

# Patronage and perceived efficacy of herbal antityphoid preparations, and anti-salmonella activity of a herbal preparation used in Ghana

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## ABSTRACT

**Objectives:** To assess the patronage, and the perceived efficacy of herbal preparations in the treatment of typhoid fever, and to ascertain the anti-salmonella activity of a herbal preparation used as an antityphoid in Ghana. **Materials and Methods:** Purposively and conveniently from 700, 65 individuals who had had typhoid fever (clinically confirmed) were sampled. Well-structured questionnaires on the subject were administered to sampled individuals. Experimentally, the Minimum Inhibitory Concentration (MIC) of a herbal antityphoid preparation on *Salmonella typhi* was determined using the broth dilution method. **Results:** 46/65 (70.8%) used herbal preparations (19 used pre-packaged products; 27 used extemporaneous preparations) while 19/65 (29.2%) used orthodox drugs to treat their infection. Some of the herbs commonly used were *Nauclea latifolia*, *Morinda lucida*, *Paullinia pinnata*, *Vernonia amygdalina*, *Cassia alata*, *Phyllanthus fraternus*, *Azadirachta indica*, *Mangifera indica*, and *Carica papaya*. Majority, 42/45 (91.3%), recovered after the use of the herbal antityphoid products (laboratory confirmation), 7/42 (15.2%) had relapse within three months, 9/45 (19.6%) experienced mild side effects. Experimentally, both the prepared herbal mixture and ciprofloxacin had MICs of 4 and 2 µg/µl respectively. **Conclusion:** Herbal anti-typhoid preparations are highly patronized and have been found to be efficacious. Experimentally the herbal mixture prepared showed interesting anti-salmonella activity.

## INTRODUCTION

Typhoid fever, a potentially life-threatening gastrointestinal infection, is caused by a non-spore-bearing bacilli called *Salmonella enterica* serovar Typhi (*S. typhi*) (Santos *et al.*, 2001). This bacterium is transmitted by the orofecal route with the organism gaining entry into the body through the intestinal mucosa in the region of the Peyer's patches (Ochiai *et al.*, 2008). Advances in public health strategies, technology, and hygiene have led to the eradication of typhoid fever from the developed world but since the 1800s, typhoid fever has remained an endemic disease in many developing countries (Ashbolt, 2004; Bhutta and Dewraj, 2006). This is worrying because of

typhoid fever associated morbidity and mortality (Crump, 2004) particularly in children younger than 5 years (Sinha *et al.*, 1999, Siddiqui *et al.*, 2006), as well as the emergence of multidrug-resistant (MDR) *Salmonella typhi* strains against first line antimicrobials such as Ampicillin, Chloramphenicol, and Cotrimoxazole (Rowe *et al.*, 1997; Renuka *et al.*, 2005; Bhutta and Dewraj, 2006; Bhutta, 2006).

The sources of infection vary but the commonest mode of transmission is by ingesting an infective dose of *S. typhi* through food or water contaminated with feces or urine of a patient or carrier. The true global disease burden of typhoid fever is difficult to estimate as few established surveillance systems on typhoid fever exist in developing countries (Bhutta and Dewraj, 2006). For example, in Africa the overall burden of typhoid fever remains largely unknown, mainly because facilities capable of performing the blood culture tests essential for diagnosis are absent from many regions (Mweu and English, 2008).

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Typhoid fever like malaria and schistosomiasis, is one of the commonest febrile illnesses in developing countries (Hathout, 1970; Nsutebu, 2003; Ochiai *et al.*, 2008). Factors that influence the extent and the overall clinical outcome of the disease include the patient's age and or immune status, vaccination history, the amount of inoculum ingested, the choice of antimicrobial agent as well as rising antimicrobial resistance which has led to increased disease related hospitalization and complications (Sinha *et al.*, 1999; Brooks *et al.*, 2005; Siddiqui *et al.*, 2006). Untreated typhoid fever can lead to gruelling complications such as gastrointestinal haemorrhage, ileal perforation, hepatomegaly, anorexia, diarrhoea, toxicity, encephalopathy, myocarditis and disseminated intravascular coagulation (McConkey, 2002, Mert *et al.*, 2004). For decades, the antibiotics Chloramphenicol, Ampicillin, and Cotrimoxazole were the mainstay of typhoid treatment (Acharya *et al.*, 1995). However, the widespread emergence of multidrug-resistant (MDR) *S. typhi* strains necessitated the search for other therapeutic alternatives such as the fluoroquinolones (Ciprofloxacin, Norfloxacin, and Ofloxacin), the third generation cephalosporins (e.g. Ceftriazone), and the azalides (e.g. azithromycin) (Mirza *et al.*, 1996). Fluoroquinolones are however restricted from routine use in children and quinolone-resistant *S. typhi* strains have been documented (Wallace *et al.*, 1993; Wain *et al.*, 1996; Vinh *et al.*, 1996). Ceftriazone is highly effective against *S. typhi* but parenteral administration limits its usage (Wallace *et al.*, 1993). Azithromycin is however very effective against *S. typhi* (Butler and Girard, 1993). These drugs are very expensive and less affordable to a majority of individuals in developing countries such as Ghana, hence a greater proportion of the population resort to the use of herbal medicines which are generally affordable and easily accessible to the majority. It is estimated that about 80 % of the world's population rely on traditional medicine particularly herbal medicine for primary health care because of less side effect profile, better compatibility with the human body, efficacy and better cultural acceptability (Gijtenbeek *et al.*, 1999, Abbiw *et al.*, 2002, WHO, 2003). Ghana is a land of immense biodiversity and a hub of very potent and efficacious herbal medicines which are involved either in the holistic treatment of diseases or in the alleviation of symptoms. An impressive number of plants have been used traditionally in the treatment of typhoid fever in Africa and in Ghana since time immemorial such as *Vernonia amygdalina* (Asteraceae), and *Nauclea latifolia* (Rubiaceae) (Omobuwajo *et al.*, 2008). This study involving a survey, and laboratory investigation was therefore carried out to assess the patronage and perceived efficacy of herbal preparations in the treatment of typhoid fever and to ascertain the anti-salmonella activity of a herbal preparation used as an antityphoid drug in Ghana.

## METHODOLOGY

### Study area

The study was conducted at Asafo, Ayigya, Adum and Bantama which are suburbs in Kumasi, the capital of the Ashanti

Region of Ghana. These areas were selected because they are densely populated with people from different ethnic groups and cultural diversity, high commercial activity and well established industries.

### Sampling technique and sample size

Non-probability and random sampling methods were used to sample 700 individuals who were randomly interviewed to ascertain that the individual had had typhoid fever before. Of these, 65 individuals were purposively and conveniently sampled to participate in this study.

### Inclusion criteria

A total of sixty five individuals were selected for this study based of the following;

- The individuals had been laboratory diagnosed of typhoid fever within the last five years.
- The individual was presently diagnosed with typhoid fever.
- The individuals used either herbal remedies, orthodox/allopathic medicine or both for the treatment of the disease before but at different times.

### Exclusion criteria

After the preliminary interview, most individuals were excluded from the study because those individuals;

- Had not been laboratory diagnosed of typhoid fever in the last five years.
- Had been presumptively diagnosed with typhoid fever.
- Had been laboratory diagnosed of typhoid fever but had used only orthodox/allopathic drugs for treatment.
- Only knew about typhoid fever and its symptoms.
- Knew the herbal drugs for typhoid fever but had not used any of them before in therapy.

### Study design

A well-structured questionnaire designed to include close and open ended questions was pretested on a convenient sample of 10 individuals for easy comprehension and easy readability. Semi-structured interviews were conducted (between November 2013 and March, 2014) in twi (the local language of the indigenous people; which is spoken and understood by all) where necessary after verbal consent was sought from participants.

### Study variables

Data gathered from respondents included their bio-data, choices of drugs (herbal or orthodox medicines), patronage of herbal anti-typhoid preparation, how long herbal antityphoid drugs had been used by the respondents, names of herbs used, and perceived efficacy of anti-typhoid herbal preparation, among others.

## Data analysis

The data obtained from respondents were analyzed using SPSS (Statistical Package for Social Scientists) version 20.0 for windows. Graphs were drawn with GraphPad prism Version 6 (GraphPad Software, San Diego California USA, www.graphpad.com).

## Anti-salmonella activity of a herbal antityphoid drug

### Preparation of the herbal antityphoid product (NCVP)

This formula was provided by Adutwumwaa Herbal Industries Limited, Abuakwa, Kumasi, in the Ashanti Region of Ghana; a manufacturer of prepackaged herbal products. The plant parts of *Nauclea latifolia* (roots), *Cassia alata* (leaves), *Vernonia amygdalnas* (leaves) and *Phyllanthus fraternus* (leaves) were obtained from Techiman, in the Brong Ahafo Region of Ghana. These were selected based on the most common herbs mentioned by respondents.

The plants were authenticated by a Pharmacognosist, in the Department of herbal medicine, KNUST, Ghana. The plant parts as outline above were quantified in the ratio of 10:1:1:1 respectively, combined and boiled for two hours with 10.5 litres of water. The herbal preparation was evaporated to dryness in a hot air oven at 40 °C.

The weight of sample before drying was 90.59g and the percentage yield after evaporation to dryness was 16.82%. The dry powder, labelled NCVP, was stored in a dessicator and portions of it reconstituted in sterile water for use in this study.

### Drugs Used

Ciprofloxacin hydrochloride (Denk Pharma GmbH & Co. KG., Germany) was used as the reference anti-salmonella drug.

### Determination of anti-salmonella activity of NCVP

The broth dilution method was employed in the determination of Minimum Inhibitory Concentration (MIC), using a 200 µl volume 96 well microtitre plate. A stock solution of NCVP of concentration 256 µg/µl was prepared. From this, 200 µl dilute solutions of NCVP of concentrations 1, 2, 4, 8, 16, 32, 64, and 128 µg/µl were prepared using 80 µl of double strength nutrient broth, 10 µl of *S. typhi* suspension, a volume of the NCVP stock solution, and sterile water to make up to volume. The same was done for ciprofloxacin (1, 2, 4, 8, 16, 32, 64, and 128 µg/µl); the reference anti-salmonella antibiotic used. The mixtures were incubated for 48 hours at 37 °C and the MICs estimated.

## RESULTS

### Demographic characteristics of sampled population

Of the 65 respondents who had ever had typhoid fever before, 34 (52%) were male while 31 (48%) were female. The modal age (25; 38.5%) was 31-40 years. The majority 34 (52.3%) of the respondents were traders (Table 1).

### Patronage of herbal anti-typhoid preparation

Results indicate that 46 (70.8%) [25 males, 21 females], used herbal anti-typhoid preparations while 19 (29.2%) were using orthodox drugs. Of the 46 using herbal preparations, 19 (41.3%) used pre-packaged herbal products, while 27 (58.7%) used extemporaneous preparations made from various combinations of herbs and leaves listed in Table 2. Data on patronage did not seem to differ significantly among gender however the 21-30 and the 31-40 year ranges had 64.7 % and 60% patronage respectively. All the unemployed, as well as majority of civil servants (83.3%) and traders (76.5%) patronized herbal preparations (Table 3).

### How long individuals had used herbal antityphoid drugs

The highest recorded time for which herbal anti-typhoids have been used by respondents anytime they had typhoid fever, after being introduced to it, was 8 years and this was by 2 (4.3%) respondents. The least duration of time was within three months and this was by 7 (15.2%). The majority 12 (26.1%) of respondents had used these within four to six months after being introduced as this was their first time of having the disease (Table 4).

### Perceived efficacy of anti-typhoid herbal preparation

While majority, 42 (91.3%), recovered after the use of the herbal anti-typhoid products (according to medical laboratory confirmation), six (8.7%) did not recover. Seven (15.2%) had relapse of the disease; two after one month, and five, within three months. Nine (19.6%) experienced side effects (i.e. two, three, and four experienced dizziness, diarrhea, and vomiting respectively) after the use of the herbal anti-typhoid products but these were not severe (the diarrhea, and vomiting were self-limiting). Thirty-seven (80.4%) experienced no side effects.

### Combination of herbal and orthodox antityphoid products

Based on the result obtained from combination of herbal and orthodox antityphoid drugs, 14.3% of the users of herbal antityphoid products combined theirs with orthodox drugs while 85.7% used only herbal antityphoid products.

**Table 1:** Age and employment status of 65 respondents used in the study on the patronage and perceived efficacy of herbal preparations used in the treatment of typhoid fever in Kumasi, Ghana.

Gender	Frequency/ percentage	Age range	Frequency/ Percentage	Occupation	Frequency/ Percentage
Males	34 (52%)	11-20	12 (18.5%)	Farmers	3 (4.6%)
Females	31 (48%)	21-30	17 (26.2%)	Traders	34 (52.3%)
		31-40	25 (38.5%)	Civil servant	6 (9.2%)
		41-50	10 (15.4%)	Unemployed	3 (4.6%)
		> 50	1 (1.5%)	Student	17 (29.2%)

**Table 2:** Herbs used for the prepackaged extemporaneous preparations used by respondents.

Herbs	Botanical names	Vernacular/local name	Frequency	Percentage
	<i>Nauclea latifolia</i>	Kankanu	14	30.4
	<i>Morinda lucida</i>	Konkronma	19	41.3
	<i>Citrus aurantifolia</i>	Ankaadwea	7	15.2
	<i>Persia americana</i>	Paya	9	19.6
	<i>Paullinia pinnata</i>	Tuantini	11	23.9
	<i>Ricinodendron heudelotii</i>	Wan ma	2	4.3
	<i>Alchornea cordifolia</i>	Agyamma	3	6.5
	<i>Picalima nitida</i>	Zkuamen	5	10.9
	<i>Terminalia superba</i>	ξfram	1	2.1
	<i>Rauwolfia vomitoria</i>	Kakapenpen	11	23.9
	<i>Mangifera indica</i>	Amango	8	17.4
	<i>Trichilia ornithothena</i>	Tanuro niniakra	2	4.3
	<i>Vernonia amygdalina</i>	Anwowene	19	41.3
	<i>Cassia alata</i>	Simpe	15	32.6
	<i>Phyllanthus fraternus</i>	Abξwommaguwakyi	12	26.1
	<i>Azadirachta indica</i>	Nim tree	16	34.7
	<i>Carica papaya</i>	BξξfrZ	15	32.6
	<i>Spathodea campaulata</i>	Kuakuanusu	3	6.5
	<i>Antholeisia nobilis</i>	ξkuafo kZtZ	1	2.1
	<i>Cymbopogon citrates</i>	Tee sare	3	6.5

The names of the herbs were obtained from the list of active ingredients on the products mentioned by the respondents themselves. Respondents gave vernacular names which were translated into their botanical names.

**Table 3:** Data on the frequency and the percentage patronage of the 46 individuals who used herbal antityphoid drugs to treat typhoid fever.

Gender	Frequency/ percentage	% patronage	Age range	Frequency/ Percentage	% patronage	Occupation	Frequency/ Percentage	% patronage
Males	25 (54.3%)	73.5	11-20	12 (26.1%)	100	Farmers	2 (4.3%)	66.7
Females	21 (45.7%)	67.8	21-30	11 (23.9%)	64.7	Traders	26 (56.5%)	76.5
			31-40	15(32.6%)	60	Civil servant	5 (10.9%)	83.3
			41-50	10 (15.2%)	100	Unemployed	3(6.5%)	100
			> 50	1 (0.02%)	100	Student	10 (21.7%)	52.6

**Table 4:** How long respondents have been using herbal anti-typhoid drugs to treat typhoid fever after being introduced to it.

Time period	Frequency (n)	Percentage (%)
0-3 months	7	15.2
4-6 months	12	26.1
7-9 months	7	15.2
10-12 months	5	10.9
2 years	4	8.7
4 years	6	13.0
7 years	3	6.2
8 years	2	4.3
Total	46	100.0

**Table 5:** Minimum Inhibitory Concentration of ciprofloxacin and herbal antityphoid product (NCVP) on growth of *Salmonella typhi* in the broth dilution method.

Wells	Concentration (µg/µl)								
	1	2	4	8	16	32	64	128	
NCVP (Decoction)									
A	+	+	-	-	-	-	-	-	
B	+	+	-	-	-	-	-	-	
C	+	+	-	-	-	-	-	-	
D	+	-	-	-	-	-	-	-	
Ciprofloxacin hydrochloride									
E	+	-	-	-	-	-	-	-	
F	+	-	-	-	-	-	-	-	
G	+	-	-	-	-	-	-	-	
H	+	-	-	-	-	-	-	-	

The ‘-’ (negative sign) used signifies the inhibition of the bacteria *Salmonella typhi* at the different concentrations. The ‘+’ (positive sign) used signifies the presence of the bacteria *Salmonella typhi* at the different concentrations.

#### Anti-salmonella activity of NCVP

At concentrations of 4, 8, 16, 32, 64, and 128 µg/µl, there was complete inhibition in growth of *Salmonella typhi* by both NCVP and ciprofloxacin in all the wells (A-H). At concentration

2 µg/µl, there was also inhibition of growth of the organism by Ciprofloxacin in wells E-H. For the concentration 1 µg/µl, there was presence of growth in all the wells (A-H) for both NCVP and Ciprofloxacin (Table 5).

## DISCUSSION

The vast contribution of traditional medicine to the well-being and the improvement in the quality of life of the African particularly the Ghanaian cannot be overemphasized. Despite the numerous challenges facing traditional medicine use globally such as standardization, stability and quality control issues, traditional medicines have managed to thrive well through the years (Sen *et al.*, 2011; Gyasi *et al.*, 2015). Based on this background, this study was conducted to ascertain the perceived efficacy and hence the patronage of herbal preparations used in the management of typhoid fever, and to ascertain the anti-salmonella activity of a herbal preparation used as an antityphoid drug in Kumasi, the second largest city in Ghana.

Of 65 purposively sampled individuals who had typhoid fever, males were more than females (52%:48%). Evidence exists to support this distribution, that typhoid fever is more prevalent in males than females (Hosoglu *et al.*, 2004). The exact reason for this male predisposition to the infection is not well known although it is possible that males have an increased exposure to unsafe drinking water and food than females (Whitaker *et al.*, 2009). More than half (64.7%) of the respondents were between 20 - 40 years which was in line with findings from previous studies. For instance, the study by Akinyemi *et al.*, (2000) on antibacterial screening of five Nigerian medicinal plants used against *S. typhi* and *S. Paratyphi* showed that young adults were more predisposed to the infection. Going about their normal daily activities, young adults are more likely to consume food and water contaminated with *S. typhi* strains, or come into contact with individuals who are carriers of the disease.

Majority (52.3%) of the respondents were traders. In Ghana, traders have a high probability of exposure to *Salmonella typhi* by coming into contact with carriers, ingestion of contaminated food and water, or being exposed to non-sanitary or unhygienic environments. When *S. typhi* enters the digestive system, it multiplies in the intestines and spreads rapidly throughout the blood stream causing a systemic infection with associated symptoms such as fever, headache, nausea, loss of appetite, constipation and diarrhoea (House *et al.*, 2001). Currently, global typhoid fever prevention strategy is focused at improving sanitation by ensuring clean and safe food and good water supplies, identification and efficient treatment of chronic *S. typhi* carriers as well as the use of typhoid vaccines (Crump and Mintz, 2010).

A lot of people in Africa, and in Ghana resort to herbal medicines as their first line of treatment when they are sick (Gyasi *et al.*, 2015). This fact has also been made evident by the findings of this study. In this study, 70.8% of the respondents with typhoid fever used herbal medicine for treatment. This is line with results of a previous study conducted in the Kumasi Metropolis and the Sekyere South District in Ghana on prevalence and pattern of traditional medical therapy utilization (Gyasi *et al.*, 2015). Out of this number, 21 were females while 25 were males. This result showing male dominance in the use of traditional medicine is in

contrast to the results of previous studies where females dominate in the use of herbal medicine (Loera *et al.*, 2001, Adusumilli *et al.*, 2004).

In recent times, public interest in natural remedies, mostly herbal medicine, has increased drastically not only in developing countries but also highly industrialized countries (Grunwald, 1995). This has increased international trade in herbal medicine tremendously. Self-prescribed herbal remedies are on the ascendency these days for the treatment of diseases such as headaches, insomnia, fever, malaria, intestinal disorders, typhoid fever, depression, coughs, cancer, premenstrual syndrome etc (Crag *et al.*, 1993, Craig, 1999). Medicinal plants such as *Morinda lucida*, *Magnifera indica*, *Carica papaya*, *Paullina pinnata*, *Phyllantus fraternus*, *Cassia alata*, *Veronia amydalina* and *Rawolfia vomitoria* are very popular and have been used in the management of several diseases including typhoid fever since prehistoric times (Akinyemi, 2000; Ashafa and Olunu, 2011). The popularity and usage of these plants have been confirmed in this study as a lot of respondents alluded to the fact that they had used these medications for the management of typhoid fever. In his study, majority (76.2%) of the respondents after being introduced to herbal anti-typhoid drugs a year had used it to treat typhoid fever (Table 4). It appears there is massive usage of herbal products in the management of both acute and chronic conditions (Zollman and Vickers, 1999, Li and Wang, 2005) and this has been evidenced in this study as 2 (4.3%) had used herbal anti-typhoid preparations, anytime they had the infection, for about 8 years.

It is known that factors considered in selecting herbal medicine as a choice of treatment include the efficacy of the medicine, affordability, convenience and easy accessibility (Eddouks *et al.*, 2002). Due to the known and documented side effects caused by synthetic products, herbal products are now moving from fringe to mainstream use with a lot of people seeking health remedies from natural products (Johnson and William, 2002). Herbal products which were hitherto confined to health food shops are now marketed in a lot of pharmacies. Whereas some herbal products contain physiologically safe and beneficial active constituents, others may not be unsafe to use. Some herbs are classified as unsafe even in minute quantities by the Food and Drug Administration (Larkin, 1983, Saxe, 1987). Natural medicinal plants are however in danger of extinction due to unscrupulous harvesting techniques and loss of growth habitat. During the collection of medicinal products for curative purposes, the season, age of the plant, storage conditions, and temperature play an indispensable role in its potency.

The fact that 91.3% of users of herbal anti-typhoid preparations have recovered (confirmed by medical laboratory tests) after use support the findings of several studies done to prove the efficacy of herbal anti-typhoid products (Ernst, 2005, Bent, 2008). It is generally believed that herbal preparations are pure because they are prepared using natural bases without any additives. However, there is limited scientific evidence to ascertain the safety and side effect profile of most herbal products (Bent, 2008). In this study, 9 (19.6%) experienced mild side effects after

using herbal anti-typhoid products. Side effects of herbal preparations can range from relatively mild ones such as diarrhea, vomiting and dizziness as reported in this study to more serious and complex ones such as hepatotoxicity, precipitous labor, tetanic uterine contractions, hyperthermia, hypertension, seizures and coma as reported in previous studies (MacGregor *et al.*, 1989, McFarlin *et al.*, 1999; Wells and Bjorksten, 1989).

Attempts have been made to integrate traditional and orthodox medical systems although it has seen much difficulty. Polytherapy is indicated as a good pharmaceutical principle however, further studies are needed to ascertain the relative advantage of polytherapy (Ebong *et al.*, 2008). Polyherbal therapy is also recommended as a good pharmaceutical principle because of its advantage of producing maximum therapeutic efficacy with minimum side effects (Ebong *et al.*, 2008, Chan, 2003). Out of the total users of the herbal anti-typhoid products, 14.3% combined theirs with orthodox medicine.

The herbal anti-typhoid mixture tested for anti-salmonella activity contained *Vernonia amygdalina*, *Cassia alata*, *Phyllanthus fraternus* and *Nauclea latifolia* in a ratio of 1:1:1:10 respectively. These herbs have good antibacterial activity especially against gram negative bacteria, analgesic, anti-diabetic, anthelmintic, anticancer, antimalarial, antioxidant and anti-inflammatory properties. This is because they contain flavonoids, sesquiterpene lactones, saponins, tannins, alkaloids and sterols in varying degrees (Ebong *et al.*, 2008, Abosi and Raseroka, 2003, Akah and Okafor, 1992).

*In vitro* studies was carried out to prove the efficacy of the herbal anti-typhoid preparation by cultivating *S. typhi* on bismuth sulphite agar. The presence of *S. typhi* was confirmed by the growth of silver rabbit eyed colonies on the agar. Isolation of *S. typhi* was done by sub-culturing into a test tube containing nutrient broth which had a cloudy top indicating growth of viable organisms.

Ciprofloxacin, which is a fluoroquinolone, was used as a standard solution as it is one of the leading orthodox drugs used in the treatment of typhoid fever. Using the broth dilution method, ciprofloxacin inhibited *S. typhi* at a minimum concentration of 2 µg/µl while the herbal mixture inhibited the organism at 4 µg/µl indicating that ciprofloxacin is more potent than the plant extract. Also, ciprofloxacin had higher antimicrobial activity than the herbal mixture.

In addition to the increasing complexity of managing typhoid fever because of antimicrobial resistance, there is a strong case for much greater effort in disease control through improvements in sanitation, greater access to safe water and food, identification and treatment of *S. typhi* carriers and more widespread use of currently available vaccines in populations at high risk of infection.

## CONCLUSION

Herbal anti-typhoid preparations are highly patronized and have been reported to be efficacious in the treatment of

typhoid fever. Experimentally the herbal mixture prepared from *Vernonia amygdalina*, *Cassia alata*, *Phyllanthus fraternus*, and *Nauclea latifolia* showed anti-salmonella activity by inhibiting the growth of *Salmonella typhi* at a Minimum Inhibitory Concentration of 4 µg/µl.

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