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Evaluation of the Tubers and Oil of *Cyperus rotundus* Linn (CYPERACEAE)

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Abstract: The proximate analysis of *Cyperus rotundus* tubers were evaluated and the composition was found to be: 9.0±0.80, 1.75±0.55, 9.50±0.86, 7.87±0.92, 17.48±1.04 and 63.60±1.52% for moisture, crude protein, oil, ash, crude fibre and carbohydrate respectively. The quality of the oil extracted by Soxhlet was assessed in terms of acid value, free fatty acid content, iodine value, saponification value and specific gravity. Results showed that the oil has a low iodine number thus placing it as a non-drying oil, stable and reduced degree of unsaturation. The saponification value and the heat of combustion, implicated the oil as non-edible but can be used for making alkyd resin, shampoo and soaps. The phytochemical constituents; terpenoids, tannins and flavonoids are also implicated in the allelopathic properties of the tubers.

Key words: *Cyperus rotundus* tubers, proximate evaluation, oil extraction, characterization

INTRODUCTION

Cyperus rotundus Linn (Nutgrass), a grass-like plant of the family Cyperacea (Sedge family), order Cyperales or graminales (Lowe and Standfield, 1974). The Plant is one of the most invasive weeds known, having spread out to a world-wide distribution in tropical and temperate regions. *C. rotundus* has been called “the world’s worst weed” as it is known as a weed in over 90 countries and infests over 50 crops worldwide (Anon, 2006). Like other sedges, the plant is mostly found growing in farmlands, pastures, wastelands, sandbeds, damp and marshy places (Swift, 1989). The plant is an annual, growing to heights between 20 and 40 cm and produces prominent subterraneous swollen tuberous bases. These tuberous bases remain dormant after the growing season and in adverse conditions and are linked together in a chain by short lengths of thin rhizomes. (Umerie and Ezeuzo, 2000). The existence of the plant in a field significantly reduce crop yield, both because it is a tough competitor for ground resources and because it is allelopathic, the roots releasing substances harmful to other plants. Similarly, it has also been reported to have a bad effect on ornamental gardening. The difficulty in controlling the spread is a result of its intensive system of underground tubers and its resistance to most herbicides. Herbicides may kill the plant’s leaves, but most have no effect on the root system and the tubers. In addition, the tubers can survive harsh conditions, further contributing to the difficulty in eradicating the plant (Anon, 2006). The tubers (seeds) of *C. rotundus* has been reported to contain sesquiterpenes, hydrocarbons, epoxides and ketones, and also used as anti-inflammatory estrogenic, antipyretic, antiemetic, diuretic, hypotensive agent (Aslam, 2002). Apart from the documentation on the physicohemical characterization and utilization of *C. rotundus* starch by Umerie and Ezeuzo (2000), there is no report on the proximate composition of *C. rotundus* tubers; characterization and utilization of oil fraction; hence the present investigation and possible applications.

MATERIALS AND METHODS

Sample of *C. rotundus* tubers: Tuberous roots of the plant were harvested from farmlands, wastelands in Awka, Anambra State, Nigeria. They were sun-dried, sorted and the fibrous appendages removed. The samples were milled to a fine powdered state using a Moulinex Type 276 mill and stored in a well-stoppered container in a refrigerator prior to subsequent analysis.

Proximate analysis of the tubers: The standard procedures described by Egan *et al*. (1981) and the AOAC methods (1975) were used for the determination of moisture, ash, fibre, fat and total crude nitrogen contents. The soluble protein content was determined by the Folin-Lowry method described by Plummer (1987). The carbohydrate fraction was obtained by subtracting the sum of protein, fat and fibre from total dry matter. Reducing sugars as D-glucose, were determined by the method of Bernfeld (1955). The gross energy was obtained by multiplying the mean value of the protein, fat and carbohydrates by Atwater factors and expressing the sum of the products in kilocalories (Davidson *et al*., 1975; Osborne and Voogt, 1978).

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Physicochemical properties of *C. rotundus* oil: The crushed tubers were extracted with petroleum ether (60-80) in a Soxhlet. The solvent was then distilled off at 80°C and the oil content calculated from the weight of oil and weight of the milled tuber sample used.

The acid, iodine and saponification values of the oil were estimated by standard procedures described by Plummer (1987) and Lambert and Muir (1968). The Free Fatty Acid (FFA) was calculated from the relationship given by Norris (1995): 1 unit of Acid value = 0.503% FFA. (calculated as Oleic acid). The specific gravity was determined by the method of Williams (1966). The ester value was obtained by subtracting the acid value from the saponification value (Baltes, 1964) and the heat of combustion from the Bertram's formular given by Norris (1995): heat of combustion = 11380 - iodine value - 9.15 (saponification value). Density at 15°C (d^{15}) was computed from Lund's correlation given by Norris (1995); d^{15} = 0.8467 + 0.00030 (Saponification value) + 0.00014 (iodine value).

Production of alkyd resin: The alcoholysis method was used with known amounts of the oil, glycerol and phthalic anhydride fed into a three-necked flask connected to a CO_2 has inlet and heated. The resultant resinous product was thinned with benzene and then pigmented (Chatterjee, 1952).

RESULTS AND DISCUSSION

The proximate composition of *C. rotundus* tubers and the standard values for a plant material are summarized in Table 1. Table 2 shows the physico-chemical properties of the oil. The phytochemical components of *C. rotundus* extract is given in Table 3, while Table 4 is the formulation of the resinous product from the *C. rotundus* oil.

C. rotundus tubers were found to be rich in carbohydrate reserves as with starchy tubers (Table 1). This supports the work of Umerie and Ezeuzo (2000) who reported starch yield (24.1%) and found the starch to be of good quality, with high gelatinization temperature, high adhesive and tensile strengths. The crude fibre content was also found to be high thus the material can serve as a good source of fibre in foods (Davidson *et al*., 1975). The ash content suggests the presence of mineral elements in fairly good amounts. The crude protein was far too small while the value for the non-protein nitrogen was high. The latter case indicates the greater presence of non-protein nitrogenous compounds including amines, alkaloids, cyanogenic glycoside, indole, purines, pyrimidines and cytokinnins (Harborne, 1998). The *C. rotundus* tubers oil has a brown colour (Table 2) with a characteristic pungent odour, suggesting the presence of an essential oil that possibly has medicinal properties (Anon, 2006). The oil can be classed as a stable, non-drying oil as implicated by low iodine value (<90, of low unsaturation and as an oleic-linoleic acid oil (Norris, 1995; Baldwin and Formo, 1982). The heat of combustion (10080.40 gcal/g) which is greater than the approximate value for edible oil 9500 gcal/g (Norris, 1995) and the saponification value (136.00) which lies outside the range for most edible oils and fats (180-200) also implicated the oil as non-edible oil (Glasser, 2008). However, the oil can be used in the formulation of shampoos and alkyd resin (Fasina, 1989).

Table 1: Proximate composition of *C. rotundus* tuber compared with standard values for *C. esculentus* (g/100 g dry basis)

	Plant materials	
Parameters	*C. rotundus* tuber	*C. esculentus* tuber[b]
Moisture	9.0±0.50	3.63
Crude protein (N x 6.25)	1.75±0.55	2.68
Fat/oil	9.50±0.86	29.67
Ash	7.87±0.92	2.48
Crude fibre	17.48±1.04	12.88
Carbohydrate	63.60±1.52	52.29
Total nitrogen	20.53±2.07	-
Non-prtein nitrogen	20.25±0.09	-
Reducing sugar as D-glucose (mg/g)[a]	14.04	-
Gross energy (K Cal/100 g)	346.90±2.08	486.91

[a]Values is mean of two determinations. [b]Umerie *et al*. (1997)

Table 2: Characteristics of *C. rotundus* oil

Parameter	Value
Colour	Brown
Iodine value	55.20±1.85
Saponification value	136.00±2.64
Acid value	0.97±0.21
Free fatty acid	0.47±0.05
Average molecular weight	411.87±8.00
Specific gravity@room tem (30°C)	0.93
Ester value	135.03±2.01
Heat of combustion (gcal/g)	10080.40±21.52
Density @ 15°C (d^{15})	0.94

Values are mean+SD of three estimations

Table 3: Phytochemical components of *C. rotundus* extract[a]

Phytochemical components	Observation
Alkaloids	+++
Glycosides	++
Flavonoids	+++
Tannins	++
Terpenoids	+++
Steroids	+++
Saponins	++

+ = Low concentration; ++ = Medium concentration; +++ = High concentration. [a]Umerie and Emelugo (2007)

Table 4: Formulation of Alkyd resin

Constituent	Composition (%)
Cyperus rotundus oil	64
Phthalic anhydride	20
Glycerol	16
Dye/pigment	q.s

q.s = quantity sufficient

The strong presence of terpenoids and phenolic compounds (flavonoids and tannins) in the phytochemical analysis of the *C. rotundus* tuber extracts. (Table 3) as earlier reported by Umerie and Emelugo (2007) could be responsible for the allelopathic property of the plant. This corroborates the findings of Moore *et al.* (1995) that the terpenoids produced by the soft-leaved purple sage, *Salvia leucophylla* inhibit the growth of near-by plants and that the indole (nitrogenous compound) derivatives Thelypterin A and Thelypterin B diffusing from the roots of saprophytes of *Thelypteris normalis* inhibited the growth of its gametophytes. It is also in keeping with the reports of Mann (1996) that monoterpenes primarily camphor and 1,8-cineole are allelopathic and that many phenolic compounds including juglone from the walnut tree, phlorizin from the apple tree, salicylic acid and scopoletin from the oak tree, arbutin, vanillic acid, ferulic acid, p-hydroxybenzoic acid, p-courmaric acid are broad spectrum allelopathics. Most of the phenolics are stored as water soluble glycosides, thus are more easily leached by rain.

Resins can be applied in the production of paints and varnishes since they serve as binding agents and give gloss to the paint (Uppal, 2005). The tuber oil alkyd resin was of acceptable quality.

Conclusion: The defatted residue of *C. rotundus*, rich in carbohydrates and fibres could be processed further into animal feeds and other forms for diverse purposes, thus suggesting solvent extraction as the most acceptable and economical method of oil extraction relative to those enumerated by Dollear (1977) and Uzo *et al.* (1985). The tubers could therefore serve as a cheap source of raw material for chemical industries. The plant tubers will also serve as source of non-protein nitrogenous phytocompounds whose allelopathic properties will be of great economic value in general agriculture.

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