International Journal of Scientific Research in Science and Technology
Available online at : www.ijsrst.com
Print ISSN: 2395-6011 | Online ISSN: 2395-602X
doi : https://doi.org/10.32628/IJSRST2513109

Investigation into the Constituents of the Seed Oils of Tomato (Lycopersicon Esculentum). Okra (Albelmoschus Esculentus) and Nutmeg (Monodora Myristica) and Their Biological Activities

Abdullahi Moyosore*, Dr. Bilya Abdu, Yazid Salele
School of Secondary Education Sciences, Department of Chemistry Federal College of Education, Katsina, Nigeria

ARTICLEINFO

Article History:
Accepted : 01 Sept 2025
Published: 20 Sept 2025

Publication Issue :
Volume 12, Issue 5
September-October-2025

Page Number :
192-205

ABSTRACT

Volatile oils and fixed oils of the dry seeds of Tomato, Okra and Nutmeg plants found or grown in Katsina, Nigeria were obtained by maceration using n-Hexane. GC/MS analysis was performed using a Shimadzu QP2010 plus series gas chromatography coupled with Shimadzu QP2010 mass spectroscopy detector. Characterization of constituents was done by comparison with the MS library (NIST) and further confirmed by interpreting the observed fragmentation pattern. Comparison of the mass spectra with the database on MS library was done. The antimicrobial screening of the oils was also performed for oils from the seeds of these plants species, Ciprofloxacin and Fluconazole were used as control drugs. The most common major constituents of the fixed oils and their percentages were determined so also the essential oils components The minimum inhibition concentrations and minimum bactericidal/fungicidal activities were evaluated for all the samples. Recommendations for further research was also proffered. The study was expected completed within a period of six months, from April to October. This work was published in an international journal of scientific research The sum of two million two hundred and fifty thousand (2,250 000) has been the expected budget for the work.

Keywords: Seed Oils Extraction, GC-MS analysis, Anti-microbial activity

I. INTRODUCTION

Apart from the uses of some plants as food items and ingredients, oils extracted from the seeds are also used for different purposes ranging from medicinal to biofuels. Their chemical compositions, physical and chemical properties generally determine their applications for different purposes. Many microbial diseases worldwide have become a serious threat to human health because of the emergence of drug resistant or multi-drug resistant (MDR) microbial strains (Tabassum *et al.,* 2013 Several *in vitro* studies

Copyright © 2025 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)**

have been published confirming the effect of seed oils and their major compounds on pathogenic microbes (Burt, 2004). However, there are only limited data available on the antifungal activity of these seed oils against fungal pathogens. Essential (volatile) oils from aromatic and medicinal plants have been known since antiquity to possess biological activity, notably antibacterial, antifungal, and antioxidant properties (Baratta *et. al.* 1998; Cosentino *et al.* 1999; Bounatirou *et al.* 2007). In the last decade there has also been an increased interest in essential oils and their antimicrobial activity due to the spread of antibiotic resistance. Since the discovery of penicillin by Alexander Fleming in 1929 many new classes of antibiotics have become available for treatment of bacterial infections, but due to excessive and often unnecessary use of antibiotics in humans and animals, bacterial resistance has now been reported against every currently available antibiotic (Gopal Rao, 1999). Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin Resistant *Enterococci* (VRE) and resistant strains of *Pseudomonas* are examples of multiresistant bacteria that are becoming an alarming problem within the healthcare system. MRSA is probably the most common antibiotic resistant bacterium found in hospitals throughout the world and it naturally colonizes skin and infects wounds. Emergence of resistance to the existing drugs (Rios and Recio, 2005) led the scientists to search for the new alternatives including seed oil producing plants and their oil, which are known for their antimicrobial properties. Several *in vitro* studies have been published confirming the effect of seed oils and their major compounds on pathogenic microbes (Burt, 2004). However, there are only limited data available on the antifungal activity of these seed oils against fungal pathogens.

Inuoye, *et, al.*, (2001), reported that bacteria are more susceptible to oxygenated compounds than hydrocarbons. In this report, cinnamaldehyde of Cinnamon bark oil had significant activities against *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus pyogen*, *Staphylococcus pneumonia* and *H. influenzae*. This was followed by citral and then penalladehyde, octanol and nonanol. Thymol, a phenolic constituent of thyme oil, showed activity comparable to that of cinnamaldehyde, terpenols exhibit moderate activity while terpenes such as D – limonene and α- pinene were lowest in activity. Meanwhile the activities of the oil major constituents were close to the parent oils. Magiatis et, al., (2002), reported the antibacterial properties of camphor and 1, 8 - cineole found in the essential oils of *Achillae frasil* and *Achillae toygetea*. The same properties were also reported for the two compounds by Prudent (1993) and Aligiannis (2000). It has been established that essential oils exhibit anti-feedants and cytotoxic properties, these properties were reported for volatile oil of *Echiochilon fruiticosum* against adult of *Tribolium confusum* by Zardi - Bergaoui, *et al* (2007). Similarly, the cytotoxic activities of the essential oils of *Aeollanthus pubescens* and *Ocimum gratissimum* on the human epidermic cell line, have been evaluated and it was found that the essential oils of *A. pubescens* was more active than those of the *O. gratissimum* (Koba *et, al.,* 2008). Essential oils of *Cryptomeria japonica* was also reported to show significant lethality against brine shrimp larvae (Cheng *et, al.*, 2003). Essential oils from *cyperus* species are generally constituted by sesquiterpenoids and traces of monoterpenoids. The main hydrocarbon is always cyperene (Triveds, 1964). Many other sesquiterpene of caryophyllane, eudesmane, patchoulane and rotundane types are also present as hydrocarbon and oxygenated compounds. Mustakone and cryophyllene oxide have been identified in rhizome essential oil of Brazilian grown *Cyperus articulatus* by Zohgbi *et, al.*, (2006). Sönwa, and Konig (2001) had also isolated (-) - norotundane, (-) - isorotundone, cypera - 2, 4(15) - diene and (+) - cyperadone from *Cyperus rotundus*. The rhizome essential oils of red and black types of *C. articulatus* growing in Nigeria were studied (Olawore *et, al.,* 2006). Like other cyperus species both oils were richer in sesquiterpenoids than monoterpenoids. However,

the oils showed substantial quantitative and qualitative variations in their constituents. Some of the identified constituents were present in both oils while others were characteristics of one of the oil. Oil of the red type was characterized by the abundance of cypertundone, piperitone, α - maaline, germacrone, α - epicubenol, α - pinene amd cyperene oxide. For the oil of the black type, the main constituents were; cedrol, guai - 5 - en - 11 - ol, cyperotundone, sabinene, α - pinene, trans - pinocarveol, cis - carveol, trans - carveol and α - cardinol. With the abundance of oxygenated sesquiterpenoids in both oils, the oils are expected to be biologically active (Guynot *et, al.,* 2003).

1.1 Botany and Health Benefits of the Plants

1.1.1 Tomato (Lycopersicon esculentum)

Tomato (*Lycopersicon esculentum*) is a very nutritive vegetable that is cultivated throughout the whole world for its fruits. It has a high nutritive value and because of the many uses in culinary domain it is one of the most important vegetable. Tomatoes are processed in factories to obtain products like puree, juices, ketchup, sauce, and paste and tomato powder. The solid waste that remains after the juice/pulp extraction process, consists of skin, seeds, fibrous matter and cull tomato (Sogi *et, al* 2005), Seeds of tomatoes have in composition essential fatty acids, vitamins (A, D, E, K), phytosterols and other components with an important role in nutrients that play an important role in the human health and diet The tomato seeds are a source of vegetable oil, and was related that tomato seeds contains 20% oil (Rabak 1997). A very important parameter of the vegetable oils is the degree of unsaturation of the fatty acids that are present in the chemical structure of the oil (Lazos *et al* 1988)

1.1.2 Okra (Abelmoschus esculentus

Abelmoschus (Malvaceae) is a genus composed by about 15 species of flowering plants, among which Abelmoschus esculentus and Abelmoschus moschatus. A.esculentus (L.) Moench, formerly classified as Hibiscus esculentus (L.), is known as okra or ‘‘lady’s finger’’ or ‘‘gumbo’’. A. esculentus is native of Africa, where it spontaneously grows along the banks of Nile and in Ethiopia (Kochlar, 1986). It is largely cultivated in the tropical and sub-tropical areas. Among the main producers, India, Costa Rica, Nigeria and Ghana should be remembered (Torkpo, Danquah, Offei, & Blay, 2006). About its cultivation in Angola, Michotte (1928) reported ‘‘the aromatic seeds are used as scent by the local population’’. The genus name itself suggests the musk scent produced by the seeds (Bevans, Alford, Guanchez, Aregullin, & Rodriguez, 2001). In North America it is cultivated in Texas, Georgia, Florida, California, Tennessee and Alabama. Besides America, okra is also marketed in South Europe, particularly in Greece and Turkey (Calisir, Ozcan, Haciseferogullari, & Yildiz, 2005); it is largely used as a food in Germany (Incalcaterra, Vetrano, & Nicosia, 2000). In Turkey, the seeds obtained from the ripe fruits are roasted and used as coffee surrogate. Seeds contain high-quality proteins and they are often used as food for cattle or for the small-scale production of oil (Oyelade, Ade-Omowaye, & Adeomi, 2003). reported a high content (14%) of important unsaturated fatty acids, such as linoleic acid in this oil. In the past, the seeds were also used as antispasmodics, but at present they are mainly used for the manufacture of perfumes. The plant is emollient, demulcent and diuretic. Fruit is given in fevers, catarrh affections, gonorrhoea, cystitis, dysuria and leucorrhoea. It is also used in facial skin affections. A. esculentus is an annual plant, up to 2.5 m high, with main semi-woody stem and 5-lobed leaves; roots are collated and deep (Quagliotti & Lotito, 1989). Temperature plays a very important role in its life cycle: temperatures below 20° C during night and 26° C during the day prevent fruiting (Sionit, Strain, & Bevkford, 1981)

1.1.3 Nutmeg (Monodora myristica)

Spices are group of food adjunct that have been in use for decades to enhance sensory quality of foods by imparting characteristic flavour, aroma and colour; in

some instances, modifying the texture of the food (Srinivasan, 2005). The uses of spices gone beyond food flavouring and seasoning, rather many of the spices find applications in perfumery, cosmetics and toiletries(Nadkarri *et al*; Kochhar, 1986) some are also considered as nutrient for human and livestock consumption since they contain considering level of macro and micro nutrient imbedded in them(Gupta *et al*, 2003; Ozcan, 2004) Spices are refutable rich storehouse of different active compounds that have beneficial health effect, being used as stomach antispasmotic, anthelminitic, digestive stimulant, anti-inflammatory etc.(Tamaino *et al* 1992) This no doubt attributed to their use in pharmacological applications in the medicinal sector. Nigeria is endowed with varieties of spices both cultivated and grown in wild; among such spices is nutmeg (*Monodora myristica*) . Nutmeg plant is a native of Mulucca Island, but subsequently naturalized in tropics. *Monodora myristica* belongs to the family of *Annonacaceae* and posseses oval, pale brown and smoothly surface seeds. The plant is locally called Gyadar *miya* by Hausas.

1.2 Aims and objectives of the Study

The aim of this research work was to extract and screen the oils from the seeds of Tomato, Okra and Nutmeg plants

The specific objectives include

I. Determine the major constituents of the seed oils
II. Determine the chemical compositions of the seed oils using GC-MS
III. Determine the biological activity of the seed oils

II. MATERIALS AND METHODS

2.1 Study Area

The study will be conducted in Katsina State, Northern Nigeria. Katsina State is located between latitudes 11°08′N and 13°22′N and longitudes 6°52′E and 9°20′E. The state covers an area of 23,938 sq km and lies in the Northern Nigerian Sahelian Savannah. The state is bordered by Niger Republic to the North, Jigawa and Kano States to the East, Kaduna State to the South and Zamfara State to the West. The state has 34 Local Government areas (OCHA, 2018).

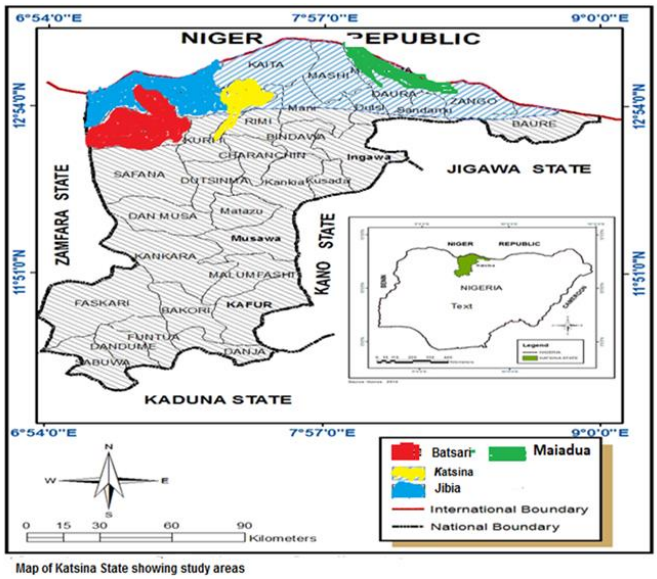


Figure 1: Map of Katsina State, Nigeria

2.2 Sample Collection and Preparation

2.2.1 Plant materials

Lycopersicon esculentus, Albelmoschus esculentus and Monodora myristice fruits and seeds as the case might be, were collected from markets located within the three zones in the state (Funtua, Katsina and Daura), Nigeria and authenticated by direct comparison with authentic samples at the Department of Biological Sciences, Umaru Musa Yaradua University Katsina.

2.2.2 Instruments

A Shimadzu QP2010 plus series gas chromatography coupled with Shimadzu QP2010 plus mass spectroscopy detector (GC-MS) system was used.

III.METHODS

3.1 GC-MS analysis

25 g of each sample plant seeds was crushed and oil extracted with n-Hexane. The oils were extracted by maceration (Handa *et, al.* 2008), The extracted oil was concentrated under reduced pressure and dried. The GC-MS was conducted at the National Research Institute of Chemical Technology(NARICT) Zaria.

Oils from these three species were studied. In GC-MS analysis, the temperature program was set up from 70°C to 280°C. Helium gas was used as carrier gas. The injection volume was 2 µL with injection temperature of 250°C and a column flow of 1.80 ml/min for the GC. For the mass spectroscopy ACQ mode scanner with scan range of 30-700 amu at the speed of 1478 was used. The mass spectra were then compared with the NIST05 mass spectral library (NIST, 2012)

3.2 Antimicrobial screening

In cup plate agar diffusion bioassay, seed oils from these plants were assessed for antimicrobial activity (Hammer *et, al,* 1999), the antimicrobial activity was assessed against six standard pathogenic microbes. The microbes were obtained from the Department of Medical Microbiology, ABU Teaching Hospital, Zaria. Anti-microbial screening was done at institute of leather technology Zaria.

Diffusion method was used for screening the oil. Mueller Hinton and Sabouraud dextrose agars media were used as the growth media for the bacteria and the fungus respectively. The media were prepared according to the manufacturer's instructions, sterilized at 121°C for 15 minutes, poured into sterile Petri dishes and allowed to cool and solidify. The sterilized media were sealed with 0.1ml of the standard inoculums of the test microbe (Mueller Hinton agar was sealed with the bacteria and Sabouraud dextrose agar was sealed with the fungus). The inoculums were spread over the surface of the medium by the use of a sterile swab. By the use of a standard cork borer of 6mm in diameters, a well was cut at the centre of each inoculated medium. (0.1ml) of the oil (concentration of 50mg/ml) and was then introduced into the well on the inoculated medium. Incubation of the inoculated medium was made at 37°C for 24 hours for the bacteria and at 30°C and for 4 days for the fungus. After incubation each plate of the medium was observed for the growth inhibition zone. The zone was measured with a transparent ruler and the results were recorded in millimeters.

3.3 Minimum Inhibition Concentration

The minimum inhibition concentration of the oil was determined using the broth dilution method. Mueller Hinton and Sabouraud dextrose broth were prepared, 10ml of each broth were dispensed into test tubes and sterilized at 121°C for 15 minutes, and the broth were allowed to cool. Mc-Farlands turbidity standard scale number 0.5 was prepared to give turbid solution. Normal saline was prepared. 10ml solutions were dispensed into sterile test tubes and the test microbes were inoculated and incubated at 37°C for 6 hours. Dilution of the test microbe was done in the manual saline until the turbidity matched that of Mc-Farland's scale by visual comparison, at the point the test microbe concentration was about 1.05 x 10^8 cfu/ml.

Having obtained the different concentrations of the oil in the sterile broth, 0.1ml of the test microbe in the normal saline were then introduced into the different concentration. Incubation was made at 37°C for 24 hours for the bacteria and at 30°C for the fungus, then the test tubes were observed for turbidity (growth). The lowest concentration of the oil in the broth which shows no turbidity was regarded as the minimum inhibition concentration.

3.4 Minimum Bactericidal and Fungicidal Concentrations

MBC/MFC was carried out to determine whether the test microbes were killed or only their growth was inhibited. Mueller Hinton and Sabouraud dextrose agars was prepared, sterilized at 121°C for 15 minutes, poured into sterile Petri dishes and allowed to cool and solidify.

The content of the mixture in the serial dilution was then sub-cultured onto the prepared media. The bacteria were cultured onto the Mueller Hinton agar and the fungus on the Sabouraud dextrose agar. Incubation was made at 37°C for 24 hours for the bacteria and at 30°C for 4 days for the fungus after which the plates of the media were observed for colony growth.

IV. RESULTS AND DISCUSSIONS

The oils were extracted by maceration and then identified and quantified by GC-MS analysis. Characterization of constituents was initially accomplished by comparison with the MS library (NIST) and further confirmed by interpreting the observed fragmentation pattern. Comparison of the mass spectra with the database on MS library revealed about 90-95% match

4.1 Lycopersicon esculentum

The GC-MS spectrum of the studied oil of *lycopersicon esculentum* showed the presence of 18 components (Table:1). The typical total ion chromatograms (TIC) of hexane extract is shown in Fig.1. as indicated below

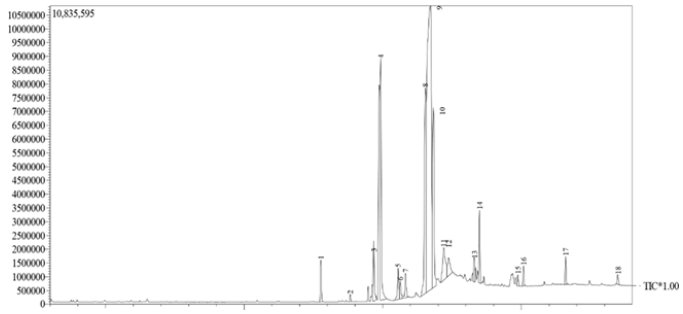


Fig 1 Total ion *lycopersicon esculentum* Chromatogram

Table 1 Constituents of the oil

	Peak#	R.Time	I.Time	F.Time	Area	Area%
1	12.766	12.717	12.858	3482328	1.44	
2	13.830	13.800	13.883	568463	0.24	
3	14.672	14.642	14.750	5844213	2.42	
4	14.926	14.900	15.158	25116574	10.40	
5	15.554	15.433	15.600	3793235	1.57	
6	15.627	15.600	15.708	2137517	0.89	
7	15.823	15.708	15.933	2997455	1.24	
8	16.537	16.375	16.567	32929586	13.64	
9	16.729	16.567	16.783	111951960	46.36	
10	16.827	16.783	16.933	25749542	10.66	
11	17.205	17.092	17.317	8492475	3.52	
12	17.376	17.317	17.517	4116436	1.70	
13	18.301	18.267	18.333	2415509	1.00	
14	18.491	18.450	18.550	5833391	2.42	
15	19.876	19.833	19.950	1067672	0.44	
16	20.078	20.017	20.125	1588032	0.66	
17	21.597	21.542	21.658	2321332	0.96	
18	23.477	23.425	23.567	1064128	0.44	
	241469848				100.00	

Major constituents of the oil are discussed below:

Hexadecanoic acid methyl ester (10.40%)

The EI mass spectrum of hexadecanoic acid methyl ester is shown in Fig.1.1 The peak at m/z 270, which appeared at R.T. 14.926 in total ion chromatogram, corresponds to $M^+[C_{17}H_{34}O_2]^+$ .The peak at m/z 239 corresponds to loss of a methoxyl function.

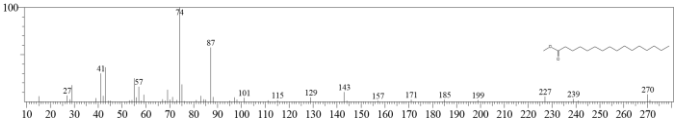


Fig. 1.1 Mass spectrum of hexadecanoic acid methyl ester 9,12-Octadecadienoic acid (13.64%)

The EI mass spectrum of 9,12-Octadecanoic acid methyl ester is shown in Fig1.2 The peak at m/z 294, which appeared at R.T. 16.537 in total ion chromatogram, corresponds to $M^+[C_{19}H_{34}O_2]^+$.

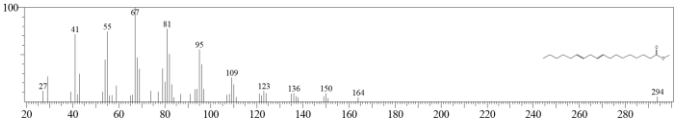


Fig. 1.2 Mass spectrum of 9,12-Octadecanoic acid methyl ester 9-Octadecenoic acid (Z)-, (46.36%}

The EI mass spectrum of 9-Octadecanoic acid(Z), methyl ester is shown in Fig1.3 The peak at m/z 296, which appeared at R.T. 16.729 in total ion chromatogram, corresponds to $M^+[C_{19}H_{36}O_2]^+$.

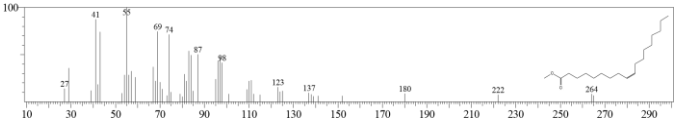


Fig.1. 3 Mass spectrum of 9-Octadecanoic acid(Z) methyl ester Octadecanoic acid (10.66%)

The EI mass spectrum of Octadecanoic acid methyl ester is shown in Fig1.4 The peak at m/z 298, which appeared at R.T. 16.827 in total ion chromatogram, corresponds to $M^+[C_{19}H_{38}O_2]^+$.

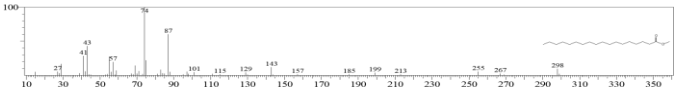


Fig.1. 4 Mass spectrum of Octadecanoic acid methyl ester ***4.2 Abelmoschus esculentus***

The GC-MS spectrum of the studied oil of *Abelmoschus esculentus* showed the presence of 20 components (Table:2.). The typical total ion chromatograms (TIC) of hexane extract is shown in Fig 2.1 as indicated below

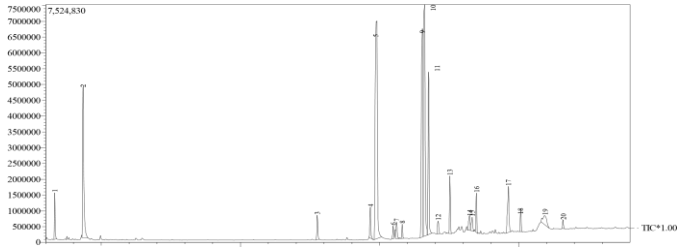


Fig 2. Total ion Chromatogram Abelmoschus

Table 2 Constituents of the oil

Peak#	R.Time	I.Time	F.Time	Area
1	3.326	3.292	3.400	2524759
	1.61			
2	4.346	4.308	4.517	13271696
	8.48			
3	12.758	12.717	12.825	1747247
	1.12			
4	14.662	14.617	14.758	2244719
	1.43			
5	14.896	14.792	15.067	37895277
	24.21			
6	15.483	15.433	15.525	954206
	0.61			
7	15.605	15.575	15.675	1527798
	0.98			
8	15.810	15.675	15.867	1022607
	0.65			
9	16.538	16.450	16.558	26954451
	17.22			
10	16.607	16.558	16.708	33346722
	21.30			
11	16.760	16.708	16.875	13609002
	8.69			
12	17.093	17.050	17.158	1288166
	0.82			
13	17.523	17.475	17.592	3946210
	2.52			
14	18.226	18.167	18.267	1760449
	1.12			
15	18.322	18.267	18.383	1481910
	0.95			
16	18.474	18.433	18.533	2577772
	1.65			
17	19.627	19.542	19.717	5451588
	3.48			
18	20.069	20.025	20.125	1512426
	0.97			
19	20.931	20.792	21.092	2819687
	1.80			
20	21.586	21.550	21.642	603618
	0.39			
	Area%			
156540310	100.00			

Eucalyptol (8.48%)

The EI mass spectrum of Octadecanoic acid methyl ester is shown in Fig2.1 The peak at m/z 154, which appeared at R.T.4.346 in total ion chromatogram, corresponds to $M^+[\ C_{10}H_{18}O\ ]^+$

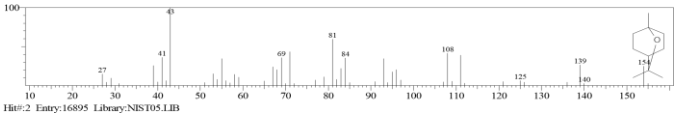


Fig 2.1 Mass spectrum of Octadecanoic acid methyl ester

14-methyl- pentadecanoic acid (24.21%)

The EI mass spectrum of 14-methyl- pentadecanoic acid, methyl ester is shown in Fig.2.2 The peak at m/z 270, which appeared at R.T. 14.896 in total ion chromatogram, corresponds to $M^+[\ C_{17}H_{34}O_2\ ]^+$

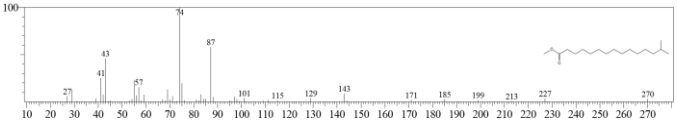


Fig 2.2 Mass spectrum of 14-methyl- pentadecanoic acid, methyl ester

9,12-Octadecadienoic acid, methyl ester (17.22%)

The EI mass spectrum of 9,12-Octadecadienoic acid, methyl ester is shown in Fig2.3 The peak at m/z 294, which appeared at R.T. 14.538 in total ion chromatogram, corresponds to $M^+[\ C_{19}H_{34}O_2\ ]^+$

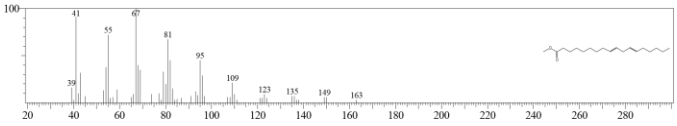


Fig 2.3 Mass spectrum of 9,12-Octadecadienoic acid, methyl ester

11-Octadecenoic acid, methyl ester (21.30%)

The EI mass spectrum of 11-Octadecadienoic acid, methyl ester is shown in Fig.2.4 The peak at m/z 296, which appeared at R.T 16.607 in total ion chromatogram, corresponds to $M^+[C_{19}H_{36}O_2]^+$

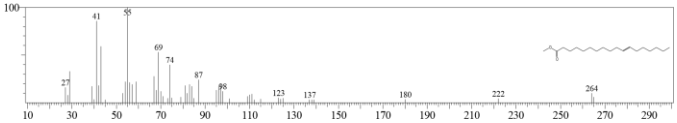


Fig 2.4 Mass spectrum of 11-Octadecadienoic acid, methyl ester

Octadecanoic acid, methyl ester (8.69%)

The EI mass spectrum of 11-Octadecadienoic acid, methyl ester is shown in Fig.2.5 The peak at m/z 298, which appeared at RT 16.670 in total ion chromatogram, corresponds to $M^+[C_{19}H_{38}O_2]^+$

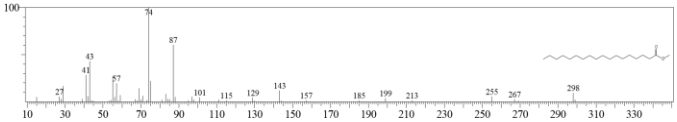


Fig 2.5 Mass spectrum of Octadecadienoic acid, methyl este

4.3 Monodora myristica

The GC-MS spectrum of the studied oil of *Monodora myristica* showed the presence of 25 components (Table:3). The typical total ion chromatograms (TIC) of hexane extract is shown in Fig.3 as indicated below

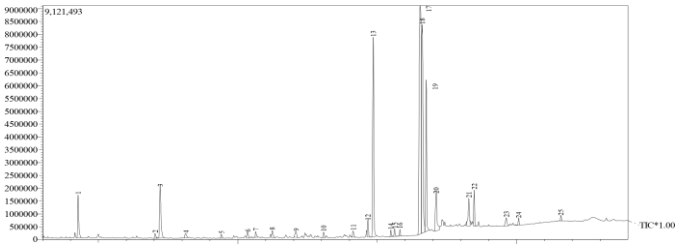


Fig 3 Total ion Chromatogram *Mondora myristica*

Table 3. Constituents of the oil

Peak#	R.Time	I.Time	F.Time	Area	Area%
1	4.269	4.217	4.392	4429061	3.00
2	7.031	6.992	7.083	494673	0.34
3	7.210	7.083	7.367	7096923	4.81
4	8.123	8.067	8.25	720501	0.49
5	9.404	9.358	9.475	420917	0.29
6	10.342	10.308	10.433	822699	0.56
7	10.642	10.600	10.725	625255	0.42
8	11.238	11.200	11.342	895214	0.61
9	12.085	12.017	12.158	863425	0.59
10	13.078	13.033	13.142	594369	0.40
11	14.134	14.058	14.208	772593	0.52
12	14.666	14.633	14.758	1660015	1.12
13	14.860	14.800	14.992	21361001	14.48
14	15.487	15.442	15.533	594117	0.40
15	15.621	15.533	15.683	786693	0.53
16	15.815	15.683	15.875	562204	0.38
17	16.540	16.450	16.592	49452966	33.51
18	16.614	16.592	16.708	25734927	17.44
19	16.760	16.708	16.867	14583163	9.88
20	17.120	17.042	17.225	6240730	4.23
21	18.291	18.217	18.333	3397994	2.30
22	18.477	18.442	18.542	3034454	2.06
23	19.631	19.550	19.725	1287776	0.87
24	20.074	19.933	20.125	644467	0.44
25	21.592	21.550	21.642	486162	0.33

147562299 100.00

14-methyl Pentadecanoic acid, methyl ester (14.48%)

The EI mass spectrum of 14-methyl Pentadecanoic acid, methyl ester is shown in Fig3.1 The peak at m/z 270, which appeared at RT 14.860 in total ion chromatogram, corresponds to $M^+[C_{17}H_{34}O_2]^+$

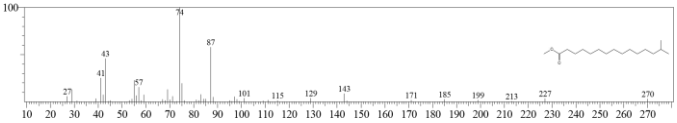


Fig 3.1 Mass spectrum of 14- Pentadecadienoic acid, methyl ester

12-Octadecadienoic acid, methyl ester (33.51%)

The EI mass spectrum of 14-methyl Pentadecanoic acid, methyl ester is shown in Fig.3.2 The peak at ,

m/z 294 which appeared at RT 16.540 in total ion chromatogram, corresponds to $M^+[C_{19}H_{34}O_2]^+$

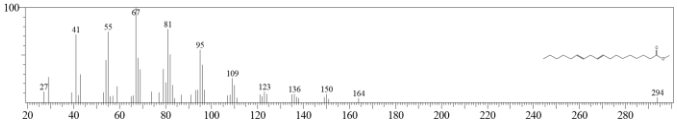


Fig 3.2 Mass spectrum of 12- Octadecadienoic acid, methyl ester

11-Octadecenoic acid, methyl ester (17.44%)

The EI mass spectrum of **11-Octadecenoic acid, methyl ester** is shown in Fig.3.3 The peak at , **m/z 296** which appeared at RT 16.614 in total ion chromatogram, corresponds to $M^+[C_{19}H_{36}O_2]^+$

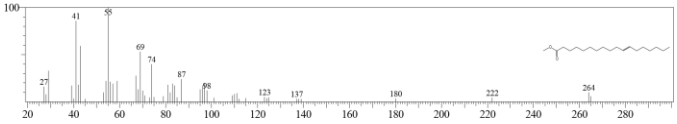


Fig 3.3 Mass spectrum of 11- Octadecadienoic acid, methyl ester

Octadecanoic acid, methyl ester (9.88%)

The EI mass spectrum of **Octadecenoic acid, methyl ester** is shown in Fig.3.4 The peak at m**/z 298** which appeared at RT 16.760 in total ion chromatogram, corresponds to $M^+[C_{19}H_{38}O_2]^+$

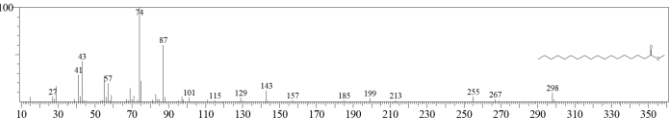


Fig 3.4 Mass spectrum of Octadecadienoic acid, methyl ester

In the disc diffusion bioassay of all the three samples only Lycopersicon esculentum and *Mondora myristica* showed strong antimicrobial potency against Staphylococus *aureus*, *Escherichia coli* and *Candida albicans* while *Albesmochus esclentus* showed strong antimicrobial potency against *Bacillius cereus and Salmonella typi Also lycopersicon esculentum and monodora myristica* were inactive against *Bacillius cereus and Salmonella typi* (Table 4 and 5).

Table 4. Antimicrobial activity of target species

Test organism	*Albelmoschus*	*Lycopersicon*	*Monodora*
Staphylococus aureus	R	S	S
Bacillius cereus	S	R	R
Escherichia coli	R	S	S
Vibrio choloreae	S	S	R
Salmonella typhi	S	R	R
Candida albicans	R	S	S
Aspergillus nigre	R	S	R

Table 5 Diameter of inhibition zones (mm)

Test organism	*Albelmoschus*	*Lycopersicon*	*Monodora*
Staphylococus aureus	0	26	22
Bacillius cereus	20	0	0
Escherichia coli	0	24	21
Vibrio choloreae	20	25	0
Salmonella typhi	19	0	0
Candida albicans	0	23	20
Aspergillus nigre	0	21	0

The minimum inhibition concentration is displayed in Tables (6-8). *Abelmoschus esculentus* and *monodora myristica* showed a minimum inhibition concentration at 12.50 mg/ml so also *Lycopersicon esculentum* except against *Stapyllococus aureus*, *Escherichia coli and Vibrio choloreae* at 6.25mg/ml

Table 6 Minimum inhibition concentration-*Abelmoschus esculentus*

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus						
Bacillius cereus	-	-	0*	+	++	+++
Escherichia coli						
Vjbrio choloreae	-	-	0*	+	++	+++
Salmonella typhi	-	-	0*	+	++	+++
Candida albicans						
Aspergillus nigre						

Table 7 Minimum inhibition concentration-*Lycopersicon esculentum*

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus	-	-	-	0*	+	++
Bacillius cereus						
Escherichia coli	-	-	-	0*	+	++
Vjbrio choloreae	-	-	-	0*	+	++
Salmonella typhi						
Candida albicans	-	-	0*	+	++	+++
Aspergillus nigre	-	-	0*	+	++	+++

Table 8 Minimum inhibition concentration-*Monodora myristica*

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus	-	-	0*	+	++	+++
Bacillius cereus						
Escherichia coli	-	-	0*	+	++	+++
Vjbrio choloreae						
Salmonella typhi						
Candida albicans	-	-	0*	+	++	+++
Aspergillus nigre						

The minimum bactericidal activity was evaluated for the oil samples and the results are depicted in Tables (9-11). *Abelmoschus esculentus* gave minimum bactericidal activity at 50mg/ml. *Lycopersicon esculentum* exhibited a minimum bactericidal potential against test organisms at 12.5-50mg/ml, while a concentration of 25-50mg/ml was observed for *Monodora myristica*.

Table 9. Minimum bactericidal/Fungicidal concentration-Abelmoschus esculentus

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus						
Bacillius cereus	0*	+	++	+++	+++	+++
Escherichia coli						
Vjbrio choloreae	0*	+	++	+++	+++	+++
Salmonella typhi	0*	+	++	+++	+++	+++
Candida albicans						
Aspergillus nigre						

Table 10. Minimum bactericidal/Fungicidal concentration-Lycopersicon esculentum

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus	-	-	0*	+	++	+++
Bacillius cereus						
Escherichia coli	-	-	0*	+	++	+++
Vjbrio choloreae	-	-	0*	+	++	+++
Salmonella typhi						
Candida albicans	-	0*	+	++	+++	+++
Aspergillus nigre	0*	+	++	+++	+++	+++

Table 11. Minimum bactericidal/Fungicidal concentration-Monodora myristica

Test Organism	50mg/ml	25mg/ml	12.5mg/ml	6.25mg/ml	3.13mg/ml	1.56mg/ml
Staphylococus aureus	-	0*	+	++	+++	+++
Bacillius cereus						
Escherichia coli	0*	+	++	+++	+++	+++
Vjbrio choloreae						
Salmonella typhi						
Candida albicans	0*	+	++	+++	+++	+++
Aspergillus nigre						

V. CONCLUSION

Volatile oils and fixed oils of the dry seeds of Abelmoschus esculentus, Lycopersicon esculentum and Monodora myristica plants grown and or found in Nigeria were obtained by maceration using n-hexane. GC/MS analysis was performed. Characterization of constituents was done by comparison with the MS library (NIST) and further confirmed by interpreting the observed fragmentation pattern.

The most common major constituents of the fixed oils were :9-Octadecenoic acid(Z) (46.64%).12-Octadecanoic acid methyl ester (33.51%). 9,12-octadecadienoic acid (linolelaidic acid) (13.64-17.44%), Octadecenoic acid (stearic acid), (6.69-10.66%) and hexadecanoic acid (palmitic acid) (10.40%). 14-methylpentadecanoic acid methyl ester (14.48-24.21%).11-Octadecanoic acid methyl ester (17.44-21.30%) and the minimum inhibition concentrations and minimum bactericidal/fungicidal activities were evaluated for all the samples.

REFERENCES

[1]. Aligiannis, N., Kalpoutzakis, E., Chinou, I.B., Mitakou, S., Gikas, E., Tsarbopoulos, A. (2000). Composition and antimicrobial activity of the essential oil of five taxa of siderites from Greece. J. Agric food chem. 49:811-815

[2]. Baratta M.T., Dorman H.J.D., Deans S.G., Figueiredo A.C., Barroso J.G., Ruberto G. (1998): Antimicrobial and antioxidant properties of some commercial essential oils. Flavour and Fragrance Journal, 13: 235–244.

[3]. Bevans, N., Alford, M., Guanchez, F., Aregullin, M., & Rodriguez, E. (2001). Preliminary phytochemical study of two Caribbean Malvaceae used in the treatment of conjunctivitis. Journal of Undergraduate Study and Independent Research, 2, 20–24.

[4]. Bounatirou S., Smiti S., Miguel M.G., Faleiro L., Rejeb M.N., effati M., Costa M.M. Figueiredo A.C., Barroso J.G., Pedro L.G. (2007): Chemical composition, antioxidant and antimicrobial activities of the essential oils isolated from Tunisian Thymus capitus Hoff. et Link. Food Chemistry, 105: 146–155

[5]. Calisir, S., Ozcan, M., Haciseferogullari, H., & Yildiz, M. U. (2005). A study on some physic-chemicalproperties of Turckey okra (Hiscus esculenta L.) seeds. Journal of Food Engineering, 68, 73–78.

[6]. Cheng, S. S.; Chang, H. T.; Chang, S. T.; Tsai, K. H. and Chen, W. J. (2003) Bioactivity of selected plant essential oils against the yellow fever mosquito Aedis aegypti and brine shrimp, Bioresour. Technol., 89(1): 99 - 102.

[7]. Cosentino S., Tuberoso C.I.G., Pisano B., Satta M., Mascia V., Arzedi E., Palmas F. (1999): In vitro antimicrobial activity and chemical composition of Sardinian Thymus essential oils. Letters of Applied Microbiology, 29: 130–135

[8]. Rios J.L, Recio M.C (2005) Medicinal plants and antimicrobial activity. Journal of Ethnopharmacology. 100:80–84

[9]. Tabassum W, Kullu AR, Sinha MP (2013). Effects of leaf extracts of Moringa oleifera on regulation of hypothyroidism and lipid profile. The Bioscan. 8:665-669.

[10]. Burt S. (2004). Essential oils: their antibacterial properties and potential applications in foods a review. Int J Food Microbiol. 94:233-253.

[11]. Cosentino S., Tuberoso C.I.G., Pisano B., Satta M., Mascia V., Arzedi E., Palmas F. (1999): In vitro antimicrobial activity and chemical composition of Sardinian Thymus essential oils. Letters of Applied Microbiology, 29: 130–135

[12]. Gopal Rao G (1999). Risk factors for the spread of antibiotic resistant bacteria Drugs 55:323-330

[13]. Gupta, K.K., Bhattacharjee, S., Kar, S., Chakrabarty, S., Thakur, P.,Bhattacharyya G. and Srivastava, S.C. (2003). Comm. Soil Sci. Plant Analy., 34: 681 -693

[14]. Guynot M..E, Ramos A.J, Setó L, Purroy P, Sanchis V, Marín S (2003). Antifungal activity of volatile compounds generated by essential oil against fungi commonly causing deterioration of bakery products. Journal of Applied Microbiology. 94:893-899

[15]. Hammer K.A, Carson C.F, Riley T.V (1999). Antimicrobial activity of essential oils and other plant extracts. J. Appl. Microbiol. 86: 985- 990.

[16]. Handa S.S, Khanuja S.P.S, Longo G, Rakesh D.D (2008) Extraction Technologies for Medicinal and Aromatic Plants, (1st edn), no. 66. Italy: United Nations Industrial Development Organization and the International Centre for Science and High Technology

[17]. Incalcaterra, G., Vetrano, F., & Nicosia, M. (28-30 marzo 2000). Ricerche sulla produzione sementiera dell'okra. V giornate scientifiche SOI. Sirmione I,. 241–242

[18]. Inouye, S.; Takizawa, T.; Yamaguchi, H (2001). Antibacterial activity of essential oils and their

major constituents against respiratory tract pathogenbs by gaseous contact. Journal of antimicrobial Chemotherapy, 47, 565 - 576.

[19]. Kochlar S.I. (1986). Okra (lady finger) in tropical crops, a text book of economic botany 1: 263-264.

[20]. Koba, K. Sanda, C. Guyon, C. Raynaud, J. Millet, J. P. Chaumont and L. Nicod (2008) Chemical composition and in vitro cytotoxic activity of essential oils from two tropical Lamiacea: Aeollanthus pubescens Benth and Ocimum gratissimum L., JEOBP, available at http://www.jeobp.com/ access on 20/7/2016

[21]. Lahlou, M. (2004) Methods to study the Phytochemistry and bioactivity of essential oils. Phytother. Res. 18: 435 - 448.

[22]. Lazos, E.S; Kalathenos, P. (1988) Composition of tomato processing wastes. International Journal of Food Science and Technology, Chicago, , 23(6), 649-6528

[23]. Michotte, F. (1928). Les Hibiscus. Bulletin de la soc. coloniale Francaise. 64. 3–6

[24]. Mueller J. H. and Hinton J.(1941), Proc. Soc. Exp. Biol. Med., 48:330

[25]. Nadkarni, K.M.and Nadkarni, A.K (1976). India Material Medica, Mumbai, India popular prakasha publishers limited. 30-60

[26]. NIST GC-MS NIST Library Information Manual. (2012) National Institute for Standard Technology. Octadecanoic acid.

[27]. Olawore, N. O.; Usman, L. A.; Ogunwade, I. A. (2006). Constituents of rhizome essential oils of two types of Cyperus articulatus growing in Nigeria. 18: 604 - 606.

[28]. Oyelade, O. J., Ade-Omowaye, B. I. O., & Adeomi, V. F. (2003). Influence of variety on protein, fat contents and some physical characteristics of okra seeds. Journal of Food Engineering, 57, 111–114.

[29]. Quagliotti, L., & Lotito, S. (1989). Un ortaggio nuovo per l'Italia: l'okra. L'informatore agrario., 27, 59– 65.

[30]. Ozcan, M. (2004). Food Chem. 84: 437 - 440.

[31]. Rabak F., (1997) The utilization of waste tomato seeds and skins. US Dept Agric Bull, , 632:15

[32]. Sabouraud K., (1892) Ann. Dermatol. Syphilol, 3:1061

[33]. Sionit, N., Strain, B. R., & Bevkford, H. A. (1981). Environmental controls on the growth and yield of okra. Effect of temperature and CO2 enrichment at cool temperature. Crop Science, 21, 885–888.

[34]. Sogi D.S, Bhatia R, Garg S.K, Bawa A.S, (2005) Biological evaluation of tomato waste seed meals and protein concentrate, Food Chemistry, , 89(1), 53–56,

[35]. Srinivasan, K.(2005). J. Food Review International, 21: 167- 188

[36]. Tamaino, A., Cimino, F., Zimbaiatti, V., Venuti, V., Sulfaro, V., De-Pasquale,A.D. and Saija, A. (2005). Food Chem. 89: 549 -554.

[37]. Torkpo, S. K., Danquah, E. Y., Offei, S. K., & Blay, E. T. (2006). Esterase, total protein and seed storage protein diversity in okra (Abelmoschus esculentus L. Moench). West African Journal Applied Ecology, 9, 1–7.

[38]. Triveds, B., Motl, O., Smolikova, J., Sorm, F., (1964). Structure of the hydrocarbon cyperene. Tetrahedron Letters. 1197.

[39]. Magiatis, P.; Skaltsounis, A.; Chinou, I. and Haroutounian, S.A. (2002). Chemical composition and in-vitro antimicrobial activity of the essential oils of three Greek Achillea Species. Z. Naturforsch. 57; 287-290.

[40]. Prudent, D., Perineau, F., Bessiere, J.M., Michael, G., Bravo, R. (1993). Chemical analysis, bacteriostatic and fungistatic properties of the essential oil of the atoumau from M artinique (Alphinia speciosa) J. Essential Oil. Research. 5:.255-264.

[41]. Zardi - Bergaoui, H. B. Jannet, F. Harzallah - Skhiri, I. Chaeb, S. Hammami and Z. Mighri (2007) Chemical composition, toxicity and antifeedant activities of the Tunisian of

Echiochilon fruiticosum Desf. Aerial part volatile fracions against Tribolium confusum du val, JEOBP, available at http://www.jeobp.com Accessed on 12/10/2016

[42]. Zoghbi, B.M. Adrade, A.E., Oliveira, J., Carreura, M.L. Giulthou, S.P.N., (2006). Yield and chemical composition of the essential oil of the stems and rhizomes of cyperus articulatus L. cultivated in the state of Para, Brazil. Journal of essential oil researcher 18(1): 261 - 263.