International Journal of Medical Science and Health Research

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Comparative Study on the Phytochemical Constituents and Fatty Acid Content of Palm Kernel and Coconut Oils

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Abstract

This study was aimed at determining the phytochemical constituents and fatty acid content of palm kernel and coconut oils. This was done to reveal the composition of the oils which are responsible for the medicinal and pharmacological properties of the oils. The phytochemicals present in the oils were determined by qualitative analysis using standard method. The fatty acid content of the oils was determined using Gas Chromatography Mass Spectrometry (GCMS) Analysis. The phytochemical analysis revealed the Presence of Saponins, Phenol, Terpenoids, Flavonoids and Steroids. The GCMS Analysis revealed the presence of Lauric acid, Myristic acid, Palmitic acid, Oleic acid, Stearic acid and others. Among the Fatty acids, Oleic acid was the Predominant as revealed in this study. The result revealed that both oils contain similar phytochemicals and Fatty acids. From the results obtained it can therefore be concluded that the oils contain some beneficial compounds such as Oleic acid which contains anticancer properties; Lauric acid which contains antimicrobial properties; Myristic acid which help the body to stabilize different proteins used in the immune system and to fight tumors; and Phenols which serve as a standard for other antimicrobial agents.

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Keywords: Phytochemical Constituents and Fatty Acid Content, Saponins, Phenol, Terpenoids, Flavonoids and Steroids.

1.0 INTRODUCTION:

The Palm tree has a long history of providing man with useful materials for his daily life. Among these useful materials are palm kernel oil and coconut oil obtained from the palm nut. Palm kernel and Coconut oil contain similar compounds. These compounds are responsible for the versatile use of the oils. The constituents range from secondary metabolites (Phytochemicals) to fatty acids. Palm kernel oil is a rich source of Lauric acid, known as 'magical' medium chain saturated fat that is highly antimicrobial [1]. Coconut oil is also high in Lauric acid which is one reason it is being studied by scientist all over the world for it antibacterial, antiviral and antifungal properties [1], particularly in the face of the worrisome problem of increasing antibiotic resistance

Many people use these oils for a wide variety of purposes including alternative medicine and natural therapies. This is because plant products contain large varieties of chemical substances with important therapeutic properties that can be utilized in the treatment of human diseases. Consequently, there is increasing assumption that traditional medicines are not only cheaper but more effective than modern medicine [17].The studies of medicinal plants used as folklore remedies have therefore attracted immense attention in the scientific world in an attempt to find possible solutions to the problems of multiple resistances to the existing synthetic and conventional antimicrobials [8].

Secondary metabolites, also known as phytochemicals, natural products or plant constituents are responsible for medicinal properties of plants to which they belong. In human life, these compounds are used as medicines, flavorings, or relaxing drugs, especially essential oils [13]. They contain numerous natural products with interesting pharmacology activities [13]. Some of these secondary metabolites possess antimicrobial properties.

2.0 MATERIALS AND METHODS:

2.1 Materials:

- Test tubes
- Nose mask
- Hand gloves
- Syringes
- Test tube racks

2.2 Methods:

2.2.1 Collection and Preparation of Plant Samples

The plant samples (palm kernel oil and coconut oil) used for this study were extracted locally using local extraction method. These samples were authenticated in Biological Sciences

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Department of Kaduna State University, (KASU),Nigeria. Some oil samples were also bought from local extraction industries within Kaduna.

2.2.2 Phytochemical Screening of Oil samples

The methods described by [11; 9 and 18], were used to test for the presence of saponins, tannins, alkaloids, flavonoids and in the test samples.

2.2.2.1 Test for Flavonoids

Two (2) mls of 10% sodium hydroxide was added to 2ml of the oil extract in a test tube. A yellow color formed which turned colorless upon addition of 2ml of diluted hydrochloric acid indicates a positive result.

2.2.2.2 Test for Phenol

Two (2) mls of the oil extract was mixed with few drop of 10% ferric chloride solution. The formation of green-blue or violet or blue-black coloration was an indication of a positive result.

2.2.2.3 Test for Tannins

Five (5) drops of 0.1% ferric chloride was added to 2ml of the oil extract, formation of a brownish green or blue-black coloration indicates a positive result.

2.2.2.4 Test for Saponins

Two (2) mls of oil extract was diluted with 2ml distilled water. It was then agitated in a test tube for 5minutes. 0.1cm layer of foam indicates a positive result.

2.2.2.5 Test for Phlobatannins

Two (2) mls of the oil extract was boiled with 1% aqueous hydrochloride. Deposition of a red precipitate indicates a positive result.

2.2.2.6 Test for Alkaloids

To Two (2) mls of the oil**,** 2ml of 10% hydrochloric acid was added. To the acidic medium, 1ml Hager's reagent (saturated picric acid solution) was added. Presence of alkaloids is confirmed by the formation of yellow colored precipitate.

2.2.2.7 Test for Steroids

Two (2) mls of the oil was dissolved in 10ml of chloroform and then, 10ml of concentrated sulphuric acid was added by the side of the test tube. The upper layer turned red whereas, the sulphuric acid layer turned yellow with green fluorescence. This indicates the presence of steroids.

2.2.2.8 Test for Terpenoids

Two (2) mls of the oil was mixed with 2ml of chloroform and 1ml of concentrated sulphuric acid was carefully added to form a layer. Clear upper and lower layers with a reddish brown interphase indicate a positive result.

Vol. 2, No. 02; 2018

ISSN: 2581-3366

2.2.2.9 Test for Glycosides

Two (2) mls of acetic acid was added to 2ml extract. The mixture was cooled in a cold water bath. 2ml of concentrated H_2SO_4 was added. Colour development from blue to bluish green indicates the presence of glycosides.

2.2.2.10 Test for Anthraquinones

Two (2) mls of the oil extract was boiled with 5ml of 10% hydrochloric acid for 3 minutes. 5ml of chloroform was added. 5 drops of 10% ammonia was further added. A rose pink coloration indicates a positive result.

2.3 Determination of Fatty Acids Composition of Palm Kernel Oil (PKO) and Coconut Oil (CNO)

The chemical composition of the fatty acids in the crude PKO was determined using a Gas Chromatograph equipped with Mass Spectrometry (GC-MS). The GC-MS QP2010 PLUS SHIMADZU, JAPAN was initially calibrated with fatty acid standards before the PKO sample was injected. The injection technique was the micro-syringe type with an injection volume of 5.0 µL. The operating temperatures of injection and that of the MS were respectively 250 and 200^{o}C. Other conditions of the measurement include an oven temperature of 70^{o}C (at 1min hold) with a programming rate of 1^{o}C/min. and 250^{o}C (at 40 mins. hold). The carrier gas was nitrogen at flow rate of 1.4 ml/min. Actual concentrations of the fatty acids in the crude palm kernel oil sample was detected as the displayed peaks of the chromatogram. The molecular weight of the FFA was calculated from the result of the composition from the chromatogram. Same was repeated for coconut oil sample.

3.0 RESULTS:

Table 1: Phytochemical Constituents of Palm Kernel Oil (PKO).

Phytochemicals	PKO 1	PKO 2	PKO 3	PKO 4
Saponins	+	+	+	+
Tanins	–	–	–	–
Alkaloid	–	–	–	–
Phenol	+	+	+	+
Terpenoid	+	+	+	+
Flavonoid	+	+	+	+

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Phlobatanins	_	_	_	_
Glycoside	_	_	_	_
Steroids	+	+	+	+
Anthraquinones	_	_	_	_

KEY:
P.K.O: Palm Kernel Oil
+: Positive
-: Negative

Table 2: Phytochemical Constituents of Coconut oil (CNO)

Phytochemicals	CNO 1	CNO 2	CNO 3	CNO 4
Saponins	+	+	+	+
Tanins	_	_	_	_
Alkaloid	_	_	_	_
Phenol	+	+	+	+
Terpenoid	+	+	+	+
Flavonoid	+	+	+	+
Phlobatanins	_	_	_	_
Glycoside	_	_	_	_
Steroids	+	+	+	+
Anthraquinones	_	_	_	_

KEY:
CNO: Coconut Oil
+: Positive
-: Negative

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Table 3: Gas Chromatography Mass Spectrometry (GCMS) Analysis of Palm kernel oil Extracted by Heat Method

No.of peaks	Compound name	Molecular weight	Percentage	Formular
1	Lauric acid	200	6.90	$C_{12}H_{24}O_2$
2	Myristic acid	228	4.06	$C_{14}H_{28}O_2$
3	Valeric acid	312	2.01	$C_{20}H_{40}O_2$
4	Palmitic acid	256	16.70	$C_{16}H_{32}O_2$
5	Oleic acid	282	34.60	$C_{18}H_{34}O_2$
6	Stearic acid	284	7.08	$C_{18}H_{36}O_2$
7	Oxalic acid	426	1.57	$C_{26}H_{50}O_4$
8	Hexadecanoic acid	330	3.31	$C_{19}H_{38}O_4$
9	Linoleicacid chloride	298	8.68	$C_{18}H_{31}C_{10}$
10	Pentanoic acid	254	11.75	$C_{15}H_{30}O_2$
11	9-octadecanoic acid(2)-	356	3.35	$C_{21}H_{40}O_6$

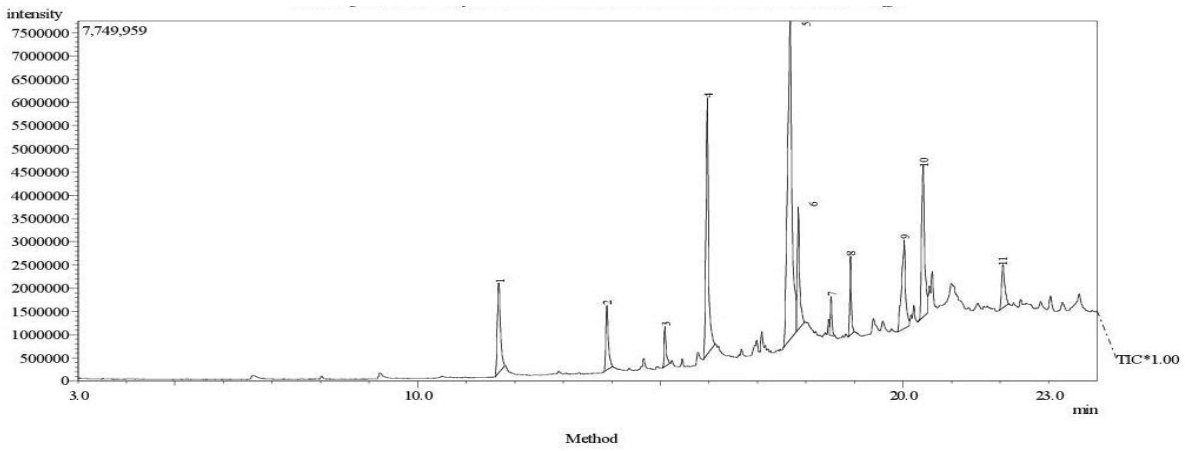

Figure 1 Gas Chromatography Mass Spectrometry Analysis of Palm Kernel Oil extracted by heat method

Vol. 2, No. 02; 2018

ISSN: 2581-3366

KEY:

Peak 1 ----- Lauric acid
Peak 2------ Myristic acid
Peak 3------ Valeric acid
Peak 4-------Palmitic acid
Peak 5-------Oleic acid
Peak 6-------Stearic acid
Peak 7-------Oxalic acid
Peak 8------Hexadecanoic acid
Peak 9---- - Linoleic acid Chloride
Peak 10---- Pentanoic acid
Peak 11 ----9-octadecanoic acid

Table 4: Gas Chromatography Mass Spectrometry (GCMS) Analysis of Palm kernel oil Extracted by Cold Method

No. of peaks	Compound name	Molecular weight	percentage	Formular
1	Capric acid	172	0.25	$C_{10}H_{20}O_2$
2	Myristic acid	228	0.83	$C_{14}H_{28}O_2$
3	Lauric acid	200	4.95	$C_{12}H_{24}O_2$
4	Stearic acid	284	1.96	$C_{18}H_{36}O_2$
5	Palmitic acid	284	5.83	$C_{16}H_{32}O_2$
6	Pentadecanoic acid	242	4.23	$C_{15}H_{30}O_2$
7	Oleic acid	282	26.43	$C_{18}H_{36}O_2$
8	Stearic acid	284	8.49	$C_{18}H_{36}O_2$
9	Erucic acid	338	14.46	$C_{22}H_{42}O_2$
10	Pentafluoropropioic acid tridycel ester	346	3.62	$C_{16}H_{27}F_5O_2$
11	1-octanol,2-methyl	144	2.60	$C_9H_{20}O$
12	9-octadecenal	266	6.03	$C_{18}H_{34}O$
13	Pentanoic acid	254	4.06	$C_{16}H_{30}O_2$

Vol. 2, No. 02; 2018

ISSN: 2581-3366

14	Hexadecanoic acid	330	6.30	$C_{19}H_{38}O_4$
15	Tetradecenal	210	9.96	$C_{14}H_{26}O$

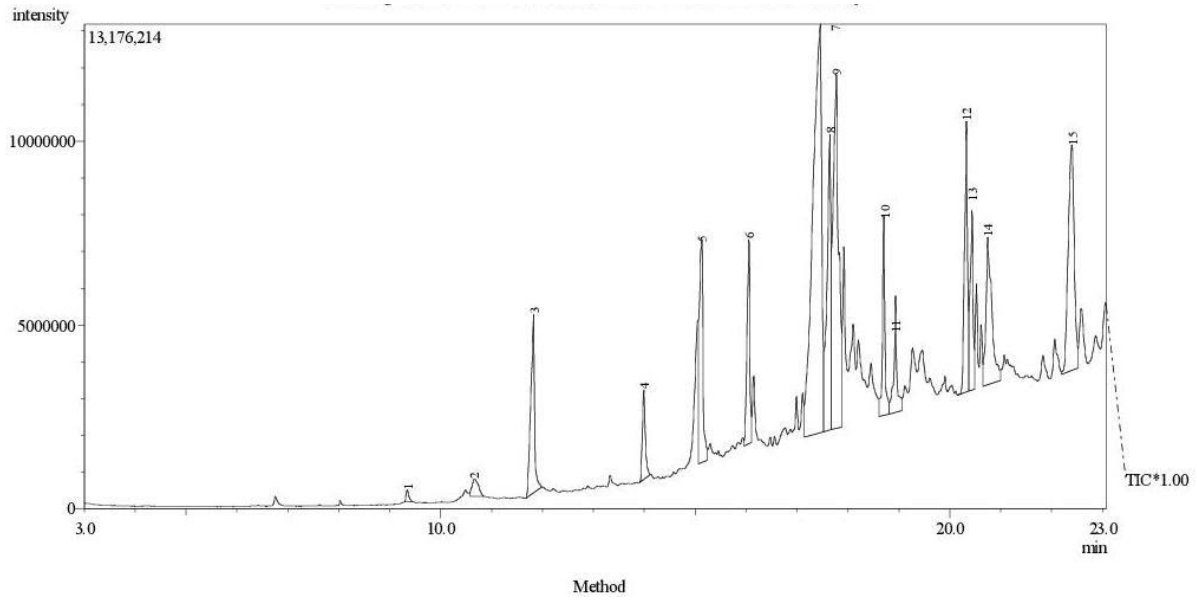

Figure 2 Gas Chromatography Mass Spectrometry Analysis of Palm Kernel Oil extracted by cold method

KEY:

Peak 1 --Capric acid
Peak 2---Myristic acid
Peak 3---Lauric acid
Peak 4---Stearic acid
Peak ----Palmitic acid
Peak 6---Pentadecanoic acid
Peak 7---Oleic acid
Peak 8---Stearic acid
Peak 9----Erucic acid
Peak 10---Pentafluoropropioic acid
Peak 11---1-octanol,2-methyl
Peak 12---9-octadecenal
Peak 13---Pentanoic acid
Peak 14---Hexadecanoic acid
Peak 15---Tetradecenal

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Table 5: Gas Chromatography Mass Spectrometry (GCMS) Analysis of Coconut oil Extracted by cold method

No. of peaks	Compound name	Molecular weight	Percentage	Formular
1	Lauric acid	200	11.16	$C_{12}H_{24}O_2$
2	Myristic acid	228	6.04	$C_{14}H_{28}O_2$
3	Hexadecanoic acid	330	7.52	$C_{19}H_{38}O_4$
4	Palmitic acid	256	9.28	$C_{16}H_{32}O_2$
5	Decanoic acid	312	4.23	$C_{20}H_{40}O_2$
6	Oleic acid	282	20.30	$C_{18}H_{36}O_2$
7	Stearic acid	284	3.68	$C_{18}H_{36}O_2$
8	Pentafluoropropionic acid	346	8.73	$C_{16}H_{27}FO_2$
9	Pentanoic acid	254	18.40	$C_{16}H_{30}O_2$
10	Decane,1-fluoro	160	5.15	$C_{10}H_{21}F$
11	Tetradecanoic acid	256	1.40	$C_{15}H_{28}O_3$
12	Decanoic acid	200	4.1	$C_{11}H_{20}O_3$

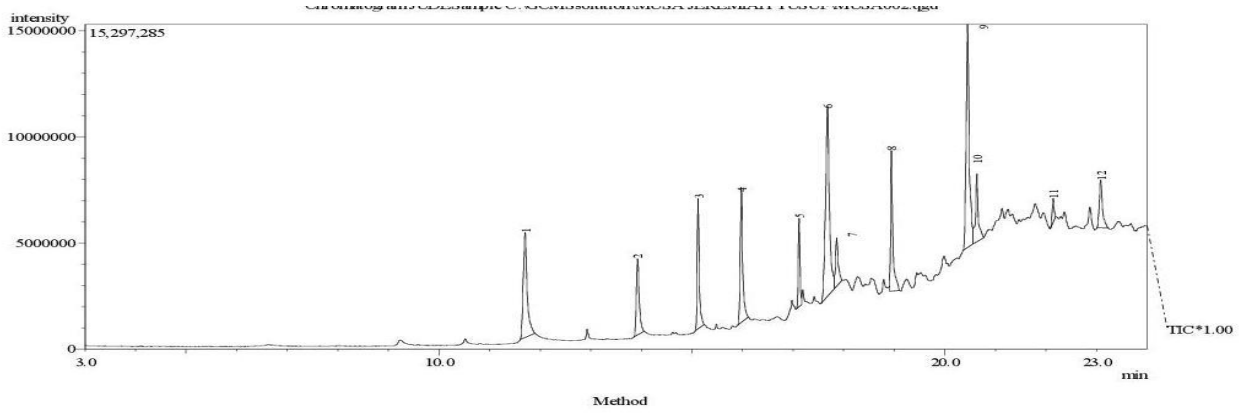

Figure 3 Gas Chromatography Mass Spectrometry Analysis of Coconut Oil extracted by cold method

Vol. 2, No. 02; 2018

ISSN: 2581-3366

Key:

Peak 1 ------Lauric acid
Peak 2-------Myristic acid
Peak 3-------Hexadecanoic acid
Peak 4-------Palmitic acid
Peak 5-------Decanoic acid
Peak 6-------Oleic acid
Peak 7-------Stearic acid
Peak 8-------Pentafluoropropionic acid
Peak 9------ Pentanoic acid
Peak 10---- Decane,1-fluoro
Peak 11------Tetradecanoic acid
Peak 12------ Decanoic acid

Table 6: Gas Chromatography Mass Spectrometry (GCMS) Analysis of Coconut oil Extracted by Heat Method

No.of peaks	Compound name	Molecular weight	Percentage	Formular
1	Lauric acid	200	11.51	$C_{12}H_{24}O_2$
2	Palmitic acid	256	6.29	$C_{16}H_{32}O_2$
3	1-Octanol,2-butyl	186	5.76	$C_{12}H_{26}O$
4	Pentadecanoic acid	242	9.53	$C_{15}H_{30}O_2$
5	Pentafluoropropionic acid	346	3.02	$C_{10}H_{27}F_5O_2$
6	Oleic acid	282	20.57	$C_{18}H_{34}O_2$
7	Stearic acid	284	3.95	$C_{18}H_{36}O_2$
8	Decane,1-fluoro-	160	9.67	$C_{10}H_{21}F$
9	Cyclododecene epoxide	182	20.60	$C_{12}H_{22}O$
10	Octane,2,3 dimethyl	142	6.07	$C_{10}H_{22}$
11	Oxalic acid	272	3.03	$C_{15}H_{28}O_4$

Vol. 2, No. 02; 2018

ISSN: 2581-3366

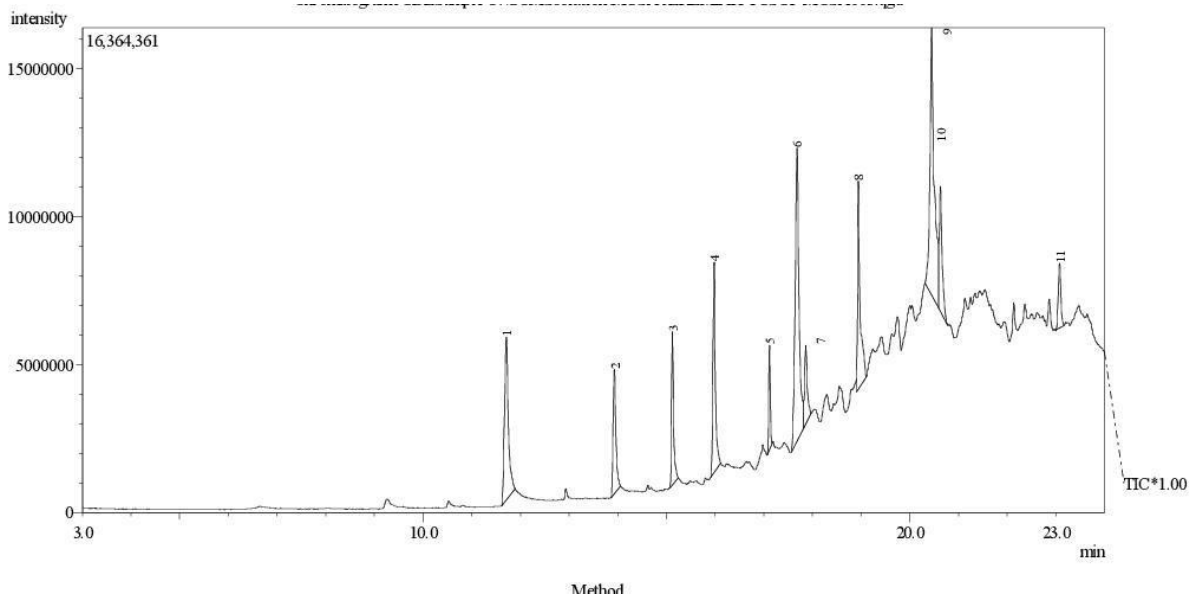

Figure 4 Gas Chromatography Mass Spectrometry Analysis of Coconut Oil extracted by heat method.

KEY:

Peak 1 ----Lauric acid
Peak 2-----Palmitic acid
Peak 3-----1-Octanol, 2-butyl
Peak 4-----Pentadecanoic acid
Peak 5-----Pentafluoropropionic acid
Peak 6-----Oleic acid
Peak 7-----Stearic acid
Peak 8-----Decane, 1-fluoro-
Peak 9-----Cyclododecene epoxide
Peak 10---- Octane,2,3 dimethyl
Peak 11--- Oxalic acid

4.0 DISCUSION:

Secondary metabolites, also known as phytochemicals, natural products or plant constituents are responsible for medicinal properties of plants to which they belong [13]. The phytochemicals present in the oil samples as revealed in this study are in conformity with the work of [19] who reported the physicochemical properties, phytochemicals and mineral composition of coconut

Vol. 2, No. 02; 2018

ISSN: 2581-3366

oils. The presence of these phytochemicals in the oil samples explain why they are used for diverse purposes. Each phytochemical was briefly considered for it significant role in the oil samples

The presence of Saponin which produces lather on shaking could be the reason Palm Kernel Oil is used for Soap making. The saponins are largely distributed in the plant kingdom which has many physico-chemical properties such as foaming, emulsification, solubilization, sweetness and bitterness [6]. They occur as glycosides whose aglycone is tripenoid or steroidal structures. The combination of lipophilic sugars at the end gives them the ability to lower surface tension, producing the detergent characteristics or soap-like effect on the membrane and skin [6].

The presence of Terpenoid which constitute a large family of phytoconstituents such as; Steroids, carotenoids, and gibberelic acid are known to have pharmacological activity and are used for diseases treatment both in humans and animals [10].

Phenolic compounds from plants are one of largest groups of secondary plants constituents synthesized by fruits, vegetables, teas, cocoa and other plants that possess certain health benefits. They are characterized by the antioxidant, anti-inflammatory, anti-carcinogenic and other biological properties, and may protect from oxidative stress and some diseases. Simple phenolics are bactericidal, antiseptic and anthlemintic. Phenol itself is a standard for other antimicrobial agents [12]. They are distributed in almost all plants and subject to a great number of chemical, biological, agricultural, and medical studies

Flavonoids are the first class of polyphenols. They are water-soluble pigment found in the vacuoles of plant cells. Some of the activities attributed to them include: anti-allergy, anti-cancer, antioxidant, anti-inflammatory and anti-viral. The flavonoids quercetin is known for its ability to relieve high fever, eczema, asthma and sinusitis [3].

The fatty acid constituents of Palm Kernel Oil and Coconut Oil were determined using Gas Chromatography Mass Spectrometry (GC-MS) Analysis. The major fatty acids in palm kernel oil and coconut oil were lauric acid (C12), myristic acid (C14), palmitic acid and oleic acid (C18). In this study, the lauric acid content was observed to be very low compared to the work of [16] who reported 49.2%. However, the low percentage of lauric acid in this study conforms to the work of [7], who reported low fatty acid contents of virgin coconut oil. [15] reported that virgin coconut oil contained Lauric acid at a concentration of 0.47mg/ml. [5] and [4] also reported low percentage of Lauric acid at 14.57%.

In this study, Oleic acid was the predominant fatty acid in both palm kernel and coconut oil.

Oleic acid (omega-9) is a fatty acid found in animal and vegetable oils, such as olive oil, avocados, almonds, peanuts, sesame oil, pecans, pistachio nuts, cashews, hazelnuts, macadamia nuts, etc. It occurs naturally in greater quantities than any other fatty acid. It lowers heart attack risk and artherosclerosis, and aids in cancer prevention. It is essential but technically not an EFA (essential fatty acid), because the human body can manufacture a limited amount [14]. It is used

Vol. 2, No. 02; 2018

ISSN: 2581-3366

in the food industry to make synthetic butters and cheeses. It is also used to flavor baked goods, candy, ice cream and sodas [2]. There is no significant difference in the fatty acid content of the oils ($P > 0.05$).

At room temperature, lipids can be oils or fat depending on the degree of saturation of the fatty acid components. Lipids serve as food, which is used when calories demand exceeds calories supply. They are used up when there is deficiency in other sources of energy.

Palm kernel oil, like most contemporary edible oils, also contain high amount of unsaturated fatty acids required by human body as essential fatty acids (i.e., fatty acids that cannot be synthesized by the human body).

5.0 CONCLUSION:

From this research the following conclusions were deduced:

The Coconut oil and Palm kernel oil samples used in this study contain some useful phytochemicals which are responsible for their medicinal properties; as well as some health promoting fatty acids which are of great public health importance.

ACKNOWLEDGEMENT

The authors wish to thank Dr. (Mrs.) A.A Orukutan, Dr S.S.D Mohammed, Dr Jonathan Maiangwa for their intellectual contributions towards the success of this work. This was supported in part by fund from Mr. Musa Yusuf

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Vol. 2, No. 02; 2018

ISSN: 2581-3366

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