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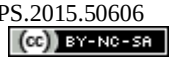
ISSN 2231-3354 

Phytochemical screening and antibacterial activity of medicinal plants used to treat typhoid fever in Bamboutos division, West Cameroon

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ABSTRACT

This study was undertaken to document how typhoid is traditionally treated in Bamboutos division. For this purpose thirty eight plants species were selected. These plants underwent phytochemical screening and antibacterial study using standard procedures. The antibacterial tests using agar well diffusion method and microdilution assay indicated that, all the thirty eight plant samples showed activity against *S. typhi*, while *S. paratyphi A* and *S. paratyphi B* reacted on fifteen and fourteen plants respectively. The highest zones of inhibition were obtained from *Senna alata* with diameter of 24, 22.5 and 20.5 mm against *S. paratyphi* A, *S. paratyphi* B and *S. typhi* respectively at 160 mg/ml concentration. The lowest MIC values 128 µg/ml was exhibited by the extract of *Vitex doniana* against *Salmonella paratyphi A.* Bactericidal activity was obtained by the extract of *Carica papaya, Pseudarthria confertiflora, Moringa oleifera and Harungana madagascariensis*. Antibacterial screened of *Pseudartthria confertiflora* was reported for the first time. *Annona muricata, Laggera alata, Spathodea campanulata, Cordia platythyrsa, Carica papaya, Terminalia glaucescens and Pseudarthria confertiflora* gave positive results for all secondary metabolites while other plants contained two to five metabolites. The presence of these secondary metabolites probably contributes to the antibacterial potential of these plants. This finding supported the uses of these plants for treatment of typhoid fever and other infectious diseases in the study area.

INTRODUCTION

Knowledge on plant uses is the result of many years of man's interaction and selection on the most desirable, the most vigorous and the most successful plant present in the immediate environment at a given time (Rindos, 1984). According to the World Health Organization, 80% of people in developing countries still depend on local medicinal plants to fulfill their primary health needs (WHO, 2002). Besides that, there is a global consensus on the benefits of phytopharmacy and at present medicinal plants occupy a key position in plant research and medicine. In many African countries, such as Ghana, Mali, Nigeria and Zambia, the first line of treatment for 60% of the children with high fevers, is the use of herbal medicines at home (WHO, 2003). The importance of plants in medicine remains even of greater relevance with the current global shift to obtain drugs from plants sources, as a result of which attention has been given to the medicinal value of herbal remedies for safety, efficacy and economy (Abubakar *et al.* 2009).

Plants constitute an important source of active ingredients which differ widely in terms of structure and therapeutic properties. The continued investigation into the secondary plant metabolites for anti-infective properties has gained importance in recent years because of the alarming increase in resistance of pathogenic microorganisms to existing antibiotic. For instance, the emergence and spread of *Salmonella* resistance to many commonly used antibiotics (Ciprofloxacin, Ampicillin, Chloromphenicol, Amoxicilllin) is now a subject of international concern.

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The problem has become endemic in many developing countries, causing enormous childhood morbidity and high cost of treatment (Leume, 1999). Multidrug resistant *Salmonella* species are being increasingly reported from the developed world. There is therefore, the need for efficient and safe vaccine which can be used as a preventive public health tool (Leume, 1999).

Thus, the resistances of Salmonella to these antibiotics couple with the high cost of treatment have prompted the present study on plant used for the treatment of typhoid fever. Furthermore, typhoid fever is a systemic infection caused by the bacterium *Salmonella enterica* subspecies enterica serotype *typhi*, which is acquired by ingestion of contaminated food and water (Iroha *et al.,* 2010).

Much more, in 2009, Zofou *et al.*, report that this disease remains the second cause of mortality in the Bamboutos Division after malaria. In the same way, the report provided by the NGO "Action for the formation and the natural stock management", indicated that, 2715 cases of typhoid fever and 1998 cases of diarrheas and gastro-enteritis were recorded in 2010 in this Division. In the same line, Nanfack *et al.*, in 2014 have found that typhoid fever was the hydrous widespread disease in this locality, follow by dysentery and gastro-enteritis. Besides, each year the disease affects at least 12.6 million people world-wide, most of them resides in the developing countries of Southeast Asia and Africa (WHO, 2003).

Typhoid fever is uncommon in industrialized regions such as the USA, Canada, Europe, Australia and Japan and new cases of the disease in these countries are related to a journey in the developing countries (Papadimitropoulos *et al.,* 2004). Mortality rates associated with this disease vary form one region to other, with highest reported from Indonesia, Nigeria and India (Miller *et al.,* 1994).

The prevalence of this disease and the increasing prices of medicine have resulted in the demand for discovery of less expensive but more potent sources of drugs. Plants are one of the best sources of potent drugs. In fact, medicinal plants represent a rich source form which antimicrobial agents may be obtained (Kubmarawa *et al.,* 2007).

The traditional knowledge on medicinal plants that is inherent within local communities is a very important source of information that continually provides the present-day herbal remedies (Shahid-ud-Daula & Basher, 2009). In recent years, researches in various countries have been directed towards discovering the medicinal uses of plants through phytochemical and antimicrobial screening (Hashim *et al.,* 2010).

Nevertheless, the present investigation represents a preliminary screening of some medicinal plants used against typhoid fever in Bamboutos division.

These medicinal plants have been claimed by traditional medical practitioners in this locality to be effective when used for the treatment of typhoid fever. However, no detailed reports on anti-typhoid activity of these plants exist in literature in Cameroon; therefore, the present work investigates phytochemical compounds and antibacterial activity against *Salmonella* species.

MATERIALS AND METHODS

Study area

The Bamboutos Division is located in the western highlands and extends between 5–6° N and between 9–11°E (Figure 1). It's one of the eight divisions which forms the West Region of Cameroon and is bordered to the north by Mezam Division, to the south by Mifi and Menoua divisions, and to the west by Noun Division. The Bamboutos division covers an area of 1155 km² which represents 8.31% of the total area of the West Region of Cameroon. Located on the eastern slope of the Bambouto Mountain from which it is named, Bamboutos Division is characterized by the great diversity of its relief, climate, vegetation, and soils. Mount Bambouto is the third highest mountain in Cameroon (2740 m) after Mount Cameroon (Fako) (4100 m) and Mount Oku (3008 m). The main occupation in the community is farming. There are two seasons: the dry season from November to March and the rainy season from March to October. The climate is subtropical with an annual rainfall estimated at 1621.5 mm and a mean annual temperature of 24–29°5C (MINEF, 1999). They have four main languages used in the community (Ngomba'a, *Ngiembon, Ngombalé* and *Megaka*).

Collection of ethnomedical information

An ethnobotanical survey was carried out in the Bamboutos Division January–November 2009. Traditional healers and elderly persons were the target key informants in the study, and the selection process was based on the knowledge base of informants, experience, and current practices in ethnobotany medicine of the target individual. The traditional healers were interviewed using semi-structured questionnaires as described by Martin (1995) and open-ended conversations. Trips were made to the sites where traditional healers usually go to harvest plants. The interviews and discussions were carried out in the local language for each of the villages visited. Since the author is a native of the division, data on the local names of the plants, the plant parts used, mode of usage and administration, and mode of preparation were easily obtained. Selected respondents were well-known in the community due to their long practice in providing services related to traditional health care. The age of the respondents ranged between 40 and 95 years (29 were between 40-50, whereas 18 were between 51-60 and 23 were above 60 years old). Forty of them were traditional healers, whereas the rest were elders who had gained knowledge on medicinal uses of plants from their parents and relatives who were historically using the plants.

Collection of plant samples

Fresh plant (s) parts that were found to be used by traditional healers and elderly people for treatment of typhoid fever after carrying out the survey by use of questionnaires were collected from Bamboutos division as shown in Figure 1. The taxonomic identities of these plants were confirmed by the senior taxonomist at the Yaoundé National Herbarium and the voucher specimens were kept in the Department of Plant Biology, University of Dschang.

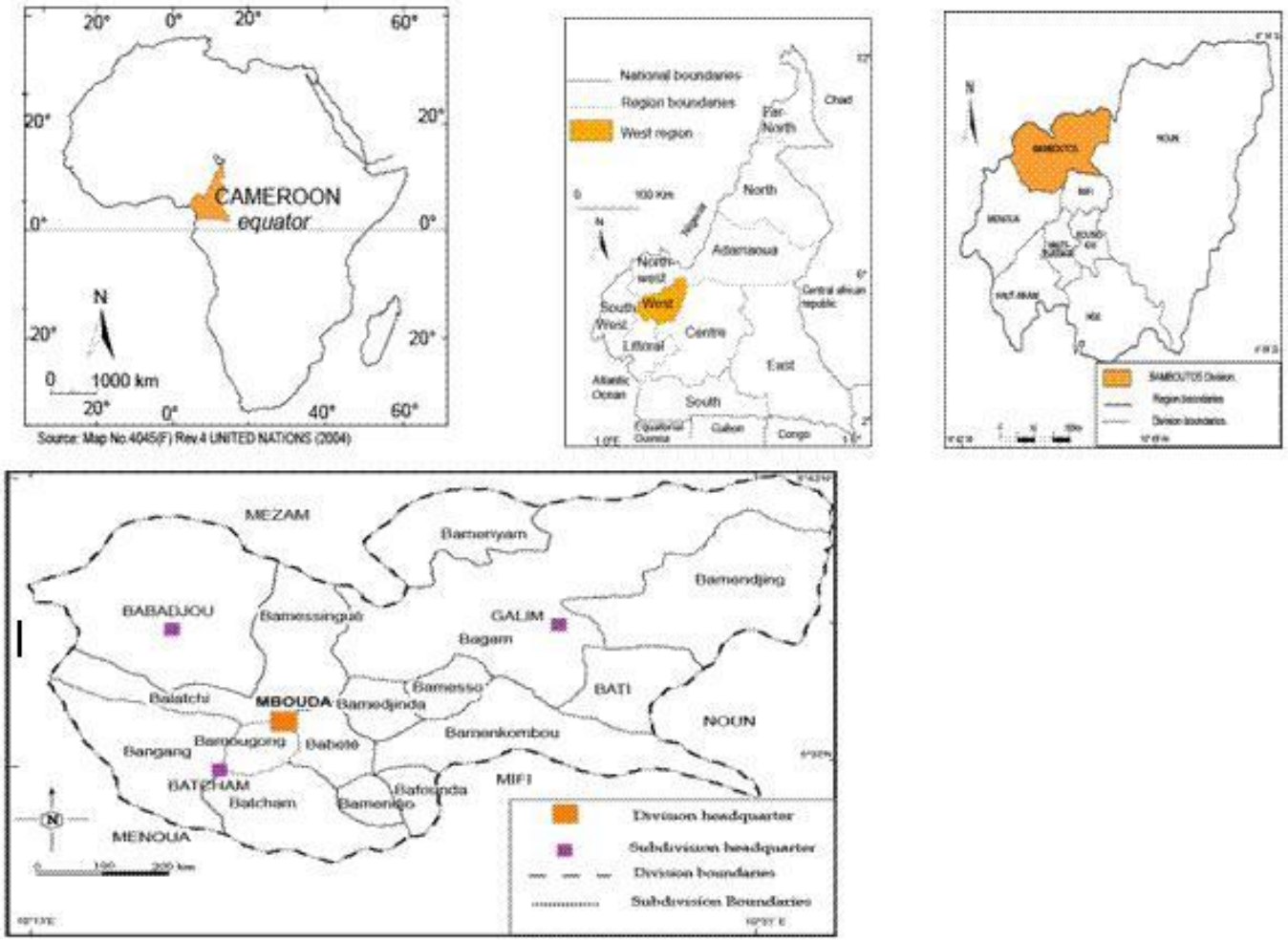

Fig. 1: map of the study area.

Microbial strains

Fresh clinical strains of *Salmonella typhi* ATCC 6539, *S. paratyphi A* and *S. paratyphi B.* were obtained from the Microbiology Laboratory, Department of Biochemistry, University of Dschang. All the strains were stored at 4°C temperature until use.

Preparation of plant extracts

Fresh plant material were washed with tap water, air dried at room temperature for 15-30 days, and then homogenized to fine powder. A sample (200 g) of each powdered plant material was soaked in ethanol (500 ml) for 48 h with constant stirring. The suspension was filtered through Whatman filter paper N° 1. The filtrate was concentrated under vacuum using a rota-vapor to obtain the dry ethanol extract and stored at 4°C until further use. These extracts were used both for the phytochemical screening of secondary metabolites and antibacterial activity.

Phytochemical analysis of the plant extract

The extracts were subjected to phytochemical tests in order to identify secondary metabolites such as, flavonoids, alkaloids, saponins, steroids, polyphenols and triterpenes according to standard methods (Ronchetti et Russo, 1971; Hegnauer, 1973; Békro *et al.*, 2007 and N'Guessan *et al.*, 2009).

Antibacterial assay

Determination of diameter inhibition

The media were prepared according to the manufacturers' standard, 38 g/1000ml of distilled water. The ethanolic extracts were dissolved in 10% dimethylsulpoxide (DMSO) and further diluted to obtain different concentrations (160 mg/ml, 80 mg/ml and 40 mg/ml). Negative control used was DMSO. Ciprofloxacin was used as positive reference standard having a concentration of 10 µl/ml for all bacterial strains.

The organisms were maintained on nutrient agar plates and were revived for bioassay by subculturing in fresh nutrient agar for 24 h before being used. The agar wells diffusion method described by Kuete, (2010), was adopted. Briefly, nutrient agar was prepared by autoclaving and allowed to cool to 40-50°C before seeded with the test organism (in sterile petri-dishes of 90 mm diameter). The seeded plates were allowed to set and cylindrical plugs were removed from the agar plates by means of a cork borer to produce wells of approximately 6 mm diameter. The wells were equidistant from each other and the edge of the plate

(Washington, 1995). The wells were then filled with 50 µl of each ethanolic extract at a concentration of 160 mg/ml, 80 mg/ml and 40 mg/ml. Also, concentration of 10 µg/ml of ciprofloxacin and 200 µg/ml DMSO were introduced into other wells as positive and negative controls, respectively with the aid of micropipette. The plates were incubated at 37°C for 24 h. antibacterial activity was determined by measuring the zone of inhibition surrounding the well. The zones of inhibition were then measured, recorded and compared with standard control, Ciprofloxacin (10 µg/ml). The assays were carried out under aseptic conditions. All tests were performed in triplicate.

Determination of MIC and MBC

Preparation of the solutions of extracts

The stock ethanolic extracts solutions were prepared by dissolving 59 mg of each extracts in 200 µl of 10% dimethylsulphoxide (DMSO) and mixed with 1600 µl of Mueller Hinton broth, to give the final concentration of 8192 µg/ml and serially diluted two fold to obtain the concentration ranges from 128-8192 µg/ml for the extract and 2-256 µg/ml for ciprofloxacin. 100 µl of each concentration was added in 96 wells plates containing 100 µl of MHB and inoculums standardized at 1,5x 10^8 CFU/ml. Negative growth controls were included in every test. The plates were covered with a sterile plate sealer, then agitated to mix the contents of the wells using a plate shaker and incubated at 37°C for 24 h. The MIC of each sample was detected following addition (40 µl) of 2% *p*-iodonitrotetrazolium chloride and incubation at 37°C for 30 minutes (Pettit *et al.,* 2005). Viable microorganisms reduced the yellow dye to a pink colour. MIC was defined as the lowest sample concentration that prevented this change and exhibited complete inhibition of bacterial growth. For the determination of MBC, a portion of liquid (50 µl) from each well that showed no change in color was placed on MHB (150 µl each new 96 wells plates) and incubated at 37°C for 24 h. The lowest concentration that yielded no growth after this sub-culturing was taken as the MBC. The MBC/MIC was calculated to determine if the extract is bactericidal or bacteriostatic, according to Noumedem *et al.,* (2013).

STATISTICAL ANALYSIS

Data were expressed as mean ±standard deviation. The data obtained were subjected to ANOVA test to determine whether there was significant difference in zone of inhibition between extract concentrations and also antibiotic used.

RESULTS

Seventy informants (traditional healers and elderly persons) were interviewed on how they used plants to treat typhoid fever. Fifty-nine species, distributed among 56 genera and 33 families were recorded (Tsobou *et al.,* 2013). Thirty-eight of the 59 species recorded were selected for this study (Table 1). Various parts were harvested depending on the parts the informants used in the treatment of typhoid fever. The leaves, barks, whole plant, roots, fruits and stem were the ones that were harvested, but the part that is used most was found to be the leaves, followed by stem bark. The most common mode of preparation was decoction. The species name, family, vernacular name, ethnomedical uses elsewhere, plant part used, biological activity and chemical studies of the 38 selected species are presented in Table 1. However, *Bidens pilosa* was the most cited plant in our study. The only mode of administration was oral.

Phytochemical screening

Phytochemical screening of collected plant species has been carried out following the methods reported in literature and the results have been reported in table 2. The result of the phytochemical analysis showed that, these plants extracts are rich in at least one of the following class of compounds: triterpenes, flavonoids, alkaloids, polyphenols, sterols and saponins. All these group of compounds were found in *Annona muricata, Picralima nitida, Laggera alata, Spathodea campanulata, Cordia platythyrsa, Carica papaya, Terminalia glaucescens, Pseudarthria confertiflora, Senna alata* and *Musa paradisiaca*. Triterpenes were found in all plant extracts except *Gossypium barbadense* and *Dioscorea dumetorium.* While alkaloids have been found to be absent in 18 species (i.e. *Pseudospondias microcarpa, Stereospermum acuminatissimum, Cupressus lusitanica, Entada abyssinica, Theobroma cacao* and *Mitracarpus villosus*). Polyphenols have been found to be present in thirty seven species. Flavonoids are generally present in most of the 38 plants except in *Dracaena deisteliana, Pteridium aquilinum, Dioscorea dumetorum, Ocimum gratissimum* and *Paullinia pinnata*. Sterols and saponins are present in 36 and 23 plants species respectively.

Antibacterial activity

The results of the antibacterial screening of the ethanolic extract on the test strains are shown in table 2. All the thirty eight (38) plants tested showed activity against *S. typhi*. While 23 and 24 plant species did not showed any activity against *S. paratyphi A* and *S. paratyphi B* respectively. The zone of inhibition increased with increasing concentration of extract in wells. This showed that the concentration influence the activity. The highest zone of inhibition were obtained from *Senna alata* against *Salmonella paratyphi* A, *S. paratyphi* B and *S. typhi* with diameter of 24, 22.5 and 20.5 mm respectively at 160 mg/ml.

Among 38 plants tested *Pseudarthria confertiflora, Terminalia glaucescens, Senna alata, Dacryodes edulis* and *Stereospermum acuminatissimum* were found to be the most effective against *S. typhi. Senna alata* and *Rauvolfia vomitoria* were found to be the most sensitive against *Salmonella paratyphi* A. Similarly, *Senna alata, Pseudarthria confertiflora* and *Rauvolfia vomitoria* were found to be the most active against *S. paratyphi* B. The inhibition zone (7.5 – 24 mm) of each extract on all the bacterial used was less than the zone of inhibition caused by ciprofloxacin (Table 2).

Table 1: Information about medicinal plants recorded and tested in this study.

Species	Freq	Local names	Reported relevant ethnomedical uses elsewhere	Part used/MP	Biological activity	Chemical constituents
Eremomastax speciosa (Hochst) cufod **Acanthaceae**	20	Kouokmegar, pankuzem, panzemmock, panzemmock, piezeumok	Dysentery, anemia, irregular menstruation, fractures cough, constipation, pile and urinary infections (Adjanohoun *et al.*, 1996). Infertility, burns, post-partum and fungi infections (Oben *et al.*, 2006).	L (I, D)	Antidiarrheic properties (Oben *et al.*, 2006).	Tannins, phenols, flavonoids, alkaloids, saponins, terpenes (Mboso *et al.*, 2013).
Pseudospondias microcarpa Engl. **Anacardiaceae**	2	Gueme	Teeth problems (Adjanohoun *et al.*, 1996).	B (D)		Alkaloids, tannins, terpenoids, steroids and cardiotoniques heterosides
Annona muricata Linn. **Annonoceae**	5	Corossole, saba saba sour-sop	Hernia, intestinal worms, breast lactation (Baskar *et al.*, 2006). Hypertension and stomach pains (Anbu *et al.*, 2010).	L, B (D)	Antidiarrheic activity, antispasmodic, sedatif, antitumor and antibacterial activity (Baskar *et al.*, 2006). Cytotoxic, molluscidic, anti-inflammatory and anthelmintic (Pimenta *et al.*, 2011).	Alkaloids, flavonoids, glycosides,reductive sugar, steroids and tannins
Picralima nitida (Stapf) Th. et H. **Apocynaceae**	10	Djicka	Malaria, male impotence, dysmenorrhoea, digestives tract infections (Adjanohoun *et al.*, 1996). Inflammations, pneumonia and intestinal worms (Ubulom *et al.*, 2011).	R, F (D, M)	Antimicrobial, antifungal, antiprotozoa (Ubulom *et al.*, 2011).	Alkaloids, cardiotonic glycosides, saponins, tannins and terpens (Ubulom *et al.*, 2011)
Rauvolfia vomitoria Afz. **Apocynaceae**	5	Not found	Snake bites, madness, malaria (Bellomaria & Kacou, 1995). Hypertension (N'Guessan *et al.*, 2009). Jaundice, gonorrhoea, schizophrenia, intestinal worms and urinary infections (Adjanohoun *et al.*, 1996).	B, R (D)	Anticancer activity, antipyretic effect, antihypertensives, sedatives, emetic, purgative, dysenteric, arbotive and insecticidal properties (Oyewole & Massaquoi, 2008).	Active indole alkaloids, β-carboline alkaloids and alstonine (Oyewole & Massaquoi, 2008).
Dracaena deisteliana Engl **Asparagaceae**	15	Kikeng, kion	Cough (Adjanohoun *et al.*, 1996)	L, R (D, I, S)	Antileishmaniales, antimalaria, antimolluscidic, fungistatic and fungicidic (Okunji et al., 1996).	Not found
Bidens pilosa Linn. Asteraceae	40	Lietmik, lipiliep metsemik	Cough, malaria, expulsion of the placenta, fractures, panaris and convulsions (Adjanohoun et al., 1996). Diabetes, dysentery diarrhoea (Rabe & Van Staden, 1997). Diabetes, liver diseases, malaria (Brandao et al., 1997).	Wp, L (D, I)	Anti-hyperglycemiantes (Ubillas et al., 2000). Anti-ulcerogenic (Tan et al., 2000). Anti-inflammatory (Jager et al., 1996). Hypotensives, anti-pyretic, anticancerous and anti-tumor, antivirales (Chiang et al., 2007). Antifungal (Deba et al., 2008). Antibacterial (Rojas et al., 2006).	Flavonoids, phenylacetylens, alkaloids, steroids, triterpenoids and tannins (Khan et al., 2001). Satureted carbohydrate, aliphatic carboxylic acids, acetylenic 38 hydrocarbons, phenols, chalcons, flavonols, porphyrines (Silva et al., 2011)
Emilia coccinea (Sims) G. Don.	18	Made-sonlume	Male and female infertility (preorgasm ejaculation, pelvic inflammatory disease), gastric and dysmenorrhoea (Focho et al., 2009). Cough (Ubulom, 2010). Fever (Burkill, 1985).	Wp (D, C)	Antimicrobial activities of E. sonchifolia (Yoga Latha et al., 2009).	Alkaloids, tannins, steroids, terpenoids, flavonoids and cardiac glycosids (Edeoga et al., 2005).
Laggera alata (G. Don)Sch. BipEx. Oliv. Asteraceae	7	Depack-kenan, negikock	Hepatitis, arthritis, bronchitis, nephritis (Wu et al., 2011). Fever (Adjanohoun et al., 1996).	L (D)	Antibacterial, anti-inflammatory and anti-leukaemia (Asfaw et al., 2003).	Essential oils (Asfaw et al., 2003); eremophiloids eudesmanoids (Zhao et al., 2003). Thymoquinol dimethyl ether & α-eudesmol (Ekundayo et al., 1989). Flavonoids (Wu et al., 2006).
Vernonia colorata (Willd.) Drake Asteraceae	2	Bitali, mekang, melute	Diabetes, toxoplasmose, worms infections (Benoit et al., 2000). Fever, infertility, epilepsy, rheumatism, wounds, gonorrhoea, hepatitis & disgestive tract infections (Arbonnier, 2002).	L (D, S)	Antimicrobial (Kelmanson et al., 2000). Antimalariala, antispasmodic (Benoit et al., 1996).	Oils & sesquiterpens (Kerharo & Adam, 1974). Vernolide & hydrovernolide (Gasquet & Bamba, 1985).

Spathodea campanulata P.Beauv. **Bignoniaceae**	3	Foufougue, foukfouk	Hernia, schizophrenia, leucorrhoea, malaria & haemorrhoids (Adjanohoun *et al.*, 1996). Infertility, postpartum & weakness impotence (Focho *et al.*, 2009). Dysentery, ulcer, gonorrhoea, diarrhoea & poisons (Amusan *et al.*, 1995). Diabetes (Nagla'a, 2007). Haemorrhoids (Agyare *et al.*, 2009).	L, B (D)	Antimalarial, hypoglycemiant, anti-HIV (Niyonzima *et al.*, 1999). Antimicrobial, antioxydant & nephroprotective (Rajesh *et al.*, 2010).	Spathodic acids, steroids, saponins, ursolic acids, tomentosolic acids, verminosids, pectic compounds, anthocyanins (Amusan *et al.*, 1996). Phenolic acids, cafeic acids, ferulic acids, flavonoids (Nagla'a, 2007). Specioside, diglucoside kampeferol & cafeic acids (Elusiyan *et al.*, 2011).
Stereospermum acuminatissimum K. Schum. **Bignoniaceae**	2	Watefè	Not found	B (D, M)	Not found	Not found
Cordia platythyrsa Bak. **Boraginaceae**	4	Fapbè	Not found	F (S)	Not found	Not found
Canarium Schweinfurthii Engl. **Burseraceae**	3	Beré, pui	Cough (Adjanohoun *et al.*, 1996). Fever, constipation, malaria, diarrhoea, sexual infections, rheumatism (Koudou *et al.*, 2005).	B (D)	Antioxydant, antimicrobial (Obame *et al.*, 2008).	Lipids and fatty acids (Obame *et al.*, 2008).
Dacryodes edulis (G.Don) H.J. **Burseraceae**	8	Zo'o	Digestive tract infections, ear infections, dysentery & anemia (Ayuk *et al.*, 1999). Leprosy (Bouquet, 1969). Skin infections (Ajibesin *et al.*, 2008).	L, B (D)	Antimalarial (Zofou *et al.*, 2011). Antibacterial (Ajibesin *et al.*, 2011). Antimicrobial & antioxydant (Obame *et al.*, 2011).	Essential oils rich in monoterpens, sesquiterpens, diterpens, triterpens, phellandrène & β-caryophyllène (Onocha *et al.*, 1999).
Carica papaya Linn. **Caricaceae**	27	Papaye, popo'o	Asthma, rhinitis (Morton, 1977). Wounds, burns, dyspesia, gastro-intestinales disorders, cancer, infectious diseases (Otsuki *et al.*, 2010). Diabetes, malaria, gonorrhoea, jaundice, headache, splenomegaly (Adjanohoun *et al.*, 1996). Urinary tract infections (Mesfin *et al.*, 2005). Hypertension, galactagogue, dyspesia (Arbonnier, 2002).	L, B, F (D)	Anthelmintic, antimicrobial, anti-tumor, antiprotozoa (Banerjee, 2001). Antioxydant, anti-inflammatory (Imaga *et al.*, 2010).	Folic acids, vitamin B12, alcaloids, saponins, glycosides, tannins, anthraquinones, flavonoids (Suresh *et al.*, 2008). Carpaine, carpasemine, chymopapaine (Gurub-Fakim, 2008).
Terminalia glaucescens Planch. **Combretaceae**	11	Tsi-sa'a	Diabetes, bacteria infections, obesity, typhoid fever, malaria, asthma, hepatosplenomegaly (Adjanohoun *et al.*, 1996). Dysentery, anti-HIV (Koudou *et al.*, 1995).	B (D)	Antimicrobial (Ndukwe *et al.*, 2005 ; Balou *et al.*, 2010). Antispasmodic, antivirale, antioxydants (Njomen *et al.*, 2011).	Glaucinoic acids, triterpenoids (Atta-Ur-Rahmana *et al.*, 2005). Alkaloids, saponins, tannins, steroids, flavonoids, anthraquinones, phlobatannins (Adebayo & Ishola, 2009 ; Kolapo *et al.*, 2009).
Cupressus lusitanica Mill. **Cupressaceae**	5	Sapin	Postpartum, hair loss (Bussmann & Ashley, 2010).	Wp, L, S (D)	Not found	Not found
Pteridium aquilinum (Linn.) kulh. **Dennstaedtiaceae**		Koukoumazong	Antiprotozoa (Crane, 1990).	L (D)	Antimicrobial activity (Hassan *et al.*, 2007).	Glycoside anthraquinones, cardiac glycosides, cyanogenic glycosides, essential oils (Hassan *et al.*, 2007).
Dioscorea dumentorium **Dioscoreaceae**	3	Leliock, meliock neliock	Not found	L (D)	Not found	Not found
Entada abyssinica A. Rich. **Fabaceae**	3	Not found	Infertility, menstruation disorders (Chifundera, 1998). Asthma, tuberculosis, cough (Otieno *et al.*, 2011). Rheumatism, abdominale pains, diarrhoea, fever (Bekele-Tesemma *et al.*, 1993). Malaria, syphilis, wounds, psoriasis, convulsions (Arbonnier, 2002).	B (D)	Antivirale (Cos *et al.*, 2002). Antibacterial (Fabry *et al.*, 1998). Antiprotozoa (Freiburghaus *et al.*, 1998).	5S, 6R, 8a R-5-(carboxymethyl)-3-4-4a, 5, 6, 7, 8, 8a-Octahydro-5, 6, 8a trimethylnaphthalenecarboxylic, methyl 3,4,5-trihydroxybenzoate, 1,2,3-triol benzene, 2,3-dihydroxypropytriacontanoate (Teke *et al.*, 2011).

Pseudarthria confertiflora (A. Rich.) Baker **Fabaceae**	2	Not found	Not found	L (D)	Not found	Not found
Senna alata (Linn.) Roxb **Fabaceae**	21	Foupan	Constipation, gastro-enteritis, intestinal worms, eczema, typhoid fever, hepatitis, jaundice (Adjanohoun, *et al.*, 1996). Skin infections, syphilis, gonorrhoea (Arbonnier, 2002). Hypertension (Okafor & Ham, 1999).	L (D)	Hepatoprotective (Pieme *et al.*, 2006). Antimicrobial (Awal *et al.*, 2004).	Phenols, tannins, saponins, alkaloids, steroids, flavonoids, carbohydrates (Owoyale *et al.*, 2005).
Harungana madagascariensis Lam-expoir **Hypericaceae**	5	Not found	Menstruation disorders, dysentery, female infertility, hernia (Adjanohoun *et al.*, 2009). Postpartum (Focho *et al.*, 2009). Malaria, fever, nervous depression, kidney & liver diseases (Adeneye *et al.*, 2008).	B (D)	Antimicrobial activity (Okoli *et al.*, 2002). Analgesic, anti-inflammatory, antioxydants (Kouam *et al.*, 2006). Antiplasmodic (Ndjakou Lenta *et al.*, 2007).	flavonoids, alkaloids, saponins, glycosides, tannins (Moulari *et al.* 2006). Harunmadagascarins C & D, Kenganthrol D, harumadagascarins A & B, harunganol B, harungin anthrone, bazouanthrone (Kouam *et al.*, 2007).
Ocimum gratissimum Linn. **Lamiaceae**	15	Kotemadjo, masep, masepo	Gonorrhoea, vaginitis, metritis (Abdulrahma, 1992). Respiratory infections, diarrhoea, headache, conjunctivitis, skin infections, pneumonia, fever (Okigbo & Ogbonnanya, 2006). Cough, convulsion, gastroenteritis (Adjanohoun *et al.*, 1996). Hypertension, malaria (N'Guessan *et al.*, 2009). Facilitate the childbirth (Kamatenesi *et al.*, 2007).	L (D)	Antimicrobial, antidiabetic activity (Oussou *et al.*, 2008). Insecticidal activity (Seri-Kouassi *et al.*, 2004). Anti-HIV activity (Elujoba, 2000).	Sterols, polyterpens, polyphenols, flavonoids, catechic tannins, alkaloids (N'Guessan *et al.*, 2009). Monoterpens, sesquiterpens, saponosids (Oussou *et al.*, 2008).
Vitex doniana Sweet **Lamiaceae**	6	Vounetane, voutane	Typhoid fever (Faleyimi *et al.*, 2012). Syphlis (Adjanohoun *et al.*, 1996). Dysmenorrhoea, infertility, gastritis, smallpox, epilepsy, wounds, snake bites (Arbonnier, 2002).	B (D)	Antimicrobial activity (Kubmarawa *et al.*, 2007; Iroha *et al.*, 2010).	Sponins, tannins, essential oils (Kubmarawa *et al.*, 2007).
Gossypium barbadense Linn. **Malvaceae**	10	Coton, ti-sisi	Pelvic pains, postpartum (Rajith *et al.*, 2010). Malaria (Ajaiyeoba *et al.*, 2006).	L (D)	Not found	Not found
Theobroma cacao L. **Malvaceae**	2	Caca	Wounds (Agyare *et al.*, 2009)	L, B (D)	Not found	Not found
Thespesia populnea (Linn.) soland ex corr **Malvaceae**	6	Kepfou	Asthma, cholera, diarrhoea, diabetes, dysentery, gonorrhoea, haemorrhoids, hernia, wounds (Parekh & Chanda, 2008). Liver diseases (Venkata & Sai, 2011).	L (S)	Antidiabetic, antioxydant activity (Parthasarathy *et al.*, 2009). Antimicrobial activity (Saravanakumar *et al.*, 2009).	Alkaloids, flavonoids, carbohydrates, phytosterols, tannins, saponins, proteins, amino acids, terpens, phenols, mucilage (Venkata et Sai, 2011). Essential oils, glycosides, fatty acids (Siddharth *et al.*, 2009). Gossypol, herbacetine, kaempferol (Parekh & Chanda, 2008). Thespones, thespesones, mansonone-D & H, gossypol (Akila & Rani, 1993).
Ficus sur Forssk **Moraceae**	5	Gack, gaia	Galactagogue (Addo-Fordjou *et al.*, 2008). Wounds, burns, ulcers (Agyare *et al.*, 2009).	B (D)	Not found	Not found
Moringa oleifera Lam. **Moringaceae**	2	Moringa	Typhoid fever (Faleyimi *et al.*, 2012). Skin infections, headache, rheumatism (Amri & Kisangau, 2012). Urinary tract infections, diarrhoea, dysentery, diabete, hypertension (Fahey, 2005).	L (D)	Antidiabetic, hypocholesterolemic activity, anti-inflammatory, liver, kidney infections, cardiovascular problems, anticancer (Bharali *et al.*, 2003).	Gallic tannins, catechol tannins, steroids, triterpenoids, flavonoids, saponins, anthraquinones, alkaloids (Kasolo *et al.*, 2010).

Musa paradisiaca Linn. **Musaceae**	22	Kedong, kadong	Diarrhoea, dysentery, intestinal infections, diabetes, uraemia, nephritis, hypertension, venereal diseases (Ghani, 2003). Nervous depression, epilepsy, hysteria, mastitis, cystitis, prostatis, syphilis (Focho *et al.*, 2009).	L (D)	Antimicrobial, hematoprotectives, hypoglycemic, antihypertensive activity (Biswas *et al.*, 2011).	Pectines, flavonoids (Ragasa *et al.*, 2007). Serotonine, norepinephrine, tryptophane, indolic compounds, tannins, starch, iron, cristalized & non cristalized sugar, vitamin C, vitamin B, albuminoids, fatty acids, mineral salts (Ghani, 2003). Alkaloids, steroids, flavonoids, saponins, sugars, tannins (Biswas *et al.*,2011).
Psidium guajava Linn. **Myrtaceae**	22	Goyave, gravou	Weakness impotence (Focho *et al.*, 2009). Diarrhoea, dysentery, dermatitis (Adjanohoun *et al.*, 1996). Vaginitis, haemorrhoids, leucorrhoea (Arbonnier, 2002). Malaria, infectious diseases (Gurib-Fakim, 2008).	L, B (D)	Antimicrobial activity (Gurib-Fakim, 2008). Antioxydants (Ayoola *et al.*, 2008). Hepatoprotective, antispasmodic, hypoglycemiant, hypotensive (Ojewole, 2005).	Tannins, essential oils, cinnamic acids, 3-hexenoic, quercetin, glycosides, eugenol (Gurib-Fakim, 2008).
Imperata cylindrica (L.)Raeusch. **Poaceae**	4	Kenick, neuck, nick	Wounds (Anbu et al., 2009). Abdominale pains (Kamatenesi *et al.*, 2011).	Wp (D)	Antibacterial , antipyretic (Balangcod *et al.*, 2012).	Alkaloids, flavonoids, tannins, glycosides (Balangcod *et al.*, 2012) .
Paullinia pinnata Linn. **Sapindaceae**	3	Dzick	Rheumatism, weakness impotence (Addo-Fordjour *et al.*, 2008). Ulcers, haemorrhoids, wounds (Agyare *et al.*, 2009). Malaria (Adinorthey *et al.*, 2012). Fever, hypertension, contraceptive (N'Guessan *et al.*, 2009). Buruli ulcer (Yemoa *et al.*, 2008). Syphilis (Focho *et al.*, 2009).	L (D)	Stimulent, antioxydants (Annan & Houghton, 2010).	Tannins, saponins (Yemoa *et al.*, 2008). Sterols, polyterpens, polyphenols, flavonoids, tannins, alkaloids, saponosids (N'Guessan *et al.*, 2009).
Gardenia ternifolia Schum et Thonn. **Rubiaceae**	2	Metoucbouor	Ascites, diarrhoea, rachitism, leprosy, constipation, hepatitis, rheumatism, onchocerciasis, female infertility, wounds, haemorrhoids (Arbonnier, 2002).	B (D)	Purgatives, cholagogue, duiretic, emetic, asthenia (Arbonnier, 2002).	Not found
Mitracarpus villosus(Swartz)DC. **Rubiaceae**	3	Not found	Leprosy, skin infections (Jegede *et al.*, 2005). Dysentery, diarrhoea (Dalziel, 1937).	Wp (D)	Antibacterial, anti-inflammatory (Jegede *et al.*, 2005).	Stigmasterols, urlolic acids (Sofowora, 1986). Coumarins (Ekpendu, 1995).
Lantana camara Linn. **Verbenaceae**	7	Lantana	Cataracte, snake bites, epilepsy (Kamatenesi *et al.*, 2011). Malaria (Clarkson *et al.*, 2004). diarrhoea, cough, asthma, jaundice, constipation, gastritis, asthenia, rheumatism, arthritis (Arbonnier, 2002).	L (D)	Antimicrobial (Tripathi, 2010). Antiulcerogenic, antihyperglycemic, antimotility, anti-inflammatory, antifertility, anticancer, antiproliferative (Ghosh & Sarma, 2010). Hemolitic activity (Kalita, 2011).	Essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, iroids glycosides, phenyl ethanoids, oligosaccharids, quinine, saponins, steroids, triterpens, sesquiterpens, tannins (Kensa, 2011; Kalita, 2011).

WP: whole plant; L: leaves; B: barks; R: roots; S: stems; SL: stems with leaves; T: tuber; F: fruits
MP: mode of preparation, are written in parenthesis for each part used; D: decoction; M: maceration; S: squeezed; I: infusion
Freq.: frequency of citation by informants

The minimum inhibition concentrations (MIC) and minimum bactericidal concentration (MBC) values are presented in Table 2. The lowest MIC values 128 µg/ml was exhibited by the extract of *Vitex doniana* against *Salmonella paratyphi* A; followed by the extract of *Rauvolfia vomitoria, Senna alata* and *Terminalia glaucescens* with MIC values of 512 µg/ml each on *S. paratyphi A,* while *S. paratyphi B* was most sensitive on *Senna alata* and *Terminalia glaucescens* extract with a MIC of 512 µg/ml.

The extract of *Bidens pilosa, Harungana madagascariensis, Gardenia ternifolia* and *Lantana camara* were most effective against *Salmonella typhi* with MIC values of 512 µg/ml. *Annona muricata, Senna alata, Terminalia glaucescens, Paullinia pinnata* and *Vitex doniana* inhibited the growth of all the bacteria tested. The results of table 2 showed detectable MBC values for some of the studied plants on the tested microbial strains.

When analyzing carefully the MIC and MBC results for each plant samples, it can be noted that MBC/MIC ratios lower than 4 were obtained for *Carica papaya, Pseudarthria confertiflora, Moringa oleifera and Harungana madagascariensis*, thus considered to have bactericidal activities (Noumedem *et al.*, 2013). To the best of our knowledge, the activity of *Pseudarthria confertiflora* on the microorganisms studied in the present work is being reported for the first time.

Table 2: Screening of 38 plant species for potential antibacterial activity against some *Salmonella* species.

Botanic name	P Sc	*S. typhi*					*SPA*				
		40 mg/ml	80 mg/ml	160 mg/ml	MIC	MBC	40 mg/ml	80 mg/ml	160 mg/ml	MIC	MBC
Eremomastax speciosa (Hochst) cufod	L	7.67 ± 0.46	8 ± 0.81	10,5 ±0.40	2048	4096 (2)	nd	nd	nd	1024	8192 (8)
Pseudospondias microcarpa Engl.	B	8,5 ± 0.40	9,5 ± 0.40	11,5 ±0.40	4096	/	nd	nd	nd	/	/
Annona muricata Linn.	L	9.5 ± 0.40	11 ± 0.81	14,5 ±0.40	4096	4096 (1)	0±0	10 ±00	13 ± 00	2048	/
Picralima nitida (Stapf) Th. et H.	R	0± 0	9 ± 00	12 ± 0.81	1024	4096 (4)	0±0	8,5 ±1.22	10 ±1.63	/	/
Rauvolfia vomitoria Afz.	B	0 ±0	10± 00	12 ± 0.81	8192	/	11±0.81	12.5±0.40	15.5 ±0.40	2048	/
Dracaena deisteliana Engl	L, R	0±0	0±0	7.5±0.40	/	/	nd	nd	nd	/	/
Bidens pilosa Linn.	Wp, L	10.5 ± 1.22	12 ± 0.81	13 ± 0.81	512	2048 (4)	10 ±00	10.5 ±0.40	12 ±0.81	/	/
Emilia coccinea (Sims) G. Don.	Wp	0±0	0±0	8.5±0.41	nd	nd	0±0	0±0	8.5±0.41	/	/
Laggera alata (G. Don)Sch. BipEx. Oliv.	L	7.5 ± 0.40	10 ± 00	13.5 ±0.40	4096	/	nd	nd	nd	/	/
Vernonia colorata (Willd.) Drake	L	0 ± 00	9 ± 0.81	10.5 ±0.40	/	/	nd	nd	nd	/	/
Spathodea campanulata P.Beauv.	L	9 ± 00	10 ± 0.81	12.5 ±0.40	1024	8192 (8)	nd	nd	nd	/	/
Stereospermum acuminatissimum K. Schum.	B	11 ± 00	13 ± 0.81	15 ± 0.81	2048	/	nd	nd	nd	/	/
Cordia platythyrsa Bak.	F	10 ± 00	11 ± 0.81	12 ± 0.81	2048	8192 (4)	nd	nd	nd	/	/
Canarium Schweinfurthii Engl.	B	0 ± 00	9 ± 00	10,5 ±0.40	4096	8192 (2)	nd	nd	nd	/	/
Dacryodes edulis (G.Don) H.J.	L	14.5 ± 0.40	15.5 ± 0.40	19.5 ±0.40	2048	4096 (2)	nd	nd	nd	/	/
Carica papaya Linn.	L, B, F	8.5 ± 0.40	10 ± 00	12 ± 00	1024	2048 (2)	9 ±0.81	11 ±0.81	12 ±0.81	/	/
Terminalia glaucescens Planch.	B	9.5 ± 0.40	16.5 ± 0.40	20.5 ±0.40	8192	/	0 ± 00	10.5±0.40	13 ±0.81	512	2048 (4)
Cupressus lusitanica Mill.	Wp, L, S	0 ± 00	8.5 ± 0.40	10.5 ±0.40	2048	/	nd	nd	nd	/	/
Pteridium aquilinum (Linn.) kulh.	L	0 ± 00	9 ± 0.81	11.5 ±0.40	4096	/	0 ± 00	8.5 ± 0.40	11 ± 0.81	2048	/
Dioscorea dumentorium	L	0 ± 00	9.5 ± 0.40	11 ± 0.81	1024	8192 (8)	nd	nd	nd	/	/
Entada abyssinica A. Rich.	B	0 ± 00	8.5 ± 0.40	10.5 ± 0.40	2048	/	nd	nd	nd	/	/
Pseudarthria confertiflora (A. Rich.) Baker	L	11.5 ± 0.40	15 ± 0.81	23,5 ± 1.22	2048	8192 (4)	nd	nd	nd	/	/
Senna alata (Linn.) Roxb	L	10.5 ± 0.40	17.5 ± 0.40	20,5 ± 0.40	1024	/	12.5 ±0.40	17.5 ± 0.40	24 ± 0.81	512	4096 (8)
Harungana madagascariensis Lam-expoir	B	0 ± 00	8.5 ± 0.40	11.5 ± 0.40	512	2048 (4)	nd	nd	nd	/	/
Ocimum gratissimum Linn	L	10.5 ± 0.40	11.5 ± 0.40	12 ± 0.40	2048	4096 (2)	0 ± 00	10.5 ± 0.40	11 ± 00	/	/
Vitex doniana Sweet	B	0 ± 00	0 ± 00	10 ± 00	1024	4096 (4)	9.5 ± 0.40	11 ± 0.81	11.5 ± 1.22	1024	4096 (4)
Gossypium barbadense Linn.	L	0 ± 00	10 ± 0.81	10.5 ± 0.40	8192	/	nd	nd	nd	/	/
Theobroma cacao L.	L, B	9.5 ± 0.40	10.5 ± 0.40	13.5 ± 0.40	8192	/	nd	nd	nd	/	/
Thespesia populnea (Linn.) soland ex corr	L	8 ± 00	10 ± 0.81	11 ± 0.81	2048	/	nd	nd	nd	/	/
Ficus sur Forssk	B	0 ± 00	10.5 ± 0.40	11 ± 00	8192	/	nd	nd	nd	/	/
Moringa oleifera Lam	L	9.5 ± 0.40	11 ± 00	12.5 ± 0.40	1024	2048 (2)	9.5 ± 0.40	10 ± 00	11.5 ± 0.40	/	/
Musa paradisiaca Linn.	L	9.5 ± 0.40	10.5 ± 1.22	12 ± 0.40	2048	4096 (2)	0 ± 00	0 ± 00	10.5 ± 0.40	/	/
Psidium guajava Linn.	L, B	9 ± 0.81	10 ± 00	11.5 ± 0.40	2048	4096 (2)	nd	nd	nd	/	/
Imperata cylindrica (L.)Raeusch.	Wp	0 ± 00	0 ± 00	10.5 ± 0.40	2048	/	nd	nd	nd	/	/
Paullinia pinnata Linn.	L	0 ± 00	10.5 ± 0.40x	11 ± 00	2048	8192 (4)	0 ± 00	9.5 ± 0.40	12 ± 0.40	2048	2048 (1)
Gardenia ternifolia Schum et thonn.	B	0 ± 00	9.5 ± 0.40	11 ± 0.81	512	2048 (4)	nd	nd	nd	/	/
Mitracarpus villosus(Swartz)DC.	Wp	0 ± 00	11 ± 00	13,5 ± 0.40	4096	/	nd	nd	nd	/	/
Lantana camara Linn	L	10.5 ± 0.40	11.5 ± 0.40	13 ± 0.81	512	2048 (4)	8.5 ± 0.40	9 ± 0.81	11 ± 0.81	/	/
Eremomastax speciosa (Hochst) cufod	nd	nd	nd	/	/	-	++	++	+	+	-
Pseudospondias microcarpa Engl.	nd	nd	nd	/	/	-	+++	+++	+	+	+
Annona muricata Linn.	0±0	9±0.81	11,5 ± 0.40	4096	8192 (2)	+	+	+	+	+	+++
Picralima nitida (Stapf) Th. et H.	nd	nd	nd	/	/	+	+	+	+	+	+++
Rauvolfia vomitoria Afz.	11 ± 0.81	12,5 ± 0.40	15.5 ± 0.40	512	4096 (8)	+	+	++	+	+	-
Dracaena deisteliana Engl	0±0	8,5 ± 1.22	12 ± 00	/	/	+	-	-	+	+	++
Bidens pilosa Linn.	9 ± 00	10 ± 00	12.5 ± 0,40	/	/	+	+	+	+	+	-
Emilia coccinea (Sims) G. Don.	/	/	/	/	/	+	+++	+	+	+	-
Laggera alata (G. Don)Sch. BipEx. Oliv.	nd	nd	nd	/	/	+	+	++	+	+	+
Vernonia colorata (Willd.) Drake	nd	nd	nd	/	/	-	++	+++	+	+	-
Spathodea campanulata P.Beauv.	nd	nd	nd	/	/	+	+	+++	+	+	+
Stereospermum acuminatissimum K. Schum.	nd	nd	nd	/	/	-	+	+	+	+	+++
Cordia platythyrsa Bak.	0 ± 00	8.5 ± 0.40	9,5 ± 0.40	/	/	+	+++	+++	+	+	+++
Canarium Schweinfurthii Engl.	nd	nd	nd	/	/	+	+	+++	+	+	-
Dacryodes edulis (G.Don) H.J.	nd	nd	nd	/	/	+	+	+++	+	+	-
Carica papaya Linn.	0 ± 00	9.5 ± 0.40	11 ± 0.81	/	/	+	+	+	+	+	+
Terminalia glaucescens Planch.	nd	nd	nd	512	4096 (8)	+	+++	+++	+	+	+++
Cupressus lusitanica Mill.	nd	nd	nd	/	/	-	+	+	++	+	+++
Pteridium aquilinum (Linn.) kulh.	0 ± 00	0 ± 00	9 ± 0.81	/	/	-	-	++	+	+	++
Dioscorea dumentorium	nd	nd	nd	/	/	-	-	++	-	-	++
Entada abyssinica A. Rich.	nd	nd	nd	/	/	-	++	++	+	+	++
Pseudarthria confertiflora (A. Rich.) Baker	11 ± 0.81	13.5 ± 1.22	17.5 ± 0.40	2048	2048 (1)	+	+++	+++	+	+	+++
Senna alata (Linn.) Roxb	10.5 ± 0.40	13.5 ± 0.40	22 ± 2.03	512	4096 (8)	+	+	++	++	+	++
Harungana madagascariensis Lam-expoir	nd	nd	nd	/	/	-	+++	+++	++	++	-
Ocimum gratissimum Linn	0 ± 00	8.5 ± 0.16	10 ± 00	/	/	+	-	+	+	+	-
Vitex doniana Sweet	0 ± 00	10 ± 00	11 ± 0.81	128	2048 (16)	-	++	++	+	+	+
Gossypium barbadense Linn.	nd	nd	nd	/	/	-	+++	+++	-	-	+
Theobroma cacao L.	nd	nd	nd	/	/	-	+++	+++	+	+	+
Thespesia populnea (Linn.) soland ex corr	nd	nd	nd	/	/	-	+	+	++	+	-
Ficus sur Forssk	nd	nd	nd	/	/	-	++	++	+	+	+++
Moringa oleifera Lam	nd	nd	nd	/	/	-	++	+++	+	+	-
Musa paradisiaca Linn.	0 ± 00	9 ± 0.81	12 ± 00	/	/	+	+	+	+	+	+
Psidium guajava Linn.	nd	nd	nd	/	/	+	+	+	+	+	-
Imperata cylindrica (L.)Raeusch.	nd	nd	nd	/	/	+	+	+	+	+	-
Paullinia pinnata Linn.	8.5 ± 1.22	10.5 ± 1.2	13 ± 0.81	1024	8192 (8)	-	-	+	+	+	+++
Gardenia ternifolia Schum et thonn.	nd	nd	nd	/	/	+	+++	+++	+	+	-
Mitracarpus villosus(Swartz)DC.	nd	nd	nd	/	/	-	+++	+++	+	+	+++
Lantana camara Linn	9.5 ± 0.40	11 ± 0.81	12.5 ± 1.22	8192	/	-	+	+	+	+	-

	I.Z.D	MIC	MBC	MBC/MIC	
Ciprofloxacin (10 µg/ml)	30 ± 0.81	**64**	**128**	**2**	*S. typhi* ATCC 6539
	28,5 ± 1.22	**32**	**64**	**2**	*SPA*
	30 ± 1.63	**32**	**64**	**2**	*SPB*

P Sc: part screened., I.Z.D.= Mean diameter of growth inhibition zones in mm average of three replicates, SD= Standard deviation. *S. typhi : Salmonella typhi ; SPA: Salmonella paratyphi A ; SPB : Salmonella paratyphi B.*, Al: Alkaloids; Fl: Flavonoids; Pl: Polyphenols; T: Triterpens ; Se : Sterols ; Sa : Saponins., /: indicates no zone of inhibition or activity; the result are mean ±S.D (n=3)., +++, high concentration; ++, medium concentration; +, low concentration; -, not detected

DISCUSSION

The high diversity of species used for treatment of typhoid fever in the study area, is an indication of the importance of medicinal plants. The reliance on traditional medicine may be due to the perceived potency of the plants. High consensus among users in different countries reflects the significance of medicinal plants to the people (Cotton, 1996). It was clear that the informants harvest the bark, roots, stem, fruits and leaves; but the part that is used most was found to be the leaves. Leaves as frequently used organ in traditional herbal drugs is also reported elsewhere (Muthu *et al.,* 2006 ; Panghal *et al.,* 2010). In addition to this, leaves are the main photosynthetic organs in plants and are considered to be the natural pharmacy for synthesis of many active constituents those are pharmacologically more active against certain diseases (Passalacqua *et al.,* 2007). In general the use of leaves as the chosen plant part is a more sustainable practice as opposed to where roots and/or the bark are used. The prevalence in the use of leaves for preparation of traditional herbal remedies has been reported in other studies (Muthu *et al*. 2006; Focho *et al*. 2009; Panghal *et al*. 2010; Amri & Kisangau 2012). This practice helps to increase the chances of species survival and enhances the sustainable management of plants, as long as only an appreciable amount of leaves is harvested (Abede & Ayehu, 1993; Tadesse *et al*. 2005).

It was not surprising that decoction was the preferred preparation method. Decoction is known to be an effective extraction method compared to maceration in cold water, since boiling facilitates the extraction of constituents and also kills microorganisms potentially associated with the harvested plants. Plant parts were generally prepared using water as the solvent, likely because water is a readily available and cheap solvent and provides good solubility of the active components. Oral administration was the only mode of dispensing of herbal medicines against typhoid fever. This is because the causal bacterium is located in the intestinal tract. This mode of administration of herbal medicine was also reported elsewhere (Kamatenesi & Oryem-Origa, 2006; Bhattarai *et al*. 2010).

Bidens pilosa is the most commonly used plant for treatment by informant. Several studies document good antimicrobial effects of its extract (Rojas *et al.,* 2006; Deba *et al.,* 2008).

Phytochemical screening conducted on the plant extracts (Table 2) revealed the presence of compounds which are known to exhibit biological as well as physiological activities (Sofowora, 1993). These are alkaloids, flavonoids, polyphenols, saponins, sterols and triterpens. The presence of all the secondary metabolites in *Annona muricata, Laggera alata, Spathodea campanulata, Cordia platythirsa, Carica papaya, Terminalia glaucescens and Pseudarthria confertiflora*, is an indication that these plants are of pharmacological importance (Adebayo & Ishola, 2009), and also justified their potential use as drug in the study area. Almost all the plants contained triterpenes except in *Dioscorea dumetorum* and *Gossypium barbadense*. Triterpenes have been found to be useful in the prevention and therapy of several diseases, including cancer. Triterpenoids are also known to possess antimicrobial, antifungal, antiparasitic, antiviral, anti-allergenic, antispasmodic, antihyperglycemic, antiinflammatory and immunomodulatory properties (Wagner & Elmadfa, 2003). The presence of this compound probably justified the use of the selected plants for the treatment of typhoid fever. However, the absence of this constituent in the leaves of *Gossypium barbadense* did not corroborates the findings of Charu *et al.,* (2012).

Furthermore, most of these plants contained phenolic compounds (Polyphenols and flavonoids) which are one of the largest and most ubiquitous groups of plant metabolites (Singh *et al.,* 2007). They possess biological properties such as antiapoptosis, antiaging, anticarcinogenesis, antiinflammation, antiatherosclerosis, cardiovascular protection, improvement of endothelial function, as well as inhibition of angiogenesis and cell proliferation activities (Han *et al.,* 2007). Flavonoids are hydroxylated phenolic substances known to be synthesized by plants in response to microbial infection and they have been found to be antimicrobial substances against wide range of microorganisms *in vitro*. Their activity is probably due to their ability to complex with extracellular and soluble proteins and to complex with bacterial cell wall (Marjorie, 1996). In addition, Polyphenols have been reported to exhibit antibacterial activities with distinguished characteristics in their reactivity with proteins related polyamides polymers (Haslam, 1996).

Sterols present in most of our plant sample, have been reported to have antibacterial properties (Raquel, 2007) and they are very important compounds especially due to their relationship with compounds such as sex hormones (Okwu, 2001).

The absence of alkaloids and saponins in *Moringa oleifera* in the present work is in contrast with the opinion of Gills (1992) and Kasolo *et al.,* (2010) who noted that saponins and alkaloids are two of the active constituents. For instance, alkaloids are nitrogen-containing naturally occurring compound, commonly found to have antimicrobial properties due to their ability to intercalate with DNA of the microorganisms. Also, the presence of saponin in *Annona muricata* is in agreement with previous findings of Yusha'a *et al.* (2011).

The activity of plant extracts against bacteria have been studied for years, but in more intensified way during the last three decades. During this period, numerous antimicrobial screening evaluations have been published based on the traditional Chinese, African and Asian uses of plant-based drugs (Suffredim *et al.,* 2004). In the present study, the results of antibacterial property of the 38 plant extracts (table 2) against tested organisms varied depending on bacteria tested and concentration as previously reported by (Ravikumar *et al.,* 2007; Rajesk *et al.,* 2010). However, 38, 15 and 14 plants shows inhibition diameter against *Salmonella typhi, S. paratyphi B* and *S. paratyphi A* respectively. Nevertheless, negative results obtain with some of the plants extracts tested do not indicate the absence of bioactive constituents, nor that the plant is inactive. Active compound(s) may be present in insufficient quantities in the extracts to show

activity with the dose levels employed (Taylor *et al.,* 2001). Lack of the activity can thus only be proven by using large dose (Farnsworth, 1993), if the active principle is present in high enough quantities, there could be other constituents exerting antagonistic effects or negating the positive effects of the bioactive agents (Jager *et al.*, 1999).

It was noticed that *Senna alata,* showing the highest antibacterial activity on both pathogens with zone of inhibition of 24, 22.5, 20.5 mm on the *Salmonella paratyphi A, S. paratyphi B* and *S. typhi* respectively at 160 mg/ml. This could probably have been due to the fact that the rate of the active ingredients or constituents in the plant materials is higher compared to the other plants used in this research (Kunle & Egharevba, 2009). Preliminary phytochemical analysis of *S. alata* leaves showed that, they possess polyphenols, triterpenes and saponins. Phytoconstituents such as polyphenols, triterpenes and saponins have been reported to inhibit bacterial growth and to be protective to plants against bacterial and fungal infections (Mather & Gonzalel, 1982; Okwute, 1992). The presence of saponins in this plant must have exhibited direct antibacterial activity and suppression of bacterial virulence resulting to the antimicrobial activity seen in this study (Gills, 1992). This also corroborate with the report of Owoyale *et al.,* (2005) who documented on the plant *Senna alata* to be effective in treatment of fungal and bacterial diseases.

The fact that *Salmonella typhi* was more susceptible to the extract of *Pseudarthria confertiflora, Terminalia glaucescens, Senna alata, Dacryodes edulis* and *Stereospermum acuminatissimum* indicated the potency of these plants against typhoid fever. *Senna alata* and *Rauvolfia vomitoria* were found to be the most sensitive against *Salmonella paratyphi* A. However, *Salmonella paratyphi B* was sensitive to the extract of *Senna alata, Pseudarthria confertiflora* and *Rauvolfia vomitoria.* The antibacterial activity of *Terminalia glaucescens, Senna alata, Dacryodes edulis and Rauvolfia vomitoria* have been reported in the literature (Owoyale *et al.,* 2005; Obame *et al.,* 2008; Adebayo and Ishola, 2009; Ayepola, 2009; Ogundiya *et al.,* 2009; Ajibesin *et al.,* 2011; Bolou *et al.,* 2011; Omogbai & Eneh, 2011).

In local area, these plants are being used in the treatment of typhoid fever, diarrhea, dysentery etc. So, the uses of these plants as antibacterial agent are justified; since they showed good inhibition zones. Demonstration of low MIC (128 µg/ml) especially by *Vitex doniana* (table 2) is an indication that the phytoconstituents of the plant have therapeutic potential. Similar report revealed the antimicrobial potency of *Vitex doniana* with MIC range from 0.4-128 µg/ml (Iroha *et al.,* 2010). It is important to highlight that *Vitex doniana* has been thoroughly studied phytochemically and its antimicrobial activity has been evaluated (Kubmarawa *et al.,* 2007; Iroha *et al.,* 2010). In this study, its antibacterial activity was demonstrated. It is no surprising the activity shown by this plant, since other species of the same genus (*V. negundo*) have shown to have antibacterial, anti-inflammatory and anti-fungal activity (Rusia & Srivastava, 1998; Dharmasiri *et al.,* 2003; Panda *et al.,* 2009).

Based on literature on these 38 plants, there is no biological and chemical on *Pseudarthria confertiflora*. Several species of the genus *Pseudarthria* (*P. viscida* and *P. hookeri*) has been studied and it has been demonstrated that they presented immunomodulatory and anti-fungal activity (Clarkson *et al.,* 2004; Deepa *et al.,* 2004; Mathew & Sasikumar, 2007; Vijayabaskaran *et al.,* 2010), but the particular species *Pseudarthria confertiflora* has never been studied before and in this work, its antibacterial activity was demonstrated. The activity of this plant against *salmonella typhi, S. paratyphi A* and B has added one more plant that can offer alternative medicare to diseases caused by these microorganisms.

According to Noumedem *et al.* (2013), a sample is bactericidal when the ratio MBC/MIC ≤ 4 and bacteriostatic when this ratio is >4. It therefore appeared that bactericidal effects were obtained with the extracts from *Carica papaya, Pseudarthria confertiflora, Moringa oleifera and Harungana madagascariensis*. The result of antibacterial of *Vitex doniana, Rauvolfia vomitoria, Senna alata, Terminalia glaucescens Bidens pilosa, Harungana madagascariensis Gardenia ternifolia* and *Lantana camara* is highly encouraging and gives new lead plants for isolation and characterization of the active compounds. It is probably these active chemical constituents present in these plants which are responsible for the treatment of various bacterial infections caused by *Salmonella sp*.

CONCLUSION

The result of the present study offers a scientific basic for the use of the majority of tested plants in the treatment of typhoid fever in Bamboutos division. These plants species can be regarded as promising resources for anti-typhoid drugs. It seems that further investigations are necessary in order to draw solid conclusions.

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