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Comparative phytochemical composition of ripe and unripe extracts of *Solanum aethiopicum* exocarp

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Abstract

The aim of this study was to comparatively determine the phytochemical constituents of various extracts of ripe and unripe *Solanum aethiopicum* exocarp in order to ascertain its therapeutic importance. Analysis of the phytochemical constituents in the Ethyl acetate, Hexane and Methanol extracts were investigated using Gas Chromatography-Mass Spectrometry. The results of the analysis revealed the presence of twenty five, twenty three and twenty one compounds in the Ethyl acetate, Hexane and Methanol extracts respectively. Also, the ethyl acetate extract of the unripe exocarp contained eighteen compounds while both Hexane and methanol extracts of the same contained twenty compounds each. This showed that extracts of the ripe exocarp contained more phytochemicals than the unripe exocarp. Some of these compounds include 3,5-Dihydroxy-6-methyl-2,3-dihydro-4H-pyran-4-one, 4,5-Dihydro-2-methyllimidazole-4-one, Hexadecanoic acid, methyl ester, Methyl 2-oxooctadecanoate, Squalene, n-Octacosane, 1- Hexadecene, Hexadecane, 15-Heptadecanal, Furaldehyde-5-(hydroxymethyl), 10-Methylicosane and 1-Heptacosanol with reported anti-inflammatory, antimicrobial, antioxidant, antidiarrheal, antibacterial, antifungal, anti-sckling, antibiotic flavoring and mosquitocidal activities. Due to the presence of these biologically active compounds in its exocarp, *Solanum aethiopicum* could be recommended as a healthy food for all population especially people with sickle cell anemia. Therefore, the results of this study underscore the pharmacological importance of *Solanum aethiopicum* as a potential therapeutic food and an important source of useful bioactive principles.

Keywords: GC/MS, *Solanum aethiopicium,* exocarp, phytochemicals, 2-Furaldehyde- 5-(hydroxymethyl)

Introduction

The study of plants and their fruits encompasses the isolation and the structural identification of their compounds for proper understanding and analyzing their food and medicinal values. Plants are used therapeutically in different countries due to their potency and nontoxic properties if taken measurably. Plants have always being the main source of treatment for all ailments since (rephrase). These traditional medicines are known as herbs (Iordache *et* *al*., 2009; Ezhilan *et al*., 2012). *Solanum aethiopicum* a widely cultivated perennial herb whose edible fruit is generally known as eggplant or garden egg belongs to the family of *Solanaceae* which is one of the largest vegetable family (Anosike *et al.*, 2011)

All over Africa, eggplants are very common and play important nutritional roles. They have up to three months' storage life and can be easily transported without any worries of spoilage. They are usually dried and kept for future use in agricultural planting whenever fresh foods are rarely obtainable. The plants are distinguished for their high yields at a small plot available; even a few plants grown in garden containers can provide a worthy yield of fruits. They provide a dependable and sustaining source of income for millions of farmers in which most of them are women also as staple food. The plants are easily nurtured relatively free of disease and pests.

Eggplants could be prepared in several ways which make them lovable fruits and consumed anyhow you make them. They could be eaten raw, fried, grilled, roasted, boiled, seared, baked, steamed, mashed, pickled, stir-fried, pureed, and in many other ways depending on culture. The Turks claim to have hundreds of ways of preparing these fruits in "yummy dishes" (National Academies Press, 2006).

The therapeutic values of these fruits have been reported by different researchers. These include anti-asthma, anti-allergic rhinitis, weight loss (hypolipidemic), painkiller, anti-inflammatory, anti-glaucoma, treatment of constipation, dyspepsia, and as an expectorant (Bello *et al*., 2005; Mennella *et al*., 2010; Chinedu *et al*., 2011; Anosike *et al*., 2012)

There are various methods of extraction and analytical measurements developed for plant and fruit active compounds study such as spectrophotometry, high performance liquid chromatography (HPLC), capillary electrophoresis (CL), gas chromatography (GC) with flame ionization detection (FID), gas chromatography– mass spectrometry (GC–MS) etc. For our study, gas chromatography– mass spectrometry (GC–MS) was used since it combines a separation technique (GC) and identification technique (MS) together and allows for qualitative and quantitative analysis of the eggplant compounds. The exocarps of ripe and unripe eggplants were extracted with different solvents (polar and non-polar) and subjected to gas chromatography- mass spectrometry to comparatively determine the phytochemicals present in each solvent extract.

Materials and methods

Sample collection and preparation

Fresh and healthy unripe fruits of *Solanum aethiopicum* were purchased from Ijede market in Ikorodu Local Government Area, Lagos State, Nigeria. A portion of the unripe fruit was kept under the shade for about one week in order for them to ripe. The fruits (ripe and unripe) were washed with copious amount of water to remove dirt and the exocarp was removed manually. The exocarp was oven-dried at 50 ^{o}C for 48 hours and thereafter pulverized with a laboratory blender (Lexus Model No. 25520). The pulverized samples were extracted with methanol, ethyl acetate, and hexane for GC/MS analysis.

Extraction

The dried ripe and unripe powdered exocarp was subjected to Soxhlet extraction in methanol, ethyl-acetate and n-hexane. The extracts were concentrated at 40 ^{o}C under reduced pressure (vacuum pump-RE3022C.) using rotary evaporator (RE52-3). The concentrated extracts were labeled MER (Methanol Ripe extract), MEU (Methanol Unripe extract), EAR (Ethyl-acetate Ripe extract), EAU (Ethyl-acetate Unripe extract), NHR (n-Hexane Ripe extract), NHU (n-Hexane unripe extract).

Gas chromatography- mass spectrometry of the extracts

The methanol (MER and MEU), ethyl-acetate (EAR and EAU) and n-hexane (NHR and NHU) concentrated extract was investigated for its chemical composition using GC-MS analysis in (which Institute or Laboratory) Zaria, Kaduna, Nigeria. A SHIMADZU, QP- 2010 plus GC-MS were used. The GC-MS was equipped with a split injector and an ion-trap mass spectrometer detector, together with a fused-silica capillary column having a thickness of 1.00µm, dimensions of 30 m x 0.25 mm and temperature limits of 60 ^{o}C and 250 ^{o}C at a rate of 3.0 ml/min. The temperature of the injector and detector were set at 250 ^{o}C and 200 ^{o}C respectively. Helium gas was used as a carrier gas at a flow rate of 46.3

cm/sec. Components were identified by computer-aided matching of their spectra with spectra of known compounds from the Library of spectra from the National Institute of Standards and Technology (NIST), formerly National Bureau of Standards, Washington, USA (NIST, 2009). The fragmentation patterns of the identified compounds were then examined for consistency with known data from literature (Williams, 1989). In addition, the hit quality which indicated how closely matched, the compounds are with the library data was used to further verify the identity of the compounds in the samples.

Results

Figures A and B show the GC chromatograph of the ethyl acetate extract of the ripe and unripe exocarp of *Solanum aethiopicum* respectively. The ripe has 25 peaks and the unripe has 18 peaks. Figures C and D show the GC chromatograph of methanol extract of the ripe and unripe exocarp of *Solanum aethiopicum* with 21 and 20 peaks respectively. Figures E and F show the GC chromatograph of hexane extract of the ripe and unripe exocarp of *Solanum aethiopicum* with 23 and 20 peaks respectively.

A

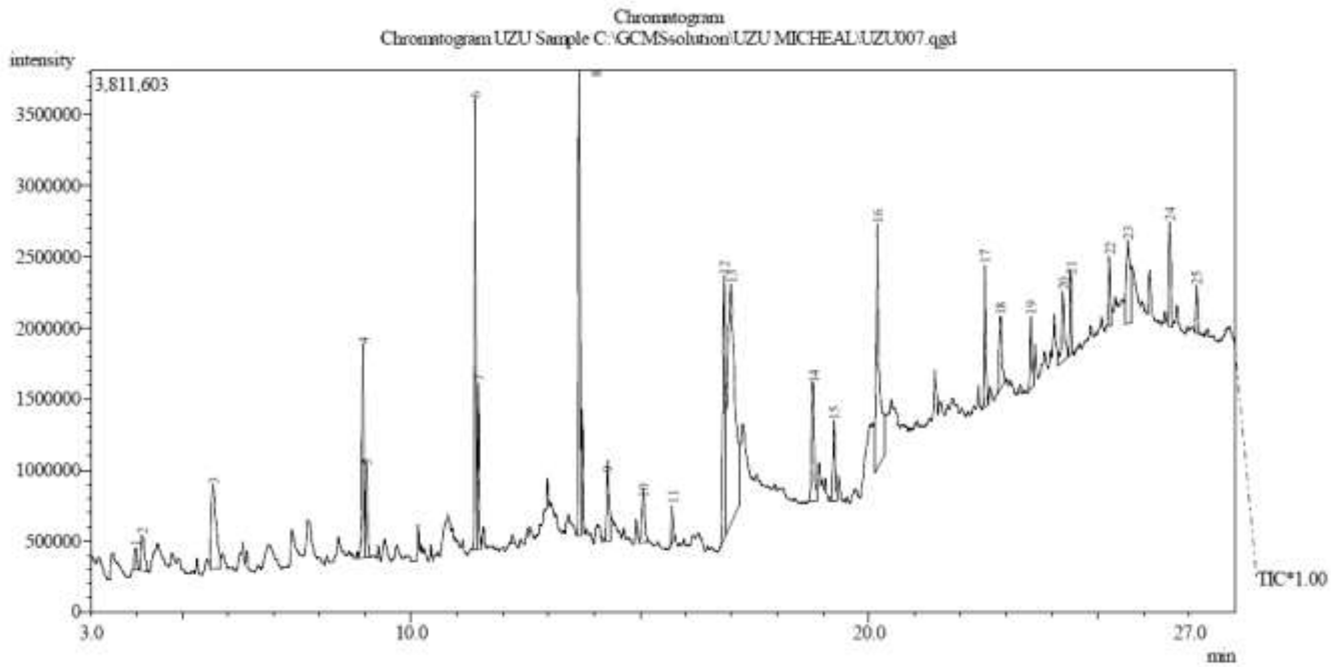

Figure A: Gas Chromatography Mass Spectrometry chromatogram of the Ethyl Acetate extract of exocarp of Ripe (EAR) *Solanum aethiopicum*

B

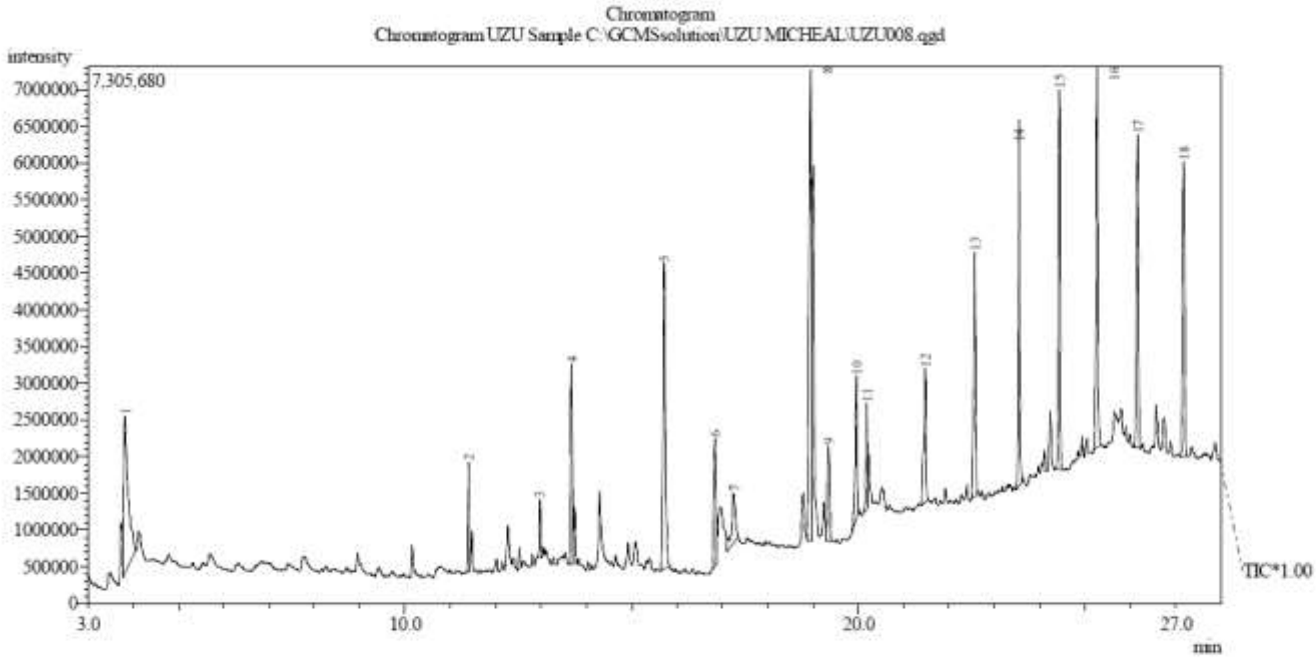

Figure B: Gas Chromatography Mass Spectrometry chromatogram of the Ethyl Acetate extract of exocarp of Unripe (EAU) *Solanum aethiopicum*

C

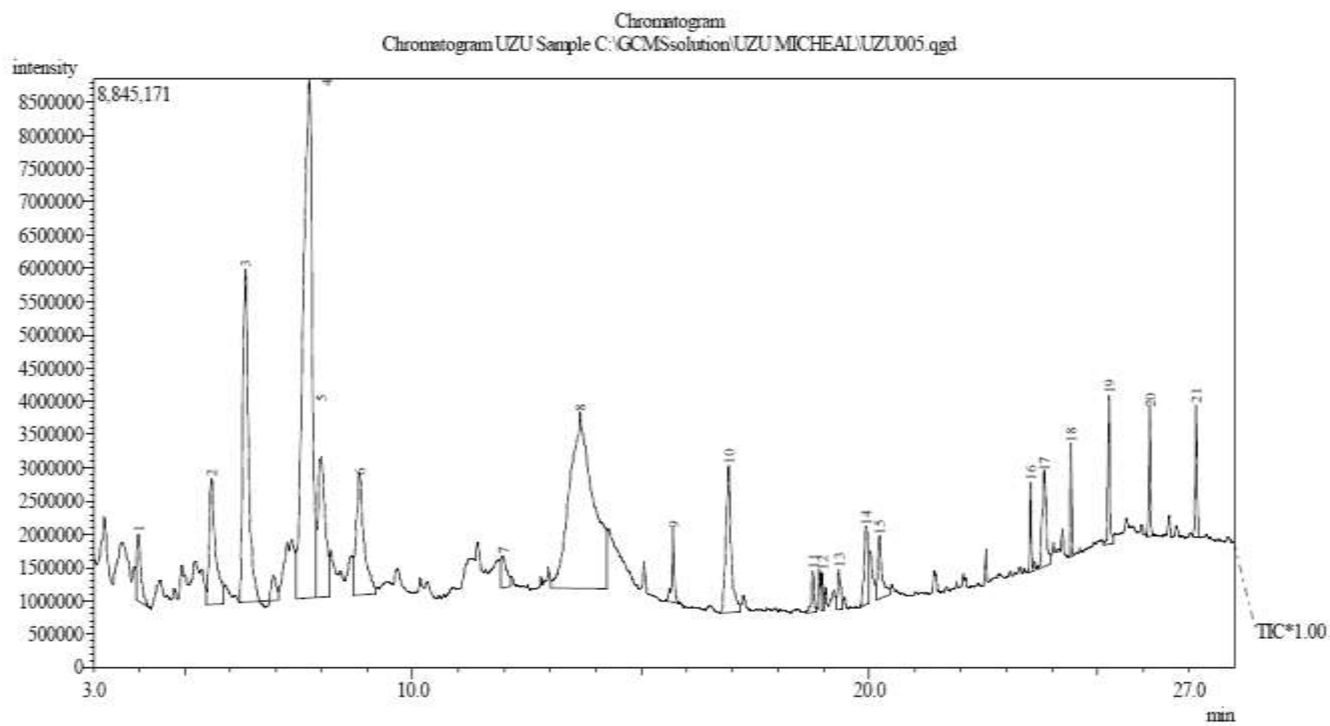

Figure C: Gas Chromatography Mass Spectrometry chromatogram of the methanol extract of exocarp of Ripe (MER) *Solanum aethiopicum*

D

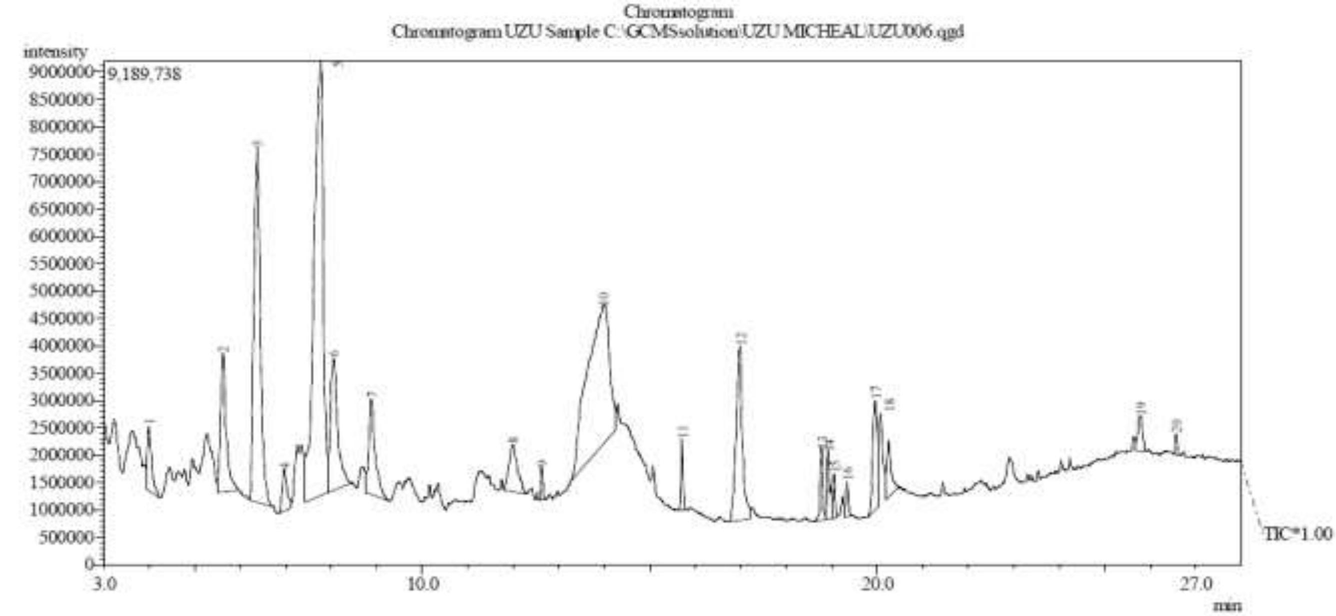

Figure D: Gas Chromatography Mass Spectrometry chromatogram of the methanol extract of exocarp of Unripe (MEU) *Solanum aethiopicum*

E

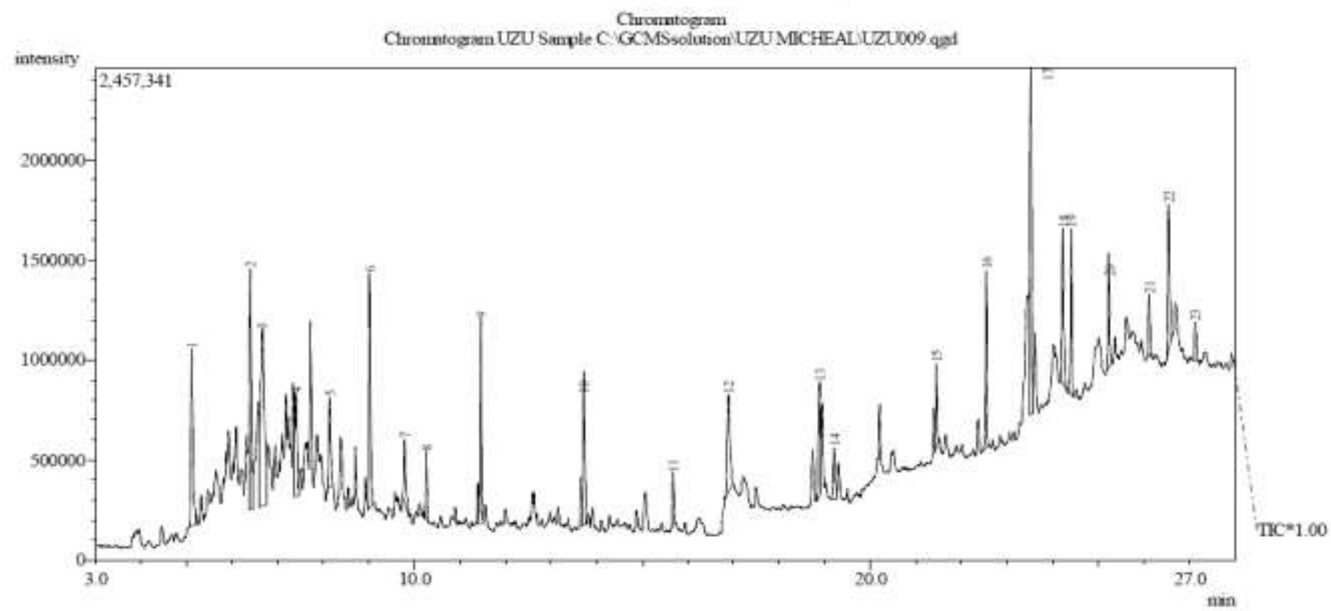

Figure E: Gas Chromatography Mass Spectrometry chromatogram of the n- hexane extract of exocarp of Ripe (NHR) *Solanum aethiopicum*

F

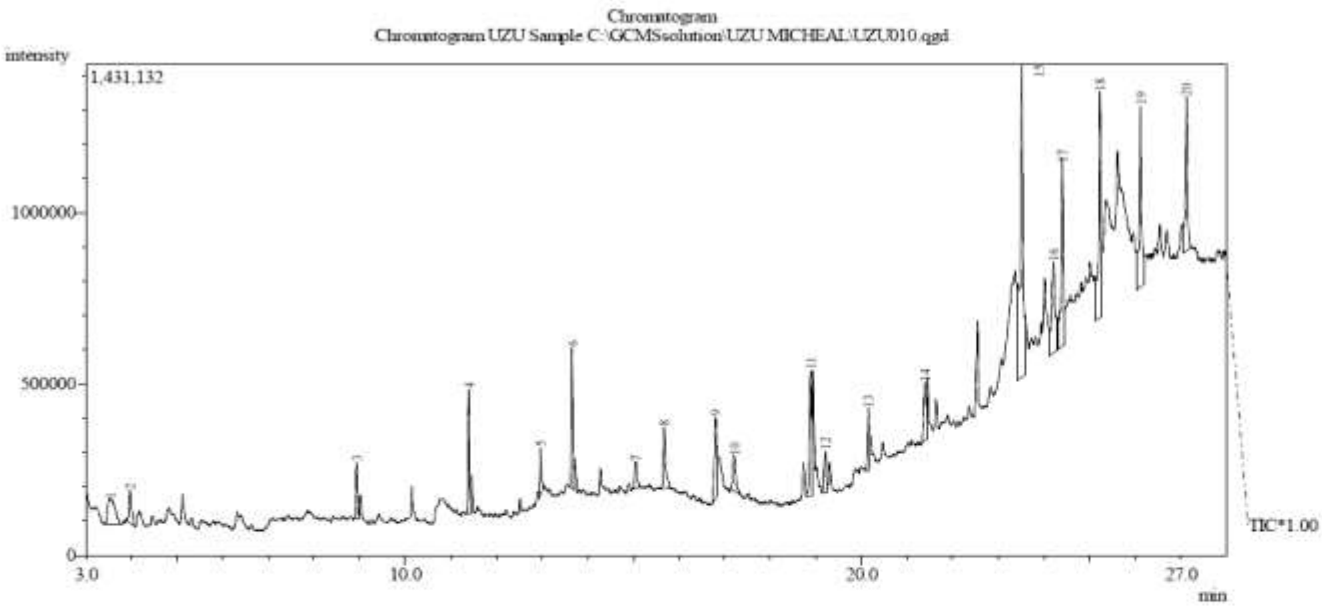

Figure F: Gas Chromatography Mass Spectrometry chromatogram of the n- hexane extract of exocarp of Unripe (NHU) *Solanum aethiopicum*

Discussion

The order of the ability of solvent extractability for the unripe exocarp is Methanol (20) = Hexane (20) > Ethyl acetate (18) while the order for the ripe exocarp is Ethyl acetate (25) > Hexane (23) > Methanol (21). This is different from the observation of Anwar *et al*.,(2013) and Swamy *et al*.,(2015). n-Hexadecanoic acid and its ester, Linolelaidic acid, methyl ester, were present in methanol and hexane extracts of the ripe exocarp. Stearic acid and Stearic methyl ester was present in methanol and ethyl acetate extracts of the unripe exocarp. Ethylene glycol mono dodecyl ether, 14-Hexadecenal, Diethylene glycol mono-dodecyl ether, 8-Heptadecanol, n-Octacosane, and n-Tetracosane were present in hexane and ethyl acetate extracts of the unripe exocarp. 1-Hexadecanol and n-Eicosane were present in all the three extracts of the unripe exocarp. 2, 4 -Dihydroxy-2, 5-dimethyl- 3(2H)-Furanone was present in methanol and ethyl acetate extracts of the ripe exocarp. 1, 2, 3-Propanetriol, monoacetate was present in all the three extracts of the ripe exocarp. Hexadecane, and Squalene were present in the hexane and ethyl acetate extracts of the ripe exocarp. Methyl-14-methylpentadecanoate and Octacosane were present in the methanol and hexane extract of the ripe exocarp. Isomers were detected in some of the extracts. For example, three isomers of Eicosane were found in the hexane extracts of the ripe exocarp at 22.54, 25.232, and 27.13 minutes respectively. All the detected phytochemicals are known to show a wide range of biological activities that include antibacterial, antifungal, antiviral, antioxidant, and cytotoxic properties (Tables I and II [11]).

This underscores the nutraceutical importance of vegetables in the human nutrition. The results of the GC –MS on the phytochemicals found in ethyl acetate, methanol and hexane solvent extracts of exocarp of unripe and ripe *Solanum aethiopicum* are presented in Tables I and II respectively. Different phytochemicals such as alkaloids, terpenoids, heterocyclics, ketones, oxygenated heterocyclics, glycols, aromatics, mono-terpenoids alcohol’s, aliphatic acids, fatty acids, aliphatic alcohol’s, essential fatty acids, fatty esters, alkatrienes, fatty hydrocarbon, triterpene, oxygenated ketone, ethers, alkenes, glycol ethers, fatty alcohols, fatty aldehydes, glycerols, Spiro-hydrocarbons, alkanes, phytols, phenols, acyl hydrocarbon, phthalates, piperazzines were detected in the extracts.

Plant phytochemicals and its secondary metabolites occur in several medicinal plants and have been shown to exhibit antimicrobial, antioxidant, antispasmodic, antidepressant, antitumor, anti-mutagenic, anti-inflammatory, and many other biological activities (Apetrei *et al*., 2011; Ghasemzadeh *et al*., 2011) Plants phytochemicals are also known to provide defense against various pathogens, regulate cell division and growth, and help in pigmentation and many other metabolic pathways (Lattanzio *et al*., 2006). Similarly, components from the extracts of *Solanum aethiopicum* have shown that it has components which are known to address many various diseases (Tables I and II). Examples include antioxidant activity, anti-inflammatory, antimicrobial, anti-proliferative, auto nerve activity, antifungal, inhibition of formation of sickled cells in the blood, cytotoxicity activity against leukemia cell lines, inhibits tumor cells, fat burner supplement, insecticidal, surfactants, nematicidal activity etc. A very interesting use is its anti-sickling effect of one of its components, 2-Furaldehyde-5-(hydroxymethyl), which indicates that *Solanum aethiopicum* can be recommended as a healthy food for people with sickle cell.

Table I: Phytochemical composition of extracts of unripe *Solanum aethiopicum* fruit exocarp

S/N	Compound Name	Extract/ RT	Extract/Peak area %	Activity	Class /MW	References
1	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3-one	M/3.99	M/1.88	Flavor and Perfume industry	Heterocyclic/144	(Zabetakis *et al*., 1999)
2	4-Ethyl-3-methyl-4-penten-2-one	M/5.62	M/5.11	Difficulty in breathing	Ketone/126	(Smyth *et al*., 1942)
3	3,5-Dihydroxy-6-methyl-2,3-dihydro-4H-pyran-4-one	M/6.38	M/14.96	Anti-inflammatory, antiproliferative, anti-microbial	Oxygenated Heterocyclics/144	(Kumar and Bhaskar, 2012)
4	4-amino-1,2,5-oxadiazole-3-carbohydrazonamide	M/6.97	M/1.30	Antifungal	Oxygenated Heterocyclics /142	(Hasan *et al*., 2011)
5	2-Furaldehyde,5-(hydroxymethyl)	M/7.77	M/25.37	Inhibits the formation of sickled cells in the blood	Heterocyclic/126	(Abdulmalik *et al*., 2005)
6	1,2,3-Propanetriol, monoacetate	M/8.05	M/6.07	Food and fuel Additive, antiknocking agent	Glycerol/134	(Melero *et al*., 2007)
7	4,5-Dihydro-2-methyllimidazole-4-one	M/8.88	M/3.93	Antimicrobial	Heterocyclics/98	(Dirersa, 2017)
8	Benzoic acid, m-hydroxyl	M/11.99	M/2.58	Perfumery	Aromatic/138	(Clarke and Owen, 1950)
9	Carveol,dihydro	M/12.63	M/0.38	potent antiparkinsonian activity	Monoterpenoid alcohol /154	(Ardashov *et al*., 2014)
10	1,2,3,5-Cyclohexanetetrol	M/13.99	M/20.44	Anifungal, antibacterial	Aliphatic alcohol/148	(Ravikumar *et al*., 2012)
11	Hexadecanoic acid, methyl	M/15.71	M/0.93	Antioxidant,	Aliphatic Acid/270	(Akpuaka *et al*., 2013)

	ester			antifungal		
12	n-Hexadecanoic acid	M/16.99 H/15.68	M/7.24 H/2.99	Antioxidant, Nematicide,	Aliphatic Acid/256	(Akpuaka *et al*., 2013)
13	1-Hexadecanol	M/18.78 H/15.05	M/1.22; H/1.26; EA/2.50	Cosmetic, foam stabilizer.	Aliphatic Alcohol/242	(Caligiani *et al*., 2010)
14	Linolelaidic acid, methyl ester	M/18.92 H/18.88	M/1.30; H/5.52	Antifungal, Antioxidant	Essential Fatty Acid/294	(Chandrasekaran *et al*., 2011)
15	Linolenic acid, methyl ester	M/19.06	M/0.58;	Antimicrobial	Essential Fatty Acid /292	(Chandrasekaran *et al*., 2008)
16	Stearic acid, methyl ester	M/19.34 EA/19.34	M/0.49; EA/2.22	Biodiesel	Fatty Ester/298	(Farobie and Matsumura, 2015)
17	1,E-11,Z-13-Octadecatriene	M/19.95	M/3.34	Heart Disease	Alkatrienes/248	(Gopalakrishnan and Udayakumar, 2014)
18	Octadecanoic acid (Stearic acid)	M/20.25	M/1.58	Antibacterial	Fatty Acid/284	(Gopalakrishnan and Udayakumar, 2014)
19	Octadecane	M/25.77	M/1.06	Antimicrobial, antifungal	Long Chain Hydrocarbon	(Abubacker and Devi, 2005)
20	Squalene	M/26.57	M/0.25	Antioxidant, antibacterial,	Triterpene Hydrocarbon/410	(Anitha *et al*., 2012; Gideon, 2015)
21	Dihydroxyacetone	H/3.53	H/3.80	Coloring agent	Oxygenated Ketone/90	(Wittgenstein and Guest, 1961)
22	Ether, butyl isopropyl	H/3.97	H/1.90	Antiknock agent, Dissolve gallstones	Secondary Ether/116	(Schoenfield and Marks, 1993)
23	3-Tetradecene	H/8.94	H/1.66	Detergents production	Alkene/196	(Kurt, 2005)
24	1-Hexadecene	H/11.39	H/3.42	Antibacterial, antifungal, antioxidant	Alkene/224	(Hsouna *et al*., 2011)
25	Ethylene glycol mono dodecyl ether	H/12.97 EA/12.98	H/1.63; EA/1.04	Nonionic Surfactant	Glycol Ether/230	(Calum and Franz, 1985)
26	14-Hexadecenal	H/13.66	H/4.28; 3.73	Anti-inflammatory	Alkene/238	(Mohammed *et al*., 2014)

		EA/13.67		activity		
27	1-Tridecene	H/16.80	H/4.74	Antioxidant	Acyclic Alkene/182	(Bhardwaj *et al*., 2014)
28	Diethylene glycol mono-dodecyl ether	H/17.2 EA/17.26	H/2.20; EA/2.32	Nonionic Surfactant	Glycol Ether/274	(Tidswell *et al*., 1996)
29	Phytol	H/19.21	H/1.93	Anticancer, antimicrobial, anti-inflammatory, antioxidant, Diuretic	Acyclic Diterpene alcohol/296	(Kalaivani *et al*., 2012)
30	8-Heptadecanol	H/20.15 EA/20.18	H/2.28	Aromatic Flavor	Fatty Alcohol/256	(Rita *et al*., 2011)
31	Triethylene glycol monododecyl ether	H/21.39	H/2.51	Nonionic Surfactant	Glycol Ether/318	(Tidswell *et al*., 1996)
32	Methyl 2-oxooctadecanoate	H/23.52	H/18.59	Antidiarrheal, nonionic surfactant	Fatty Ester/312	(Ikhsanov *et al*., 2020)
33	Tetraethylene glycol mono dodecyl ether	H/24.21	H/6.28	Nonionic Surfactant	Glycol Ether/362	(Caligur, 2008)
34	n-Octacosane	H/24.41 EA/21.48	H/8.47; EA/3.70	Antifungal, antibacterial	Saturated acyclic hydrocarbon/394	(Chandrasekaran *et al*., 2011)
35	n-Eicosane	H/25.23 H/27.13 EA/22.57	H/10.26; H/7.06; EA/5.81	Antibacterial, antitumor, antifungal, cytotoxic, Antioxidant	Saturated acyclic hydrocarbon/282	(Hsouna *et al*., 2011; Rao et al., 2016)
36	n-Tetracosane	H/26.12 EA/25.27	H/9.21; EA/7.74	Antioxidant anti-inflammatory	Saturated acyclic hydrocarbon/338	(Kazemi, 2014)
37	Pyrazin-2-carboxylic	EA/3.82	EA/8.92	Antitubercular	Heterocyclic Acid/124	(Njire *et al*., 2017)
38	1-Tetradecene	EA/11.4	EA/1.89	Antimicrobial	Alkene Hydrocarbon/196	(Mishra and Sree, 2007)

39	Tridecanoic acid methyl ester	EA/15.72	EA/8.90	Antibacterial, antifungal	Fatty Acid ester/228	(Chandrasekaran *et al*., 2011)
40	15-Heptadecanal	EA/16.84	EA/3.70	Antibacterial	Fatty Aldehyde hydrocarbon/252	(Junairiah *et al*., 2016)
41	7,10-Hexadecadienoic acid, methyl ester	EA/18.95	EA/14.75	Antimicrobial	Fatty Acid Ester/266	(Abubakar and Majinda, 2016)
42	Octadecanoic acid methyl ester	EA/19.34	EA/2.22	Antiviral, antibacterial, antioxidant	Fatty acid ester/298	(Sudharsan *et al*., 2010)
43	Octadecenoic acid ethyl ester	EA/19.95	EA/3.40	Antiviral, antibacterial, antioxidant	Fatty acid ester/298	(Sudharsan *et al*., 2010)
44	Heptadecane	EA/23.55	EA/7.21	Anti-inflammatory antimicrobial and antifungal agents	Fatty Hydrocarbon/240	(Abubacker *et al*., 2015)
45	Heptadecane-2,6,10,15-tetramethyl	EA/23.44; EA/27.18	EA/7.68; EA/7.47	Sex hormone in algae	Fatty Hydrocarbon	Amudha and Rani, 2014
46	Nonacosane	EA/26.16	EA/7.03	Chemical communication	Fatty hydrocarbon/408	(Brei *et al*., 2004)

Extract = Solvent of Extraction (M, H, A), M=Methanol H = Hexane, EA=Ethyl Acetate Extract, NF = Not Found, RT = Retention time, MW = Molecular Weight, Class = Class of Compound

Table II : Phytochemical composition of extracts of ripe *Solanum aethiopicum* fruit exocarp

S/N	Compound Name	Extract/ RT	Extract/Peak Area (%)	Activity	Class /MW	References
1	2, 4 -Dihydroxy-2,5-dimethyl- 3(2H)- furanone	M/3.98; EA/3.98	M/1.71 EA/0.60;	Flavor and Perfume industry	Heterocyclic/ 144	(Zabetakis *et al*., 1991)
2	1,2,3-Propanetriol, monoacetate	M/7.99 EA/4.13 EA/5.67	M/5.85 EA/1.36; EA/4.74;	precursor of tricetin (antifungal), prodrug and vehicle for anticancer agents, anti-bacterial	Glycerol/134	(Juneious, 2014)
3	3,8-dimethylundecane	H/9.78	H/2.03	NF	Spiro hydrocarbon/ 184	N/A
4	1-Dodecene	EA/8.95	EA/3.86	NF	Alkene Hydrocarbon/ 168	N/A
5	Undecane	EA/9.03	EA/1.75	mild sex attractant for various types of moths and cockroaches, and an alert signal for a variety of ants.	Alkane Hydrocarbon/156	(Edeoga *et al*., 2005)
6	1- Hexadecene	EA/11/40; EA/13.68	EA/7.66; EA/8.75	Antibacterial, Antifungal, Antioxidant	Alkene Hydrocarbon/224	(Silva, 2016)
7	Hexadecane	EA/11.47 H/9.02 H/11.46	EA/2.64; H/6.07; H/4.78	Antibacterial, antioxidant	Alkane Hydrocarbon/226	(Yogeswari *et al*., 2012)
8	1,6-Methanol (10) annulene	H/8.14	H/2.92	NF	Aromatic Hydrocarbon/142	N/A
9	2H-Pyran-3-ol-6-ethenyltetahydro-2,2,6-trimethyl	EA/14.23	EA/2.60	NF	Terpene/170	N/A
10	1-Hexadecanol	EA/15.07 EA/18.78 EA/20.18 M/18.77	EA/1.84; EA/3.71; EA9.59; M/0.68	antioxidant	Fatty alcohol/242	(Kumaradevan *et al*., 2015)
11	Pentadecanoic acid,14-	EA/15.70	EA/0.81	Antioxidant,	Fatty Acid ester/270	(Bashir *et al*., 2012)

	methyl, methyl ester			antifungal and antimicrobial		
12	15-Heptadecanal	EA/16.84	EA/8.10	Antibacterial	Fatty Hydrocarbon Aldehyde	(Kumar *et al*., 2011)
13	n-Hexadecanoic acid	EA/16.99 M/16.92	EA/20.01 M/4.72	Anti-inflammatory, Antioxidant, hypocholesterolemic nematicide, pesticide, anti androgenic flavor, hemolytic, 5-Alpha reductase inhibitor, potent mosquito larvicide	Fatty acid/256	(Rahuman *et al*., 2000; Kumar *et al*., 2010; Aparna *et al*., 2012)
14	2-phenyl-4-pentanal	H/7.4	H/3.85	aroma volatiles of tea, peppermint Ingredient of cocoa and chocolate-type flavours	Aromatic/160	N/A
15	Trans Phytol	EA/19.24 H/19.24	EA/2.18; H/1.99	Systhesis of Vitamins E and K	Acyclic diterpene alcohol/296	(Daines *et al*., 2003; Netscher, 2007)
16	2-Allyl-4-methylphenol	H/6.67	H/11.68	Anthelmintic	Phenol/148	(Long, 2013)
17	1-Heptacosanol	EA/22.53	EA/3.05	Antibiotic	Fatty alcohol/396	(Friedman, 2015)
18	Linalyl isobutyrate	EA/22.88	EA/ 2.42	Perfumery/ Food flavor	monoterpene/224	(Yannai, 2004)

19	Nonadecane	EA/23.54	EA/1.67	Component of gasoline	Long chain Hydrocarbon/268	(Schauer *et al.*, 2002)
20	Triethylene glycol monododecyl ether	EA/24.24	EA/2.44	Non-ionic Surfactant	Glycol Ether/318	(Drummond *et al.*, 1985)
21	Tetracosane	EA/24.41 H/26.114 M/24.42	EA/1.73 H/1.59 M/0.95	Cytotoxic, Flavor	Fatty Hydrocarbon	(Uddin *et al.*, 2012)
22	Docosane	EA25.26 EA/27.16	EA/1.33 EA/1.11	Antimicrobial activity	Fatty hydrocarbon	(Cai *et al.*, 2014)
23	9,12-Octadecadienoyl chloride	EA/25.66	EA/3.77	coatings and polymers	Acyl hydrocarbon/298	(Lohbeck *et al.*, 2000)
24	Squalene	EA/26.57 H/26.54	EA/2.28 H/4.37	Immunologic adjuvants	Terpene/410	(Mosca *et al.*, 2008)
25	Dodecane	H/5.12 H/6.40	H/6.38 H/7.64	Scintillator component	Alkane hydrocarbon/ 170	(Rydberg, 2004)
26	2, 3, 5, 8-Tetramethyldecane	H/10.27	H/1.61	Cytotoxic Effects and Antibacterial	Acyclic alkane /198	(Aneb *et al.*, 2016)
27	Octadecane	H/13.72	H/3.81	Phytotoxic effect on germination	Acyclic alkane/254	(El *et al.*, 2017)
28	Methyl-14-methylpentadecanoate	H/15.67 M/15.704	H/1.72; M/1.11	lubricant	Fatty Ester/270	(Bongardt *et al.*, 1996)
29	2-Methyl Eicosane	H/16.89	H/4.68	Antibacterial, antioxidant	Acyclic Hydrocarbon/296	(Khatua *et al.*, 2016)
30	Linolelaidic acid, methyl ester	H/18.88	H/3.78	Antibacterial, antifungal	Fatty Ester/294	(Agoramoorthy *et al.*, 2007)
31	Tetradecene	H/21.45	H/2.18	Oil-soluble surfactants and as lubricating fluids	Acyclic Alkene hydrocarbon	(Murray, 1990)
32	Eicosane	H/22.54 H/25.232	H/4.46; H/2.87;	flavor.	Acyclic	(Craveiro *et al.*, 1978)

		H/27.13	H/1.24		Hydrocarbon/282, 366	
33	9-Octylheptadecane	H/23.52	H/11.36	Antibacterial	Hydrocarbon /352	(Abdul-Hafeez *et al*., 2015)
34	Di-n-octyl phthalate	H/24.23	H/5.05	Plasticizer	Phthalates/390	(Agency, 1997)
35	Octacosane	H/24.41 M/25.25	H/3.94; M/1.52	Mosquitocidal activities	Hydrocarbon/394	(Rajkumar and Jebanesan, 2004)
36	4-Ethyl-3-methyl-4-penten-2-one	M/3.59	M/4.72	solvent	Carbonyl Hydrocarbon /126	(Conant and Tuttle, 1921)
37	3,5-Dihydroxy-6-methyl-2,3-dihydro-4H-pyran-4-one	M/6.33	M/11.25	Nerve activity	Heterocyclic/ 144	(Beppu *et al*., 2012)
38	2-Furaldehyde-5-(hydroxymethyl)	M/7.74	M/26.63	Feedstock for production of fuels and chemicals	Heterocyclics/ 126	(Huber *et al*., 2006)
39	1-(N-Methylpiperazine) ethanol	M/8.83	M/5.35	Antibacterial and Antiprotozoan Activity.	Heterocyclicpiperaz zines/144	(Pedrazzoli and Asta, 1971)
40	Benzoic acid, m-hydroxy	M/11.96	M/1.02	Plasticizer, Manufacture of alkyd resins	Aromatic acid/138	(Ungnade and Henick, 1942)
41	Butanoic acid, 2-ethylhexyl ester	M/13.66	M/23.96	Flavoring ingredient	Acyclic Esters/200	(Adams *et al*., 2005)
42	Elaidic acid, methyl ester	M/18.97	M/0.45	Increases plasma cholesterylester transfer protein	Fatty acid Ester/296	(Abbey and Nestel, 1994)
43	Stearic acid, methyl ester	M/19.34	M/0.69	Aid drug delivery Mechanism	Fatty acid ester/298	(Aishamsan *et al*., 2009)
44	Oleic acid	M/19.93	M/1,87	Emollient.	Fatty Acid/282	(Carrasco, 2009)
45	Stearic acid	M/20.22	M/1.60	Detergents, soaps, and cosmetics, ceramic	Fatty acid/284	(Tsenga *et al*., 1999)

				powders		
46	10-Methylicosane	M/23.53	M/0.81	Antifungal	Fatty hydrocarbon /296	(Chuang *et al*., 2006)
47	1,4- Methanocycloocta(d) pyrridazine	M/23.84	M/2.24	Antibacterial activity	Heterocyclics/204	(Abd El-Salam *et al*., 2013)
48	Heptacosane	M/26.14	M/1.33	lubricant	Hydrocarbon/380	(Griesbaum *et al.* 2012)
49	Nonacosane	M/27.16	M/1.53	lubricant	Hydrocarbon/408	(Griesbaum *et al*. 2012)

Extract = Solvent of Extraction (M, H, A), M=Methanol H = Hexane, EA=Ethyl Acetate Extract,
NF = Not Found RT = Retention time, MW = Molecular Weight, Class = Class of Compound

Conclusion

Solanum aethiopicum exocarp contains phytochemicals that have various medicinal and industrial uses. It can be recommended as a healthy food for all population especially people with sickle cell anemia. Further studies should be done to extract the pulp and determine its phytochemical components in order to determine the complete medicinal or industrial use of *Solanum aethiopicum.* Also, the vegetable can be genetically modified to increase the content of 2-Furaldehyde-5-(hydroxymethyl), the anti-sickling agent, which will enhance its use as treatment against sickle cell.

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