

# Original Research Article

## ANTIOXIDANT AND ANTIMICROBIAL EFFECTS OF AQUEOUS AND ETHANOLIC EXTRACTS OF SELECTED MEDICINAL PLANTS FROM SOUTHERN NIGERIA

### Abstract



valuation of ethanolic and aqueous extracts of select plants indicated inhibition of microbial activity. In particular some of the extracts exhibited high anti-oxidant activity at the lowest concentrations evaluated.

Keywords:-anti-oxidant, anti-microbial, inhibition, phytochemicals

### 1. Introduction

Knowledge of certain plants and herbs which possess a large collection of bioactive, chemically diverse compounds which can be applied towards the therapeutic regiment for the handling of diseases has gained favourable attention in recent years (Zampini *et al.*, 2009; Bhalodia and Shukla, 2011; Vashney *et al.*, 2012). Furthermore, the prophylactic action coupled with the immune-enhancing effects of certain plants against several pathogens/microbial agents that plague humans and animals alike has prompted the need to screen for candidates termed as forgotten plants such that the exploitation of these does not constitute a threat to normal food production (Emmanuel *et al.*, 2016). Moreover, to cope with the ever increasing appeal for the use and consumption of natural food additives in everyday meals, multi-vitamin capsules and other health drinks, all of which are consumed in a bid to prevent diseases and boost immunity, it is therefore conceivable to examine the applicability and benefits of indigenous plant materials to mankind using modern scientific analysis methods (Abdel *et al.*, 2011). Phyto-medicine is a broadly accepted prophylactic and treatment option for an array of infections worldwide with certain identified bioactive compounds such as alkaloids, cardiac glycosides, flavonoids, glycoalkaloids, glycosides, phenols, tannins, terpenes and terpenoids being implicated in the therapeutic ability (Okwute *et al.*, 2017). The function of these bioactive compounds, together with certain minerals within the plant are principally to avert the growth and proliferation of disease causing pathogens, particularly some multi-drug resistant variants with the added benefit of producing marginal to no adverse side effects as well as essential nutritional supplements (Uttu *et al.*, 2015; Adebisi *et al.*, 2016). Studies show that the bioactive compounds of certain plant crude extracts such as *Waltheria indica* Linn work in symphony to stimulate anti-oxidative processes that hinders pathogen-induced free radicals (Dahiya and Purkayastha, 2012; Okwute *et al.*, 2017). Free radicals are metastable species which are generated as by-products of various biochemical reactions. Living organisms are equipped with a defense system (such as superoxide dismutase, catalases, glutathione peroxidase, glutathione reductase; or

compounds such as glutathione, vitamins C and E, etc.) to neutralize these free radicals and other reactive oxygen species (ROS). If a balance exists between free radicals and the body's anti-oxidative defense system, the body is in healthy condition. However, depletion of antioxidant levels may lead to oxidative stress which can cause cellular and tissue damages, DNA mutation, cancer, neurodegenerative diseases (e.g. Parkinsonism, Alzheimer's disease), gastrointestinal ulcerogenesis, and even AIDS etc (Okwute *et al.*, 2017).

Several indigenous and forgotten plants in the southern parts of Nigeria possess many antimicrobial, anticancer, anti-oxidant, anti-cytotoxic, anti-malarial, anti-inflammatory, anti-viral, anti-allergic and anti-venom properties according to folklore. However, they are yet to receive the scientific validation required. Known only by the local names deep within the interior of their villages, this study aims at evaluating the antioxidant and antimicrobial effects of aqueous and ethanolic extracts of selected medicinal plants, herein referred to as Mfang Urukikot 1, 2, 3, Adung Urukikot, Mfang Adung Urukikot, Adia Oduoho-oduoho and Afuo Ubara, all indigenous to Akwa Ibom State, Nigeria.

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## 56 2. MATERIALS AND METHODS

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### 58 2.1 Plant Materials

The following Akwa Ibom native plants; Mfang Urukikot 1, 2, 3, Adung Urukikot, Mfang Adung Urukikot, Adia Oduoho-oduoho and Afuo Ubara were authenticated by Prof. Ndaeyo from the Department of Agriculture, University of Uyo. Fresh leaves were washed with distilled water and air-dried at room temperature in the dark for 72hrs. The dried leaves of the plants were finely homogenized into a fine powder using a blender and kept in sealed plastic bags.

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### 65 2.2 Extractions

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**2.2.1 Solvent:** 50g of each of the powdered plant was added to 200ml of ethanol and macerating for 48hrs. at room temperature. The crude extract were concentrated using a rotary evaporator under vacuum at temperature below 40°C.

**2.2.2 Aqueous:** To 1L of distilled was added 100g of each of the powdered plant and gently heated until it comes to boiling. The heat was turned off and the mixture was filtered after 30mins. After filtration, the crude extracts were concentrated using a rotary evaporator under vacuum below 40°C and freeze-dried.

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### 75 2.3. Proximate Composition

The proximate analysis (ash, moisture, crude fibre, crude lipid, crude protein, and carbohydrate) of the samples was determined using standard method (Useh *et al.*, 2017). All determinations were done in triplicate and reported in percentage.

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### 80 2.4. Phytochemical screening

Preliminary qualitative phytochemical analysis was carried out to identify the secondary metabolites present in the various alcoholic and aqueous extracts of plants using standard methods (Useh *et al.*, 2017).

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## 2.5 Screening for antioxidant activity

The 2,2-Diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity of the extracts was performed according to Olajide and colleagues with some modifications by using a UV/VIS spectrophotometer 1700 (Olajide *et al.*, 2013). Various concentrations (0.03125, 0.0625, 0.125, 0.25, 0.5mg/ml) of 1 ml of each plant extract were added to 3ml of 0.1mMol of DPPH methanol solution. The absorbance was read against blank at 517nm in duplicates after 30mins of incubation and from these values corresponding percentage of inhibitions were calculated. The extent of discoloration indicates the scavenging potentials of the antioxidant compounds. A lower absorbance value indicates the higher radical scavenging activity. Results were compared with the standard antioxidant (Ascorbic acid). The percentage inhibition was calculated as follows:

$$\text{Inhibition (\%)} = \frac{A_b - A_s}{A_b} \times 100$$

Where  $A_b$  = absorbance of the blank sample;  $A_s$  = absorbance of the extract

## 2.6 Antimicrobial activity

Agar Well Diffusion technique was used to determine the antimicrobial activity of the extracts on Mueller Hinton agar (MHA). The extracts were dissolved and diluted using 50%v/v dimethylsulphoxide (DMSO) to obtain different concentrations (250µg, 500µg, 750µg and 1000 µg) in 100µL. The microbial cultures used in this assay include bacteria (*Staphylococcus aureus*, *Streptococcus pyogenes*, *Klebsiella pneumoniae* and *Salmonella typhi*) and fungus (*Candida albicans*). 18–24hrs nutrient broth cultures of the organisms that has equaled the optical density of 0.5% McFarland solution were spread on MHA plates and labeled accordingly. Six wells, 8mm in diameter were made using sterile cork borer on each plate and the bases sealed with agar using micro pipette. 100µL of different concentrations of the extracts including the positive control (200µg of chloramphenicol and nystatin for bacteria and fungus respectively and the negative control (50% v/v DMSO) were introduced into the wells and incubated for 24 hrs. The experiment was done in triplicates for each of the extracts.

## 3 RESULTS

**Table 1: Proximate Composition of the Samples**

| SAMPLES | % Ash | % Moisture | % Fibre | % Lipid | % Protein | % Carbohydrate |
|---------|-------|------------|---------|---------|-----------|----------------|
| MU1     | 19.70 | 11.71      | 8.87    | 14.99   | 11.00     | 33.73          |
| MU2     | 16.05 | 11.04      | 17.09   | 18.16   | 27.71     | 9.95           |
| MU3     | 5.92  | 9.95       | 36.93   | 15.99   | 19.58     | 11.63          |
| AU1     | 5.67  | 9.97       | 44.86   | 12.56   | 8.56      | 18.38          |
| AU2     | 2.75  | 9.03       | 41.02   | 10.93   | 19.15     | 17.12          |
| AOU     | 0.66  | 9.64       | 28.56   | 15.76   | 13.45     | 31.93          |
| AFU     | 4.13  | 10.27      | 22.06   | 13.61   | 18.85     | 31.08          |

Where: MU1 = Mfang Urukikot 1, MU2 = Mfang Urukikot 2, MU3 = Mfang Urukikot 3, AU1 = Adung Urukikot, AU2 = Mfang Adung Urukikot, AOU = Adia Oduoho-oduoho and AFU = Afuo Ubara

126 **Table 2: Phytochemical Analysis of the Samples**

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| TEST         | Ethanol Extracts |      |      |      |      |     |     | Aqueous Extracts |      |      |      |      |     |     |
|--------------|------------------|------|------|------|------|-----|-----|------------------|------|------|------|------|-----|-----|
|              | MU 1             | MU 2 | MU 3 | AU 1 | AU 2 | AOU | AFU | MU 1             | MU 2 | MU 3 | AU 1 | AU 2 | AOU | AFU |
| Tannins      | +                | +    | +    | +    | +    | +   | +   | -                | -    | -    | +    | +    | +   | +   |
| Steroids     | +                | -    | -    | +    | +    | -   | -   | -                | -    | -    | +    | -    | -   | -   |
| Saponins     | +                | -    | +    | -    | -    | +   | -   | -                | -    | -    | -    | -    | +   | +   |
| Glycosides   | -                | +    | -    | -    | +    | -   | -   | +                | +    | -    | +    | -    | -   | -   |
| Phenols      | +                | -    | +    | +    | -    | +   | +   | +                | -    | -    | -    | +    | +   | -   |
| Alkaloids    | +                | +    | -    | +    | +    | +   | +   | -                | -    | +    | +    | -    | -   | +   |
| Cardenolides | -                | -    | +    | -    | -    | +   | -   | -                | +    | -    | -    | -    | -   | +   |
| Terpenoids   | +                | +    | +    | +    | -    | +   | +   | +                | +    | +    | +    | +    | -   | -   |
| Flavonoids   | +                | +    | +    | +    | +    | +   | +   | +                | +    | +    | +    | +    | +   | +   |
| Phlobatanins | -                | -    | +    | -    | -    | -   | +   | -                | -    | +    | -    | +    | -   | -   |
| Resins       | -                | +    | -    | -    | +    | +   | -   | -                | +    | -    | -    | -    | -   | -   |

128 KEY: present= +, absent= -

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130 **Table 3: Percentage of Inhibition at different concentrations (mg/ml) compared with ascorbic acid**

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| Sample        | Concentration (mg/ml) | Ethanol Extract (%) | Aqueous Extract (%) |
|---------------|-----------------------|---------------------|---------------------|
| MU 1          | 0.5                   | 65.78               | 53.76               |
|               | 0.25                  | 65.42               | 47.95               |
|               | 0.125                 | 58.61               | 41.82               |
|               | 0.0625                | 52.57               | 43.42               |
|               | 0.03125               | 37.94               | 36.65               |
| MU 2          | 0.5                   | 27.27               | 49.61               |
|               | 0.25                  | 24.85               | 45.47               |
|               | 0.125                 | 09.81               | 38.88               |
|               | 0.0625                | -                   | 31.75               |
|               | 0.03125               | 23.74               | 25.99               |
| MU 3          | 0.5                   | 33.69               | 47.45               |
|               | 0.25                  | 43.90               | 48.82               |
|               | 0.125                 | 37.53               | 54.76               |
|               | 0.0625                | 25.20               | 62.93               |
|               | 0.03125               | 53.58               | 67.22               |
| AU 1          | 0.5                   | 64.85               | 60.91               |
|               | 0.25                  | 64.46               | 58.74               |
|               | 0.125                 | 59.02               | 55.86               |
|               | 0.0625                | 41.64               | 51.62               |
|               | 0.03125               | 59.15               | 44.73               |
| AU 2          | 0.5                   | 65.25               | 48.01               |
|               | 0.25                  | 47.48               | 57.16               |
|               | 0.125                 | 22.68               | 58.09               |
|               | 0.0625                | 18.44               | 60.61               |
|               | 0.03125               | 40.72               | 72.81               |
| AOU           | 0.5                   | 45.76               | 59.28               |
|               | 0.25                  | 51.86               | 45.89               |
|               | 0.125                 | 56.63               | 26.92               |
|               | 0.0625                | 55.70               | 19.63               |
|               | 0.03125               | 71.22               | 45.09               |
| AFU           | 0.5                   | 46.82               | 50.66               |
|               | 0.25                  | 32.89               | 40.05               |
|               | 0.125                 | 15.65               | 06.95               |
|               | 0.0625                | 05.31               | 21.62               |
|               | 0.03125               | 35.81               | 47.48               |
| Ascorbic acid | 0.5                   | 79.03               |                     |
|               | 0.25                  | 76.82               |                     |
|               | 0.125                 | 79.40               |                     |
|               | 0.0625                | 79.77               |                     |
|               | 0.03125               | 81.24               |                     |

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133 Where: MU1 = Mfang Urukikot 1, MU2 = Mfang Urukikot 2, MU3 = Mfang Urukikot 3, AU1 = Adung  
134 Urukikot,

135 AU2 = Mfang Adung Urukikot, AOU = Adia Oduoho-oduoho and AFU = Afuo Ubara

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138 **Table 4: Zone of inhibitory activity (mm) of different plant extracts against tested**  
139 **microorganisms**

| Plants | Conc.<br>(µg) | Ethanollic Extract |            |            |            |            | Aqueous Extract |            |            |            |            |
|--------|---------------|--------------------|------------|------------|------------|------------|-----------------|------------|------------|------------|------------|
|        |               | <i>S.a</i>         | <i>S.p</i> | <i>K.p</i> | <i>S.t</i> | <i>C.a</i> | <i>S.a</i>      | <i>S.p</i> | <i>K.p</i> | <i>S.t</i> | <i>C.a</i> |
| MU1    | +ve           | 28.3               | 25.3       | 22.7       | 29.0       | 30.5       | 22.7            | 19.0       | 17.0       | 25.3       | 26.0       |
|        | 250           | 15.3               | 13.0       | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 500           | 15.6               | 13.7       | -          | -          | -          | 11.0            | -          | -          | 10.5       | -          |
|        | 750           | 17.5               | 15.0       | -          | 11.5       | -          | 12.7            | 11.3       | -          | 11.0       | -          |
|        | 1000          | 18.7               | 15.3       | -          | 13.0       | -          | 13.7            | 13.7       | -          | 12.0       | -          |
| MU2    | +ve           | 28.7               | 21.7       | 21.3       | 28.3       | 30.3       | 25.3            | 20.0       | 18.7       | 24.3       | 25.7       |
|        | 250           | -                  | 14.5       | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 500           | -                  | 14.7       | -          | 10.0       | -          | 10.5            | -          | -          | -          | -          |
|        | 750           | -                  | 16.7       | -          | 11.3       | 11.0       | 11.3            | -          | -          | -          | -          |
|        | 1000          | -                  | 18.3       | -          | 13.7       | 15.3       | 12.0            | 13.7       | -          | -          | -          |
| MU3    | +ve           | 27.3               | 21.0       | 20.0       | 30.3       | 33.0       | 22.7            | 19.3       | 17.7       | 21.3       | 26.7       |
|        | 250           | 10.5               | -          | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 500           | 11.3               | -          | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 750           | 13.0               | -          | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 1000          | 14.7               | -          | -          | -          | -          | -               | -          | -          | -          | -          |
| AU1    | +ve           | 28.7               | 23.3       | 20.7       | 30.3       | 29.0       | 23.3            | 23.3       | 18.7       | 20.0       | 26.0       |
|        | 250           | -                  | 10.0       | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 500           | 10.0               | 11.0       | -          | -          | -          | 10.0            | -          | -          | -          | -          |
|        | 750           | 13.3               | 11.3       | -          | -          | -          | 11.3            | 11.0       | -          | -          | -          |
|        | 1000          | 18.6               | 14.0       | -          | -          | -          | 12.0            | 15.0       | -          | -          | -          |
| AU2    | +ve           | 27.7               | 22.7       | 22.7       | 28.3       | 30.0       | 22.7            | 18.7       | 19.3       | 25.3       | 25.7       |
|        | 250           | -                  | -          | -          | -          | -          | 10.0            | -          | -          | -          | -          |
|        | 500           | -                  | -          | -          | 10.0       | -          | 11.0            | -          | -          | 10.0       | 10.0       |
|        | 750           | 11.0               | -          | -          | 10.7       | -          | 12.7            | 12.0       | -          | 11.3       | 10.7       |
|        | 1000          | 14.0               | -          | -          | 13.0       | -          | 13.7            | 13.0       | -          | 12.0       | 13.3       |
| AOU    | +ve           | 29.3               | 22.3       | 21.3       | 29.7       | 29.7       | 22.7            | 19.0       | 17.7       | 26.7       | 26.0       |
|        | 250           | 12.0               | -          | -          | 11.0       | -          | 9.5             | -          | -          | -          | -          |
|        | 500           | 11.5               | 12.0       | -          | 14.0       | -          | 10.67           | 10.0       | -          | -          | -          |
|        | 750           | 13.3               | 12.7       | -          | 17.0       | 12.0       | 13.0            | 10.3       | -          | -          | 10.5       |
|        | 1000          | 15.0               | 15.3       | -          | 19.0       | 14.3       | 15.7            | 12.3       | -          | -          | 12.33      |
| AFU    | +ve           | 27.3               | 22.3       | 22.7       | 30.3       | 30.3       | 25.33           | 19.3       | 17.7       | 24.3       | 25.7       |
|        | 250           | -                  | -          | -          | -          | -          | -               | -          | -          | -          | -          |
|        | 500           | -                  | -          | -          | 10.5       | -          | 10.5            | -          | -          | -          | -          |
|        | 750           | 11.0               | -          | -          | 12.7       | -          | 12.0            | 10.5       | -          | 10.0       | -          |
|        | 1000          | 15.3               | -          | -          | 14.0       | -          | 14.7            | 12.3       | -          | 11.0       | -          |

140 *S.a* = *Staphylococcus aureus*; *S.p* = *Streptococcus pyogenes*; *K.p* = *Klebsiellapneumoniae*; *S.t* = *Salmonella*  
141 *typhi*,  
142 *C.a* = *Candida albicans*; Diameter of inhibition zone less than 6mm is represented as “-”.

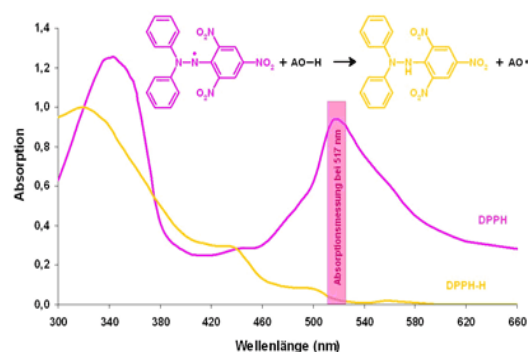
## 144 4. DISCUSSION

145  
146 **4.1 Proximate analysis:** of all the plant extracts revealed that extracts MU1 and MU2 had  
147 the highest overall ash (19.7, 16.05% respectively) and moisture (11.71, 11.04% respectively)  
148 contents (Table 1). The results also showed that the highest percentage content of fiber was  
149 found in extracts AU1 > AU2 > MU3 > AOU > AFU > MU2 > MU1 (44.86% - 8.87%). The  
150 varied distribution of Lipid and Protein amongst all extracts, for which both factors were  
151 highest in extract MU2 (18.16%, 27.71%) could be as a result of their distinctive biochemical  
152 diversities.

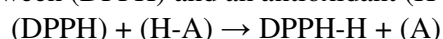
153  
154 **4.2 Phytochemical Screening:** The preliminary qualitative phytochemical screening carried  
155 out showed that these plants contain vital secondary metabolites (Table 2). The bioactive  
156 compounds in medicinal plants have been reported to be the active principles responsible for  
157 the pharmacological potentials of medicinal plants (Edeoga *et al.*, 2005). The presence of  
158 these chemicals in the leaves and root of these plants justifies the local uses of these plants

for the treatment of various ill conditions. Data obtained in this study revealed that flavonoids was present in all the samples while tannins was present in all but three aqueous (MU1, MU2, MU3) samples. This suggests that consumption of any of the studied plant extracts should aid in hepato-modulatory functions particularly in flushing out liver toxins, thwarting microbial growth and propagation, protect against inflammation, tumor and free radicals (Okwu, 2004). Saponins are natural glycosides that act as hypoglycemic, antifungal and serum cholesterol lowering agents in animals (Sapna et al., 2009). Saponins are essential elements in ensuring hormonal balance and synthesis of sex hormones (Okwu, 2003). Tannins are bitter polyphenolic compounds that hasten the healing of wounds. They also possess anti-diuretic and anti-diarrhea properties (Okwu, 2004). Terpenoids was present in all the extracts except ethanolic extract of AU2 and aqueous extracts of AOU and AFU. Terpenoids have been found to be useful in the prevention and therapy of several diseases, including cancer. Terpenoids are also known to possess antimicrobial, antifungal, antiparasitic, antiviral, anti-allergenic, antispasmodic, antihyperglycemic, antiinflammatory and immunomodulatory properties [15-16]. In all, aqueous extracts contained lesser metabolites.

**4.3 Anti-oxidant activity:** DPPH is a stable nitrogen-centered free radical, the color of which changes from violet to yellow upon reduction by either the process of hydrogen donating ability or electron donation. DPPH solution exhibit a deep purple color with an absorption maximum at 517nm.



The scavenging reaction between (DPPH) and an antioxidant (H-A) can be written as:



Purple                      Yellow

Antioxidants react with DPPH and reduce it to DPPH-H and as a result the absorbance is decreased from the DPPH radical to the DPPH-H form. The degree of discoloration indicates the scavenging ( anti-oxidant) potential of the extract.

The DPPH radical scavenging activity of Ascorbic acid in ethanolic solution regardless of concentration is virtually the same with an average of 79% ( ± 2%). Figure 1 illustrates the inhibition trends observed when a range of concentrations ((0.03125, 0.0625, 0.125, 0.25, 0.5mg/ml) of the ethanolic extracts are compared to ascorbic acid.

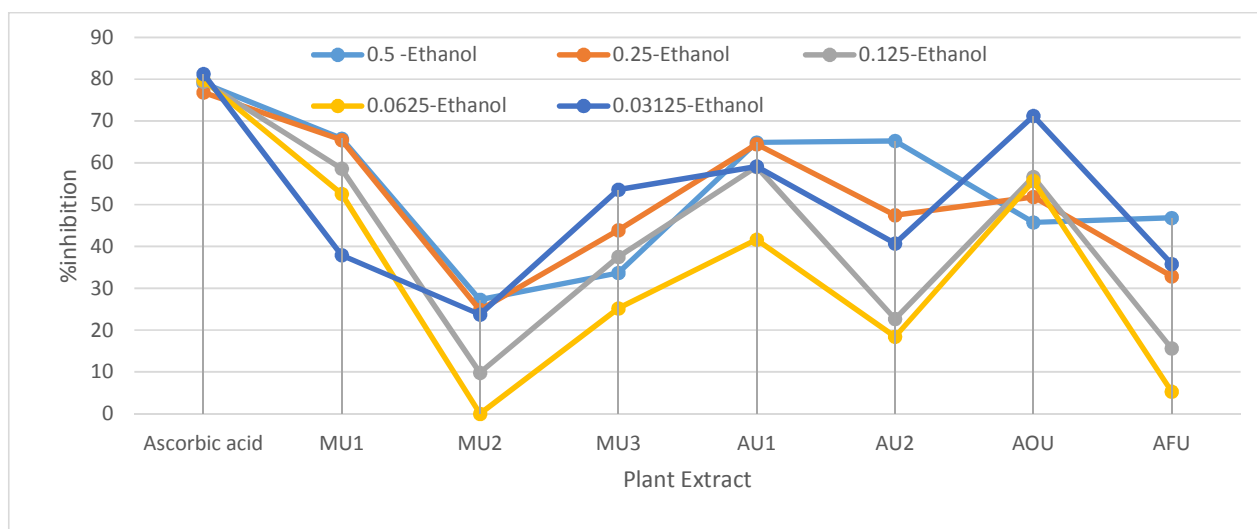


Figure 1: Inhibition trend of various concentrations of plant ethanolic extracts

Three ethanolic extracts (MU1, AU1 and AOU) all exhibited above 35% inhibition (equivalent to over 50% of ascorbic acid performance). Interestingly with respect to MU1, the % inhibition trends lower with increase concentration while with AOU the % inhibition increases with lower concentrations. The rest of the extracts had varying results and did not indicate a trend. With the exception of MU2, they had some concentrations that indicated inhibition above 35%. MU3 and AOU, indicated relatively the highest DPPH scavenging activity at lowest concentrations (0.03125mg/ml) with AOU indicating 71.22mg/ml an equivalence of 87% performance with respect to ascorbic acid. With respect to aqueous extract as indicated in figure 2, four of the plants indicated activity above 35% (MU1, MU3, AU1 and AU2). AU1 had least changes over the concentration ranges.

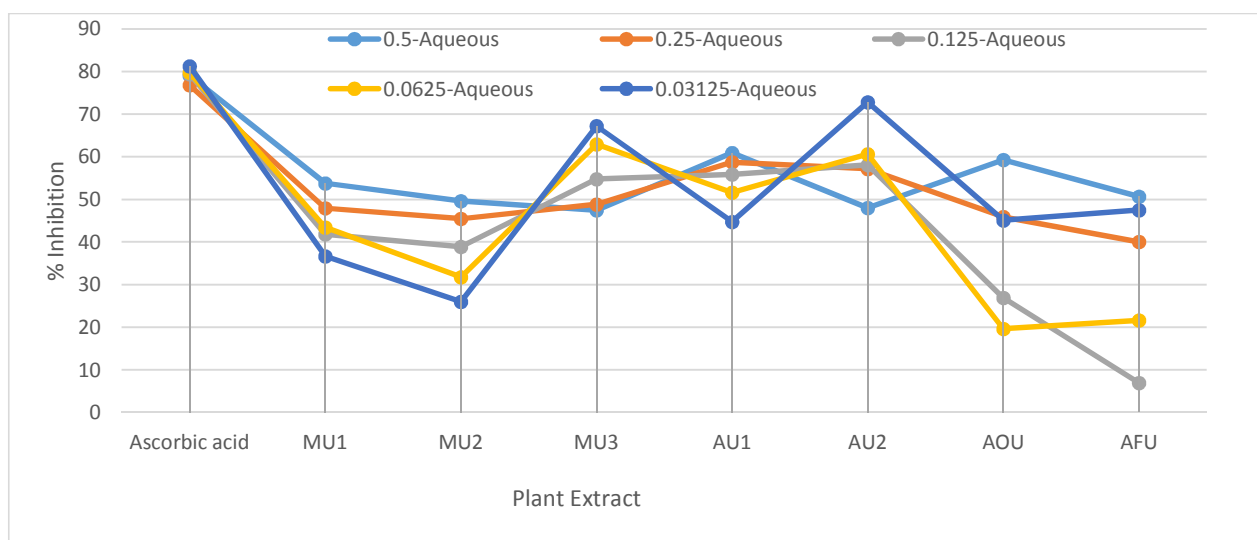


Figure 2: Inhibition trend of various concentrations of plant aqueous extracts

As seen in figure 2, the inhibition is highest for AU2 (72.81mg/ml) at lowest concentration followed by MU3 (67.22mg/ml). With aqueous extract of MU1, MU2, the activity increases with increase in concentration. Comparing both ethanolic and aqueous extracts at the lowest concentrations, Figure 3, in general it was observed that the aqueous extracts had relatively higher % inhibition compared to the ethanol samples. MU3, AU2 and AOU indicated higher inhibition. Interestingly MU1 and MU2 had minimal to no changes regardless of the medium of extraction.

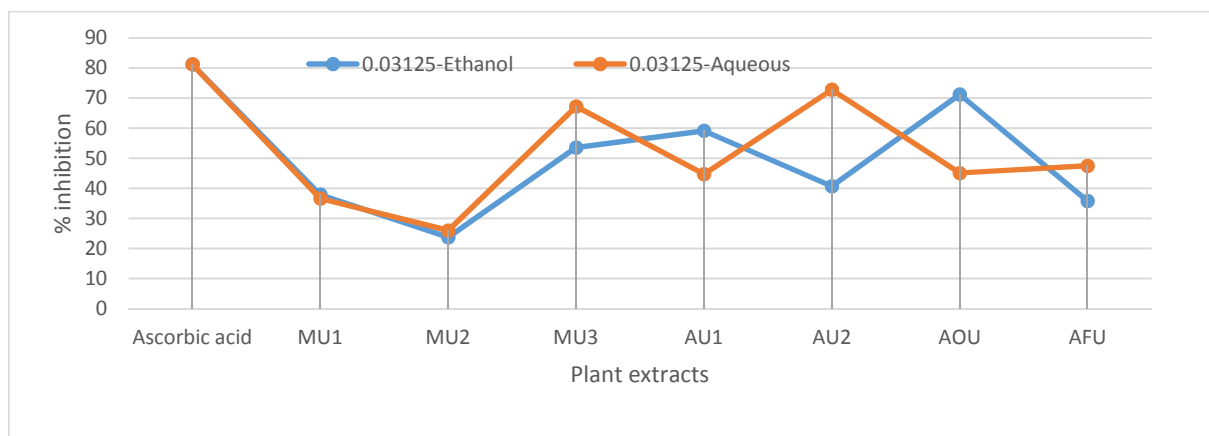


Figure 3: Comparison of inhibition trends at the lowest concentration levels of the extracts. In all, the results showed the activity to be higher in ethanolic extracts of the sample than the aqueous. Nonetheless, the activities compared relatively well with the ascorbic acid used as standard reference. This might be due to the presence of higher flavonoids and tannins, the most required bio-compounds for scavenging activity in these extracts. Flavonoids and tannins which are phenolic compounds found in plants act majorly as free radical scavengers. The results suggest that the antioxidant activities of these plants may contribute to their claimed antimicrobial properties.

**4.4 Anti-microbial activity:** The agar disc diffusion method was used to evaluate the antimicrobial activity by measuring the inhibition zone against the test microorganisms. 100µL of different concentrations of the extracts including the positive control (200µg of chloramphenicol and nystatin for bacteria and fungus respectively and the negative control (50% v/v DMSO) were introduced into the wells and incubated for 24 hrs.

#### 4.4.1 Staphylococcus aureus (S.a)- Inhibition-Gram negative bacteria

The ethanolic extract of MU2 and the aqueous extract of MU3 did not show any inhibition zone above 6mm. However the extracts of all plants in either ethanol or water show some degree of activity with inhibition zone ranging from 9.5mm up to 18.7mm. Interestingly the ethanolic extract of MU1, MU3, AOU and the aqueous extract of AU2, AOU show inhibition at all concentration levels. The others indicated inhibition only at concentrations above 500 µg (Table 5)

| S.a  | Ethanol Extract |      |      |      |      |      |      | Aqueous Extract |      |      |      |      |       |       |
|------|-----------------|------|------|------|------|------|------|-----------------|------|------|------|------|-------|-------|
|      | MU1             | MU2  | MU3  | AU1  | AU2  | AOU  | AFU  | MU1             | MU2  | MU3  | AU1  | AU2  | AOU   | AFU   |
| +ve  | 28.3            | 28.7 | 27.3 | 28.7 | 27.7 | 29.3 | 27.3 | 22.7            | 25.3 | 22.7 | 23.3 | 22.7 | 22.7  | 25.33 |
| 250  | 15.3            | -    | 10.5 | -    | -    | 12   | -    | -               | -    | -    | -    | 10   | 9.5   | -     |
| 500  | 15.6            | -    | 11.3 | 10   | -    | 11.5 | -    | 11              | 10.5 | -    | 10   | 11   | 10.67 | 10.5  |
| 750  | 17.5            | -    | 13   | 13.3 | 11   | 13.3 | 11   | 12.7            | 11.3 | -    | 11.3 | 12.7 | 13    | 12    |
| 1000 | 18.7            | -    | 14.7 | 18.6 | 14   | 15   | 15.3 | 13.7            | 12   | -    | 12   | 13.7 | 15.7  | 14.7  |

**Table 5: *Staphylococcus aureus* inhibition**

#### 4.4.2 *Streptococcus pyogenes* Inhibition-Gram negative bacteria

The ethanolic extract of the following plants MU3, AU2, AFU and the aqueous extract of MU3 did not indicate any activity. Interestingly only ethanolic extracts of MU1, MU2, AU1 show activity at all concentrations. The rest only indicated activity at concentration of 500µg and above.

| S.p  | Ethanol Extract |      |     |      |      |      |      | Aqueous Extract |      |      |      |      |      |      |
|------|-----------------|------|-----|------|------|------|------|-----------------|------|------|------|------|------|------|
|      | MU1             | MU2  | MU3 | AU1  | AU2  | AOU  | AFU  | MU1             | MU2  | MU3  | AU1  | AU2  | AOU  | AFU  |
| +ve  | 25.3            | 21.7 | 21  | 23.3 | 22.7 | 22.3 | 22.3 | 19              | 20   | 19.3 | 23.3 | 18.7 | 19   | 19.3 |
| 250  | 13              | 14.5 | -   | 10   | -    | -    | -    | -               | -    | -    | -    | -    | -    | -    |
| 500  | 13.7            | 14.7 | -   | 11   | -    | 12   | -    | -               | -    | -    | -    | -    | 10   | -    |
| 750  | 15              | 16.7 | -   | 11.3 | -    | 12.7 | -    | 11.3            | -    | -    | 11   | 12   | 10.3 | 10.5 |
| 1000 | 15.3            | 18.3 | -   | 14   | -    | 15.3 | -    | 13.7            | 13.7 | -    | 15   | 13   | 12.3 | 12.3 |

**Table 6: *Streptococcus pyogenes* inhibition**

#### 4.4.3 *Klebsiella pneumoniae* inhibition- Gram negative bacteria

None of the extracts indicated activity against this bacteria at the concentrations evaluated.

**Table 7**

| K.p  | Ethanol Extract |      |     |      |      |      |      | Aqueous Extract |      |      |      |      |      |      |
|------|-----------------|------|-----|------|------|------|------|-----------------|------|------|------|------|------|------|
|      | MU1             | MU2  | MU3 | AU1  | AU2  | AOU  | AFU  | MU1             | MU2  | MU3  | AU1  | AU2  | AOU  | AFU  |
| +ve  | 22.7            | 21.3 | 20  | 20.7 | 22.7 | 21.3 | 22.7 | 17              | 18.7 | 17.7 | 18.7 | 19.3 | 17.7 | 17.7 |
| 250  | -               | -    | -   | -    | -    | -    | -    | -               | -    | -    | -    | -    | -    | -    |
| 500  | -               | -    | -   | -    | -    | -    | -    | -               | -    | -    | -    | -    | -    | -    |
| 750  | -               | -    | -   | -    | -    | -    | -    | -               | -    | -    | -    | -    | -    | -    |
| 1000 | -               | -    | -   | -    | -    | -    | -    | -               | -    | -    | -    | -    | -    | -    |

**Table 7: *Klebsiella pneumoniae* inhibition**

#### 4.4.4 *Salmonella typhi* inhibition- Gram negative bacteria

The ethanolic extract of MU3, AU1 and the aqueous extract of MU2, MU3, AU1 and AOU did not indicate any activity. The other remaining extracts exhibited inhibition at concentrations of 500µg and above except ethanolic AOU that showed activity at all concentration levels. Table 8

| S.t  | Ethanol Extract |      |      |      |      |      |      | Aqueous Extract |      |      |     |      |      |      |
|------|-----------------|------|------|------|------|------|------|-----------------|------|------|-----|------|------|------|
|      | MU1             | MU2  | MU3  | AU1  | AU2  | AOU  | AFU  | MU1             | MU2  | MU3  | AU1 | AU2  | AOU  | AFU  |
| +ve  | 29              | 28.3 | 30.3 | 30.3 | 28.3 | 29.7 | 30.3 | 25.3            | 24.3 | 21.3 | 20  | 25.3 | 26.7 | 24.3 |
| 250  | -               | -    | -    | -    | -    | 11   | -    | -               | -    | -    | -   | -    | -    | -    |
| 500  | -               | 10   | -    | -    | 10   | 14   | 10.5 | 10.5            | -    | -    | -   | 10   | -    | -    |
| 750  | 11.5            | 11.3 | -    | -    | 10.7 | 17   | 12.7 | 11              | -    | -    | -   | 11.3 | -    | 10   |
| 1000 | 13              | 13.7 | -    | -    | 13   | 19   | 14   | 12              | -    | -    | -   | 12   | -    | 11   |

Table 8: *Salmonella typhi* inhibition

#### 4.4.5 Candida albican-Yeast-Fungus

Only of the extracts indicated activity at concentrations above 500µg, ethanolic extractions of MU2, AOU and the aqueous extractions of AU2 and AOU. The rest of the extracts evaluated indicated no activity. Table 9

|      | Ethanol Extract |      |     |     |     |      |      | Aqueous Extract |      |      |     |      |       |      |
|------|-----------------|------|-----|-----|-----|------|------|-----------------|------|------|-----|------|-------|------|
| C.a  | MU1             | MU2  | MU3 | AU1 | AU2 | AOU  | AFU  | MU1             | MU2  | MU3  | AU1 | AU2  | AOU   | AFU  |
| +ve  | 30.5            | 30.3 | 33  | 29  | 30  | 29.7 | 30.3 | 26              | 25.7 | 26.7 | 26  | 25.7 | 26    | 25.7 |
| 250  | -               | -    | -   | -   | -   | -    | -    | -               | -    | -    | -   | -    | -     | -    |
| 500  | -               | -    | -   | -   | -   | -    | -    | -               | -    | -    | -   | 10   | -     | -    |
| 750  | -               | 11   | -   | -   | -   | 12   | -    | -               | -    | -    | -   | 10.7 | 10.5  | -    |
| 1000 | -               | 15.3 | -   | -   | -   | 14.3 | -    | -               | -    | -    | -   | 13.3 | 12.33 | -    |

Table 9: *Candida albican* inhibition

#### Conclusion

**Results** reported here contribute to the **knowledge** of antibacterial and therapeutic activities of 6 Nigerian medicinal plants extracts from organic and aqueous solvent. These plants are mainly used by indigenes for anti-venom purposes. The findings that these medicinal plants possess antioxidant and antimicrobial properties strongly approve their use as herbal medicine.

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