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Quality Assessment of Oil Extracted from Two Species of Malabar Spinach (*Basella alba*)

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Abstract

The study assesses the quality of oil extracted from two species of Malabar Spinach (Green Malabar Spinach and Red Malabar Spinach). The aim of the study is to determine the usefulness of the oils extracted from these two species of Malabar spinach for industrial usage and human consumption while the objectives are; the extraction of oils from the spinaches, determination of free fatty acids profile and evaluation of the usefulness of the extracted oils. Soxhlet apparatus was used for the extraction of the oils with hexane as the extracting medium. Gas chromatogram was used to carry out the fatty acid methyl ester analysis to determine the fatty acid composition of the oils. Both saturated and unsaturated fatty acids were present in both oils. The saturated fatty acids present were; lauric acid, arachidic acid, behenic acid, lignocenaric acid, palmitic acid, stearic acid and myristic acid. The unsaturated fatty acids present were; oleic acid, eicosenoic acid, palmatoleic acid, erucic acid, docosahexanaenoic acid, arachidonic acid, linoleic acid and alpha-linoleic acid. The total unsaturated fatty acid present in both oils amounted to about 52.36% in the green Malabar spinach oil and about 50.7% in the red Malabar spinach oil. The total saturated fatty acid present in the oils amounted to about 21.41% in the green Malabar spinach oil and 22.19% in the red Malabar spinach oil. The total unsaturated fatty acids present in the oils are greater than the total saturated fatty acids in them. Therefore, from this study, it can be recommended that the oils are useful for human consumption and industrial purposes because of the health benefits, lubricating properties and softening properties of the oils.

Keywords: Green Malabar Spinach; Red Malabar Spinach; Saturated Fatty Acid; Unsaturated Fatty Acid and Oils.

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1. Introduction

Malabar spinach *(Basella alba)* is an extremely heat tolerant and fast growing perennial vine belonging to the family *Basellaceae*. It is known as Malabar spinach, Red vine spinach, Creeping spinach, Indian spinach, Ceylon spinach, Chinese spinach, Cyclone spinach and "Amunututu" by the Yorubas of the southwestern Nigeria. It is commonly found in the tropical regions of the world, and is widely used as a leaf vegetable. *Basella alba* is a vigorous soft-stemmed climbing vine and grows up to10m long. It has broad heart-shaped, thick semi-succulent green leaves, 5-12cm wide. The plant is a good source of vitamins A, and C, Iron and Calcium [3]. The leaf juice is used in Nepal to treat catarrh as its pastes are used externally to treat boils. The cooked leaves and stems are used as laxatives while the flowers are locally used as Antidote for poisons. This vegetable can be a very good source of vegetable oil which can be utilized in replace of all other vegetable oils both commercially and in homes. The assessment of the oil extracted from the vegetable is carried out in other to know the quality of the oil and recommend the oil for usage in homes and also for commercial purposes. The rate at which human population is growing and oleo-chemicals industry is expanding with increasing demand for vegetable oils makes the exploration of some non-conventional and newer resources of vegetable oils to be of much concern. Malabar spinach, which is a currently grown vegetable, has a potential for cultivation as a vegetable oil source. The oil can be characterized and utilized for commercial purposes. Therefore, the present research work was undertaken with the objective to assess the quality of oil extracted from Malabar spinach cultivated under local environment.

2. Literature Review

2.1 Taxonomy of Malabar spinach

The generic name *Basella* given by Linnaeus was derived from Malayalam. The genus consists of five species; one is pantropical and remaining four is widely distributed in East and Southeast Africa and Madagascar. Linnaeus first described two species of *Basella* L. in *Species Plantarum* [4]. These species were *Basella rubra* and *Basella alba* which were separated from each other on the basis of leaf character and stem colour. Roxburg first treated *Basella alba, Basella rubra* and *Basella lucida* in synonymy and adapted *Basella alba* as a correct name according to the article 11.5 of the code [9]. As per the Echo plant information sheet, most authors agreed that the two colour forms of *Basella* are not separate species. Cytological, pollen morphological and protein profile studies of the red and green stem forms of *Basella* proved that both the stem forms belong to one single species and that is nothing but *Basella alba* [8]. The plant with green stem and green petiole is *Basella alba* L. and the other with red stem and red petiole is *Basella alba* L. var. *cordifolia* (Lamk.) Almeida [1].

2.2 Morphology of Malabar spinach

Basella alba l.

The plant is a perennial twining herb. Stem is fleshy, stout at the base with slender upper branches. Leaves are auxiliary dark green, broadly ovate in shape and acute. Flowers are sub sessile, white, pink or red coloured and closed at anthesis. Bracts are scaly and small. Bracteoles are acute. Stamens are included with short filaments

and cordate anthers. Ovary is unilocular. Fruit is black or dark purple coloured and enclosed within the persistent fleshy calyx. Seeds are black, globose and indehiscent [1].

Basella alba l.var. *cordifolia* (lamk.) almeida

The plant is a perennial herb. Stem is very long, slender, succulent, glabrous and much branched. Leaves are broadly ovate, acute or acuminate, thick, apiculate, entire with cordate base. Flowers are white or red in colour, sessile in few lax pendunculate spikes. Bracts are small and apiculate. Bracteoles are rather longer than the perianth, oblong and obtuse. The perianth is divided about halfway down; segments are elliptic and obtuse. The fruit is small and red or black in color. Seeds are black [1].

2.3 The basic usefulness of Malabar spinach (Basella alba)

Leaf juice is prescribed in case of constipation particularly in children and pregnant women and in urinary diseases [6]. The mucilaginous liquid obtained from the leaves and tender stalks is a popular remedy for habitual headaches. A decoction of the leaves is a good laxative for pregnant women and children. Leaf juice is used to treat catarrh and is applied externally to treat boils. *Basella alba* is boiled and administered to the cow with a retained placenta, it develops severe diarrheal that also causes the placenta to come out [2]. It is used as vegetable. The leaves are consumed in stew and soups [7]. Leaf juice is used in balanitis and catarrhal affections, externally applied in urticaria, burns, vomiting and in intestinal complaints, used as a poultice to reduce local swellings and in acne [4]. In general leaves contain several active components including flavonoids exhibits antioxidative, antiproliferative and anti - inflammatory properties in biological systems [5]. Leaves are used as anthelmintic, demulcent, anti - inflammatory, anti - malarial and analgesic [10].

2.4 Lipids

Lipids have the common property of being relatively insoluble in water and soluble in non-polar solvents such as ether and chloroform. Lipids are classified as follows:

1. Simple lipids: Esters of fatty acids with various alcohols.

(a) Fats: Esters of fatty acids with glycerol. Oils are fats in the liquid state.

(b) Waxes: Esters of fatty acids with higher molecular weight monohydric alcohols.

2. Complex lipids: Esters of fatty acids containing groups in addition to an alcohol and a fatty acid.

(a) Phospholipids: Lipids containing, in addition to fatty acids and an alcohol, a phosphoric acid residue. They frequently have nitrogen containing bases and other substituents, eg, in glycerophospholipids, the alcohol is glycerol and in sphingophospholipids the alcohol is sphingosine.

(b) Glycolipids (glycosphingolipids): Lipids containing a fatty acid, sphingosine, and carbohydrate.

(c) Other complex lipids: Lipids such as sulfo-lipids and amino-lipids. Lipoproteins may also be placed in this category.

3. Precursor and derived lipids: These include fatty acids, glycerol, steroids, other alcohols, fatty aldehydes, and ketone bodies, hydrocarbons, lipid soluble vitamins, and hormones. Because they are uncharged, acylglycerols (glycerides), cholesterol, and cholesteryl esters are termed neutral lipids.

2.5 Fatty acids

A fatty acid is a molecule characterized by the presence of a carboxyl group attached to a long hydrocarbon chain. Therefore these are molecules with a formula R–COOH where R is a hydrocarbon chain. Fatty acids can be said to be carboxylic acids, and come in two major varieties.

Saturated fatty acids do not have any double bonds. A fatty acid is saturated when every carbon atom in the hydrocarbon chain is bonded to as many hydrogen atoms as possible (the carbon atoms are saturated with hydrogen). Saturated fatty acids are solids at room temperature. Animal fats are a source of saturated fatty acids. In addition, fatty acids pack easily and form rigid structures (e.g., fatty acids are found in membranes).

Unsaturated fatty acids can have one or more double bonds along its hydrocarbon chain. A fatty acid with one double bond is called monounsaturated. If it contains two or more double bonds, we say that the fatty acid is polyunsaturated. The melting point of a fatty acid is influenced by the number of double bonds that the molecule contains and by the length of the hydrocarbon tail. The more double bonds it contains, the lower the melting point. As the length of the tail increases, the melting point increases. Plants are the source of unsaturated fatty acids.

–CH = CH – CH = CH – Unsaturated fatty acid chain

–CH – CH – CH – Saturated fatty acid chain

2.6 Importance of fatty acids

Fatty acids are essential for our cells to function normally and stay alive. The cell membranes allow the passage of necessary minerals and molecules in and out of our cells. Healthy cell membrane discourages dangerous chemicals and organism like bacteria, viruses, mould and parasites from entering the cell. These membranes also maintain chemical receptors sites for hormones the body's crucial messengers. Fatty acids are involved in countless chemical processes in bodies and are used as building blocks for certain hormones. Essential fatty acids supplements has been useful to many people with allergies, anaemia's, arthritis, cancer, depression, diabetes, dry skin, eczema, fatigue, heart disease, sluggish metabolism, viral infections etc. and in easing the addiction recovery process. Fatty acids play an important role in the life and death of cardiac cells because they are essential fuels for mechanical and electrical activities of the heart.

2.7 Health implications of fatty acids

Research focusing on heart diseases and other circulatory disorders indicate that excessive consumption of foods high in fats, including lipids and sterols, increases the risk of developing these diseases. Studies indicate that like hood of heart disease decrease when the intake of saturated fat is reduced and excessive consumption of trans fat may increase the risk of heart diseases. The brain has increased amounts of linoleic and alpha – linoleic acid derivatives. Changes in the levels and balance of these fatty acids due to a typical western diet rich in omega – 6 and poor in omega – 3 fatty acids is alleged to be associated with depression and behavioural change, including violence.

3. Methodology

3.1 Materials

The Malabar spinach species (*Basella alba* L. and *Basella alba* L.var. *cordifolia* (Lamk.) Almeida) used in this study were obtained from Osogbo, Osun State, Nigeria. Soxhlet apparatus was also used in the extraction of oils from the spinaches using hexane as the extracting medium for both species. The gas chromatograph was used for the fatty acid methyl ester analysis of the oil extracted from the spinaches**.** Chemicals like KOH, methanol, HCl, and BF3 were also used in the GC analysis.

3.2 Method

The leaves of both samples were gotten, air dried, and crushed. The crushed leaves were stored in air – tight containers to prevent moisture change. Oils were extracted from both species crushed dried leaves using the soxhlet apparatus and hexane as the extracting medium. 80g each of both crushed dried leaves were used for the extraction. The oils gotten from both Malabar spinach species were stored properly in sample bottles for fatty acid methyl ester analysis using the gas chromatograph. Standard IUPAC method was used for the preparation of fatty acid methyl esters and the oils were analysed by gas chromatogram (model HP 6890) fitted with a capillary column (HP INNOWax) with dimension of 30m x 0.25mm x 0.25µm, and FID (Flame Ionization Detector). Carrier gas, nitrogen (oxygen free) was used with inlet temperature 250^0c, detector temperature 320^0c, initial oven temperature 60^0c, and with first ramp rate at 12^0c/min for 20 min maintained for 2 min, and second ramp rate at 15^0c/min for 3 min maintained for 8 min at 22psi hydrogen pressure and 35psi compressed air. 50 mg of the extracted fat content of the sample was saponified (esterified) for five (5) minutes at 95^0c with 3.4ml of the 0.5M KOH in dry methanol. The mixture was neutralized by using 0.7M HCL. 3ml of the 14% boron trifluoride in methanol was added. The mixture was heated for 5 minutes at the temperature of 90^0c to achieve complete methylating process. The Fatty Acid Methyl Esters were thrice extracted from the mixture with redistilled n – hexane. The content was concentrated to 1 ml for gas chromatography analysis and 1 ul was injected into the injection port of GC.

Data were analysed by analysis of variance (ANOVA) using statistical software (SPSS) at 5% significance level.

4. Results and Discussion.

4.1 Results

Table 1: Table representing the fatty acid profile for oil extracted from Malabar spinach species

COMPONENTS	% COMPOSITION	
	GMS	RMS
C6 : 0	0.000±0.000[a]	0.000±0.000[a]
C8 : 0	0.000±0.000[a]	0.000±0.000[a]
C10 : 0	0.000±0.000[a]	0.000±0.000[a]
C12 : 0	0.003±0.003[a]	0.056±0.000[b]
C14 : 0	0.001±0.002[a]	0.001±0.001[a]
C14 : 1	0.000±0.001[a]	0.001±0.001[a]
C16 : 0	18.230±0.001[a]	18.919±0.002[a]
C16 : 1	2.271±0.002[a]	3.510±0.001[b]
C18 : 0	3.175±0.001[a]	3.197±0.003[a]
C18 : 1	0.000±0.003[a]	0.003±0.001[b]
C18 : 1	11.288±0.002[a]	12.969±0.002[b]
C18 : 1	0.000±0.002[a]	0.000±0.002[a]
C18 : 1	9.512±0.001[b]	7.508±0.004[a]
C18 : 1	0.000±0.000[a]	0.000±0.000[a]
C18 : 2	23.027±0.003[b]	21.968±0.001[a]
C18 : 2	0.000±0.003[a]	0.003±0.002[b]
C20 : 0	0.001±0.001[a]	0.007±0.002[b]
C18 : 3	15.245±0.002[b]	13.885±0.002[a]
C20 : 1	0.001±0.002 [a]	0.004±0.001[b]
C18 : 3	14.959±0.001[a]	14.079±0.002[a]
C20 : 2	0.000±0.002[a]	0.001±0.001[a]
C22 : 0	0.000±0.003[a]	0.007±0.001[b]
C20 : 3	0.006±0.002[a]	0.013±0.003[b]
C22 : 1	2.272±0.001[a]	3.824±0.003[b]
C20 : 3	0.000±0.003[a]	0.004±0.001[b]
C20 : 4	0.000±0.000[a]	0.000±0.000[a]
C22 : 2	0.000±0.003[a]	0.005±0.000[b]
C24 : 0	0.000±0.001[a]	0.000±0.001[a]
C20 : 5	0.000±0.002[a]	0.005±0.003[b]
C24 : 1	0.000±0.001[a]	0.000±0.001[a]
C22 : 6	0.000±0.002[a]	0.008±0.001[b]

Values are mean ± standard deviation of three samples of both green and red Malabar spinach oils analysed in triplicate.

Means followed by different superscript letter in a same represent significant differences ($p < 0.05$).

KEY:

GMS – Green Malabar Spinach

RMS – Red Malabar Spinach

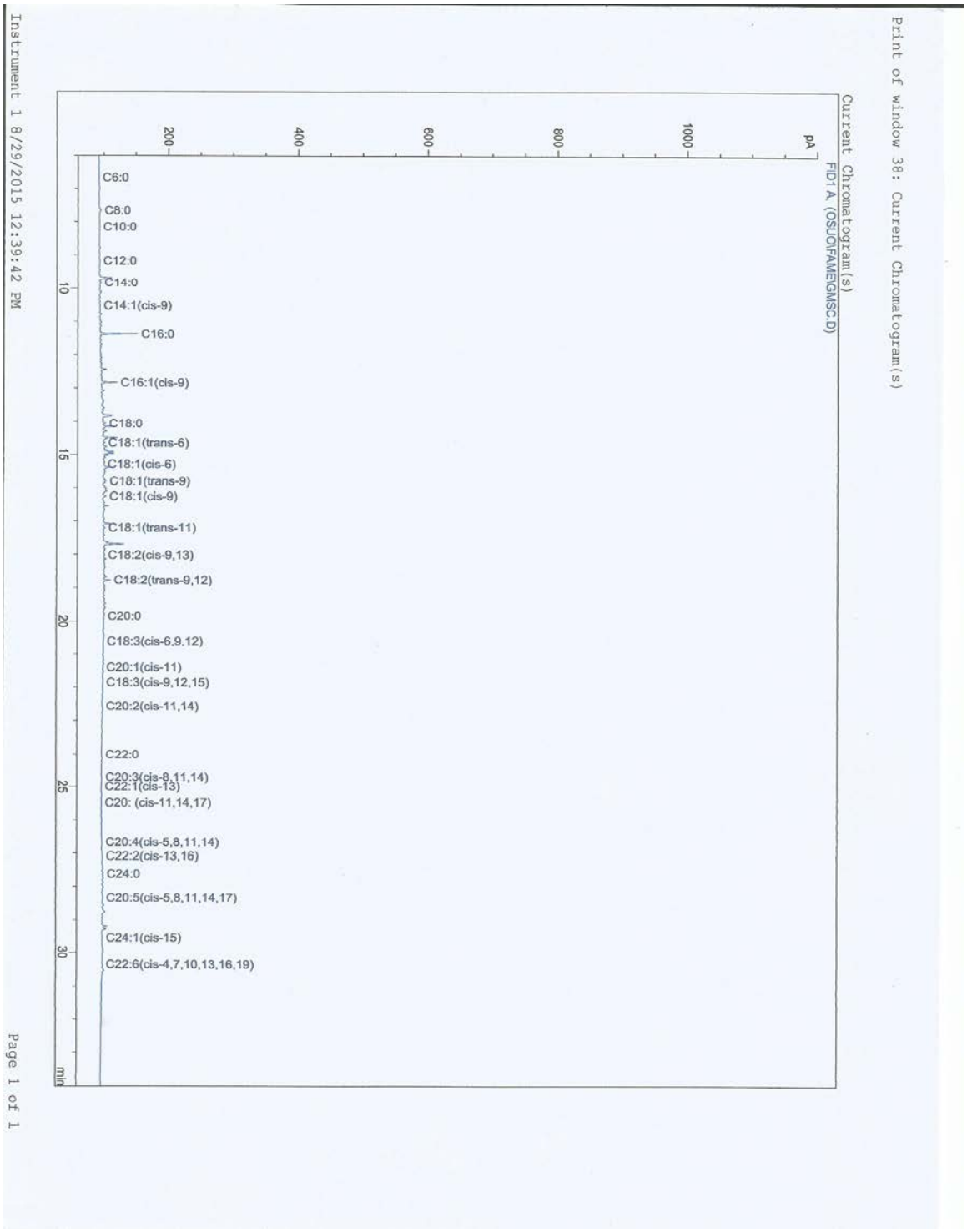

Figure 1: Chromatogram of Green Malabar Spinach (GMS)

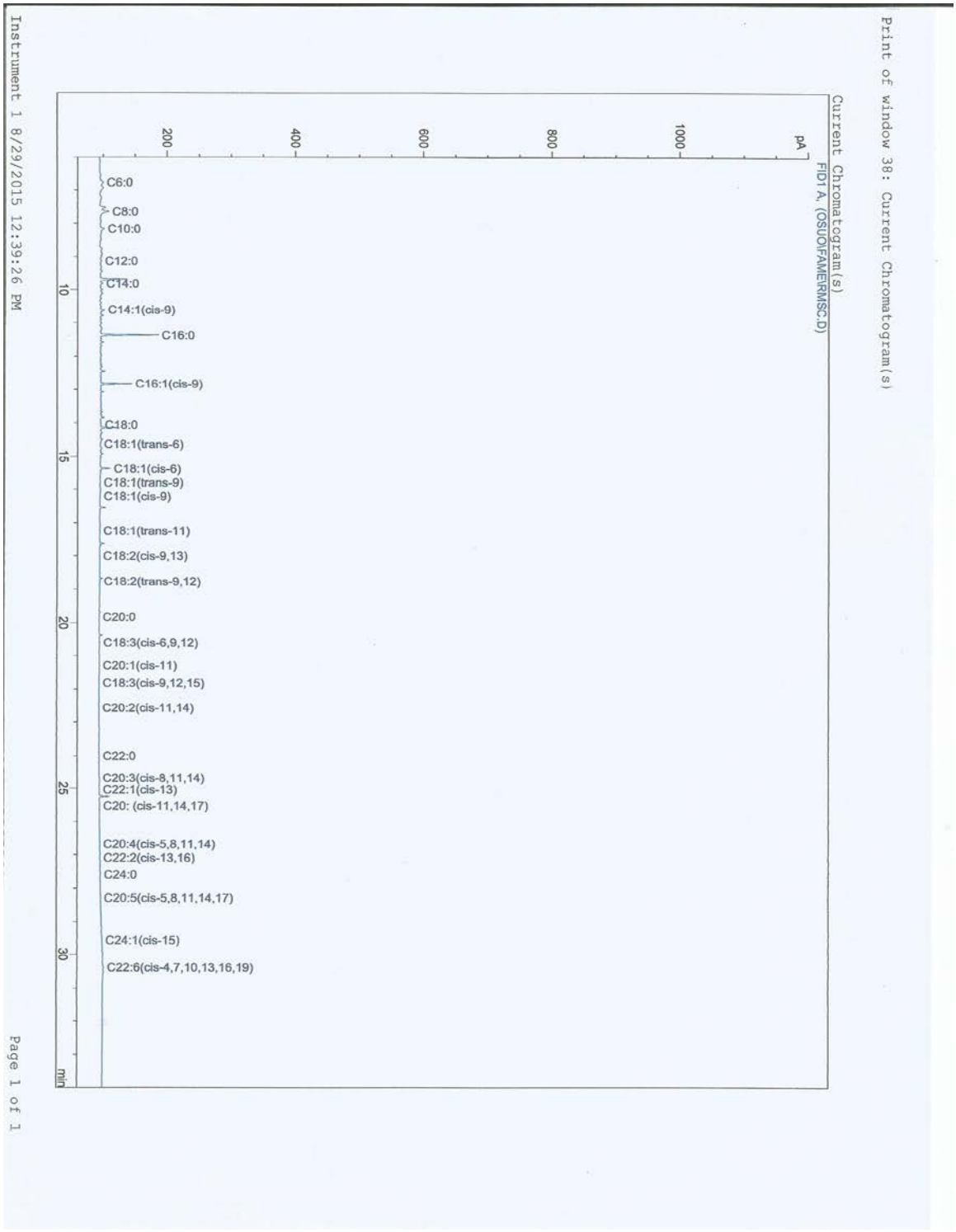

Figure 2: Chromatogram of Red Malabar Spinach (RMS)

4.2 Fatty acid composition of Malabar spinach

*F*rom the table above, it is observed that a total of about 32 components were determined from the two samples of the Malabar spinach of which are; palmatic acid (C16:0) which ranged from18.23% in GMS to 18.92% in RMS, stearic acid (C18:0) which ranged from 3.18% in GMS to 3.20% in RMS, alpha – linoleic acid (C18:3)

which ranged from 14.96% in GMS to 14.08% in RMS and linoleic acid (C18:2) which ranged from 23.03% in GMS to 21.97% in RMS appeared in a relatively large quantity in the oil samples. Myristic acid (C14:0) ranged from 0.00097% in GMS to 0.013% in RMS, gadoleic acid (C20:1) range from 0.0013% in GMS to 0.004406% in RMS, eicosapentaenoic acid (C20:5) ranged from 0.00088% in GMS to 0.0055% in RMS and also docosahexanoic acid (C22:6) ranged from 0.00063% in GMS to 0.0087% were also found in relatively small quantities in both samples.

Other saturated fatty acids present in the oils were: lauric acid (C12:0), arachidic acid (C20:0), behenic acid (C22:0) and lignocenaric acid (C24:0). Fatty acids that were not present are: caprylic acid (C8:0), caproic acid (C6:0), capric acid (C10:0) and arachionoleic acid (C20:4).

The total monounsaturated fatty acids (TMUFA) present in the oil samples were found to be about 14.06% in GMS oil and about 14.85% in RMS oil. Of this total is oleic acid (C18:1), (C18:1), eicosenoic acid (C20:1), palmatoleic acid (C16:1) and erucic acid (C22:1). Also from the table above, it can also be seen that the total polyunsaturated fatty acids (TPUFA) content of the oil samples were found to be about 38.3% in GMS oil and about 35.85% in RMS oil. The polyunsaturated fatty acids comprise of docosahexanaenoic acid (C22:6), arachidonic acid (C20:4), linoleic acid (C18:2), and alpha-linoleic acid (18:3). Therefore, the total unsaturated fatty acid (TUFA) in both oils amounted to about 52.36% in the GMS oil and about 50.7% in RMS oil.

From the table, the total saturated fatty acids (TSFA) that are constituted in the oils have relative amount of 21.41% in GMS oil and 22.19% in RMS oil. The saturated fatty acids present are palmitic acid (C16:0), stearic acid (C18:0), myristic acid (C14:0), lauric acid (C12:0), arachidic acid (C20:0), and behenic acid (C22:0).

Therefore, it can be deduced that total unsaturated fatty acids (TUFA) present in both species of Malabar spinach (green and red) are greater than the total saturated fatty acids (TSFA) in them. Also, there is little or no significant difference in the constituents of the red and green Malabar spinach. Both species are of almost the same quality.

The following unsaturated fatty acids (UFA) also posses the following characteristics making the oils from the Malabar spinaches to posses the functions: The alpha – linolenic acid which is an unsaturated omega-6 fatty acid is popularly known for preventing and treating diseases of the heart and blood vessels. These make the oils to be useful in preventing heart attacks, lowering high blood pressure, lowering cholesterol and treating rheumatoid arthritis, multiple sclerosis, lupus, diabetes and eczema. Linoleic acid which is an unsaturated omega-6 fatty acid is also present in the oils. It is useful in making quick–drying oils which makes the oils from the two samples of Malabar spinach to be useful in oil paints and varnishes. The eicosapentaenoic acid also present in small quantity is an omega-3 fatty acid which can make the oils to act as precursors for prostaglandin-3 (which inhibits platelet aggregation), thromboxane-3, and leukotriene-5 eicosanoids

The stearic acid which is a saturated fatty acid is an essential omega-3 fatty acid present in the two oils of the Malabar spinach makes the oils surfactants and softening agents enabling the oils to be useful in the production of soaps, cosmetics and detergents. Other saturated fatty acids present in the oil are: lauric acid which enables

the oils to be useful in the treatment of acne, arachidic acid which is a saturated long chain fatty acid, makes the oils to be useful in the production of detergents, photographic materials lubricants and some agricultural chemicals (non – pesticidal), behenic acid gives the oils smoothing properties which makes the oils to be lubricating agents and myristic acid although present in a relatively small quantity also makes the oil to useful in the production of cosmetics.

The caprylic acid, caproic acid and capric acid that are not present in the oils make the oils not to be useful in the production of dyes, perfumes, greases, plastics, etc.

5. Conclusions

In conclusion, total unsaturated fatty acids (TUFA) present in both species of Malabar spinach (green and red) are greater than the total saturated fatty acids (TSFA) in them. Also, there is little or no significant difference in the constituents of the red and green Malabar spinach. Both species are of almost the same quality. The oils gotten from the green Malabar spinach and red Malabar spinach contains fatty acids like stearic acid, alpha – linoleic acid, linoleic acid, myristic acid, gadoleic acid, eicosapentaenoic acid, docosahexanoic acid, lauric acid, arachidic acid, behenic acid, etc. Caprylic acid, Caproic acid, Capric acid,and arachinoleic acidb are absent in the oil.

The saturated fatty acids present make the oils to be good surfactant and softening agents which can make the oils to be useful in the production of soaps, cosmetics and detergents. The unsaturated fatty acids make the oils to be useful in preventing heart attacks, lowering high blood pressure, lowering cholesterol and treating rheumatoid arthritis, multiple sclerosis, lupus, diabetes and eczema. The caprylic acid, caproic acid and capric acid that are not present in the oils make the oils not to be useful in the production of dyes, perfumes, greases, plastics, etc.

Finally, the oil is beneficial to the human body system and also in carrying out industrial processes.

6. Recommendations

There has been no comprehensive report and characterization of the oils extracted from Malabar spinach (*Basella alba*) commonly grown in Nigeria. Therefore the present research work was undertaken with the key objective to assess the quality of the oil extracted from Malabar spinach. Therefore, I recommend the oil extracted from Malabar spinach for human consumption because of the health benefits and also for industrial uses because of the lubricating and softening properties.

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