Journal of Science Research

Variations in Chemical Constituents and Anthelmintic Activity of *Albizia zygia* (DC.) J.F. Macbr. Essential oils from Ibadan, Nigeria

Akinsola, A.[a], Aboaba, S.[a*] and Flamini, G.[b]
[a]Department of Chemistry, University of Ibadan, Ibadan, Nigeria
[b]Dipartimento di Farmacia, Universita di Pisa, Pisa, Italy
[a]Corresponding author: saboaba@gmail.com, Tel: +234 8038011394

Abstract

The widespread and impact of helminth infection on public health is a socio-economic problem in developing nations. *Albizia zygia* (DC.) J.F Macbr. (Fabaceae; Sub-family – Mimosoideae) is a gum producing tree often useful in the treatment of stomach troubles, as anti-parasitic, antidote, purgative and vermifuge purposes in traditional medicine. This study however, was designed to evaluate the chemical constituents and anthelmintic activity of *A. zygia* essential oils. The leaves, stem bark and root bark essential oils (EOs) of the plant were extracted by hydrodistillation, analysed by Gas Chromatography (GC) and Gas Chromatography-Mass Spectrometry (GC-MS) techniques and further subjected to an *in vitro* petri-dish anthelminthic assay. The EOs yield range from 0.254 to 0.268%, a total of 38 (97.6%), 37 (92.2%) and 37 (97.2%) constituents of the total oil fractions were identified in the leaves, stem bark and root bark respectively. Oxygenated sesquiterpenes (28.0%) dominated the leaf oil while non-terpene derivatives (44.4% and 27.8%) dominated the stem bark and root bark oils respectively. Major constituents identified include limonene (11.1%), acorenone (10.9%), β-caryophyllene (10.6%), valerianol (6.4%) and 1,8-cineole (5.8%) in the leaves oil, 2,6,10-trimethylpentadecane (26.5%), 1,8-cineole (12.4%), (E)-α-ionone (6.3%) and acorenone (6.0%) in the stem bark oil, while 1,8-cineole (14.8%), 2,6,10-trimethylpentadecane (12.1%), limonene (10.6%), β-caryophyllene (7.1%) and viridiflorene (5.8%) were identified in the root bark oil. *A. zygia* EOs obtained from this study and from literature in two different years, vary significantly in chemical composition. The oils exhibit anthelmintic activity against *Eudrilus eugeniae* worms *in vitro*. Paralysis and death of worms occurred faster as EO concentrations were increased. The root bark EO showed the best activity. Significant difference ($p<0.001$) in activity was observed between the oils and the standard drug, Albendazole. Thus, suggests that *A. zygia* EOs showed promising anthelmintic properties.

Keywords: *Albizia zygia*, 2,6,10-trimethylpentadecane, oxygenated sesquiterpenes, *Eudrilus eugeniae*, anthelmintic, Albendazole.

Introduction

Aromatic plants and their phytochemical constituents are used for different therapeutic purposes in many parts of the world. The use of various plant parts such as the leaves, stem, root, fruits, seeds and even the whole plant in traditional system of healing has been widely explored as source of medicines. *Albizia zygia* (DC.) J.F. Macbr. is a tree in the family Fabaceae (sub-family Mimosoideae) commonly known as West African Albizia and locally referred to as Ayinre-weere (Yoruba) and Nyieavu (Igbo) among Nigerians [1–3]. It is a tropical African medium sized deciduous tree that grows up to about 30 m tall, widely used domestically (as firewood and charcoal production), commercially (in paper, plywood, hard board and particle board production) and also medicinally. In traditional medicine, *A. zygia* is used to treat sores, wounds, toothache, cough, fever (including malaria), diarrhea, eye problems, bronchial diseases, female sterility, and also useful as aphrodisiac, purgative, stomachic, anti-parasitic, antidote and vermifuge purposes [4]. Due to the high viscosity of the gum it produces, its mucilage can serve as a good stabilizer

and thickening agent in cosmetic, pharmaceutical and food industries [5].

Bioactivity of *Albizia zygia* has been reported. Methanol stem bark extract of the tree exhibited anti-protozoal activity against *Plasmodium falciparum* (the causative organism of malaria) and *Trypanosoma bruceirhodesiense* (responsible for African trypanosomiasis) with IC_{50} of 1.0 µg/mL and 0.2 µg/mL, respectively. Three flavonoids were isolated from the plant and only the compound 3′,4′,7-trihydroxyflavone was reported to possess high antiprotozoal activity against *P. falciparum* [6]. From a study on the *in vitro* antimicrobial effects of the plant against some clinically important bacterial and fungal pathogens, the methanol leaf extract showed significant antibacterial activity [7].

According to Oloyede and Ogunlade [8], the polar and non- polar crude extracts from the stem-bark of *A. zygia* possess *in-vitro* antioxidant and antimicrobial activities. Furthermore to their work, the essential oils obtained from the leaves and stem bark were dominated by linalool (26.96% and 31.67%, respectively) and thymol (17.29% and 14.03% respectively). The bark essential oil was reported toxic to brine shrimp larvae and the oils exhibited a promising free radical scavenging activities [9]. The objectives of this study are therefore, to characterise the leaves, stem bark and root bark essential oils of *A. zygia* and also, evaluate the anthelmitic potentials of these oils based on the plant's ethno-medicinal application as purgative, stomachic and anti-parasitic purposes with a view to finding natural anthelmintic agents.

Materials and Methods

Plant Materials, Extraction and Isolation of the Essential Oils

Albizia zygia leaves, stem bark and root back samples were freshly collected in July, 2013 from a vegetation at Awotan, Ido Local Government area in Ibadan, Oyo State, Nigeria. Identification of the plant was carried out at Forest Research Institute of Nigeria (FRIN), Jericho, Ibadan where voucher specimens were deposited (Herbarium number: FHI 109920). Each of the samples was air dried, crushed separately using a Thomas model 4 Willey Mill machine and then weighed. The leaves, stem bark and root bark samples (300, 350 and 350 g respectively) were subjected to separate hydro-distillation for 4 hours in a modified all glass Clevenger-type apparatus design according to the British Pharmacopoeia specifications [10]. The hydro-distilled essential oils obtained were dried over anhydrous sodium sulphate (Na_2SO_4) and refrigerated at 4°C until use.

Essential Oil Analysis

An HP-5890 gas chromatograph fitted with a HP-Wax and HP-5 capillary columns (30 m x 0.25 mm, 0.25 mm film thickness), was employed for the Gas Chromatography (GC) analyses. The GC oven temperature was programmed at 60°C (held for 10 min), heated to 220°C at 5°C/min. The injector and detector temperatures were maintained at 250°C. A flow rate of 2 mL/min was set for the carrier gas (Helium). On a Varian CP-3800 gas chromatograph interfaced to a Varian Saturn 2000 ion trap Mass Detector operated at 70 eV, the Gas Chromatography-Mass Spectrometry (GC-MS) analyses were carried out. The injector and transfer line temperatures were 220°C and 240°C, respectively. The GC oven temperature was programmed from 60°C to 240°C at 3°C/min. Helium was used as a carrier gas at a flow rate of 1 mL/min. Constituents were identified based on comparison of the retention times with those of the authentic samples, comparing their retention indices relative to a homologous series of n-alkanes and confirmed by comparison of their mass spectral fragmentation patterns with published spectra and those of reference compounds from commercial libraries. The relative concentration of each constituent was calculated by integration of GC peak areas [11, 12].

Anthelmintic Assay

Eudrilus eugeniae (adult earthworm) has anatomical and physiological resemblance with the intestinal roundworm parasites [13–15]. In view of this resemblance, adult earthworms, average sizes of 5-8 cm were used to determine the anthelmintic activity of the oils according to the method by Priya *et al.*, [16] with some modifications. The worms were collected from moist soils around a stream in Ibadan, identified in the department of Zoology, University of Ibadan, Nigeria and further washed with distilled water to remove any feacal/organic matter prior to use. Five worms each were introduced into five petri-dishes, and each petri-dish contained concentrations of 1, 2, 3, 4 and 5% v/v respectively. The EOs and Albendazole (ALBZ) were dissolved in 10 mL of Tween-80 (10% v/v in distilled water) and diluted up to 30 mL to prepare the five concentrations. The time taken for paralysis (when no movement could be observed except when shaken vigorously) and death (when worms neither wriggled when shaken nor moved when pinched with a needle followed with fading away of body colour) to have taken place were observed. ALBZ (ZENTEL, ©SmithKline Beecham Lab. Pharm.), was used as the reference standard, and distilled water (10% v/v Tween-80 in distilled water) as negative control.

Statistical Analysis

Analyses were carried out using Graph Pad Prism 5.01 statistical software. The statistical significance was determined by two-way analysis of variance (ANOVA) and p values < 0.001 were considered significant at 95% confidence interval.

Results and Discussion

The essential oils (EOs) obtained by hydro-distillation from *Albizia zygia* leaves, stem bark and root bark samples yielded 0.254%, 0.262% and 0.258% (v/w) respectively. The characterised EO components by Gas Chromatography-Mass Spectrometry (GC-MS) analysis are presented in Table 1. A total of 38, 37 and 37 constituents representing 97.6%, 92.2% and 97.2% of the total oil fractions in the leaves, stem bark and root bark respectively were identified. The complex mixture of compounds present in the leaves, stem bark and root bark essential oils are monoterpene hydrocarbons (19.4%, 4.0% and 17.8% respectively), oxygenated monoterpenes (6.4%, 13.7% and 15.8% respectively), sesquiterpene hydrocarbons (21.9%, 4.6% and 25.0% respectively), oxygenated sesquiterpenes (28.0%, 10.1% and 9.1%respectively), apocarotinoids (6.6%, 15.4% and 1.7% respectively) and non-terpene derivatives (15.3%, 44.4% and 27.8% respectively). Oxygenated sesquiterpene (28.0%) dominated the leaves essential oil while non-terpene derivatives (44.4% and 27.8%) dominated both the stem bark and root bark respectively.

Majorly, the essential oil of the leaves comprises of limonene (11.1%), acorenone (10.9%), β-caryophyllene (10.6%), valerianol (6.4%), 1,8-cineole (5.8%), α-zingiberene (4.6%), caryophyllene oxide (4.4%), pentadecanal (4.1%), while the stem bark oil had 2,6,10-trimethylpentadecane (26.5%), 1,8-cineole (12.4%), (E)-α-ionone (6.3%), acorenone (6.0%), and the root bark oil constitutes majorly 1,8-cineole (14.8%), 2,6,10-trimethylpentadecane (12.1%), limonene (10.6%), β-caryophyllene (7.1%), viridiflorene (5.8%), viridiflorol (4.3%), pentadecanal (4.1%). α-zingiberene and valerianol were only identified in the leaves while others are either present in one, two or all the three plant parts. The compound 2,6,10-trimethylpentadecane (26.5%) is the most abundant component identified in the oils. Furthermore, some other significant constituents (<4%) include p-cymene (3.0% and 2.1% in the leaves and root bark), terpinolene (2.6% and 3.3% in the leaves and root bark), β-copaene (2.4% in the stem bark) and ar-curcumene (3.4% in the leaves).

The characterised essential oils of *A. zygia* leaves and stem bark samples obtained by Oloyede and her group in July 2012 reveal linalool, thymol, carvacrol, octanal, o-cymene, γ-terpinene, α-pinene, β-caryophyllene, α-humulene and heneicosane as the dominant constituents [9]. In contrast, linalool, thymol, carvacrol, octanal, o-cymene and heneicosane were not present among the characterised EO constituents of *A. zygia* leaves, stem bark and root bark samples collected in July 2013 for this study. Rather, 1,8-cineole, β-caryophyllene and viridiflorol, identified as dominant constituents were only present in less significant quantities from the oils of plant samples collected in July 2012. Also, the classes of compounds identified in the two oils sampled from different sites in different years seem to differ significantly in composition. From a compositional variation study of *Montanoa guatemalensis* leaf essential oils observed in two different years by Flatt *et al.*, [17], the leaf oils obtained from samples collected in May, 2008 were dominated by α-selinene, β-selinene, and cyclocolorenone contrary to samples collected in May, 2009 which showed neither α- nor β-selinene as components of the oil. Factors such as plant origin and genetic makeup, season and time of maturity, soil condition, time of harvest and the extraction method are often causes of constituent variation.

The biological activities exhibited by individual chemical structures identified, together with its complex composition, is suggestive of the plant's industrial and pharmacological importance. For instance, limonene has found its application in many fields such as in natural medicine (aromatherapy), in cosmetics, perfume, fragrance and food industries [18, 19] and as an insecticide [20]. Its chemo-preventive action against many types of cancer as well as its effect in the relief of heart burn and gastro-esophageal reflux disorder has been reported [21]. Also, because of its antibacterial and disinfecting properties, it has been used as fragrant component in household chemicals such as soaps, detergents and air fresheners [18]. Limonene and α-terpineol are derived from the same biogenetic precursor, menth-1-en-8-yl cation from which 1,8-cineole is also thought to be derived. Their co-occurrence often times alongside α-pinene, aromadendrene, globulol and α, β and γ-eudesmol have been reported [22].

The potential anthelmintic activity of 1,8-cineole [23], its gastro protective [24], anti-inflammatory and analgesic activities [22, 25], further corroborates the bioactivities and ethno medicinal uses of the plant. β-caryophyllene, another constituent identified has been reported to possess activities such as anticarcinogenic, antimicrobial, anti-inflammatory, antioxidative and analgesic effects [26, 27], which is indicative of the plant's pharmacological importance. Apocarotenoids are oxidative cleavage derivatives of carotenoids, which can function as hormones, signaling compounds and aroma constituents [28]. The presence of apocarotenoids such as β-cyclocitral, α-ambrinol, α-ionone, β-ionone and geranyl acetone are thus pointers to its application in food flavor and fragrance industries [29, 30].

Table 1. Composition of *A. zygia* essential oils from two different locations and years

Constituents	R.I	R.I[’]	R.I[A]	This study			Oloyede *et al*., 2012	
				AZL	AZSB	AZRB	AZL	AZSB
Ethylbenzene[f]	864	-	-	0.7	1.1	-	-	-
p-xylene[f]	867	-	-	1.9	3.0	-	-	-
o-xylene[f]	895	-	-	1.0	2.3	-	-	-
n-nonane[f]	900	-	900	0.7	-	-	-	-
α-thujene[a]	-	924	-	-	-	-	0.03	0.34
*α-pinene[a]	941	932	932	0.8	-	1.0	**4.76**	-
Benzaldehyde[f]	962	-	952	-	0.6	-	-	-
1-ethyl-4-methylbenzene[f]	965	-	-	0.8	-	-	-	-
β-pinene[a]	-	974	-	-	-	-	0.95	-
Myrcene[a]	993	-	988	0.7	-	-	-	-
2-pentyl furan[f]	993	-	984	-	1.0	1.0	-	-
Mesitylene[f]	996	-	994	0.7	0.6	-	-	-
*Octanal[f]	-	998	-	-	-	-	**7.93**	**4.42**
Benzyl alcohol[f]	-	1026	-	-	-	-	0.05	-
p-cymene[a]	1028	-	1020	3.0	0.6	2.1	-	-
Limonene[a]	**1032**	-	1024	**11.1**	1.9	**10.6**	-	-
1,8-cineole[b]	**1034**	**1026**	**1026**	**5.8**	**12.4**	**14.8**	0.05	0.03
α-phellandrene[a]	-	1002	-	-	-	-	0.02	-
α-terpinene[a]	-	1014	-	-	-	-	0.18	0.08
*o-cymene [a]	-	1022	-	-	-	-	**5.96**	**4.77**
(*Z*)-β-ocimene[a]	1042	-	1032	1.2	-	0.8	-	-
Dihydrotagetone[b]	1054	-	1046	0.6	0.7	-	-	-
*γ-terpinene[a]	1063	1054	1054	-	0.6	-	3.25	**5.18**
Terpinolene[a]	1090	-	1086	2.6	0.9	3.3	-	-
*Linalool[b]	-	1095	-	-	-	-	**26.95**	**31.68**
Nonanal[f]	1104	-	1100	0.9	0.8	0.7	-	-
Alloocimene[a]	-	1128	-	-	-	-	0.06	0.04
3-nonen-2-one[f]	1143	-	-	-	0.7	0.9	-	-
Citronellal[b]	-	1148	-	-	-	-	1.79	1.13
Pinene-2-ol (β-pinene oxide)[b]	-	1154	-	-	-	-	0.29	0.09
Borneol[b]	-	1165	-	-	-	-	0.04	-
Naphthalene[f]	1181	-	1178	0.9	0.7	0.8	-	-
α-terpineol[b]	1191	1186	1186	-	-	1.0	0.06	0.03
Terpinene-4-ol[b]	-	1199	-	-	-	-	0.07	0.08
Decanal [f]	1206	-	1201	-	0.5	0.7	-	-
β-cyclocitral[e]	1222	-	1217	-	0.8	-	-	-
Citronellol[b]	-	1223	-	-	-	-	0.69	0.94
p-menth-4-en-3-one[b]	1251	-	-	-	0.6	-		
Linalylacetate[b]	-	1254	-	-	-	-	0.04	0.02
Geranial[b]	-	1264	-	-	-	-	-	0.05
Borneol acetate[b]	-	1284	-	-	-	-	0.06	0.06
2-methylnaphthalene[f]	1288	-	-	0.6	-	0.6	-	-
*Thymol[b]	-	1289	-	-	-	-	**17.30**	**14.03**
2-undecanone[f]	1293	1293	1293	-	0.5	-		
*Carvacrol[b]	-	1298	-	-	-	-	**13.26**	**13.30**
Eugenol[b]	-	1356	-	-	-	-	0.04	0.02
Neryl acetate[b]	-	1359	-	-	-	-	0.30	0.61
α-copaene[c]	1377	1374	1374	-	-	0.7	0.04	0.03
Ethyl cinnamate (Z)[b]	-	1376	-	-	-	-	0.05	0.03
n-tetradecane[f]	1400	-	1400	0.6	-	-	-	-
α-gurjunene[c]	-	1409	-	-	-	-	0.04	-

trans-α-ambrinol[e]	1414	-	1415	-	2.0	-	-	-
***β-caryophyllene[c]**	**1419**	-	1417	**10.6**	0.8	**7.1**	2.49	**4.55**
(*E*)-α-ionone[e]	1428	-	1428	2.6	**6.3**	0.8	-	-
β-copaene[c]	1430	-	1430	-	2.4	0.8	-	-
γ-elemene[c]	1434	-	1434	-	-	0.8	-	-
cis-α-ambrinol[e]	1437	-	1439	-	0.7	-	-	-
Trans-β-farnesene[c]	-	1454	-	-	-	-	1.59	
*α-humulene[c]	1455	1452	1452	1.2	-	0.8	2.48	**4.30**
(*E*)-geranylacetone[e]	1457	-	1453	2.3	1.9	0.9	-	-
Alloaromadendrene[c]	1462	-	1458	-	-	1.1	-	-
γ-muurolene[c]	1478	-	1478	-	-	0.7	-	-
ar-curcumene[c]	1483	-	1479	3.4	-	-	-	-
β-selinene[c]	1487	-	1489	-	-	3.7	-	-
(*E*)-β-ionone[e]	1487	-	1487	1.7	3.7	-	-	-
Valencene[c]	1493	-	1496	-	1.3	-	-	-
Viridiflorene[c]	**1495**	-	1496	-	0.1	**5.8**	-	-
2-tridecanone[t]	1496	-	1495	-	0.7	2.4	-	-
α-zingiberene[c]	**1496**	-	1493	**4.6**	-	-	-	-
α-selinene[c]	-	1498	-	-	-	-	0.04	0.02
n-pentadecane[t]	1500	-	1500	-	-	0.9	-	-
β-bisabolene[c]	1508	1505	1505	-	-	0.9	0.06	0.03
trans-γ-cadinene[c]	1514	-	1513	-	-	1.8	-	-
δ-cadinene[c]	1524	-	1522	-	-	0.8	-	-
β-sesquiphellandrene[c]	1525	-	1521	2.1	-	-	-	-
GermacreneB[c]	-	1559	-	-	-	-	0.07	0.04
(*E*)-nerolidol[d]	1564	-	1561	0.7	-	0.9	-	-
Presilphiperfolan-8-ol[d]	1581	-	1585	0.8	-	-	-	-
Caryophyllene oxide[d]	**1582**	-	1582	**4.4**	0.6	3.3	-	-
Viridiflorol[d]	**1591**	1592	1592	1.6	1.2	**4.3**	0.03	-
n-hexadecane[t]	1600	-	1600	0.8	-	-	-	-
Tetradecanal[t]	1614	-	1611	1.6	1.4	1.4	-	-
γ-eudesmol[d]	1632	-	1630	-	-	0.6	-	-
Caryophylla-4(14),8(15)-dien-5-ol[d]	1636	-	1639	1.5	-	-	-	-
T-cadinol[d]	1641	-	1638	1.0	-	-	-	-
2,6,10-trimethylpentadecane[t]	**1642**	-	-	-	**26.5**	**12.1**	-	-
β-eudesmol[d]	1650	-	1649	0.7	-	-	-	-
Valerianol[d]	**1656**	-	1656	**6.4**	-	-	-	-
1-tetradecanol[t]	1675	-	1671	-	0.5	-	-	-
Longiborneol acetate[d]	1682	-	1684	-	2.3	-	-	-
Acorenone[d]	**1688**	-	1692	**10.9**	**6.0**	-	-	-
2-pentadecanone[t]	1699	-	1697	-	-	1.4	-	-
Pentadecanal[t]	**1716**	-	-	**4.1**	3.5	**4.9**	-	-
(Z,E)-farnesol[d]	-	1722	-	-	-	-	0.03	-
Aristolone[d]	-	1762	-	-	-	-	0.05	-
*Heneicosane[t]	-	2100		-	-	-	**8.49**	-
[a]Monoterpene hydrocarbons				19.4	4.0	17.8	-	-
[b]Oxygenatedmonoterpenes				6.4	13.7	15.8	-	-
[c]Sesquiterpene hydrocarbons				21.9	4.6	25.0	-	-
[d]Oxygenatedsesquiterpenes				28.0	10.1	9.1	-	-
[e]Apocarotenoids				6.6	15.4	1.7	-	-
[t]Non-terpene derivatives				15.3	44.4	27.8	-	-
Total identified				**97.6**	**92.2**	**97.2**		

Key: RI = Linear retention index on HP-5 column (this study)
RI' = Relative retention index (Oloyede and Ogunlade, 2015)
RI^A = Linear retention index on DB-5 column (Adams, 2007)
AZL = *Albizia zygia* leaves
AZSB = *Albizia zygia* stem bark
AZRB = *Albizia zygia* root bark
Major constituents are in bold
(*) = Major constituents of EOs characterised by Oloyede and Ogunlade, 2015

The anthelmintic activity of *Albizia zygia* oils (Table 2) were studied at varying concentrations and compared with the standard drug (Albendazole). In each group of concentrations, all values obtained were expressed as Mean ± standard error of mean (SEM). Time of paralysis and death were observed to decrease as the concentration of oils increases (i.e. the potency of the oils were inversely proportional to the time taken for paralysis and death). The root bark oil showed the best activity followed by the leaves oil and then the stem bark oil. All essential oils had better activity than Albendazole in a dose-dependent manner (values are significantly different from the reference standard, $p<0.001$. Similarly, there were significant differences ($p<0.001$) when the concentrations of the EOs and Albendazole were varied.

Table 2: Time taken (minutes) by *Albizia zygia* essential oils for paralysis and death of worms

Conc. (mg/mL)	Time of Paralysis (mins) expressed as Mean±SEM (n=5)			
	AZL	AZSB	AZRB	ALBZ
1.00	27.40±1.72	32.00±2.12	26.80±2.01	97.20±1.39
2.00	22.60±1.63	25.20±2.22	20.60±1.21	94.20±1.77
3.00	16.40±1.44	20.80±1.66	16.00±1.64	89.60±1.29
4.00	13.00±1.14	15.00±1.58	12.20±1.16	87.40±1.08
5.00	9.80±0.66	11.00±1.18	10.40±0.93	82.80±1.28
	Time of Death (mins) expressed as Mean±SEM (n=5)			
	AZL	AZSB	AZRB	ALBZ
1.00	89.40±3.33	91.00±3.43	82.60±2.71	154.60±1.86
2.00	78.60±2.71	78.00±3.03	73.20±2.52	149.20±2.35
3.00	69.20±2.13	66.20±2.78	61.40±2.94	140.60±1.72
4.00	50.80±2.22	54.20±2.85	47.60±2.73	135.00±1.92
5.00	39.80±1.71	40.40±2.38	35.20±2.08	130.20±1.77

The time taken for paralysis and death to occur in distilled water (negative control) was >>> 240 minutes probably due to osmotic effect on the worms.
n = number of worms in each petri-dish
Key: AZL = *Albizia zygia* leaves
AZSB = *Albizia zygia* stem bark
AZRB = *Albizia zygia* root bark
ALBZ = Albendazole (Standard)
SEM = Standard error of mean

Conclusion

Albizia zygia essential oils (EOs) were characterised from which oxygenated sesquiterpenes and non-terpene derivatives dominated the plant oils. Compositional variation, which often could be as a result of geographical origin, ecological, genetic, climatic or physical factors, was observed with respect to a result from literature. From the bioactive evaluation point of view, *A. zygia* essential oils exhibit a promising anthelmitic property. Although this work presents preliminary results, it could however serve as a template for further *in-vivo* anthelminthic study (its other genus inclusive) as well as some other biological and pharmacological studies.

References

[1] Ugbogu, O.A., Osiyemi, O.A. and Odewo, T.K. (2012). Checklist of ethno medicinal trees and shrubs in Federal college of forestry, Ibadan, Oyo State, Nigeria. Journal of Forestry Research and Management 9: 106-124.

[2] Lawal, I.O., Uzokwe, N.E., Igboanugo, A.B.I., Adio, A.F., Awosan, E.A., Nwogwugwu, J.O., Faloye, B., Olatunji, B.P. and Adesoga, A.A., (2010). Ethno-medicinal information on collation and identification of some medicinal plants in Research Institutes of South-west Nigeria. African Journal of Pharmacy and Pharmacology 4(1): 1-7.

[3] Orwa C., Mutua, A. Kindt, R., Jamnadass, R., and Anthony, S. (2009). *Albizia zygia* (DC.) J.F.Macbr.: Agroforestree Database: a tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/sites/treedbs/treedatabases.asp). 5 pp.

[4] Apetorgbor, M.M. (2007). *Albizia zygia* (DC.) J.F.Macbr. [Internet] Record from PROTA4U. Louppe, D., Oteng-Amoako, A.A. and Brink, M. (Editors). PROTA (Plant Resources of Tropical Africa/Ressourcesvégétales de l'Afriquetropicale), Wageningen, Netherlands. <http://www.prota4u.org/search.asp>. Accessed 27 January, 2015.

[5] Femi-Oyewo, M.N., Adedokun, M.O. and Olusoga, T.O. (2004). Evaluation of the suspending properties of *Albizia zygia* gum on sulphadimidine suspension. Tropical Journal of Pharmaceutical Research 3(1): 279-284.

[6] Abdalla, M.A. and Laatsch, H. (2012). Flavonoids from Sudanese *Albizia zygia* (Leguminosae, Sub-family: Mimosoideae), a plant with antimalarial potency. Afr. J. Tradit. Complement Altern. Med. 9(1): 56-58.

[7] Odeyemi, O., Oluduro, A.O. and David, O.M. (2014). Evaluation of antimicrobial activities of *Albizia zygia* leaf extracts against some clinically important pathogens. Journal of Natural Sciences Research 4(19): 98-105.

[8] Oloyede, G.K. and Ogunlade, A.O. (2013). Phytochemical screening, antioxidant, antimicrobial and toxicity activities of polar and non-polar extracts of *Albizia zygia* (DC) stem-bark. Annual Review & Research in Biology 3(4): 1020-1031.

[9] Oloyede, G.K. and Ogunlade, A.O. (2015). Free radical scavenging activity and toxicity of linalool and thymol dominated essential oils of *Albizia zygia* (DC) J.F. Macbr. leaves and stem-bark. Research Journal of Medicine and Medical Sciences, 10(2): 33-40.

[10] Medicines and Healthcare products Regulatory Agency (MHRA) (1980). British Pharmacopoeia, Vol. II; H.M. Stationery Office, Pharmaceutical Press: London, UK.

[11] Adams, R. (2007). Identification of Essential Oil Components by Gas Chromatography/Mass spectrometry.4th ed. Allured Publishing Corporation, Carol Stream IL, USA.

[12] National Institute of Standards and Technology (NIST) (2002). Mass Spectral Database (NIST/EPA/NIH); NIST mass spectrometry data centre, US Department of Commerce, Gaithersburge, MD, USA.

[13] Lakshananam, B., Mazumber, M.P., Sasmal, D., Ganguly, S. and Jena, S.S. (2011). *In vitro* anthelmintic activity of some 1-substituted imidazole derivatives. Acta Parasitol. Globalis, 2(1): 1-5.

[14] Thomas, S. and Devi, B.S. (2013). Phytochemical and *in vitro* anthelmintic studies of hydro-alcoholic extract of *Costus pictus* D. Don. Int J Pharm Sci., 5(3):639-641.

[15] Pueblos, K.R.S., Lagare, J.P.B., Tapales, P.V.P.P. and Quimque, M.T.J. (2015). *In vitro* anthelmintic activity evaluation of the aerial part of *Ruellia tuberose* Linn. Against *Eudrilus eugeniae*. International Symposium on Applied Chemistry. Procedia Chemistry, 16: 570-57.

[16] Priya S.R., Sheth N.R. and Jayaveera, K.N. (2012). Anthelmintic activity of essential oil of *Pimenta dioica* (Linn.) Merill, Family: Myrtaceae, collected in summer from South Canara, India. Euro. J. Exp. Bio., 2(6):2271-2275.

[17] Flatt, V.D., Campos, C.R., Kraemer, M.P., Bailey, B.A., Satyal, P. and Setzer, W.N. (2015). Compositional variation and bioactivity of the leaf essential oil of *Montanoagua temalens* is from Monteverde, Costa Rica: A preliminary investigation. Medicines, 2: 331-339. doi:10.3390/ medicines2040331.

[18] Malko, M.W. and Wróblewska, A. (2016). The importance of R-(+)-limonene as the raw material for organic syntheses and for organic industry.CHEMIK70 (4): 193-202.

[19] Uemura, M., Hata, G., Toda, T. and Weine, F.S. (1997). Effectiveness of eucalyptol and d-limonene as gutta-percha solvents. Journal of Endodontics, 23:739–741.

[20] Ciriminna, R., Lomeli-Rodriguez, M., Cara, P.D., Lopez-Sanchez, A. and Pagliaro, M. (2014). Limonene: a versatile chemical of the bioeconomy. Chemical Communications,50: 15288-15296.

[21] Sun, J. (2007). D-limonene: Safety and clinical applications. Altern. Med. Rev.,12(3): 259-264.

[22] Al-Snafi, A.E. (2017). The pharmacological and therapeutic importance of Eucalyptus species grown in Iraq.IOSR Journal of Pharmacy, 7(3): 72-91.

[23] Oliveira, G.L., Vieira, T.M., Nunes, V.F., Ruas, M.dO., Duarte, E.R., Moreira, D.d L., Kaplan, M.A.C. and Martins, E.R. (2014). Chemical composition and efficacy in the egg-hatching inhibition of essential oil of Piper aduncum against *Haemonchus contortus* from sheep. Rev Bras Farma, 24: 288-292.

[24] Rocha, C.G.F., Oliveira, A.R.dS., Araújo, A.V., Lafayette, S.S.L., Albuquerque, G.S., Silva-Neto, J.dC., Costa-Silva, J.H., Ferreira, F., da Costa, J.G.M. and Wanderley, A.G. (2015). Gastroprotective mechanisms of the monoterpene 1,8-Cineole (Eucalyptol). PLoS ONE 10(8).

[25] Kumar, H.D. and Laxmidhar, S. (2011). A review on phytochemical and pharmacological of *Eucalyptus globules*: A multipurpose tree. IJRAP 2(5): 1527-1530.

[26] Fidyt, K., Fiedorowicz, A., Strządała, L. and Szumny, A. (2016). β-caryophyllene and β-caryophyllene oxide – natural compounds of anticancer and analgesic properties. Cancer Med. 5(10): 3007-3017.

[27] Eitan, A., Rivka, O., Nativ, D., Elaine, S., Tatiana, R., and Shimon, R. (2012). β-Caryophyllene, a compound isolated from the Biblical balm of Gilead (*Commiphora gileadensis*), is a selective apoptosis inducer for tumor cell-lines. Evidence-based complementary and alternative medicine. Article ID 872394. 8 pp.

[28] Aboaba, S., Akande, A. and Flamini, G. (2013). Chemical constituents, toxicity and antimicrobial activities of the essential oil from the leaves of *Tectona grandis*. Elixir Bio Technology, 61: 16795-16798.

[29] Aboaba, S.A., Igumoye, H. and Flamini, G. (2016). Chemical composition of leaves and stem bark of *Sterculia tragacantha, Anthocleista vogelii* and leaves of *Bryophyllum pinnatum.* Journal of Essential Oil Research, DOI: 10.1080/10412905.2016.1178182. pp. 1-8.

[30] Uenojo, M. and Pastore, G.M. (2010). β-Carotene biotransformation to obtain aroma compounds. Ciênc. Tecnol. Aliment, Campinas, 30(3): 822-827.

Journal of Science Research ISSN 1119 7333

Citation: Akinsola Akande, Sherifat Aboaba and Guido Flamini. Variations in Chemical Constituents and Anthelmintic Activity of *Albizia zygia* (DC.) J.F. Macbr. Essential oils from Ibadan, Nigeria. Volume 17, 2018, pp30-37.