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Technical Note

Evaluation of the Properties of Yellow Nutsedge *(Cyperus esculentus)* Tuber Oil

ABSTRACT

Non-drying oil extracted from the tuber of yellow nutsedge (Cyperus esculentus) *of Nigerian origin has been analysed for its physical and chemical constants, lipid classes and fatty acid components of the lipid classes. Triglycerides constitute 95% of the lipid classes while polar lipids constitute the remaining 5%. The fatty acid component in the triglycerides of the yellow nutsedge tuber showed individual unsaturated acids to be: oleic, 75·72 ± 0·20%; linoleic, 11·64 ± 0·17%; linolenic, 0·64 ± 0·1%; and saturated fatty acids to be: palmitic, 10·21 ± 0·15%; stearic, 1·47 ± 087% and arachidic, 0·32 ± 0·04%. Percentages of individual fatty acid in the polar lipid were found to be: oleic, 46·9 ± 0·3%; linoleic, 35·3 ± 0·3%; linolenic, 2·6 ± 0·1%; palmitic, 12·4 ± 0·2%; stearic, 2·8 ± 0·1% and a trace amount of arachidic acid. The similarities of the yellow nutsedge oil, in some of these characteristics, to some edible vegetable oils of economic importance are discussed.*

INTRODUCTION

Yellow nutsedge (*Cyperus esculentus*), a perennial plant, is widely distributed throughout the world and constitutes one of the worst known weeds (Lowe, 1973). The tuber, which is also known as *chufa*, is usually grown and harvested during the rainy season. It thrives well on damp, sandy, extremely acidic soils. The plant has been in cultivation in Nigeria since early times for the sake of edible tubers which it bears underground. The tuber forms part of the people's diet when it is eaten raw or baked.

Previous workers have given data on the chemical composition of the

Food Chemistry 0308-8146/88/$03·50

tuber (Power & Chesnut, 1923; Gad & Osman, 1961), and on the oil content as well as the oil production per hectare (Chelowski *et al.*, 1978). The most significant of these findings is the content of 66–68% oleic; 5–6% linoleic and 15–17% palmitic and stearic combined. But none of these previous findings are based on gas–liquid chromatographic analysis. In the present instance, fatty acid composition and lipid classes of yellow nutsedge (*Cyperus esculentus*) of Nigerian origin has been investigated using the standard technique of gas–liquid chromatography. The analysis was, however, preceded by the separation of the oil into lipid classes by thin-layer chromatography.

Current knowledge on *Cyperus esculentus* tuber suggests that its products, most especially the tuber oil, are equal, if not superior, in quality to similar products from other sources (Gad & Osman, 1961). This development calls for a much more detailed study of the characteristics and structure of the oil with a view to enhancing its utilisation. The present investigation was undertaken to provide information on the chemical components of the tuber oil of Nigerian grown yellow nutsedge (*Cyperus esculentus*) as a basis for its utilisation.

MATERIALS AND METHODS

Materials

Collection and sample treatment

Fresh samples of *Cyperus esculentus* tubers were procured from local markets in Bauchi, Ibadan, Offa and Sokoto towns, in Nigeria. The tubers after sampling were soaked in water for 10 min, washed, rinsed and sun-dried in air before being stored in plastic bags. All chemicals used were Analar or GR grades of BDH and E. Merck, respectively, unless otherwise stated. Solvents that were not of analytical reagent grade were purified before use, as described in the literature (Vogel, 1978).

Methods

Extraction and analysis of oil

The dried, thinly scaly, pale tuber was ground in a laboratory grinder to pass through a 100 mesh sieve and subjected to Soxhlet extraction with petroleum ether (b.p. 40–60°C) for 6 h (10 g tuber per 100 ml petroleum ether). Solvent was removed in a rotary evaporator at 40°C and the oil dried to constant weight at 100°C to remove any trace of moisture. The oil received no further heat treatment prior to analysis. Methods for the determination of iodine number (Wij's method), acid value, saponification number, hydroxide number, peroxide number and refractive index were those recommended by the AOAC (1975). To separate the oil into its lipid classes, about 250 mg of dry extract was streaked on plates of 300 μm Si gel. The developing solvent was petroleum ether:diethylether:acetic acid in the ratio 80:20:1, v/v/v. Lipid classes were detected by exposing to iodine vapours. Triglycerides were extracted with four washes of diethyl ether:methanol in the ratio 9:1, v/v. Polar lipids were extracted from the plate with two washes of chloroform:methanol:water in the ratio 50:54:1, v/v/v and one wash of methanol. All samples were kept under nitrogen and sprayed with an anti-oxidant. The polar and triglyceride extracts were methylated according to the procedure described by Metcalfe & Schmidt (1960) and the dry heptane solution of the methyl esters was subsequently analysed on a Pye-Unicam 204 series GLC for its fatty acid components, using a column of diethylene glycol succinate (DEGS, 10%) coated on diatomite (80–100 mesh) at 200°C. Nitrogen was used as the carrier gas at a flow rate of 40 ml per minute. Standards of other acid esters in the samples were routinely chromatographed by GLC to compare retention times and identify unknown acids.

RESULTS AND DISCUSSION

On extraction with petroleum ether (b.p. 40–60°C), the tubers of *Cyperus esculentus* yielded 22·8% of light yellow oil that does not bleach on storage. On analysis by standard procedures, the oil showed characteristics given in Table 1.

Oil content in *Cyperus esculentus* tuber (22·8%) compares well with those of soybean and cottonseed oils (21·0% and 22·9%, respectively) while it is

TABLE 1
Characteristics of the Tuber Oil

Characteristics	*Range*	*Mean ± SD*[a]
Percentage oil content (on dry matter basis)	22·6–22·9	22·8 ± 0·2
Saponification number	193·2–195·6	194·4 ± 1·2
Iodine number	80·2–83·3	82·1 ± 1·3
Hydroxide number	10·3–10·7	10·5 ± 0·2
Peroxide number	5·3–6·9	6·1 ± 0·8
Refractive index (at 25°C)	1·4674	—

[a] Mean of four determinations in triplicate.

TABLE 2
Percentage Fatty Acid Component in Triglycerides and Polar Lipids of *Cyperus esculentus* Tuber Oil (Mean ± Standard error)[a]

Fatty acid[b]	*Triglycerides*	*Polar*
$C_{16:0}$	10·21 ± 0·15	12·4 ± 0·2
$C_{18:0}$	1·47 ± 0·08	2·8 ± 0·1
$C_{18:1}$	75·72 ± 0·20	46·9 ± 0·3
$C_{18:2}$	11·64 ± 0·17	35·3 ± 0·2
$C_{18:3}$	0·64 ± 0·06	2·6 ± 0·1
$C_{20:0}$	0·32 ± 0·04	Trace

[a] Mean of four determinations in triplicate.
[b] $C_{16:0}$ = palmitic acid; $C_{18:0}$ = stearic acid; $C_{18:1}$ = oleic acid; $C_{18:2}$ = linoleic acid; $C_{18:3}$ = linolenic acid, and $C_{20:0}$ = arachidic acid.

more than five times greater than that in corn seed oil (Swern, 1964). The tuber oil has an identical saponification number when compared with those of soybean, corn, cottonseed, and olive oils, while iodine value of the yellow nutsedge oil (82·1) is an indication of the preponderance of unsaturated fatty acids; the iodine value is also similar to that of olive oil (Swern, 1964).

The most abundant fatty acid in the triglyceride fractions of the tuber oil was oleic acid (Table 2). Oleic acid also has been shown to be the most abundant acid in chufa tubers (Gad & Osman, 1961). Polar lipids contained much more palmitic and linoleic acids than did the triglycerides fraction. Linoleic acid was the next most abundant acid after oleic in the polar lipid fraction.

High proportions of oleic, palmitic and stearic acids in the triglyceride fraction of the oil made it of good potential for soap making while the presence of linoleic acid in a significant proportion in both the polar and triglyceride fractions of the oil made it a good dietary lipid because it is known that linoleic acid serves as the carrier of nutritionally essential fat-soluble vitamins (Taylor, 1971).

The production of oil/hectare of the yellow nutsedge has been worked out as 190 kg (Chelowski *et al.*, 1978). This per hectare oil production is greater than that of cottonseed (128·1 kg) and soybean (84·6 kg) (Raie & Manzoor, 1980).

Thus the deliberate cultivation of *Cyperus esculentus* tuber must be intensified if shortage of edible vegetable oils is to be overcome in most tropical and sub-tropical countries of the world. It is our own considered opinion that, aside from its nutritional value, yellow nutsedge tuber could serve as a very good source of vegetable oil. On this score, we believe that increased production of the tuber through vigorous policy and overtime, will eventually lead to high sufficiency in vegetable oils in most tropical and sub-tropical nations of the world.

To further explore the utilisation of this oil, experiments are in progress in our laboratories. Details of this work, together with views on the industrial utilisation of the tuber as a source of vegetable oil, will be communicated shortly.

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