Chemical Constituents of the Leaf Essential Oil of *Physalis angulata* L.

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ABSTRACT— ***This paper report the chemical constituents identified in the essential oil obtained from the leaves of Physalis angulata L., grown in Nigeria. The essential oil was obtained by hydrodistillation in an all glass Clevenger-type oil apparatus in the Laboratory, Department of Chemistry, Lagos State University, Ojo, Nigeria. The oil was analysed for its constituents by means of gas chromatography-flame ionization detector (GC-FID) and gas chromatography coupled with mass spectrometry (GC-MS). The main chemical classes identified in the oil were diterpenes (31.7%), fatty acids (22.8%), oxygenated sesquiterpenes (22.3%) and aromatic compounds (13.6%). Monoterpene compounds occurred in trace amounts. The major constituents of the essential oil were phytol (31.7%) and hexahydrofarnesyl acetone or 6,10,14-trimethy-2-pentadecanone (18.8%), with significant amounts of n-nonadecane (8.6%) and n-hexadecanoic acid (5.0%).***

Keywords— *Physalis angulata*, essential oil composition, phytol, hexahydrofarnesyl acetone

1. INTRODUCTION

In continuation of research into the chemical constituents of poorly studied species of Nigerian flora (Ogundajo *et al*., 2014), we report the volatile compounds identified in the essential oil obtained from the leaf of *Physalis angulata* L. The plant belongs to the Solanaceae family and known in Southwest Nigeria as 'Koropo' (Gbile and Soladoye, 2004). *P. angulata* is a small tropical annual herb, which grows up to 1m with small stem, cream-coloured flowers and small edible orange-yellow fruits. The plant is distributed throughout the tropical and subtropical regions of the world including Africa, Asia and the America (Burkhill, 2008).

Previous studies have focused on the biological and pharmacological activities of *P. angulata*. Extracts of the plant were reported to have displayed anti-ulcer (Shravan *et al*., 2012), anti-inflammatory (Shravan *et al*., 2011), antinociceptive (Bastos *et al*., 2006) and antidiabetic (Abo and Lawal, 2013) potentials. In addition, the plant was known to posse's α-amylase inhibitory effect (Shravan *et al*., 2011). A review of the biologically potentials of this plant has been documented (Mahalakshmi and Ramesh, 2014).

Phytochemical studies have revealed that *P. angulata* is a source of biologically active chemicals. These includes vamonolide, physangulide, physagulmes A, B, C_5 D_5 F, H, I, J, K, witaminimine and physagulines E, F and G, sitosterol, physalins A, B, D, E, F, G, H, I, J, K and whitanguiatine (Shingu *et al*., 1992; Januário *et al*., 2002; Soares *et al*., 2003; Velazquez *et al*., 2009; Ismail and Alam, 2001; Merit *et al*., 2013). The authors are aware of only one published literature on the volatile constituents of *P. angulata* (Velazquez *et al*., 2009). The lack of readily available data on the essential oil components prompted our research into the analysis of the essential oil of *P. angulata* grown in Nigeria. However, the essential oil was previously shown possess antimicrobial activity (Osho *et al*., 2010).

2. MATERIALS AND METHODS

2.1 Plant material

Fresh and mature leaves of *P. angulata* were collected from the Federal Research Institute of Nigeria (FRIN), Ibadan, Nigeria, in May 2014. Botanical identification was carried out at the Institute where a voucher specimen (FHI 109913) was deposited.

2.2 Extraction of the oil

The air-dried and pulverised leaves of *P. angulata* (300 g) were subjected to hydrodistillation in a Clevenger-type apparatus for 3 h in accordance with the British Pharmacopoeia specification (1980). The distilled oil was preserved in a sealed sample tube and stored under refrigeration until analysis.

2.3 Gas Chromatography (GC) analysis

GC analysis was carried out on a Hewlett Packard Gas Chromatograph HP 6820 equipped with FID detector and HP-5MS column (60 m x 0.25 mm i.d, 0.25 µm film thickness), and split ratio of 1: 25. The oven temperature was programmed from 50 ^{o}C (after 2 min) to 240 ^{o}C at 5 ^{o}C/min and the final temperature was held for 10 min. Injection and detector temperatures were maintained at 200 ^{o}C and 240 ^{o}C respectively. Hydrogen was the carrier gas at flow rate of 1 mL/min. 1.0 µL of the diluted oil was injected into the GC. Peaks were measured by electronic integration. *n*-Alkanes were run at the same condition for retention indices determination.

2.5 Gas Chromatography-Mass Spectrometry (GC-MS) analysis

GC-MS analyses of the oil was performed on a Hewlett Packard Gas Chromatograph HP 6890 interfaced with Hewlett Packard 5973 Mass Spectrometer system equipped with a HP-5MS capillary column (30m x 0.25 mm id, film thickness 0.25 µm). The GC conditions were the same as described above. The ion source was set at 240 ^{o}C and electron ionization at 70 eV. Helium was used as the carrier gas at a flow rate of 1 mL/ min. Scanning range was 35 to 425 amu. 1.0 µL of the oil was injected into the GC/MS.

2.6 Identification of Components

The identification of constituents was performed on the basis of retention indices (RI) determined by co-injection with reference to a homologous series of *n*-alkanes, under identical experimental conditions. Further identification was performed by comparison of their mass spectra with commercial available data (NIST, 2011) as well as by comparison of their retention indices with literature values (Adams, 2007).

3. RESULTS AND DISCUSSION

The yield of essential oil obtained from the hydrodistillation of *P. angulata* was 0.12% (v/w) calculated on a dry weight basis. The identities and percentage composition of the twenty five compounds present in the oil are shown in Table 1. The chemical classes of compounds identified in the essential oil of *P. angulata* were diterpenes (31.7%), fatty acids (22.8%), oxygenated sesquiterpenes (22.3%) and aromatic compounds (13.6%). Monoterpene compounds occurred in trace amount. The main constituents of the essential oil were phytol (31.7%) and hexahydrofarnesyl acetone or 6,10,14-trimethy-2-pentadecanone (18.8%). There are significant amounts of *n*-nonadecane (8.6%) and *n*-hexadecanoic acid (5.0%). The minor compounds of the essential oil include heptadecane (3.8%), oleic acid (3.6%), 2-methylpentadecane (3.3%), farnesol acetate (2.8%) and 2-phenylundecane (2.3%).

A comparison of the composition of the present oil sample with the result obtained in a previous study revealed some quantitative and qualitative variations. Both β-phellandrene and β- damascenone, the main compounds identified in the previous study (Velazquez *et al*., 2009) were not present in the Nigerian oil sample. In addition, phytol and hexahydrofarnesyl acetone which were the significant compounds of the Nigerian oil sample were not reported previously as constituents of essential oil of *P. angulata*.

The volatile components of two other *Physalis* plants grown in other parts of the world have been reported. 1,2-Benzecarboxylic acid dibutyl ester was the main constituent of the berries of *P. pubescens* (Yang *et al*., 1996) while 1-hexanol, 1,8-cineole and ethyl butanoate were identified in the fruit pulp of *P. peruviana* (Yilmaztekin, 2014). However, neither 1,2-benzecarboxylic acid dibutyl ester nor 1-hexanol, 1,8-cineole and ethyl butanoate could be identified in the present study. This result and previous studies indicated that there is no homogeneity in the compositional pattern of essential oils from the genus *Physalis.*

The observed antimicrobial activity of the essential of *P. angulata* (Osho *et al*., 2010) may be attributed to the presence of some compounds such as phytol which has shown antimicrobial potentials (Lawal *et al*., 2014). In addition, essential oils with large amount of hexahydrofarnesylacetone have displayed antimicrobial (Radulović *et al*., 2006), allelopathic (Razavi *et al*., 2010) and phytotoxicity (El Ayeb-Zakhama *et al*., 2014) activities. Other compounds such as 2,3-diphenylcycloprop-2-en-1-one are known to possess analgesic and anti-inflammatory effects (Li *et al*., 2002).

4. CONCLUSIONS

For the first time, the chemical composition of the leaf essential oil of the Nigeria grown *P. angulata* was elucidated. Quantitative and qualitative chemical variations were observed between the oil of *P. angulata* cultivated in Nigeria and elsewhere. This may be attributed to factors such as the place of collection, age and nature of the plant, climatic conditions, handling procedures e.t.c.

Table 1: Chemical composition of essential oil of *P. angulata*

Compounds [a]	**RI (Cal.)**	**RI (Lit.)**	**Percent composition**
allo-Ocimene	1128	1128	Tr
Terpinen-4-ol	1177	1174	Tr
Caryophyllene	1419	1417	1.3
2-Methylpentadecane	1564	1566	3.3
Caryophyllene oxide	1583	1581	0.7
2-Phenyldecane	1588	1588	1.0
5-Phenylundecane	1622	1628	1.1
4-Phenylundecane	1638	1636	1.4
3-Phenylundecane	1661	1659	1.6
2-Phenylundecane	1690	1692	2.3
Heptadecane	1700	1700	3.8
6-Phenyldodecane	1711	1719	0.7
5-Phenyldodecane	1725	1729	1.1
2,3-Diphenylcycloprop-2-en-1-one [b]	1786	1784	1.4
Octadecane	1800	1800	1.3
Hexadecanal	1812	1817	0.6
Farnesol acetate	1840	1845	2.8
6,10,14-Trimethy-2-pentadecanone or Hexahydrofarnesyl acetone	1844	1847	18.8
Nonadecane	1900	1900	8.6
n-Hexadecanoic acid	1960	1959	5.0
Eicosane	2000	2000	1.7
Heneicosane	2100	2100	1.3
Phytol	2125	2122	31.7
Oleic acid	2140	2150	3.6
Docosane	2200	2200	0.7
Total			**97.8**
Monoterpene hydrocarbons			**Tr**
Oxygenated monoterpenes			**Tr**
Sesquiterpene hydrocarbons			**1.3**
Oxygenated sesquiterpenes			**22.3**
Diterpenes			**31.7**
Aromatic compounds			**13.6**
Fatty acids			**22.8**
Hydrocarbons			**7.1**

[a] Elution order on DB-5 column; [b] Tentative assignment; RI (Cal.) Retention indices on HP-5MS column; RI (Lit.) Literature retention indices (Adams, 2007; NIST, 2011); Tr, trace amount <0.1%

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