Original Research Article

In vitro evaluation of antibacterial activity of infused Cola nitida seeds

Jackie K. Obey¹ and T.Anthoney Swamy²*

¹Department of Medical Laboratory Sciences, School of Health Sciences, University of Eastern Africa, Baraton, P. O. Box 2500, Eldoret – 30100, Kenya
²Department of Chemistry, School of Science and Technology, University of Eastern Africa, Baraton, P.O. Box 2500, Eldoret, Kenya
*Corresponding author

ABSTRACT

The aim of the current work is to investigate the antibacterial activity of infused Cola nitida seeds. Antibacterial screening was done using agar well diffusion method against Bacillus cereus, Serratia marcescens, Staphylococcus epidermidis, Proteus vulgaris and Salmonella typhi. The extract inhibited the growth of Bacillus cereus with a zone of inhibition of 14.33±0.882, Serratia marcescens 26.67±1.202 and Staphylococcus epidermidis 12.33±0.577. The penicillin control showed large zones of inhibition and DMSO did not show any zones of inhibition. Analysis of variance (ANOVA) performed on the data showed that there were significant differences in the zone of inhibition formed by the extract and antibiotic control (p<0.0001). A Tukey’s multiple comparison tests also revealed several differences in the zones of inhibition of the extract between organisms and between all the organisms and their controls. Few pairwise comparisons showed that the zones did not differ significantly between organisms. The present study has proved that it is possible to control the growth of some pathogenic microorganisms using the infused extract of Cola nitida. The infused extracts from the plant can therefore be considered by pharmaceutical industries in production of cheap, affordable and available drugs for the cure of infections caused by these organisms in situations where expensive conventional drugs are unavailable.

Keywords

Cola nitida, Antibacterial activity, Kola, Medicinal plants, Infused

Introduction

This study is the continuation of our previous published work on Cola nitida (Obey and Anthoney, 2014). Kola nut is a native stimulant which commonly chewed in many West African cultures. It is often used ceremonially and to honour guest.

Kola nuts were widely used in Central Africa and West Africa long before the arrival of European voyagers (Russell, 1955). Leo Africanus referred to a bitter nut with the name ‘goro’ which he encountered during a visit to western Sudan in 1556. This is the name that is used to refer to kola in Nigeria. However, the first definite description of kola nuts was made by
Edouado Lopez who saw seeds with four cotyledons in 1593 (Chevalier et al., 1911).

*Cola nitida* was originally distributed along the west coast of Africa from Sierra Leone to the Republic of Benin with the highest frequency and variability occurring in the forest areas of Côte d’Ivoire and Ghana (Opeke, 1992). Chevalier and Perrott (1911) and Warburg (1902) both quoted in (Opeke, 1992) stated that cultivation of *C. nitida* was carried eastwards through Nigeria towards Cameroon and the Congo around 1900, and spread westwards as far as Senegal (Opeke, 1992). *C. nitida* is planted through Senegal, Guinea, Liberia, Côte d’Ivoire, and Ghana towards the western part of Nigeria (Voelcker, 1935).

*Cola* species occur in the hot tropical lowland forest with rainfall extending over a period of eight months or more and a temperature of between 23 and 28°C (Ekanade, 1989). Also, it has been cultivated in the transitional zones where the forest gives way to the savanna (Opeke, 1992). It is mainly grown between 6 and 7° north of the equator, but has also been found up to 10° N on the West Coast of Africa. This species requires a hot, humid climate with well-marked wet and dry seasons, and it is capable of withstanding three or more months of dry season (Keay et al., 1960).

The nuts of a small number of *Cola* species, including *Cola nitida* and *Cola acuminata*, are good to eat though most species produce seed that is hard and inedible. Some *Cola* species are polycotyledonous. The seed of the edible species is ovoid or ellipsoid, or angular by compression, varying in size up to 3 cm in wide and 5 cm long. Most of the seed consists of cotyledons to which the minute embryo is attached. In *C. nitida* there are two cotyledons and the seeds readily split into half whilst in *C. acuminata*, where there are three or four cotyledons, sometimes as many as six, the seed splits into a corresponding number of pieces (Irvine, 1956; Keay, 1958 and Russell, 1955).

According to Adiaratou (2008), infused *Cola nitida* has been used to treat Amenorrhoea. Amenorrhoea is a physiological process that can occur in childhood, during pregnancy, during lactation and after the menopause. *Cola nitida* has been used in folk medicine as an aphrodisiac and an appetite suppressant. It is also used to treat morning sickness, migraine headache and indigestion (Esimone et al., 2007). It has been applied directly to the skin to cure wounds and inflammation (Newall et al., 1996). And also being used to clean the teeth and gums (Esimone et al., 2007).

The systematics of kola species was in a state of “indescribable confusion” by the beginning of the Twentieth Century as a result of profusion of new species, named on the basis of very meagre evidence (Russel, 1955). It was not until the French botanists Chevalier and Perrot’s (1911) taxonomic account that clarity was restored. Chevalier created the subgenus Eucoma to contain the five species of edible kola nut: *C. nitida*, *C. ballayi*, *C. verticillata* and *C. sphaerocarpa*. But the latter three species are not known to be cultivated, but their seeds are sometimes used to adulterate the produce of the commercial species when it is scarce.

*Cola nitida* has been used to control vomiting in pregnant women, and also it is used as a principal stimulant to keep awake and withstand fatigue by students, drivers and other menial workers (Haustein, 1971; Chukwu et al., 2006). *Cola nitida* contain both caffeine and tannin, therefore, it is not advised for individuals with stomach ulcers (Ibu et al., 1986, Newall et al., 1996).
Plant-derived substances have recently become of great interest due to their versatile applications. Medicinal plants are the richest resource of drugs of traditional systems of medicine, modern medicines, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Ncube et al., 2008).

For a long period of time, plants have been used as a valuable source of natural products for maintaining human health. The use of medicinal plant for pharmaceutical purposes has gradually increased in Brazil. According to WHO (Santos, 1995), medicinal plants would be the best source to obtain a variety of drugs. These days about 80% of people from developed countries use traditional natural medicine. Therefore, medicinal plants should be investigated for better understanding of their medicinal properties, safety and efficiency (Ellof, 1998).

In the past few years, a number of studies have been conducted in different countries to prove antimicrobial properties of natural medicinal plants (Almagboul, 1985; Artizzu, 1995; Ikram, 1984; Izzo, 1995; Kubo, 1993; Shapoval, 1994 and Sousa, 1991). Many natural plants have been used because of their antimicrobial traits, which are due to compounds synthesized in the secondary metabolism of the plant. These products are known by their active substances, for example, the phenolic compounds which are part of the essential oils (Jansen, 1987), as well as in tannin (Saxena, 1994). The antimicrobial properties of many plants have been investigated by a number of researchers worldwide.

Natural products and mainly plants (greater than 80%) are the basis of traditional Chinese medicine. Approximately 5,000 plant species used in traditional Chinese medicine are believed to have therapeutic qualities. About 500 plants are commonly prescribed by doctors of Chinese medicine as Chinese Materia Medica, or traditional drugs, and these can be available in raw and processed or concentrated form. Hundreds of years of practical application and experience have gone into classifying the therapeutic use of ‘herbs’ and their associated properties. Chinese medicine has over 2,000 years of written history (Lee et al., 2005).

Medical practice has taught us to understand that ethnomedicinal data is an important source of new drugs. About 140 new drugs have originated directly or indirectly from Chinese medicinal plants by means of modern scientific methods, confirming that these plants are an important resource. Increasing emphasis on the use of medicinal plants in searching for new drugs is undoubtedly a correct strategy (Liu, 2005).

Medicinal plants have been tested extensively and found to have great pharmacological uses such as anti-inflammatory activity, antibacterial activity, anti-diabetic activity, anti-fungal activity, anti-cancer activity, antioxidant activity, hepatoprotective activity, haemolytic activity, larvicidal activity, anthelmintic activity, pain relief activity, central nervous system activity, sexual impotence and erectile dysfunction and hypolipidemic activity (Hosahally, et al., 2012; Anthoney et al., 2013; Farook et al., 2011; Kisangau et al., 2007; Kamatenesi-Mugisha et al., 2005; Adu et al., 2011; Deepa et al., 2007; Joshi et al., 2011; Arivoli et al., 2012; Anthoney et al., 2014).

Antimicrobial potential of different medicinal plants is being extensively studied all over the world but only a few studies
have been carried out in a systematic manner (Arora et al., 2009).

The aim of the current study is to investigate the antibacterial activity of infused Cola nitida seeds.

Materials and Methods

Sample collection and Extraction procedure

The seeds of Cola nitida were bought from Monrovia, Liberia in the West Africa region. The samples were identified by a taxonomist in the University of Eastern Africa, Baraton. The fresh seeds of the Cola nitida were cut into the pieces and dried for three weeks; the dried seeds were ground into powder. Fifty grams of the Cola nitida was put in conical flask and mixed with distilled water and heated to boiling for 20 minutes. The extract was filtered and the solvent was evaporated to dryness at a temperature of 40°C using rotary vacuum evaporator. The extract was brought to dryness using vacuum and pressure pump. The yield was kept at 4°C prior to use.

Bioassay Study

Preparation of the Bacterial Suspension

The turbidity of each of the bacterial suspension was prepared to match to a 0.5 McFarland standard. The McFarland standard was prepared by dissolving 0.5 g of BaCl₂ in 50 ml of water to obtain a 1% solution of Barium chloride (w/v). Sulphuric acid (1%) was prepared in a 100-ml volumetric flask. To prepare the 0.5 McFarland Standard, 0.5 ml of the 1% BaCl₂ solution was mixed with 99.5 ml of H₂SO₄ solution. Measure the turbidity of the 0.5 McFarland Standards with the aid of a spectrophotometer at a wavelength of 625 nm to read an optical density of between 0.08 to 1.0. At this absorbance, the McFarland Standard represents a bacterial cell density of approximately 1.5 x 10⁸ CFU/ml (1.0 x10⁸ – 2.0 x 10⁸ CFU/ml. It was then transferred to a screw-capped bottle and sealed with parafilm to prevent evaporation due to exposure to air. The bacterial suspensions were then tested against the McFarland standards until they reached the absorbance of the McFarland standard and then they were ready for use.

Preparation of the Extract Concentrations and Antibiotic

Stock solutions for the extract were prepared by dissolving 500 mg in 1 ml of dimethylsulfoxide (DMSO). An antibiotic control was made by dissolving 1µg of penicillin in 1 ml of sterile distilled water. DMSO served as a negative control.

Screening for the antibacterial potential of the plant extract

The agar well diffusion procedure used in the experiment was similar to that used by Taye et al., (2011) and Jeyachandran and Mahesh (2007). The microorganisms used for this study were laboratory strains of Bacillus cereus, Serratia marcescens, Staphylococcus epidermidis, Proteus vulgaris and Salmonella typhi. A single colony for each of the organisms was picked from agar plate and dissolved in 5 ml of Mueller Hinton broth. The broth was incubated overnight at 37°C. 5 ml of plain Mueller Hinton broth was incubated alongside the organisms to ensure that the medium was not contaminated. The spectrophotometer was set to 625 nm wavelength and each of the microbial cultures was pipetted into cuvettes to measure the absorbance. A cuvette of plain Mueller Hinton broth was used a blank at 0.000 absorbance. The
The absorbances of the microorganisms were measured. The bacterial organisms exceeding 0.1 absorbance were adjusted by adding bacterial suspension until the absorbance fell between 0.08 to 0.10, matching the McFarland Standard. The organisms falling below 0.08 absorbance were also adjusted until the McFarland standard absorbance was achieved. All the organisms, therefore, reached a cell density of $1 \times 10^8$ cfu/ml (Ngeny et al., 2013). 100 µl of each of the organisms were then inoculated onto agar plates for the bioassay (Agyare et al., 2013). Three 6 mm wells were made into each agar plate using a sterile metal cork borer. 100 µl of the standard drug penicillin was placed in one well, the extract in another well and dimethyl sulfoxide (DMSO) was placed in the third well on each plate. The experiment was run in triplicate for each extract and each organism tested. The plates were incubated for 24 to 48 hours and the zones of inhibition were measured in millimetres with the aid of a meter rule.

**Statistical Analysis**

A random sampling procedure was done for the entire test and the experiment was conducted in triplicate assays on Mueller Hinton agar plates (Jeyachandran and Mahesh, 2007). The mean values and standard error were calculated for the zones of inhibition. Analysis of variance was used to determine if there was significant difference among the average zones of inhibition of the bacterial organisms by the extract. The Tukey’s honestly significant difference test was used to determine pairwise comparisons between average zones of inhibition among the bacterial organisms by SPSS version 21.0.

**Result and Discussion**

The main zone of inhibition for *Serratia marcescens* was the highest (26.67±1.202), followed by that of *B. cereus* and *Staphylococcus epidermidis* (table 1). The extract was not active against *Proteus vulgaris* and *Salmonella typhi*. The penicillin control inhibited growth at higher zones of inhibition for all the microorganisms. Analysis of variance (ANOVA) showed that there were significant differences in the zones of inhibition among the microorganisms by the extract and the penicillin control ($P < 0.001$). On further comparison with the Tukey’s honestly significant difference test, the zone of inhibition for *B. cereus* was not significantly different from *S. epidermidis*, but was significantly smaller than those of *Serratia marcescens*, and larger than *P. vulgaris* and *S. typhi* (table 2). *S. marcescens* zone was significantly bigger than those of *P. vulgaris* and *S. typhi* but was significantly lower than *S. epidermidis*. *S. Epidermidis* was significantly bigger than those of *P. vulgaris* and *S. typhi*. And, *Proteus vulgaris* had significantly lower zone of inhibition than *S. typhi*. The control drug showed zones significantly bigger than all the zones of the extract and the extract had significantly larger zones of inhibition than the negative DMSO control.

The methanolic extract of *C. nitida* inhibited the growth of *Bacillus cereus* with a zone of inhibition of 23.67±0.882mm, while the infused extract inhibited *Bacillus cereus* with a zone of 14.33±0.822mm. *C. nitida* methanolic extract inhibited *Serratia marcescens* with a zone of 22.67±1.452mm and the infused extract with a zone of 26.67±1.202mm. *Staphylococcus epidermidis* was inhibited with a zone of 24.33±0.667 mm for the methanol extract but this was lower for the infused extract (12.33±0.577mm). The methanolic extract was active against *P. vulgaris* with a zone of inhibition of 13.00±0.577 but the infused extract was inactive against the organism.
The methanolic and infused extracts of Cola nitida did not show any activity against Salmonella typhi (Obey and Anthoney, 2014).

The ethanolic extract of G. kola was tested against organisms such as Serratia marcescens, Bacillus cereus, Escherichia coli, Proteus vulgaris and Salmonella sp. The results showed that the ethanolic extract of G. kola inhibited B. cereus with an inhibition zone of 10.17±0.477mm and E. coli with an inhibition zone of 12.83±0.833mm. All other organisms were not inhibited (Obey et. al., 2014).

According to Russel (1955), Cola nitida and Cola acuminata were believed to be resistant and biologically robust species and had no important diseases associated with them. Cola species are vulnerable to a host of fungal diseases (Emmanuel and Nick Brown) that can attack all parts of the crop. According to Oludemokun (1979), many fungi are capable of infecting kola fruits at an early stage of development, but the disease symptoms will only develop when conditions are favourable.

According to Mubo et al., (2009), the in-vitro antimicrobial evaluation of ethanol extracts of four species of Cola Schott & Endl. was done using human isolated strains of Staphylococcus aureus, Staphylococcus albus, Bacillus subtilis, Klebsiella pneumoniae, Pseudomonas aeruginosa, Candida albicans, Aspergillus niger as test organisms. The leaf ethanol extracts of the plants were found to be more effective against the tested fungi than the bacteria at high concentrations. None of the extracts was active against Staphylococcus aureus. Plant extract of C. acuminata (P. Beauv.) Schott & Endl. and C. nitida (Vent) Schott & Endl. showed activity on S. albus at concentrations ranging from 10–150 mg/ml having comparable diameters of zone of inhibition of 7.3±0.03–16.0±0.0 for C. acuminata and 10.0±0.0–19.0±0.0 for C. nitida. Also, these two species of Cola demonstrated activities on C. albicans and A. niger at concentrations ranging from 90–150 mg/ml with relatively close diameters of zone of inhibition. C. acuminata inhibited the growth of K. pneumoniae at the MIC of 90mg/ml whereas, C. albicans was inhibited by C. acuminata, C. Millenii, K. schum and C. gigantea A.Chev. at the MIC of 120mg/ml. Phytochemical screening of the four species of Cola showed the presence of alkaloids, saponins, tannins and cardenolides in all the plants which apart from showing the probable closeness of the species could also be responsible for the observed activities. The antimicrobial property shown by the plant extracts is an evidence of the ethnomedicinal uses of the plants. The similarity observed in the phytochemical constituents and antimicrobial activities demonstrated by C nitida (Vent.) Schott & Endl., C. millenii and C.gigantea A. Chev. and C. acuminata suggest a probable closeness among these species.

According to Muhammad (2014), aqueous and methanol extracts of red and white variety of kola nut showed antibacterial activity against Streptococcus anginosus, gram positive bacteria which, is a member of the viridans Streptococci. These are heterogenic bacteria with unique pathogenicity than other streptococci (Ryan, 2004). Red kola also showed the activity against Proteus vulgaris, gram negative bacteria at 60 mg/ml, which gave a zone of inhibition of 18 mm and 16 mm at 60 mg/ml for methanol and aqueous extracts. Similar report was observed in the work of (Saravana kumar et al., 2009) on kola extract against Proteus mirabilis, which gave an inhibition zone of 16 mm at 1000 µg/ml.
According to Indabawa (2011), methanol and water soluble fractions of *Garcinia kola* and *Cola nitida* possess antibacterial activity, *G. kola* was more active against some members of Enterobacteriaceae, namely, *Escherichia coli* and *Salmonella typhi*, whereas, methanol extracts of *Cola nitida* showed grater activity on *S. aureus*. Thus, the plants possess potentials for the manufacture of potent drugs for the treatment of infections caused by the test organisms, such as typhoid fever, gastroenteritis, urogenital tract infections and boils.

In Nigeria, various concoctions are made from roots, seeds and leaves obtained from a variety of the *kola* tree. And they are administered orally as purgatives, as direct cures or preventions of all sorts of diseases (Andah, 1992 and Dalziel, 1948). *Cola nitida* increases gastric acid secretion in wistar rats. The indication of gastric acid secretion of *cola nitida* could be entirely due to the presence of xanthine or it may involve gastric secretagogues in cola yet to be discovered (Tende et al., 2011).

Antibacterial activities shown by the four *Cola* species are in line with previous antimicrobial works on the species of *Cola* (Reid et al., 2005; Adeniyi et al., 2004; Ebana et al., 1991) where *Cola* extracts were found to exhibit important inhibitory activities against the growth of certain bacteria and fungi. The crude ethanolic extract of *C. acuminata, C. nitida* and *C. gigantea* showed important activity against *Staphylococcus albus*. The diameters of the zones of inhibition of these extracts were found to be remarkably close to that of the control drug: erythromycin. The MICs were 10 mg/ml, 10 mg/ml and 60 mg/ml respectively. However, the leaf ethanol extract of *C. millenii* was inactive against this organism. *C. acuminata* showed the most important activity against *Staphylococcus albus, Klebsiella pneumoniae, Aspergillus niger* and *Candida albicans*.

This is probably due to the strong presence of alkaloids in *C. acuminata* as reported by Adegoke et al., (1968). *C. gigantea* also had a high antimicrobial activity against *Staphylococcus albus, Bacillus subtilis*, and on *Aspergillus niger and Candida albicans* whereas, *C. nitida* and *C. millenii* had weak inhibitory effects on the growth of all the microorganisms. There is a need for further study to ascertain if the yield in these species would be increased by using stronger fractionating solvents such as ethyl acetone or methyl acetone. These solvents have been reported to be more vigorous than other solvents used in crude extraction of plants (Ajayeioba and Fadare, 2006).

In an agar well diffusion assay, *G. kola* was tested against several microorganisms and showed the ethanol extracts exhibited zones of inhibition ranging from 17 to 23 mm while the aqueous hot water extract showed zones ranging from 20 to 27 mm. Antifungal activity was shown against *Staphylococcus aureus* at 0.008 mg/ml. Phytochemical compounds such as flavonoids, tannins, saponins, steroids, cardiac glycosides and reducing sugar where found to be present (Arekemaje et al., 2012).

The acetic acid extract of *Garcinia Kola* has also shown zones of inhibition as high as 17.5 mm for *S. aureus*, 18.5 mm for *E.coli*, 35.0 mm for *Streptococcus pyogenes* and 37.0 mm for *Salmonella typhi*, (Ezeanya et al., 2013). Between 5 mg/ml to 25 mg/ml of *Garcinia kola* and *Cola nitida* showed zones of inhibition against *E.coli, S. aureus, S. typhi* and *K. pneumoniae*. The methanol soluble extract of *G. kola* showed zones of inhibition of 20 mm, 25 mm, 24 mm, 9 mm
and 20 mm against *E. coli*, *S. aureus*, *S. typhi* and *K. pneumonia* respectively. That of *Cola nitida* showed 23mm, 9 mm, 18.5 mm, 12.5 mm against *E. coli*, *S. aureus*, *S.typhi*, *K pneumonia* respectively. This study showed that *Cola nitida* is a better antimicrobial against *E. coli* while *G. kola* is good for *S. aureus*, *S. typhi* and *K. pneumonia*, (Indabawa et al., 2011).

**Table 1** Antibacterial Activity of *Cola nitida* Infused Extract Against Selected Pathogenic Microorganisms

<table>
<thead>
<tr>
<th>Microorganisms</th>
<th>Mean (mm± S.E.)</th>
<th>Penicillin</th>
<th>DMSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus cereus</td>
<td>14.33±0.882</td>
<td>42.66±1.201</td>
<td>0.00±0.000</td>
</tr>
<tr>
<td>Serratia marcescens</td>
<td>26.67±1.202</td>
<td>40.00±0.577</td>
<td>0.00±0.000</td>
</tr>
<tr>
<td>Staphylococcus epidermidis</td>
<td>12.33±0.577</td>
<td>28.67±0.882</td>
<td>0.00±0.000</td>
</tr>
<tr>
<td>Proteus vulgaris</td>
<td>0.00±0.000</td>
<td>35.00±0.577</td>
<td>0.00±0.000</td>
</tr>
<tr>
<td>Salmonella typhi</td>
<td>0.00±0.000</td>
<td>21.00±0.577</td>
<td>0.00±0.000</td>
</tr>
</tbody>
</table>

**Table 2** Tukey’s honestly significant difference test for zones of inhibition of *Cola nitida* Infused extract against selected pathogenic microorganisms

<table>
<thead>
<tr>
<th>Comparison</th>
<th>P-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus cereus vs Serratia marcescens</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Bacillus cereus vs Staphylococcus epidermidis</td>
<td>0.505</td>
<td>NS</td>
</tr>
<tr>
<td>Bacillus cereus vs Proteus vulgaris</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Bacillus cereus vs Salmonella typhi</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Bacillus cereus vs Bacillus cereus control</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Serratia marcescens vs Staphylococcus epidermidis</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Serratia marcescens vs Proteus vulgaris</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Serratia marcescens vs Salmonella typhi</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Serratia marcescens vs Serratia marcescens control</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Staphylococcus epidermidis vs Proteus vulgaris</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Staphylococcus epidermidis vs Salmonella typhi</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Staphylococcus epidermidis vs S. epidermidis control</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Proteus vulgaris vs Salmonella typhi</td>
<td>1.000</td>
<td>NS</td>
</tr>
<tr>
<td>Proteus vulgaris vs Proteus vulgaris control</td>
<td>0.000</td>
<td>S</td>
</tr>
<tr>
<td>Salmonella typhi vs Salmonella typhi control</td>
<td>0.000</td>
<td>S</td>
</tr>
</tbody>
</table>

Key: NS= Not Significant; S=Significant

The search for alternative treatment for diseases caused by certain human pathogens have given rise to interest in research on plant extract against microorganisms. *Bacillus cereus* is associated with food poisoning, gastrointestinal and non-gastrointestinal infections due to virulence factors that include enterotoxins, beta-lactamase, proteases and collagens (Didelot et al., 2000). *Serratia marcescens*, is a human opportunistic pathogen associated with nosocomial infections and is resistant to multiple antibiotics (Kurz et al., 2003). *Staphylococcus epidermidis* inhabit the skin of both healthy and ill individuals, hence making it an opportunistic and nosocomial pathogen and has been
associated with infections in intensive care units of hospitals (Michelim et al., 2005).

From the data obtained in this study it is therefore worthy to mention that the *Cola nitida* seeds can be used to treat against all the infections caused by *Bacillus cereus*, *Serratia marcescens* and *Staphylococcus epidermidis*.

In conclusion, infused *Cola nitida* extract had effects on the microorganisms such as *Bacillus cereus*, *Serratia marcescens* and *Staphylococcus epidermidis*. Further studies on structural elucidation of *Cola nitida* using advance spectroscopic procedures like nuclear magnetic resonance, mass spectrometry and UV spectroscopy can be used for structural elucidation of the active ingredients in the seeds of *C. nitida*. This information may offer very useful information on the ethnobotanical use of the plant. It is also recommended that communities can be educated on the correct dose and use of *C. nitida* especially where modern hospital facilities and good healthcare systems are completely lacking.

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