowed to cool and made up to 250 ml with ultrapure water, swirled, and filtered. A 200 ml of the filtrate was mixed with 20 ml hydrochloric acid (spp. g. 1.125), heated in boiling water for 3 h, cooled, neutralize with sodium hydroxide solution, made up to 250 ml, shake centrifuge, and decanted. The supernatant was used for alkaloid determination using water 616/626 HPLC with the nitrogen gas flow rate of 40 ml/min, detector temperature of 170°C, injection port temperature of 190°C, and column temperature of 125°C (Ezeonu and Ejikeme, 2016).

Phenolics determination

A 2 g of the sample was weighed into a set of test tubes. A 3 ml of 70% acetone and water were nest added to the test tube, placed in an ultrasonic water bath at 10°C for 5 min. The sample was stirred occasionally with a glass rod and filtered through a 50–60 p Gooch crucible into a 50 ml Erlenmeyer flask. Steps (ii) and (iii) were was stirred occasionally with a glass rod and less mine repeated 3 times and the test tubes with the final rinsed with 3 ml portion of 70% acetone in water and emptied into the test tubes. A 2 ml of 0.1M yb acetate and 15 ml of 0.1M TEA reagent were added into the filtrate. Thereafter, the contents of the test tube were transferred into a volumetric flask, closed with a rubber stopper swirled, shaken for 20 min, and allowed to settle for 4 h. The supernatants were collected for analysis using HPLC (Water 616/626) with the argon gas flow rate of 60 ml/min, detector temperature of 120°C, injection port temperature of 155°C, and column temperature of 117°C (Ezeonu and Ejikeme, 2016).

Glycosides determination

A 0.5 g of sample each was weighed into a set of digestive tubes. A 5 ml of 0.1M HCI was added and warmed gently for 15 min at 105°C and transferred into a 50 ml volumetric flask. Steps (i) and (ii) above were repeated twice, rinsed with two to three additional aliquots allowed for complete filtration and the filtrate made up to 100 ml mark with the extractant solution and mixed thoroughly. A 5 ml of extract solution from the 100 ml flask was purified by running it through a 2 cm layer (the resin is packed on a macropipette tip) cation exchange resin. The glycoside compounds were eluded with 10 ml of absolute ethanol, the ethanol washed from the column ultrapure water (10 ml), supernatant transferred to a sample vial and ran on HPLC with (Water 616/626) with the nitrogen gas flow rate of 38 ml/min, detector temperature of 167°C injection port temperature of 183°C, and column temperature of 130°C (Ezeonu and Ejikeme, 2016).

Flavonoid determination

A 1.5 g of sample was weighed into a set of extraction tubes. A 20 ml of boiled ultrapure water dispensed into each extraction tube, allowed to stand 1/2 h, vortexed for 5 min, and transferred to a set of centrifuge tubes, shake for 15 min, and centrifuged for 5 min at 3000 rpm. Thereafter, the supernatant was transferred to a set of vials and determined on water 616/626 HPLC with the nitrogen gas flow rate of 60 ml/min, detector temperature of 147°C, injection port temperature of 166°C, and column temperature of 115°C (Ezeonu and Ejikeme, 2016).

Determination of vitamins

The extraction and determination of Vitamins A, B_2, B_6, $B_{12,}$ and E were according to the method described by Okonwu *et al.* (2018a, 2018b) while Vitamin C was determined using the titrimetric method (Okwu, 2004).

Vitamin A extraction and determination using Waters 616/626 HPLC

Plant sample (0.5 g) was weighed into a conical flask, 20 ml of 0.2*N* HCl dispensed, and allowed to stand for 1.5 h. The solution was cooled and the pH adjusted to pH 6, using NaOH. Furthermore, 1*N* HCl was added to lower the pH to 4.5. The solution was made up to 50 ml, shook, and centrifuged for 10 min at 3000 rpm. The supernatant was separated, 1 ml of acetic acid (CH_3COOH) was added and mixed properly. Furthermore, 0.5 ml of 3% H_2O_2 was added and mixed well. Finally, 20 mg of sodium hydrogen sulfate was added and then shaken properly. The extract was run on HPLC (Waters 616/626). Water 616/626 accessories used had Merck Lichrospher WOCH-18/2 (5 µm) at 40°C column (stationary phase) and a mobile phase (Solvent "A" was 30 mM sodium acetate, pH 6.5 containing 5% dimethylformamide and solvent "B" was acetonitrile) with fluorescence detector, range of working standard (0, 2, 4, 6, and 8 ppm) and determination was carried out at a wavelength of 328 nm.

Vitamins B_1, B_2, B_3, B_6, B_9, and B_{12} combined extraction and determination using Waters 616/626 HPLC

Plant sample (2.5 g) was weighed into a set of digestion tubes, and an extraction solution (Ultra-pure water: HCl: 0.1*N* H_2SO_4, in the ratio 5:2:3) dispensed. The tube was warmed at the temperature of 40°C for 2 h, allowed to cool to room temperature, and transferred to a set of plastic centrifuged tubes. The latter was shaken for 10 min and centrifuged at 3000 rpm. The supernatant was set in autoanalyzer

tubes and ran on HPLC. Water 616/626 accessories used had Merck Lichrospher WOCH-18/2 (5 µm) at 40°C column (stationary phase) and a mobile phase (solvent "A" was 30 mM sodium acetate, pH 6.5 containing 5% dimethyl formamide and solvent "B" was acetonitrile) with fluorescence detector, range of working standard (0, 0.2, 0.4, 0.6, and 0.8 ppm) and determination was carried out at wavelength range of 240–465 nm.

Vitamin E extraction and determination using Waters 616/626 HPLC

Plant sample (0.5 g) each was weighed into a set of digestion tubes, 20 ml of diluted hydrochloric acid (HCl) added and shook vigorously for 2 h. The extract was further treated with phosphatase to liberate free Vitamin E into the solution. The extract was purified by passing through the Base Exchange silicate alkaline column to remove interfering compounds. Thereafter, the extract was stored in a set of vials for analysis using HPLC. Water 616/626 accessories used had Merck Lichrospher WOCH-18/2 (5 µm) at 40°C column (stationary phase) and a mobile phase (Solvent "A" was 30 mM sodium acetate, pH 6.5 containing 5% dimethylformamide and solvent "B" was acetonitrile) with fluorescence detector, range of working standard (0, 0.2, 0.4, 0.6, and 0.8 ppm) and determination was carried out at a wavelength of 356 nm.

RESULTS

The result of the phytochemical and vitamin analysis on *C. rotundus* and *C. esculentus* shows essential vitamins such as Vitamins A, B1, B2, B3, B6, B12, C, and E including different types of alkaloids, phenols, glycosides, and anti-nutrients.

Phytochemicals constituents

Different types of phytochemicals were detected in the plant species analyzed. Four major groups which include alkaloid, flavonoid, phenols, and glycosides were identified. The highest composition of alkaloids and flavonoids was found in *C. rotundus* while glycosides and phenols were more composited in *C. esculentus* (Fig. 1).

Alkaloids

The total concentration of alkaloids found in *C. rotundus* was 16.44 g/100 g while *C. esculentus* has a concentration of 14.14 g/100 g. Different types of alkaloids were identified. Alkaloid types varied in composition among the two species. *C. esculentus* had higher concentrations of apomorphine (0.07 g/100 g), nicotine (0.03 g/100 g), piperidine (0.05 g/100 g), and iodine (0.19 g/100 g). In *C. rotundus*, the concentration varied from atropine (0.78 g/100 g), quinine (0.04 g/100 g), and vincristine (0.04 g/100 g) (Fig. 2). Equal amounts of concentrates were noticed in quinidine (0.001 g/100 g) and ricinine (0.003/100 g).

Flavonoids

C. rotundus has a higher concentration of total flavonoid constituents (38.68 g/100 g) and has high concentrations of epigallocatechin (11.03 g/100 g) and tangeretin (0.31 g/100 g). *C esculentus*, with flavonoid constituents of 35.55 g/100 g, has the following concentrations of types of flavonoid; theaflavins (0.04 g/100 g), taxifolin (4.02 g/100 g), and epicatechin gallate (0.03 g/100 g). Equal amounts of concentrates were found in acacetin (0.004/100 g) and thearubigins (0.002 g/100 g) (Fig. 3).

Glycosides

Different glycoside types were identified in both species studied (Fig. 4). Digoxin acid was the highest in concentration in both species with *C. esculentus* having 5.32 g/100 g and *C. rotundus*, 8.16 g/100 g while lisinopril acid [*C. esculentus* (0.003 g/100 g); *C. rotundus* (0.001 g/100 mg)] and propranolol acid [*C. esculentus* (0.003 g/100 g); *C. rotundus* (0.001 g/100 mg)] were the least concentrated. *C. rotundus* has concentrations of 0.01 g/100 g for furosemide acid, 0.03 g/100 g for metoprolol acid, and 1.04 g/100 g for glycyrrhizic acid. *Cyperus esculentus* has high concentrations of captopril acid (0.03 g/100 g) and verapamil acid (0.93 g/100 g).

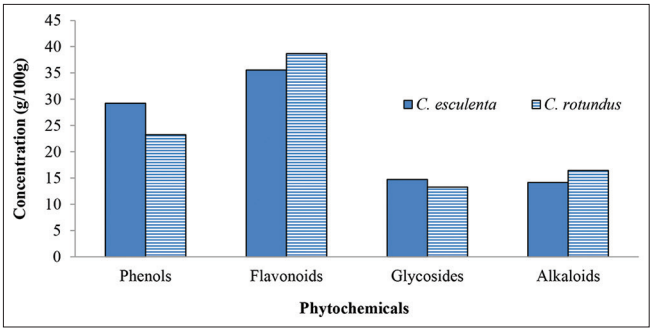

Fig. 1: Percentage composition of different phytochemicals in *Cyperus* species

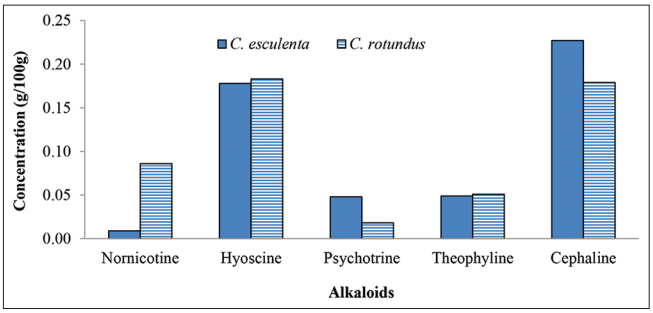

Fig. 2: Composition of different types of alkaloids

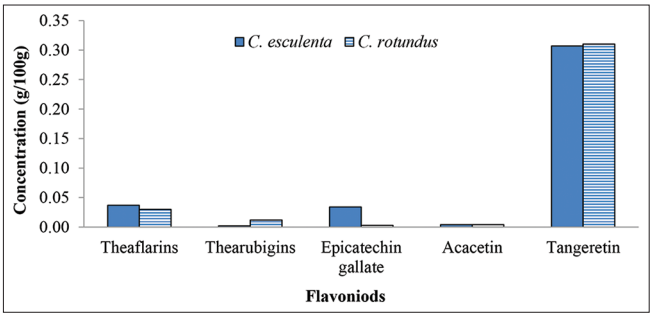

Fig. 3: Composition of different types of flavonoids

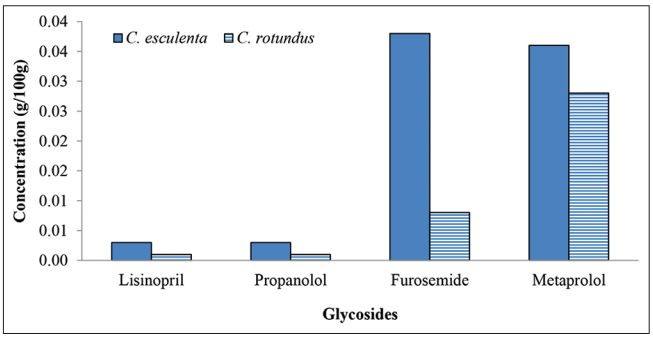

Fig. 4: Composition of different types of glycosides

Phenolic acids

Higher total phenolic content was observed in *C. esculentus* (29.23 g/100 g). *C. rotundus* has a total phenolic content of 23.23 g/100 g

with higher concentrations of the following acids; cinnamic acid (0.07 g/100 g), genticitic acid (0.18 g/100 g), and piperonic acid (0.02 g/100 g). *C. esculentus* have greater concentrations of benzoic acid (0.08 g/100 g), homogentisic acid (0.42 g/100 g), and mandelic acid (5.03 g/100 g) (Fig. 5).

Other phytochemical compounds

Other classes of phytochemicals detected included; phytate (*C. esculentus*, 6.04 ppm; *C. rotundus*, 7.05 ppm), oxalate (*C. esculentus*, 4.01 ppm; *C. rotundus*, 3.01 ppm), tannin (*C. esculentus*, 6.00 ppm; *C. rotundus*, 8.00 ppm), and saponin (*C. esculentus*, 5.00 ppm; *C. rotundus*, 7.00 ppm) (Fig. 6).

Vitamin percentage composition

Both species have high percentage composition of Vit. A, *C. esculentus*, 19.02% and *C. rotundus* 15.02%. Minimal variations in Vit. B3 (*C. esculentus*, 0.04%; *C. rotundus*, 0.05%), Vit. B6 (*C. esculentus*, 0.93%; *C. rotundus*, 1.00%), and Vit. C (*C. esculentus*, 0.07%; *C. rotundus*, 0.10%) (Fig. 7). *C. esculentus* has Vit. B1 3.00%, Vit. B2 0.72%, and Vit. B12 4.00% while *C. rotundus* has Vit. B1 1.00%, Vit. B2 0.97%, and Vit. B12 3.00%. Vit. E had the lowest values in both species, namely, 0.05% for *C. esculentus* and 0.03% *C. rotundus.*

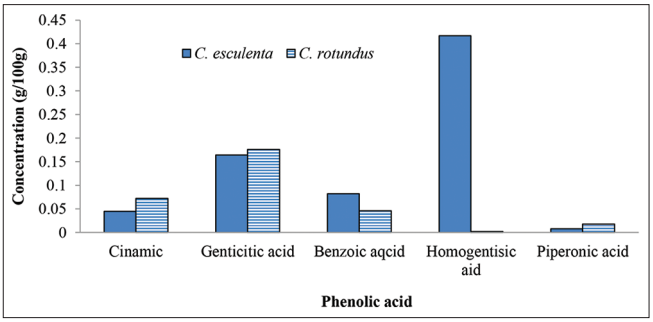

Fig. 5: Composition of different types of phenolic acid

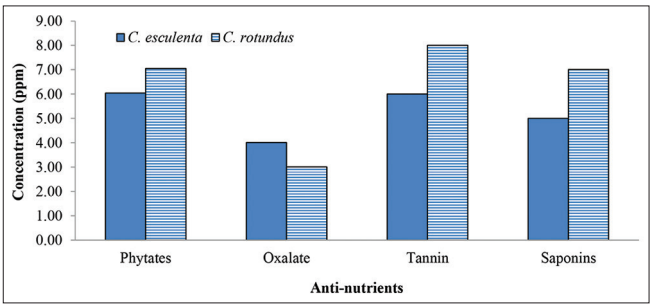

Fig. 6: Composition of different other phytochemicals (anti-nutrients) observed

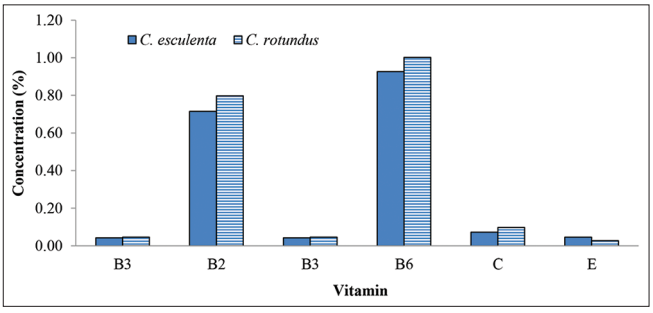

Fig. 7: Percentage composition of different of vitamins in *Cyperus* species

DISCUSSION

From the HLPC phytochemical analysis done on two different species of *Cyperus* (*C. rotundus* and *C. esculentus*), different classes of alkaloids, flavonoids, glycosides, phenolics, and other secondary metabolites were identified. *C. rotundus* and *C. esculentus* have been of great benefit to man for ages and have been used as both medicine and food. The properties of these tubers that make them useful for food and medicine can be attributed to their phytochemical constituent. From our analysis, *C. esculentus* have a higher amount of phenolic acids (29.234 g/100 g) and glycosides (14.737 g/100 g) while *C. rotundus* has higher amounts of alkaloids (16.437 g/100 g) and flavonoids (38.680 g/100 g). Flavonoids are important antioxidants and promote several health benefits such as antiviral, anticancer, anti-inflammatory, and anti-allergic activities. Functional hydroxyl groups in flavonoids mediate their antioxidant effects by scavenging free radicals and/or by chelating metal ions (Kumar and Pandey, 2013; Kumar *et al.*, 2013). The abundance of flavonoids coupled with their low toxicity relation to other plants means that they can be consumed in large amounts by animals including man (Panche *et al.*, 2016). Numerous studies have suggested protective effects of flavonoids against many infectious diseases and degenerative diseases such as cardiovascular diseases, cancer, and other age-related diseases (Kumar and Pandey, 2013). Alkaloids are secondary metabolites widely distributed in plants that synthesize them. Alkaloids display antimicrobial and anti-parasitic properties, act as narcotics, have an important role in immune systems, and treat cardiovascular disease and miscellaneous problems (Sahyan *et al.*, 2017). Alkaloids have potential therapeutic effects on neurodegenerative diseases (NDDs) (Xiaomeng *et al.*, 2018). Pharmacological effects of alkaloids include analgesic, anticancer, antiarrhythmic, and antibacterial. They also exhibit neuroprotective activities (Xiaomeng *et al.*, 2018). Cardiac glycosides are chemical compounds primarily valuable for the roles they play in the treatment of congestive heart failure (Morsy *et al.*, 2017). Cardiac glycosides slow down the heartbeat and exhibit inotropic, positive bathmotropic, weakly negative chronotropic, and dromotropic heart activity (Wink, 2015). Pharmacological activities exhibited by phenolics include antioxidant, anti-inflammatory, sedating, wound healing, antimicrobial, and antiviral activities (Winks, 2015). Previous phytochemistry of *C. rotundus* tubers revealed the presence of polyphenol, flavonoids, glycoside, alkaloid, saponins, terpenoids, and essential oils (Nagulendran *et al*., 2007). It is also found to contain proteins (Oderinde *et al*., 1989) and traces of Mg, Vs, Cr, Mn, and Co (Subhashini *et al*., 2014). The plant has a high amount of carbohydrates (Gambo and Dalu, 2014). Oladunni *et al.* (2011) reported the following results; *C. rotundus* is rich in moisture (24.73 ± 0.28), fat (29.48 ± 0.33), fiber (12.63 ± 0.01), and carbohydrate contents (21.47 ± 0.83), high sodium concentration, followed by potassium and substantial amounts of magnesium, copper, and calcium. These findings corroborate with our result on *C. rotundus.*

Vitamins A, B1, B2, B3, B6, B12, C, and E were detected in *C. rotundus* and *C. esculentus*. Vitamin C is an antioxidant that promotes healthy teeth and gums. It is also important for wound healing. Detected in little quantities, Vitamins C and E as antioxidants work together against free radicals. Vitamin E helps the body form blood cells. Vitamin E is thought to have a preventive effect against aging, cardiovascular diseases, and cancer (Wardlaw and Kessel, 2002). Vitamin B1 helps the body cells change carbohydrates into energy. It is also essential for heart function and healthy nerve cells. Vitamin B6 helps form blood cells and maintains brain function. This vitamin also plays a key role in the proteins that are part of many chemical reactions in the body. Vitamin B12 is important in metabolism and helps maintain the central nervous system. Vitamin B2 is essential for energy production and helps the body break down fats, drugs, and steroid hormones. Vitamin B3 maintains healthy skin and nerves. Both species of *Cyperus* have Vitamin A with *C. esculentus* having a higher percentage composition of 19.015% while *C. rotundus* has a composition of 15.024%. Vitamin A forms part of the visual pigments of the eye, it maintains healthy teeth, skin, bones, and mucous membrane.

Other phytochemicals detected in both species include saponins which are used medically as anti-inflammatory and immune stimulating (Tamura *et al*., 2012) and tannins have many pharmacological effects such as antioxidants, anti-inflammatory, antibacterial, antiviral, cytotoxic, and antiparasitic activities (Winks, 2015). Phytate is considered an anti-nutrient because it binds minerals in the digestive tract, making them less available to our bodies. However, research has shown that they help in protective properties against cardiovascular disease, cancer, and diabetes. Oxalic acid when bound with minerals forms oxalate. Like the phytates, they reduce the availability of minerals in the guts. They could cause kidney stones in humans.

CONCLUSION

C. esculentus and *C. rotundus* both have high pharmacological and nutritive effects evident from their phytochemical and vitamin contents. The tubers may be taken as a snack, processed into a drink, and other forms of food for man's consumption. *C. rotundus* could be consumed the same way as *C. esculentus* due to its similar phytochemical and vitamin contents.

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