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# CHEMICAL CONSTITUENTS, ANTIMICROBIAL AND ANTIOXIDANT ACTIVITIES OF ESSENTIAL OILS FROM FRESH AND AIR-DRIED LEAVES OF *ICACINA TRICHANTHA* (OLIV.)

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## ABSTRACT

*We investigated and compared the constituents, antimicrobial, and antioxidant activities of the essential oils from the fresh and air-dried leaves of Icacina trichantha. The essential oils were extracted by hydrodistillation, antimicrobial activities were tested on Staphylococcus aureus, Salmonella typhi, Escherichia coli, Pleisomonas shigellosis, Bacillus cereus, Proteus vulgaris, Candida albicans, and Candida tropicalis by agar diffusion method, while 2,2- diphenyl-1-picrylhydrazyl (DPPH) was used for the antioxidant activities at 6.25-200 µg/mL of the oils compared with ascorbic acid as standard. The fresh and air-dried leaf oils gave 0.39% (w/w) and 0.33% (w/w) corresponding to 17 compounds representing 99.99%, and 10 compounds representing 100% respectively. Major compounds in the fresh leaf oil were 9-oxabicyclo [6.1.0] nonane (15.52%), Methyl isododecanoate(11.91%), Oleic acid (10.51%), 3-Cyclohexen-1-ol,3-methyl- (8.24%) and Phytol (7.70%), while Linoleic acid- (34.61%), Palmitic acid (20.74%), 9,17-Octadecadienal, (Z)- (12.98%), 9-Octadecenal (Z) (7.96%) and gamma-sitosterol (7.13%) were the major constituents of the air-dried oil. The fresh leaf oil 50 mg/mL, gave the highest zone of inhibition of 12 mm against Candida albicans while the air-dried oil had the highest zone of inhibition of 18 mm with a minimum inhibitory concentration of 0.20 mg/mL against C. tropicalis. The fresh leaf oil had the highest antioxidant activity of 73.85% at 100 µg/mL, while the air-dried and ascorbic acid had 70.25% and 69.23% respectively at 200 µg/mL. The fresh leaf oil comprised mainly oxygenated hydrocarbons (52.51%) while the air-dried oil had fatty acids (58.44%). Both oils were more antifungal than antibacterial and had a comparable antioxidant activity with ascorbic acid.*

**Keywords:***Icacina trichantha*, hydrodistillation, antimicrobial, antioxidant, assay

## INTRODUCTION

The rural areas of many developing countries including Nigeria still depend on traditional medical treatment for their main healthcare needs because these medicines are readily available, safer and cheaper when compared to synthetic or modern medicines (Iwu *et al*., 1999; Mann *et al*., 2008). Plants provide a rich source of secondary metabolites with interesting biological activities with various

structural arrangements and properties (Vickers, 2002; El-Shemy *et al*., 2007).

Essential oils produced from the secondary metabolism of medicinal plants contain approximately 20-60 components of very different concentrations and have been extracted from a complex mixture of volatile molecules as reported by Hammer *et al.*, (1999). Essential oils are widely used in pharmaceutics, cosmetics, food, medicine, aromatherapy, and pesticide industries with some of their constituents being active against different organisms including fungi, protozoa, bacteria and viruses (Hammer *et al*., 1999; Duschatzky *et al.*, 2005). The insecticidal, anti-parasitic, antiseptic, antiviral, antioxidant, antibacterial, and antifungal properties of essential oils having significant activities have been reported (Burt, 2004).

Antioxidants are substances employed by the body to protect itself from the destruction caused by excess free radicals, which have been linked to many diseases including cancers, liver and heart diseases (Aviram, 2000; Owen *et al*., 2000). Aromatic plants are especially interesting due to their value as a source of natural antioxidants and also because research studies have shown that the main compounds of some essential oils have antioxidant activity (Ruberto and Baratta, 2000; Tiwari *et al*., 2009).

*Icacina trichantha* Oliv., from the Icacinaceae family is a perennial shrub commonly found in field crops, forest regrowth and waste areas in most parts of Nigeria. It can grow up to 2 m with scandent growth above having leaves that are simple, alternate and broadly elliptic while the stem is straggling, semi-wood, round in cross-section, with soft brown hairs and ascends from an underground tuber that also has soft brown hairs (Agyakwa and Akobundu, 1998). The Yoruba people of Nigeria call it 'Gbegbe' while among the Igbo it is called 'Ibugo' (Burkhill, 1985).

The plant is widely used in rural areas and regarded as a major handy household medicine for emergency treatment; hence, almost all households have the macerated tuber in ethanol stored in corked bottles, while the Igbo people regard the plant as an aphrodisiac (Burkhill, 1985).

The leaves are used by the Yoruba people during the coronation of their chiefs called 'Obas' (Asuzu and Egwu, 1998), and also as a wrapper for processed oil bean seeds known as 'ugba' in Igbo (Asuzu and Abubakar, 1995). The tuber has been widely used traditionally in the treatment of constipation, as a poison antidote, to induce emesis, and to cure malaria (Asuzu and Abubakar, 1995; Timothy and Idu, 2011).

It is known that a large number of herbal medicines from different plants are sources of various molecules, with quite a number of them exhibiting both antimicrobial and antioxidant properties useful in defending the body against pathogens and cellular oxidation reactions, we thus set out in this study to investigate and compare the essential oils constituents, antimicrobial and antioxidant activities of the fresh and air-dried leaves of *Icacina trichantha* to improve on the limited information about this plant in literature.

## MATERIALS AND METHODS

### Plant Collection and Preparation

The fresh leaves of *Icacina trichantha* were collected at Olabisi Onabanjo University Ago-Iwoye. Identification and authentication were done at the Forest Herbarium, Forestry Research Institute of Nigeria (FRIN) in Ibadan Oyo State, where a voucher specimen with no FHI 110445 was deposited. The fresh leaves were cut into smaller bits and extracted immediately while the air-dried sample was obtained by air-drying the fresh leaves for three weeks under shade and then blended into small particles before extraction.

### Hydrodistillation of the Essential Oils

The fresh and air-dried leaves of *I. trichantha* (500g) each were subjected to hydrodistillation in an all-glass Clevenger-type apparatus separately for 3 h following established procedure (British

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Pharmacopoeia, 1980). The oils obtained were dried over anhydrous sodium sulphate ($Na_2SO_4$), stored in separate vials and kept inside a refrigerator until ready for analysis.

**Gas Chromatography/Mass Spectrometry (GC/MS)**

The GC-MS analyses were performed on an Agilent model 5975C GC-MSD system with split/splitless automated injection interfaced to a 5973-mass selective detector operated at 70eV with a mass range of m/z 50 -500. The oven temperature was programmed from 75-250$^o$C at the rate of 4$^o$C/min. Helium was used as the carrier gas at a flow rate of 1 mL/min, and the volume of oil injected was 1.0 µL. Relative percentage amounts of the separated compounds were calculated from FID chromatograms.

**Identification of the Constituents of the Leaf Essential Oils**

The individual components of the oils were identified based on their 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 those from the National Institute of Standards and Technology NIST (Database 69) and the home-made MS library built up from pure substances and components of known essential oils, as well as by comparison of their retention indices with literature values (Adams, 2007).

**Antimicrobial Activity of the Essential Oils of *Icacina trichantha***

Inoculum of bacteria - *Staphylococcus aureus, Salmonella typhi, Escherichia coli, Pleisomonas shigellosis, Bacillus cereus, Proteus vulgaris* and fungi -*Candida albicans* and *Candida tropicalis* were maintained on nutrient agar and potato dextrose agar (PDA) respectively. Two to three colonies of the test organisms were suspended in 3 mL of normal saline in test tubes and then standardized with 0.5 McFarland solutions. Sterile swab sticks were used to touch the suspension of the test organisms and then to swab the surface of Muller Hinton Agar plates for bacteria and PDA for fungi. A sterile cork borer of 6mm diameter was used to bore holes in each plate and different dilutions (6.25-50 mg/mL) of essential oils were introduced into the different holes in triplicate. A Standard antibiotic, Gentamicin (10 µg) was used as the positive control. The plates were incubated uprightly for 24 h at 35$^o$C for bacteria and at 27±2$^o$C for fungi.

**Determination of Minimum Inhibitory Concentration (MIC)**

MIC was determined by microdilution broth susceptibility as described by Kalemba and Kunicka (2003). A stock solution of the essential oil was prepared in 10 % DMSO, and serial dilutions were prepared to yield concentrations of 0.20 – 12.50 mg/mL. Nutrient broth, essential oil of the leaves and the test organisms were prepared in test tubes to the final volume of 2 mL. A positive control (containing inoculums but no essential oil) and a negative control (containing essential oil but no inoculum) were included in each tube. The solutions were gently shaken and incubated at 35$^o$C for 24 h for bacteria and 27±2$^o$C for 48 h for the yeast, after which the MIC was determined by visual inspection of the tubes. The lowest concentration that inhibited the growth of the organism was taken to be the MIC.

**Antioxidant Activity (AA) of the Essential oils of *Icacina trichantha***

Free radical scavenging activity was evaluated according to Ebrahimzadeh *et al*., (2010), with slight modification by measuring the radical scavenging activity of the essential oils from the fresh and air-dried leaves of *Icacina trichantha* on stable 2, 2-diphenyl-1-picryl hydrazyl radical (DPPH). A 4 µM solution of DPPH in methanol was prepared and a stock solution of the sample (1 mg/mL) in methanol was prepared under dark room conditions. Various concentrations (6.25 -200 µg/mL) were added to 1.0 mL (4 µM DPPH) and the final volume was made to 3.0 mL with

methanol. The mixture was shaken thoroughly and incubated in dark room conditions for 30 min. The absorbance of the mixture was measured at 517 nm on a spectrophotometer, with a decrease in absorbance indicating an increase in DPPH radical scavenging activity. The experiment was done in triplicate with Ascorbic acid used as the standard reference. Percentage inhibition was calculated as follows:

$$I(\%) = 100 \times \frac{A_{blank} - A_{sample}}{A_{blank}}$$

where $A_{blank}$is the absorbance of the control (containing all reagents except the sample),

$A_{sample}$ is the absorbance of the test sample while,

$IC_{50}$ value (µg/mL) is the effective concentration at which DPPH radicals are scavenged by 50% of the oil and was obtained by interpolation and used for regression analysis.

## Results and Discussion

The essential oils from the fresh leaves gave a yield of 0.39% (w/w) while that of the air-dried leaves was 0.33% (w/w) with both oils having an herbal smell and colourless.

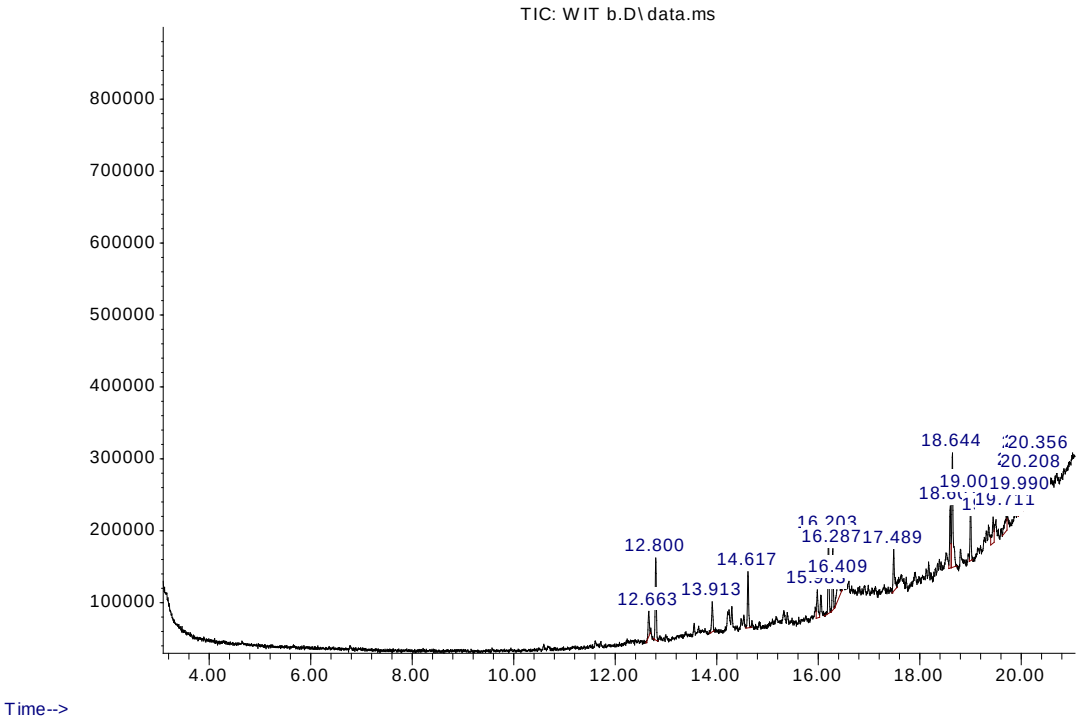


**Figure 1:** Gas chromatogram of the essential oil from the fresh leaves of *Icacina trichantha*

**Table1:**Chemical composition of the essential oil from the fresh leaves of *Icacinatrichantha*

| S/No. | Compounds | Retention time | % Abundance | Molecular formula | Mass spectral data[a,b] |
|---|---|---|---|---|---|
| 1 | 3,3-Dimethyl-4-methyl amino-butan-2-one | 12.66 | 2.53 | $C_7H_{15}NO$ | 44[a], 55, 71, 86, 89, 100, 129[b] |
| 2 | 3-Cyclohexen-1-ol, 3-methyl- | 12.80 | 8.24 | $C_7H_{12}O$ | 41, 55, 69, 79, 84, 97[a], 114[b] |

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| | | | | | |
|---|---|---|---|---|---|
| 3 | 2-piperidinone,1-methyl | 13.91 | 3.30 | $C_6H_{11}NO$ | 44[a], 57, 67, 70, 85, 113, 115[b] |
| 4 | Undecanoic acid, 10-methyl-, methyl ester | 14.61 | 11.91 | $C_{13}H_{26}O_2$ | 74[a], 87, 129, 143, 171, 183, 214[b] |
| 5 | N-omega-Nitro-L-arginine | 15.99 | 3.40 | $C_6H_{13}N_5O_4$ | 44[a], 56, 69, 112, 190, 219[b] |
| 6 | Phytol | 16.20 | 7.70 | $C_{20}H_{40}O$ | 71[a], 81, 95, 123, 137, 249, 296[b] |
| 7 | 4-Fluorohistamine | 16.41 | 5.16 | $C_5H_8FN_3$ | 44[a], 55, 60, 69, 73, 100,129[b] |
| 8 | L-Guanidino Succinimide | 17.48 | 4.87 | $C_5H_7N_3O_2$ | 44[a], 54, 69, 98, 113, 125, 141[b] |
| 9 | 4-Decyne | 18.60 | 5.95 | $C_{10}H_{18}$ | 55, 67[a], 81, 95, 109, 123 138[b] |
| 10 | 9-oxabicylo [6.1.0]nonane | 18.64 | 15.52 | $C_8H_{14}O$ | 55[a], 67, 79, 83, 97, 111, 126[b] |
| 11 | Dodecane,1-fluoro | 19.00 | 5.84 | $C_{12}H_{25}F$ | 57[a], 71, 85, 97, 111, 139, 188[b] |
| 12 | Oxalic acid Allyl pentadecyl oxalate | 19.45 | 3.56 | $C_{20}H_{36}O_4$ | 41[a], 57, 71, 83, 97, 111, 340[b] |
| 13 | Pentadecanal | 19.71 | 3.25 | $C_{15}H_{30}O$ | 82[a], 96, 109, 123, 137, 182, 206[b] |
| 14 | Dodecyl propyl ether | 19.99 | 2.33 | $C_6H_{14}O$ | 43[a], 61, 71, 97, 111, 168, 230[b] |
| 15 | Cis-Vaccenic Acid | 20.24 | 4.17 | $C_{18}H_{34}O_2$ | 55[a],69,83,97,111,123,264, 282[b] |
| 16 | Oleic Acid | 20.29 | 10.51 | $C_{18}H_{34}O_2$ | 41[a], 69, 83, 97, 111, 264, 282[b] |
| 17 | Neopentylidenecyclohexane | 20.35 | 1.75 | $C_{11}H_{20}$ | 55, 69[a], 81, 95, 109, 137, 152[b] |
| **Total** | | | **99.99%** | | |

**Key:** a= base peak, b=molecular mass

The results in Figure 1 and Table1 revealed that the fresh leaves oil is comprised mainly of oxygenated hydrocarbons (52.51%), heterocyclic compounds (16.73%), fatty acids (14.68%), hydrocarbons (7.70%) and other substituted hydrocarbons (8.37%) as other classes of compounds.

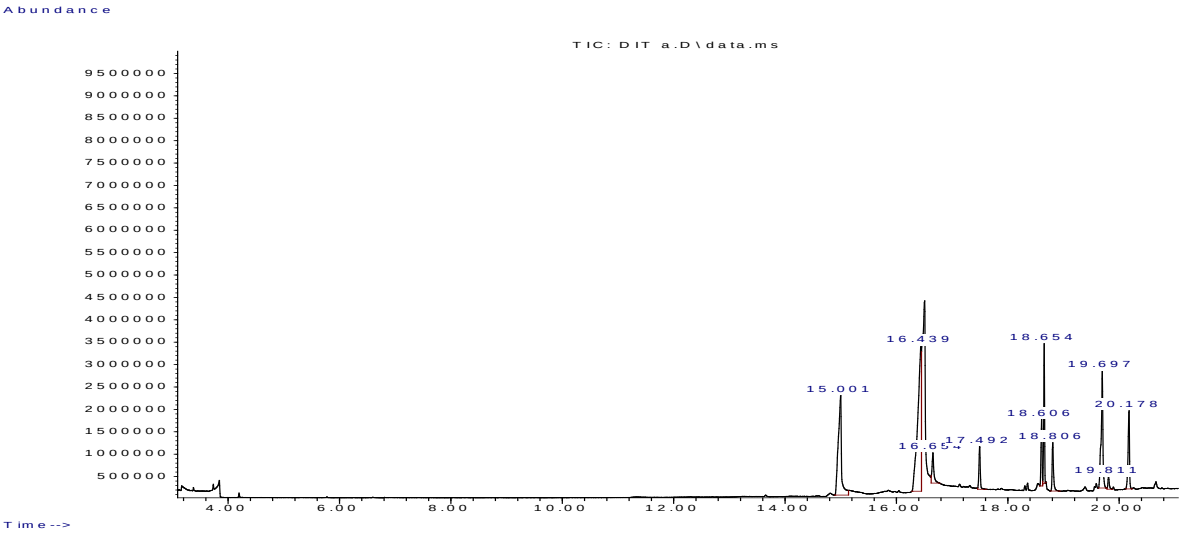


**Figure 2:**Gas chromatogram of the essential oil from the air-dried leaves of *Icacina trichantha*

**Table 2:**Chemical composition of the essential oil from the air-dried leaves of *Icacina trichantha*

| S/No. | Compounds | Retention time | % Abundance | Molecular formula | Mass spectral data[a,b] |
|---|---|---|---|---|---|
| 1 | Palmitic acid | 15.00 | 20.74 | $C_{16}H_{32}O_2$ | 43[a], 60, 73, 83, 129, 213, 256[b] |
| 2 | Linoleic acid | 16.45 | 34.16 | $C_{18}H_{32}O_2$ | 55, 67[a],81, 95, 110, 195, 280[b] |
| 3 | Stearic acid | 16.65 | 3.54 | $C_{18}H_{36}O_2$ | 43[a], 60, 73, 129, 185, 241, 284[b] |
| 4 | Palmitic acid chloride | 17.49 | 3.71 | $C_{16}H_{31}ClO$ | 69, 84, 98[a], 112, 125, 194, 274[b] |
| 5 | Linoleic acid chloride | 18.60 | 4.49 | $C_{18}H_{31}ClO$ | 67[a], 81, 95, 110, 191, 262, 298[b] |
| 6 | 9-Octadecenal (Z) | 18.65 | 7.96 | $C_{18}H_{34}O$ | 55[a], 69, 83, 98, 135, 248, 266[b] |
| 7 | Myristoyl chloride | 18.81 | 4.19 | $C_{14}H_{27}ClO$ | 41[a], 55, 84, 98, 112, 166, 246[b] |
| 8 | 9,17-Octadecadienal,(Z)- | 19.69 | 12.98 | $C_{18}H_{32}O$ | 67[a], 81, 95, 109, 137, 151, 264[b] |
| 9 | Pentadecanoicacid,2-hydroxy-l-(hydroxymethyl) ethyl ester | 19.81 | 1.10 | $C_{18}H_{36}O_4$ | 43[a], 57, 74, 84, 134, 243, 285, 316[b] |
| 10 | γ-sitosterol | 20.18 | 7.13 | $C_{29}H_{50}O$ | 43[a], 81, 95, 145, 255, 329, 414[b] |
| **Total** | | | **100%** | | |

**Key:** a= base peak, b=molecular mass

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The results in Figure 2 and Table 2 also showed the air-dried leaves oil was found to be majorly made up of fatty acids (58.44%). Other classes of compounds include; oxygenated hydrocarbons (22.04%), fatty acid derivatives (12.39%) and gamma-sitosterol, a triterpenoid (7.13%).

**Table 3:** Antimicrobial activities of the fresh and air-dried leaves essential oils of *Icacina trichantha*

| Test organisms | 6.25mg/mL | | 12.50mg/mL | | 25.00mg/mL | | 50.00mg/mL | | MIC mg/mL | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FLO | ALO | FLO | ALO | FLO | ALO | FLO | ALO | FLO | ALO |
| SA | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 6.25 | 12.5 |
| ST | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.0±1.73 | 0.0 | 3.13 | 12.5 |
| EC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.13 | 12.5 |
| PS | 0.0 | 6.3±0.45 | 0.0 | 6.7±0.66 | 7.3±1.34 | 8.0±1.16 | 11±2.65 | 12±1.53 | 1.56 | 1.56 |
| BC | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 8.0±2.00 | 6.25 | 6.25 |
| PV | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.56 | 12.3 |
| CA | 0.0 | 9.3±0.00 | 7.3±0.66 | 8.0±0.16 | 11±0.33 | 11±2.40 | 12±1.20 | 11±2.91 | 0.78 | 0.78 |
| CT | 0.0 | 9.3±0.88 | 0.0 | 11±0.58 | 7.0±1.00 | 13±1.16 | 9.3±1.77 | 18±3.34 | 1.56 | 0.20 |

Values are expressed as the Mean of the zone of inhibition n = 3 ± SEM
**Key**:FLO= Fresh leaves oil, ALO= Air-dried leaves oil, MIC = Minimum inhibitory concentration
**Bacteria:** SA=*Staphylococcus aureus,* ST= *Salmonella typhi,* EC=*Escherichia coli,* PS= *Pleisomonas shigellosis,* BC= *Bacillus cereus,* PV= *Proteus vulgaris*
**Fungi:** CA =*Candida albicans,* CT = *Candida tropicalis*

The results of the antimicrobial activity of the essential oils presented in Table 3 revealed that the air-dried leaves oil was more active than the fresh leaves oil against fungi. It showed the highest activity against *C. tropicalis* with a zone of inhibition of 18±3.34 mm at 50.00 mg/mL. Only *P. shigellosis* was susceptible to the air-dried leaves oil at 6.25-50.00 mg/mL. All the bacteria isolates were mostly resistant to the fresh leaves oil except *S. typhi* which at 50.00 mg/mL gave an inhibition of 9.0±1.73 but was resistant to the air-dried leaves oil at the same concentration and *P. shigellosis* which at 25.00 mg/mL and 50.00 mg/mL gave 7.3±1.34 mm and 11±2.65 mm zones of inhibition respectively. *B. cereus* was only susceptible to the dry leaves oil extract at 50.00 mg/mL. For the control, only *Bacillus cereus* and *Proteus vulgaris* were sensitive to the antibiotic with inhibition zones of 15 and 20 mm respectively while others were resistant to the drug. The fungi used were resistant to the fresh leaves oil at 6.25 mg/mL. The result for the MIC showed that the essential oil of the air-dried leaves was the most active with an MIC of 0.20 mg/mL for *C. tropicalis*. Both air-dried and fresh leaf oils demonstrated antimicrobial activity against *C. abicans* with an MIC of 0.78 mg/mL.

**Table 4:** Antioxidant activity (AA) of the essential oils from the fresh and air-dried leaves of *Icacina trichantha*

| Conc. (µg/mL) | Fresh leaves essential oil AA (%) | Air-dried leaves essential oil AA (%) | Ascorbic acid AA (%) |
|---|---|---|---|
| 6.25 | 48.71 | 49.48 | 60.10 |
| 12.5 | 61.50 | 61.53 | 64.30 |
| 25 | 71.96 | 64.10 | 58.35 |
| 50 | 71.79 | 64.10 | 60.50 |
| 100 | 73.85 | 65.38 | 65.40 |
| 200 | 73.15 | 70.25 | 69.23 |
| $IC_{50}$ | 10.00 | 30.00 | 5.42 |

Values are the mean of triplicate readings

The antioxidant activities of the essential oils of both samples and ascorbic acid used as the standard in Table 4 suggest that ascorbic acid and the essential oil of the air-dried leaves gave their respective highest AA values as 69.23% and 70.25% at 200 μg/mL, the essential oil of the fresh leaves gave its highest value of 73.85% at 100 μg/mL. The lowest AA values recorded for ascorbic acid was 58.35% at 25 μg/mL, while the essential oils from the fresh and air-dried leaves gave their lowest values as 48.71% and 49.48% respectively at 6.25 μg/mL.

The fresh leaves of *Icacina trichantha* revealed the presence of seventeen (17) compounds accounting for 99.99% of the extracted essential oil. The major compounds identified were 9-Oxabicyclo [6.1.0] nonane (15.52%), Methyl isododecanoate (11.92%), Oleic acid (10.51%),3-Cyclohexen-1-ol-3-methyl- (8.24%) and phytol (7.70%). Others are;4-Decyne (5.95%), Dodecyl fluoride (5.84%), 4-Fluorohistamine (5.16%), L-Guanidino Succinimide (4.87%), Cis-Vaccenic acid (4.17%), Allyl pentadecyl oxalate (3.56%), N-omega-Nitro-L-arginine (3.40%), 2-piperidinone,1-methyl (3.30%), Pentadecenal (3.25%), 3,3- Dimethyl-4-methyl amino-butan-2-one (2.53%), Dodecyl propyl ether (2.33%) and Neopentylidene cyclohexane (1.75%) as shown in Table 1. The essential oil constituents of the air-dried leaves of *Icacinatrichantha* are shown in Table 2 with a total of ten (10) compounds representing 100% of the extracted oil. The major constituents of the oil were Linoleic acid - (34.16%), Palmitic acid (20.74%), 9,17-Octadecadienal, (Z)- (12.98%), 9-Octadecenal (Z) (7.96%), γ-sitosterol (7.13%), while other constituents were Linoleoyl chloride - (4.49%), Myristoyl chloride (4.19%), Palmitoyl chloride (3.71%), Palmitoleic acid (3.54%) and Pentadecanoicacid, 2-hydroxy-l-(hydroxymethyl) ethyl ester (1.10%).

Comparing Tables 1 and 2, both oils were found to comprise mainly oxygenated hydrocarbons and fatty acids. The oxygenated hydrocarbon content of the fresh oil was found to be 52.51% (Table 1) while that of the air-dried oil was 22.04% (Table 2). Also from Table 1, the fatty acid content of the fresh oil was found to be 14.68% composed of saturated fatty acids (Cis-Vaccenic acid 4.17% and Oleic acid 10.51%) while from Table 2, the air-dried oil contained 58.44% of a mixture of both saturated (Palmitic acid 20.74% and Palmitoleic acid 3.54%) and unsaturated (Linoleic acid 34.16%) fatty acids. These results were similar to Otun e*t al*. (2015)in which the n-hexane, ethyl acetate and ethanol extracts were found to contain fatty acids; Stearolic acid (30.74%), oleic acid (36.04%), erucic acid (29.01%), 9,12-octadecadienoic acid (6.08%). Oleic acid was also identified in the fresh leaf essential oil of *Icacina trichantha* and has been implicated in the blood pressure-reducing effects of olive oil (Teres *et al*., 2008).

The antimicrobial analysis of both oils against bacteria and fungi in Table 3 showed that the fresh leaves oil had minimal activity against *P. shigellosis* at all concentrations. Both oils were inactive against the rest of the bacteria at all concentrations with the exception of the fresh and air-dried leaves oils that gave poor zones of inhibition of 9.0 mm and 8.0 mm at 50.00 mg/mL for *S. typhi* and *B. cereus* respectively. This was not in agreement with the findings of Otun *et al*. (2015) who reported that there was significant antimicrobial activity against *E. coli* by the three extracts of *Icacina trichantha* leaf tested. Alawode *et al.* (2021) reported the antimicrobial activity of *I. trichantha* non-polar hexane fraction against *S. aureus, E. coli* and *C. albicans* at a higher concentration of 200 mg/mL and identified β-sitosterol and stigmasterol from the fraction. γ-Sitosterol (a stereoisomer of β-sitosterol) was one of the compounds identified in the air-dried leaves oil and it has been known to have potential as an antidiabetic agent (Balamurugan *et al*., 2011). The susceptibility of *B. cereus* to ciprofloxacin was in agreement with the findings of Fiedler *et al.* (2019) and Adesetan *et al.* (2019) while the susceptibility of *P. vulgaris* to the same antibiotic was in line with the work of Bashir *et al.* (2021). The oils

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appeared to be more active against fungi giving high zones of inhibition. The lowest MIC of 0.20 mg/mL was obtained against *C. tropicalis*. According to Sartoratto *et al*. 2004 and Duarte *et al.* 2005, strong microbial inhibitors possessed values equal to or less than 0.50 mg/mL. Thus, the 0.20 mg/mL MIC against the fungi tested is an indicator that both oils have strong antifungal properties which could become useful in the therapeutic activities to which the oils may be subjected.

## CONCLUSION

In conclusion, the essential oil constituents of both the fresh and air-dried leaves of *Icacina trichantha*, and their antimicrobial and antioxidant activities were compared. Our findings showed that the oils had different constituents with the fresh leaves oil being made up mainly of oxygenated hydrocarbons while the air-dried leaves oil was more of fatty acids. Both oils were found to be more active against the fungi tested than the bacteria with the air-dried leaves oil having the highest zone of inhibition. The fresh leaves oil was however found to have more antioxidant activity at a lower concentration than the air-dried leaves oil with both being comparable to ascorbic acid. This research work has been able to contribute to the existing literature on the plant of study.

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### Conflict of Interest

The authors declare that there is no conflict of interest.

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