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REGULAR ARTICLE

# ANTIBACTERIAL, PHYTOCHEMICAL AND ANTIOXIDANT PROPERTIES OF *CNESTIS FERRUGINEA* DC (CONNARACEAE) EXTRACTS

*Fred Coolborn Akharaiyi*[*1], Bolatito Boboye*[2], *Adetuyi, F.C*[2]

***Address:*** Mr. Fred Coolborn Akharaiyi*[1], Department of Microbiology, Federal University of Technology, P. M. B. 704, Akure, Ondo State, Nigeria. Phone number: +234 8066982772
[2]Federal University of Technology, Department of Microbiology, P. M. B. 704, Akure, Ondo State, Nigeria.

*Corresponding Author: akharaiyifc@gmail.com

## ABSTRACT

To evaluate the health relevance of decoctions, infusions and concoction of medicinal plants in traditional medicine, antibacterial efficacy of crude aqueous, ethanol and petroleum ether extracts of *Cnestis ferruginea* leaf, stem bark and roots were assayed against nine clinical bacterial isolates namely *Pseudomonas aeruginosa, Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, Bacillus cereus, Shigalla dysenteriae, Campylobacter jejunum*, a $\beta$-hemolytic group A streptococcus*, and Salmonella enterica ser.*Typhi by agar well diffusion method. The leaf extracts had higher inhibitory effects at various degrees than the stem bark and root extracts. Chemical methods were used to determine the quality and quantity of phytochemical components where alkaloids, flavonoids, saponin, tannins, phenol and cardinolides were found present. The antioxidant activities of the extracts of the plant tested were determined by a spectrophotometric method using the stable free radical DPPH (2, 2-diphenyl-1-picrylhydrazyl). Considerable antioxidant activities were found in the plant extracts. *C. ferruginea* contains bioactive principles necessary for bacteria inhibition and therefore, the powder could be used as preservative, beverage and source of novel drug(s).

**Keywords:** Cnestis ferruginea DC (Connaraceae) extract, antibacterial, phytochemical, antioxidant properties, Nigeria

## INTRODUCTION

Medicinal plant is defined as any plant with one or more of its organs containing substance that can be used for therapeutic purpose or which can be used as precursors for the synthesis of antimicrobial drugs **(Bouayed *et al*., 2007)**. Plants are presently the sources of medicines for many people of different age in many country of the world, where diseases are treated primarily with traditional medicines obtained from plants. The modern pharmaceutical industry itself still relies largely on the diversity of secondary metabolites in plants and secondary metabolites of which at least 12,000 have been isolated; a number estimated to be less than 10% of the total **(Mallikharjuna *et al*., 2007)**. In plants, the synthesized aromatic substances (metabolites) are used as defensive weapons against predation by microorganisms, insects and herbivores. However, some of these metabolites are involved in pigmentation (tannins and quinines) and formation of plant odour (terpenoids) and flavour (capsaicin). These defensive molecules give plants their medicinal value which is appreciated by human beings because of their importance in health care of individuals and communities **(Akharaiyi and Boboye, 2010)**. The search for plants with antimicrobial has gained increasing important in recent years due to the development of antimicrobial drug resistance and often the occurrence of undesirable side effect of some antibiotics **(Soberon *et al*., 2007)**. With the recent advent of ever-increasing resistant bacteria, **Soberon *et al.*, (2007)** stated that there has been a corresponding rise in the universal demand for natural antibacterial therapeutics. Although pharmacological industries and researchers have produced a good number of antibiotics in the last three decades, resistance to these drugs by microorganisms is increasingly high. Several plants have therapeutic and pharmaceutical effects, for antimicrobial, antioxidant, anti-infectious and anti-tumour activities **(Akroum *et al*., 2009)**. **Akinyemi *et al.* (2005),** reported that herbal medicine has been widely used as an integral part of primary health care in many countries. Medicinal plants may constitute a reservoir of new antimicrobial substances to be discovered. About 80% of developing countries, citizens used traditional medicine based on plant products. Thus many studies have been conducted on medicinal plants. They are screened for antimicrobial activities, their properties and efficacy. Extraction of bioactive compounds from medicinal plants permits the demonstration of their physiological activities. It also facilitates pharmacology studies **(Manna and Abalaka, 2000)**. Antioxidants are radical scavengers which protect the human body against free radicals that may cause pathological conditions such as ischemia, anaemia, asthma, arthritis, inflammation, neuro-degeneration, Parkinson's diseases, ageing process and perhaps

dementias **(Polterait, 1997)** Flavonoids and flavones are widely distributed secondary metabolites with antioxidant and antiradical properties **(Nakayoma and Yamada, 1995)**. Many human diseases are caused or negatively affected by free radicals. The natural defense of the human organs against free radicals is not always sufficient mainly due to the significant exposition to free radicals from external sources in the modern world **(Buricova and Reblova, 2008)**. *C. ferruginea* root is used as laxative and the stem is rubbed on the skin and as a medicine for the throat while the bark juice is rubbed on the gum against gingivitis and Streptococci infections of the mouth. In this study, we have carried out the preliminary study of antibacterial, phytochemical and antioxidant activities of the leaves, stem-bark and roots of *C. ferruginea.*

## MATERIAL AND METHODS

### Collection of plant and extract preparations

Healthy looking leaf, stem bark and roots of *C. ferruginea,* were collected from forest in Akure, Ondo State, Nigeria and identified in Department of Forestry and Wood Technology, Federal University of Technology, Akure, Nigeria. The plants parts were air dried for 3 weeks at room temperature of $25\pm2^{o}C$ on side bench in the laboratory and then ground to powder with a mechanical grinder. 1.5kg each of the powders obtained was extracted separately with cold water, ethanol, methanol and petroleum ether at room temperature ($25\pm2^{0}C$). The resulting crude extracts were filtered with sterile muslin cloth and concentrated using a rotary evaporator (Resona, England). The final volume obtained from the dried crude extracts were 25g, 30g, 20 and 15g respectively from water, ethanol, methanol and petroleum ether extracts. These were contained in plastic containers and labeled appropriately as aqueous extract (AE), ethanol extract (EE), methanol extract (ME) and petroleum ether extract (PE).

The antibacterial screening of the various extracts was assessed against clinical bacterial strains isolated from human urine, feaces and septic wounds. The bacterial isolates include: *Pseudomonas aeruginosa* (wound), *Escherichia coli* (urine), *S. aureus* (wound), *Klebsiella pneumoniae* (urine), *Bacillus cereus* (wound) *Shigella dysenteriae* (feaces) *Campylobacter jejunum* (feaces), *Enterococcus feacium* (feaces) *S. dysenteriae* (feaces), a β-hemolytic Group A streptococcus (urine) and *Salmonella enterica ser.*Typhi (feaces). These bacteria organisms were studied through cultural, morphological, physiological and

biochemical characteristics and were identified by comparison of results obtained with literature standards according to Bergey's Manual of Determinative Bacteriology (**Holt *et al*., 1994), Claus** (**1992**) and Bergey's Manual of Systematic Bacteriology (**Sneath, 1986**). The cultural characteristics carried out were colour, surface, edge and elevationof the resultant colonies. The physiological tests carried out were Gram staining, catalase, spore staining, coagulase, oxidase and motility, while the biochemical tests performed include carborhydrate utilization of sucrose, maltose, glucose, arabinose, mannitol, lactose, sorbitol and fructose, starch hydrolysis, catalase, nitrate reduction, utilization of citrate, indole production, oxidative fermentation, methyl red and voges proskauar. Also carried out was the ability of the bacterial isolates to grow at temperatures of $5^0$ C, $30^0$ C, $50^0$ C and $60^0$ C., and thier growth in 2%, 5%, 7%, and 10% NaCl. Nutrient agar (Lab M) and nutrient broth (Lab M) were used for the sub culturing of the bacterial isolates. Mueller-Hinton agar (Hi-media) was used for the bacterial sensitivity screening.

**Bio assay of extracts**

The antibacterial screening of the crude extracts were evaluated by agar well diffusion **(Nair and Chando, 2005)**. The crude extracts were reconstituted in 5% V/V aqueous dimethyl sulphoxide (DMSO) at concentration of 20mg.mL$^{-1}$ The inoculations of the test bacterial isolates were prepared from 24h broth culture. The absorbance was read at 530nm and adjusted with sterile distilled water to match that of 0.5M Mc Farland standard solution. From the prepared bacterial suspension, other dilutions were prepared to give a final concentration of $10^6$ cfu.mL$^{-1}$. One milliliter each of the bacterial suspension was obtained with sterile syringe and needle and spread plated with Mueller-Hinton agar. The plates were allowed to stand for 1.5 h for the test bacterial isolates to be fully embedded and properly established in the seeded medium. With a sterile cork borer (Gallenkamp), well of equal depth ($\Delta$ = 5mm diameter) were dug with a previously sterilized No 4 cork borer. Each well was aseptically filled up with the respective extracts avoiding splashes and overfilling. The plates were incubated at $37^0$C for 24 – 48 h. The sensitivity of the test organisms to each of the extracts was indicated by clear halo around the well. The halos diameter as an index of the degree of sensitivity, were measured with a transparent plastic ruler. Sterile 5% aqueous DMSO was used as negative control while methecilin and streptomycin (10mg.mL$^{-1}$) were used as the positive control.

The minimal inhibition concentrations (MIC) of the plant extract was determined where 1mL of the each extracts was mixed with 9mL of Mueller-Hinton broth and subsequently transferred to the seventh test tube. One milliliter of 24 h culture of the test bacterial organisms (1.0 x $10^6$ cfu.$mL^{-1}$) was inoculated into each test tube of the different concentrations and mixed thoroughly. The test tubes were then incubated at $37^0$ C for 24 h. The tube containing the lowest dilution of the extract with no detectable bacterial growth was considered as the point of (MIC).

One milliliter each of the MIC positive tube was pour plated with freshly prepared nutrient agar to evaluate the minimal bactericidal concentration (MBC) of the extracts. The plates were incubated for possible growth at $37^0$ C for 96h. Plates inoculated from MIC positive tubes without growth were considered as bactericidal concentrations and those with growth as bacteriostatic concentrations of the extracts. All experiments were carried out in triplicates.

## PHYTOCHEMICAL SCREENING OF THE PLANT EXTRACTS

### Qualitative Phytochemical Determination

#### *Alkaloids test*

Five grams each of the plant extracts were stirred with 5 mL of 1% aqueous hydrochloric acid on a steam bath. One milliliter of the filtrate was treated with few drops of Draggendoff's reagent. Blue-black turbidity serves as preliminary evidence of alkaloids.

#### *Saponins test*

Five grams each of the extracts was shaken with distilled water in a test tube. Frothing which persists on warning was taken as preliminary evidence of the presence of saponins.

#### *Tannins test*

Five grams each of the extracts was stirred with 100 mL distilled water and filtered. Ferric chloride reagent was added to the filtrate. A blue-black or blue green precipitate determines the presence of Tannins **(Trease and Evans, 1989)**.

***Phlobotannins test***

Disposition of red precipitate when an aqueous extract of the test samples was boiled with 1% hydrochloric acid determines the presence of phlobotannins **(Trease and Evans, 1998)**.

***Flavonoids test***

Five milliliters of diluted ammonia solution was added to aqueous filtrate of the test samples followed by the addition of concentrated $H_2SO_4$. A yellow coloration observation determines the presence of flavonoids.

***Cardiac glycosides (keller-killiani test)***

Five grams of each of the extracts was dissolved in 2 mL glacial acetic acid containing a drop of ferric chloride solution. This was underplayed with 1mL concentrated $H_2SO_4$. A brown ring of the interface indicates a deoxy-sugar characteristic of cardenolides. A violet ring may appear below the brown ring, while in the acetic acid layer, a green ring may form just gradually spread throughout this layer **(Trease and Evans, 1989)**.

***Anthraquinones test***

A total of 0.5 g of the extract was shaken with 100 mL of benzene and filtered. Five milliliter of 10% ammonia solution was added to the filtrate. The mixtures were shaken and the presence of pink, red or violet colour in the lower phase of the ammonia indicates the presence of free anthraquinones.

***Terpenoids (Salkowski test)***

Five milliliters of each extract was mixed in 2 mL of chloroform, and concentrated $H_2SO_4$ (3 mL) was carefully added to form a layer. A reddish brown colouration of the inter face was formed to show positive results for the presence of terpenoids.

**Quantitative Phytochemical Determination**

Saponin was determined based on the criteria of **(Obadoni and Ochuko, 2000)**, Flavonoids by the method of **(Boham and Kocipai-Abyazam, 1974)**, Tannins by the method of **(Van-Burden and Robinson, 1981)**, Alkaloids by the method of (Harbone and Williams, 2000) and Phenol by the method of **(Lamien-Meda *et al.*, 2008)**.

**Antioxidants screening**

***Ferric Reducing Antioxidant Property***

The method of **(Buricova and Reblova, 2008)** was adopted but with little modifications. 0.1g each aqueous, methanol, ethanol and petroleum ether extract of each (0.1g) were dissolved in 20 mL of water and filtered. The filtrate (2.5 mL) was taken and 2.5 mL of phosphate buffer (pH 6.6) and 2.5 mL of potassium ferrocyanide were added. The mixture was incubated at a temperature $50^0$ C. Trichloroacetic acid (10%) was added, followed by addition of 5 mL of distilled water and 1 mL of 0.1% ferric chloride. All determinations were carried out in duplicate. The absorbance of the standard and the samples were read at 700nm against reagent blank.

**Free Radical Scavenging**

The method used was almost the same as used by **(Ibanez *et al.*, 2003; Dorman *et al.*, 2004)** but was modified in details. An aliquot of 0.5 mL of 0.1 mm 1, 1- diphenyl 1-2 picrylhdrazyl (DPPH) radical (Sigma Aldrich, St. Louis, USA) in the concentration of $0.05mg.mL^{-1}$. Aqueous, methanol, ethanol and petroleum ether extract each at a concentrations of $20mg.mL^{-1}$ were placed in cuvettes. The reaction mixture was mixed at room temperature and kept for 20 minutes. The absorbance was read at 520mm with a spectrophotometer. The absorbance of the DPPH radical solution containing the plant extract was expressed as mg of L-ascorbic (sigma Chemical Co, St. Louis, USA) per 1 g of dry plant material. Calibration was used in such cases, where the plant extracts were replaced with a freshly prepared solution of ascorbic acid in deionized water (concentration from 0 to 1.6 $mg.mL^{-1}$ – $100mg.mL^{-1}$). All determinations were replicated.

## RESULTS

### Bio assay

The leaf and stem bark aqueous extract of *C. ferruginea* inhibited the tested bacteria isolates with the stem bark having the highest inhibitory potency than the leaf and root extracts. Meanwhile, *S. aureus* with stem bark crude ethanol extract was inhibited with a zone of 38mm, *K. pneumoniae* (37mm), *S. dysenteriae* (36mm), a *β*-hemolytic groupn A streptococcus (35mm) and *E. coli* (34mm). Results are shown in the figure 2. Subsequently, the leaf ethanol extract follows with 30mm each inhibition on *E. coli*, *S. aureus*. *S. dysenteriae* and a *β*- hemolytic Group A streptococcus. The leaf aqueous most inhibited *S. dysenteriae*, a *β–hemolytic* Group A streptococcus, *S. aureus* and *K. pneumoniae* with zones of 30mm each. The leaf ethanol exhibited zones of between 28-30mm on *S. dysenteriae*, *E. coli*, a *β-hemolytic Group A streptococcus*, *S. aureus, S. enterica ser.* Typhi and *K. pneumoniae*, while *P.aeruginosa*, *Bacillus cereus*, *E. feacium* were inhibited with lower zones of between 14-15mm. Results are shown in the figure 1. *S. aureus, E. coli, K. Pneumoniae, a β-hemolytic* Group A streptotoccus and *S. dysenteriae* were the organisms mostly inhibited by the aqueous and ethanol extracts with inhibitory zones greater than 20mm. Results are shown in the figures 1 and 2, while *S. enterica ser.* Typhi and *E. feacium* were the least susceptible among the tested bacteria isolates. Results are shown in the Figures 1-3. The ethanol extracts of the plant had more inhibitory potency on the isolates that were susceptible to the plant extracts. Results are shown in the figures 1 and 2.

The root methanol extract of the plant was of better inhibition than other solvents though the highest inhibitory zone showed was not more than 12.7mm on *P. aeruginosa*. The root ethanol extract was next in inhibition on the test organisms and showed highest inhibition of 11mm on *K. pneumoniae*. The root methanol extract was only active on five of the test organisms which include *P. aeruginosa*, *E. coli*, *B. cereus*, *S. aureus* and *K. pneumoniae*. The root aqueous extract of the plant showed very little antibacterial activity (1.2mm) only on *β*-hemolytic Group A streptococcus and the root ethanol extract was active on six organisms namely, a *β*-hemolytic Group A streptococcus, *E. coli*, *S. aureus*, *K. pneumoniae C. jejunum* and *E. feacium*. Results are shown in the Figure 3. On general note, the root extracts were not able to show substantive inhibitions on the test organisms irrespective of the extract solvents employed. The inhibitory values of the crude extracts of *C. ferruginea* were to some extent

comparable to the zone displayed by the control drugs (streptomycin and methecilin). Results are shown in the figures 1 and 2.

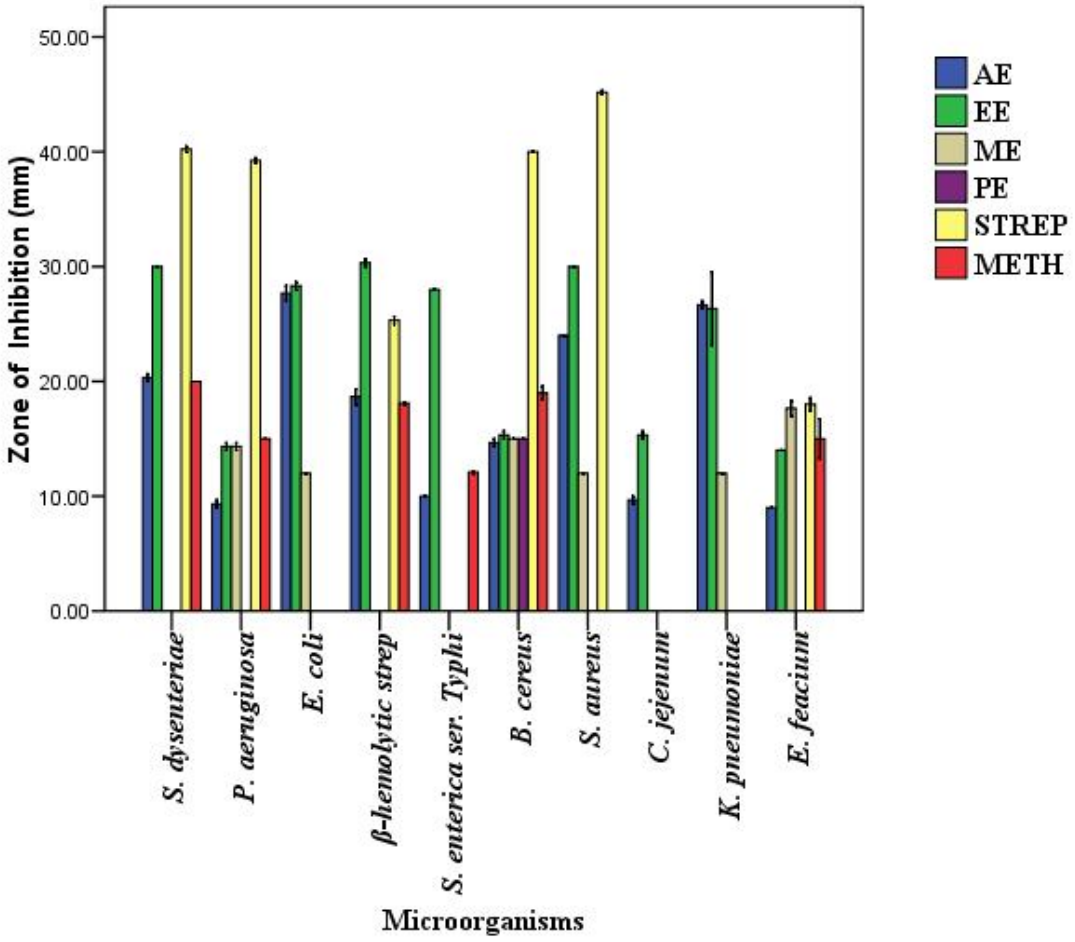


**Figure 1** Mean inhibitory halo (mm) as expressed by leaf extracts of *Cnestis ferruginea*

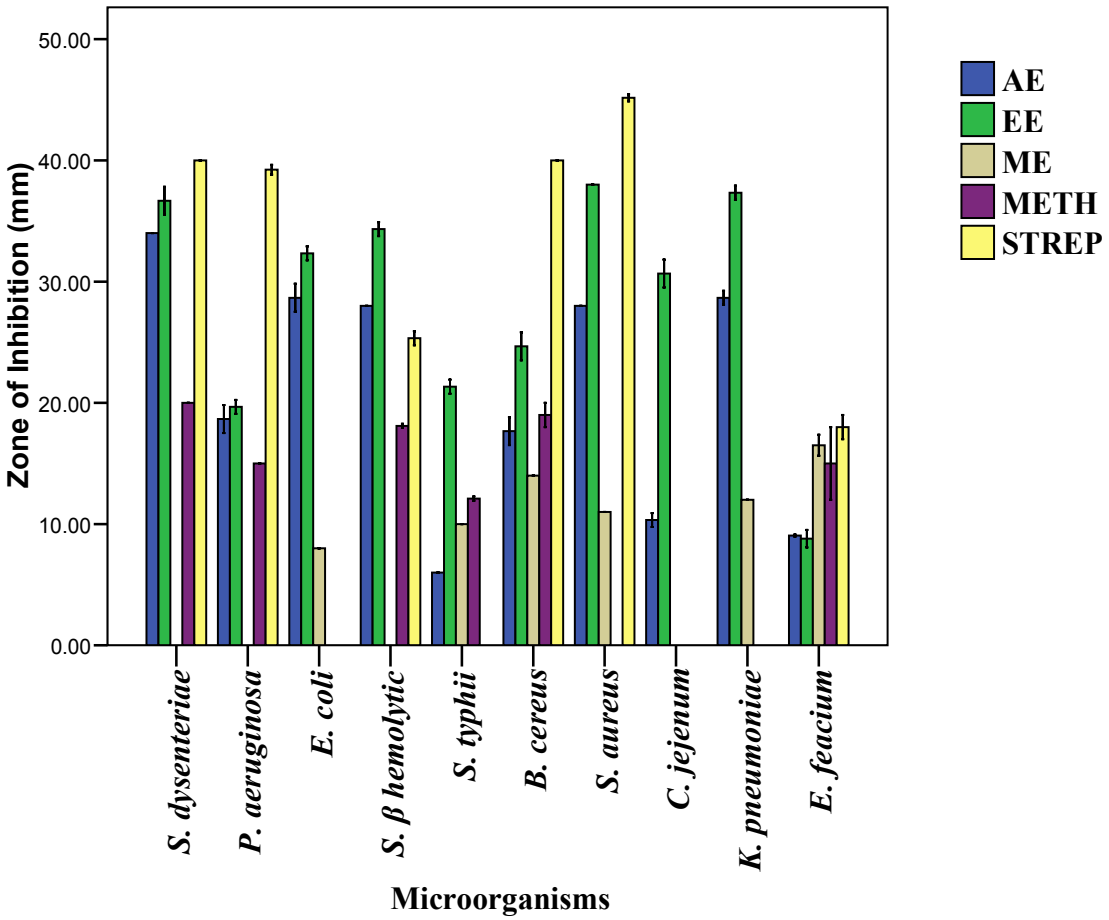


**Figure 2** Mean inhibitory halo (mm) as expressed by stem bark extracts of *Cnestis ferruginea*

Though they were higher in inhibition than the crude extracts of the plant studied, *E. coli, K. pneumoniae*, *C. jejunum* and *S. enterica ser.*Typhi found resistant to the control drugs were susceptible to the crude extracts. The Gram negative isolates (*P. aeruginosa, E. coli, K. pneumoniae, C. Jejunum* and *S. enterica ser.*Typhi) considered in this study were less susceptible to the plant parts extracts than the Gram positive bacteria isolate (*β*-hemolytic Group A streptococcus*, S. aureus,* and *B. Cereus*). Results are shown in the figures 1- 3.

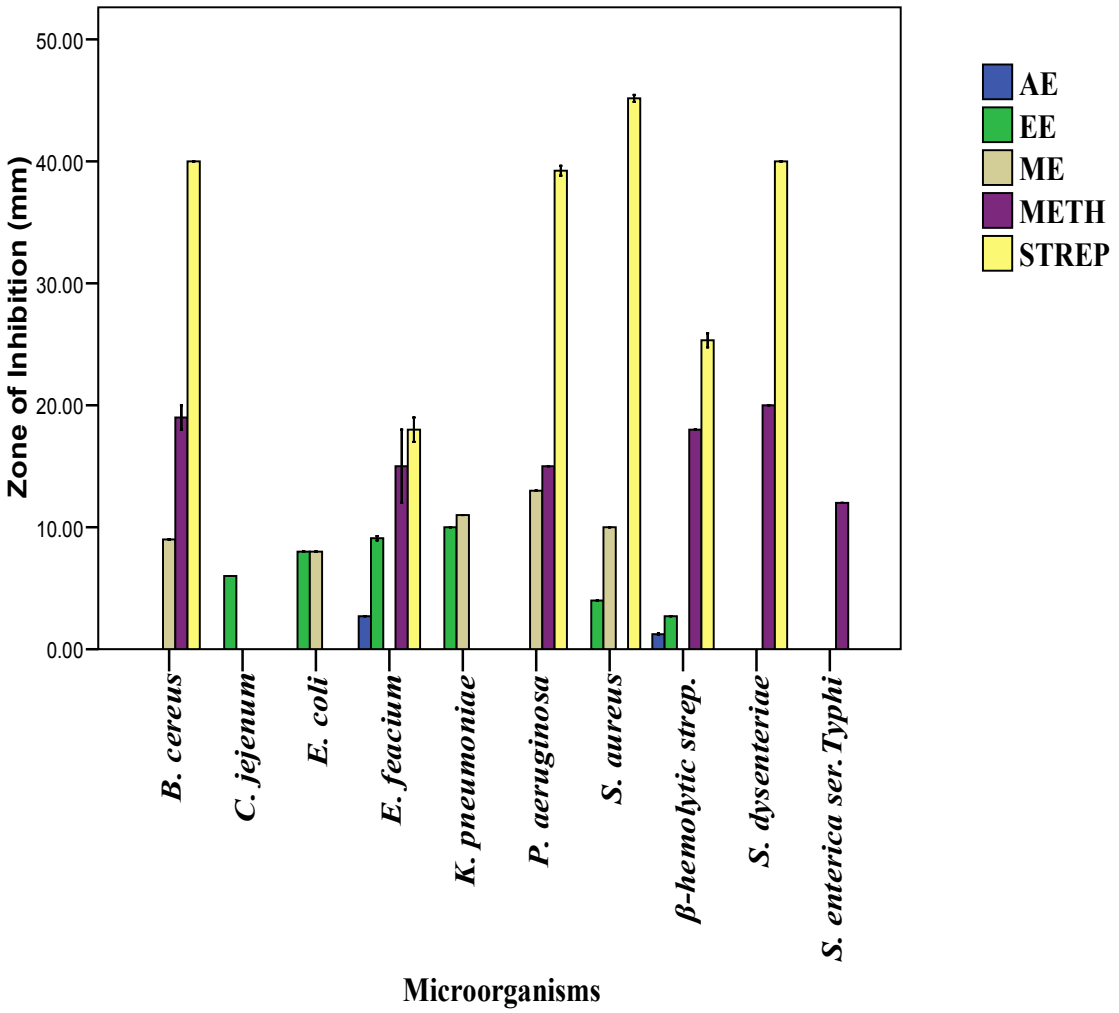


**Figure 3** Mean inhibitory halo (mm) as expressed by root extracts of *Cnestis ferruginea*

The ethanol extract of the plant leaf demonstrated more inhibitory potency on the isolates with *P. aeruginosa, K. pneumoniae* and *B. cereus* inhibited with zones above 30mm. The ethanol leaf extract least inhibited *C. jejunum* (19 mm) and the stem bark extract least inhibited *B. cereus* with zone of 25mm. However, six of the tested bacteria species were inhibited above 20 mm with leaf ethanol extract while the stem bark inhibited only seven of the tested bacteria above 20mm. Therefore, this study offers a scientific basis for the use of the plants extracts for the treatment of infections that could be caused by the strains of the tested bacteria organisms. Various concentrations of the studied plant ascertained ethanol extract at 20mg.mL$^{-1}$ and aqueous extract at 50-250mg.mL$^{-1}$ as MIC affinity. Results are shown in the table 1. The 25-150mg.mL$^{-1}$ was recorded as the MBC affinity for ethanol extract and between 100-300mg.mL$^{-1}$ for aqueous extract on the test organisms. Results are shown in the table 2.

**Table 1** Minimum Inhibitory Concentrations (MIC)(mg.mL$^{-1}$) of the crude extracts of *Cnestis ferruginea*

| Bacteria Organisms | LEAF | | | |
|---|---|---|---|---|
| | AE | EE | ME | PE |
| *S. dysenteriae* | 50 | 20 | - | - |
| *P. aeruginosa* | 150 | 20 | 350 | - |
| *E. coli* | 100 | 20 | 250 | - |
| *β*-hemolytic Group A streptococcus | 50 | 20 | - | - |
| *S. enterica ser.*Typhi | 250 | 20 | - | - |
| *B. cereus* | 100 | 20 | 200 | - |
| *S. aureus* | 50 | 20 | 250 | - |
| *C. jejunum* | 250 | 20 | - | - |
| *K. pneumoniae* | 150 | 20 | 350 | - |
| *E. faecium* | 150 | 20 | 350 | - |

Legend: AE = aqueous extract, EE= ethanol extract, ME= methanol extract, PE= petroleun extract.

**Table 2** Minimum Bactericidal Concentrations (MBC)(mg.mL$^{-1}$) of the crude extracts of *Cnestis ferruginea*

| Bacteria Organisms | LEAF | | | |
|---|---|---|---|---|
| | AE | EE | ME | PE |
| *S. dysenteriae* | 50 | 50 | - | - |
| *P. aeruginosa* | 150 | 50 | 400 | - |
| *E. coli* | 250 | 150 | 400 | - |
| *β*-hemolytic Group A streptococcus | 50 | 25 | - | - |
| *S. enterica ser.*Typhi | 250 | 50 | - | - |
| *B. cereus* | 200 | 100 | 350 | - |
| *S. aureus* | 100 | 25 | 350 | - |
| *C. jejunum* | 300 | 100 | - | - |
| *K. pneumoniae* | 200 | 150 | 400 | - |
| *E. faecium* | 300 | 150 | 400 | - |

Legend: AE = aqueous extract, EE = ethanol extract ME = methanol extract, PE = petroleum extract.

**Table 3** Qualitative phytochemical screening

| **Phytochemicals** | Leaf | Stem bark | Root |
|---|---|---|---|
| Alkaloids | + | + | + |
| Flavonoids | + | + | + |
| Saponin | + | + | + |
| Tannins | + | + | + |
| Phlobatannins | - | - | + |
| Anthraquinons | - | - | + |
| Cardinolides | + | + | + |
| Terpenoids | - | - | - |

Legend: + = positive; - = negative

The MIC results illustrated the least concentration for therapeutic activity while the MBC results established possibly the concentrations at which the leaves crude extracts of the studied plant is bactericidal and bacteristatic on the test bacterial isolates.

**Phytochemical screening**

The phytochemical compounds present in the plant extracts include alkaloids, flavonoids, saponin, phenol and cardenolides. These were present in the plant's leaf, stem bark and root. Others include tannins and phlobatannins. These could affect the differences in the antibacterial effects of *C. ferruginea* hence phytochemical differences in both qualities and quantities were observed as shown in the tables 3 and 4. The total phenol content in leaf, stem bark and root extracts yields were 1.38, 3.23 and 0.83 respectively. Results are shown in the table 4. The phenol content of *C. ferruginea* was more in the stem bark with 3.23mg.mL$^{-1}$ than the leaf which has 1.38mg.mL$^{-1}$ and root 0.83mg.mL$^{-1}$. The flavonoids content of the plant extract resulted at 0.014mg.mL$^{-1}$, 0.058mg.mL$^{-1}$ and 0.052mg.mL$^{-1}$ quecertin equivalent(QE) respectively for leaf stem bark and root. Results are shown in the table. 4

**Table 4** Quantitative phytochemical screening

| **Phytochemicals** | Leaf | Stem bark | Root |
|---|---|---|---|
| Alkaloids (%) | 5.140 | 0 | 4.320 |
| Saponin ($mg.mL^{-1}$) | 0.033 | 0.092 | 0.042 |
| Tannins ($mg.mL^{-1}$) | 0.025 | 1.175 | 0 |
| Total phenol ($mg.mL^{-1}$) TEA | 1.38 | 3.23 | 0.83 |
| Flavonoids ($mg.mL^{-1}$) | 0.033 | 0.092 | 0.042 |

**Antioxidant properties**

The antioxidant properties determined showed that aqueous extract was less efficient in the extraction of the substances with antioxidant than other employed solvents. The reducing

power of aqueous, methanol, ethanol and petroleum ether extract is summarized in Table 5. From this table, the reducing power increased with methanol extract having a value of 271%, ethanol (187%), pet. ether (123%) and aqueous extract with the least value of 64%. Oxidation process in living organisms result in the production of free radicals and uncontrolled production of free radicals may result in the unset of many diseases and accelerate aging. From the result obtained free radical scavenging ability of ethanol, methanol, petroleum ether and aqueous extract yields of the plant was 6.84%, 8.00% and 5.74% and 3.5% respectively. It was observed that the methanol extract of the plant had the highest percentage of free radical scavenging ability than the other employed organic solvents. Results are shown in the table 5

**Table 5** Antioxidant Properties

| **Phytochemicals** | Ethanol | Methanol | Water | Pet. ether |
|---|---|---|---|---|
| Free Reducing Antioxidant Property (%) | 185 | 271 | 64 | 123 |
| Free Radical Scavenging (DPPH) (%) | 6.84 | 8.00 | 3.50 | 5.74 |

## DISCUSSION

The Gram negative isolates (*P. aeruginosa, E. coli, K. Pneumoniae, C. jejunum* and *S. enterica ser.* Typhi) considered in this study were less susceptible to the plant parts extract than the Gram positive bacteria isolates (*β*-hemolytic Group A streptococcus, *S. aureus, S. dysenteriae* and *B. cereus*, similar results were reported by **(Akroum *et al*., 2009; Adomi, 2008)**. The less susceptibility of the Gram negative isolates to the plant extracts have not proved the bacteria species resistant but may necessitate higher concentrations than used in this study for more therapeutic activity. *P. aeruginosa* and *B. cereus* is natural flora of the skin and also are etiologic agents of several skin and mucous membranes infections of man **(Esimone *et al*., 2008)**. *S. aureus* and *E. coli* are the common cause of urinary tract infections and travelers' diarrhea **(Jawetz *et al*., 1991; Okigbo and Omodamiro, 2006)**. The potential for developing antibacterial from higher and lower plants appear rewarding as it will lead to the development of a phytomedicine to act against microbes of harmful effects on man and animals. Plant based antimicrobials have enormous therapeutic potentials as they could serve the purpose with lesser side effects that are often associated with synthetic antimicrobials **(Iwu *et al*., 1999)**. Majority of the phytochemical compounds identified in the aqueous extract have been reported to be highly of therapeutic importance (**Buricova and Reblova, 2008; De and James, 2002; Mallikharjuna *et al*., 2007)**. The qualitative antioxidant, the scavenging activities and the total phenol obtained in the plant extracts may be related to the presence of phenolic compounds such as flavonoides, tannins, coumarin, xanthones, procyanidins, benzoic and hydroxycinnamic acids because these compounds contain an aromatic hydroxyl moiety **(Wink, 1999)**. In the result obtained, extract with high radical scavenging and antioxidant activities showed the highest phenol content in which an important relation was found among the parameters. Methanol extract in the antioxidant activities, had more polar components and this contributed towards the scavenging and antioxidant activities and total phenol content. The antioxidant activities showed by methanol extract may be a relation to the presence of polyphenol compounds. Plants which are high in antioxidant value have been used in some countries for different purpose as remedies such as food additives. The production and accumulation of a wide range of organic chemicals is one of the major mechanisms by which plant defend themselves against herbivores and attack by microbial pathogens and invertebrates. Most of these chemicals are products of secondary metabolism, originally thought to be waste products not necessary in plants for primary metabolic functions. It is however realized that their presence in plant parts (leaves, stem bark and root)

prevent feeding by insects and vertebrates as well as attacks by viruses, bacteria and fungi **(Ruiz-Teran *et al*., 2008)**. Some secondary metabolites are known to exhibit both of these functions. Anthocyanins and monoterpenes act as insect attractant in flowers, but may be insecticidal and antimicrobial when present in leaves **(Ruiz-Teran *et al*., 2008)**.

## CONCLUSION

From the results obtained, *C. ferruginea* leaf, stem-bark and root possessed valuable antibacterial potency, adequate quality and quantity phytochemical known for effective antimicrobial therapy and source of antioxidants for health sustainability. However it is optimistic to establish the facts of the intake of *C. ferruginea* in interruption to upset diseases and age acceleration. Its extract therefore, could be used to increase the nutritional values of different foods, diet and potential for health remedy.

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