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REVIEW ON PLANTS THERAPEUTIC EFFECTS AGAINST GASTROINTESTINAL MICROBES

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Abstract

Plants play vital roles in many health care systems, be it rural or an urban community. Plants became familiar as medicine due to the primordial ideologies and believes. Several plants parts served as medicines to so many ailments including gastrointestinal ailments, due to the fact that their active ingredients are powerful against the microbes as well as healing so many physiological abnormalities. Most of the microbes identified were gram- negative and gram-positive bacteria. Some of the principal antibacterial components were recommended being polar compounds. While most of the acknowledged components with antimicrobial activity extracted from plants were aromatic or saturated organic compounds which were more soluble in polar solvents such as water and methanol but in some instances, Di methyl sulphate oxides was used to ascertain the level of activity of the plants. As such plants materials in one way or the other are very active when dealing with microbes due to their active ingredients.

Key words: Ailments, compounds, Gastrointestinal, microbes and plants

Introduction

²⁵ Plants play a significant role in many health care systems, particularly in evolving countries where modern drugs are expensive for the populations to access. ²⁵ In many cases, herbal medicines substitute the absence of modern medicines. But many traditional societies everywhere in the world are in the process of losing traditional knowledge, possibly due to the altering lifestyle and formal education (Kantati *et al.*, 2016). Medicinal plant familiarity is like all local awareness, a community invention that is part of the specific traditional system. Local awareness is not always evenly distributed, and it is not every member of the group that is inescapably with the same facts (Ene and Atawodi, 2012). Researches had shown that, there are a lot of local plants in Nigeria for the handling of numerous diseases. However, scientific facts have been known only on to a limited scope with few medicinal plants. Owing to the adverse effect of many orthodox drugs and the cost of obtaining these drugs. It is needful as a matter of fact to use plants which are natural reservoir of many antimicrobial agents as well as various healing activities (Madara *et al.*, 2018).

Moreover, African traditional curative system and ethno medication have established appreciable consideration. The widespread literature on the issue which indicates clearly that traditional medication practice occupies a very protruding place in the treatment of diseases in the African culture. ²⁸ Traditional medicine is the sum total of acquaintance, services, and applies based on the models, opinions, and experiences home-grown to different cultures that are used to maintain well-being, as well as to prevent, detect, improve, or treat physical and mental disorders. ¹⁰ The treatment has been implemented by other populations (outside its indigenous culture) is often termed balancing or substitute medicine.

The World Health Organization (WHO) reported that 80% of the developing world's population relies on traditional medicine for treatment. During the past decades, the developed world has also perceived an ascending trend in the utilization of medicine, predominantly herbal medicines (Mahomoodally, 2013). Herbal medicines include herbs, herbal materials,

herbal preparations, and finalised herbal products that contain parts of plants or other plant materials as active ingredients. While 90% of the population in some parts of Africa used herbal remedies for their primary healthcare as well as surveys carried out in developed countries like Germany and Canada tend to show that at least 70% of their population have tried at least once (Sawadogo *et al.*, 2012).

Nevertheless, it is likely that the philosophical knowledge of herbal remedies in traditional cultures, developed through trial and error over many centuries, along with the most important cures was sensibly passed on orally from one generation to another. Indeed, modern allopathic medicine has its origins in this early medicine, and it is likely that many important new remedies will be developed and commercialized in the forthcoming from the African biodiversity, as it has been till now, by following the leads provided by traditional familiarity and experiences (Mahomoodally, 2013). The main aim of this review is to ascertain the curative activities of different plants extracts on the gastrointestinal microbes.

The consumption of plants as medicines

The medicinal plants witnessed a growing number of publications geared towards evaluating the efficacy from scientific literature in Africa which are believed to have an important contribution in the maintenance of health and in the introduction of new treatments. However, there is still a scarcity of updated comprehensive compilation of auspicious medicinal plants from the African continent (Mahomoodally, 2013). Integration of traditional medicine in health systems since 1978, the WHO at its 31st Assembly has suggested countries to make a complete inventory of medicinal plants, evaluation of their efficacy, safety and a standardization of the active products (Sawadogo *et al.*, 2012). WHO has also reported some critical problems that hamper the incorporation of traditional medicine in the majority of countries: Public demands on folk medicine exceeds the know-how and resources of health authorities; Inadequate guideline and registration for herbal products and other traditional treatments and Lack of training for research in traditional medicine (Sawadogo *et al.*, 2012).

Nevertheless, the consumption of plants and their resources for fighting various ailments predates written history and they are still in use all over the world. The oldest written evidence of the usage of medicinal plants for the preparation of drugs has been found on a Sumerian clay slab from Nagpur, which is believed to be approximately 5000 years old. The isolation of morphine from opium in the early 19th century served as a gate starter for many studies aimed

at isolating active compounds from medicinal plants and this discovery led to the isolation of other bioactive combinations, such as cocaine, codeine, dig toxin, and quinine (Kankara *et al.*, 2015).

Although pharmaceutical companies as well as ⁴ Research and Development (R&D) organizations are hiring increased interest in molecular modelling, combinatorial chemistry and other synthetic chemistry techniques, natural products, precisely medicinal plants which remained as the source of new drugs and new chemical entities (Kankara *et al.*, 2015).

⁴ More so, maximum number of medicinal plants are traditionally obtained from the wild, where they grow naturally. However, as a result of many undesirable human and environmental factors, such as overharvesting, deforestation, desertification and global warming to mention a few, medicinal plants are faced with the serious problem of disappearance. It has been reported that approximately 15,000 medicinal plants species are at risk of becoming extinct due to habitat destruction, overharvesting and large trade throughout the world. This is further compounded by the fact that many medicinal plants are also useful as raw materials for some industries, such as cosmetics, textile, biomass, food and confectionaries; thus, the pressure on the diversity of medicinal plants is extremely high. The overexploitation of medicinal plants is relatively higher in developing countries, where the majority of the population depend on medicinal plants for their primary healthcare services (Kankara *et al.*, 2015).

²¹ Consequently, detailed deliberations with the informants and a cross-section of key informers among the traditional healers further exposed that even when the healers prescribe treatment to their patients, only the traditional doctor can prepare it; the patients would not be informed of the plant species from which the treatment is derived nor the method of preparation of the treatment. Nonetheless, this system is slowly changing and in recent years, some flexibility appeared to be emerging, with the traditional healers and quite willing to provide information about the traditional treatments in exchange of financial benefits or compensation (Mohammed, 2015). Lastly, today plants are considered in different uses varying from region to region and individuals to individuals. That is to say the use to which the same plant species can be put by the people in the riverine area may likely be different from those in the savannah and in certain restricted areas. Furthermore, man uses plant resources in many forms, the most basic are the following: food, medicine, cosmetics, architecture and for domestic facilities (Garba, 1997).

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However, scientific botanical data mentioned that 30% of the worldwide sales of drugs were based on natural products. Traditional indigenous medicine is limited to small tribal and geographical which are called “Slight traditions” are an outstanding source of knowledge about medicinal properties of botanical sources. Phytochemical screenings of medicinal plants are very important in recognising new sources of therapeutically and industrially important compounds. It is also used in pharmaceutical and nutraceuticals products of commercial importance. Encouragement for conservation and cultivation of herbal fauna can play an important role in livelihood enhancement of rural population (Kumari *et al.*, 2017). The clinical success of quinine and quinidine isolated from the Cinchona tree bark and recently artemisinin from *Artemisia annua* used in the treatment of malaria, which have renewed interest in medicinal plants as potential sources of novel drugs (Igoli *et al.*, 2005). Today artemisinin based combination therapy is recognized as drug of choice for treatment of malaria and the numerous advantages of herbal medicine such as low-cost, affordability, prepared availability, convenience, adequacy and low harmfulness are ready sources of medical power. However, the various disadvantages of the practices which include; lack of adequate scientific proof, inaccurate diagnosis and dosage, unstandardized medicines and occultic practices can also be resolved. Medicinal plants play vigorous roles in disease prevention and their promotion and use fit into all existing prevention strategies. However, conscious efforts need to be made to properly recognise, distinguish and position medicinal plants in the design and implementation of these strategies (Elekwa, Ugbogu, Okereke, & Okezie, 2017).

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Nevertheless, preparations were either crude extracts made with water or local spirits, such as gin, or poultices. For decoctions, quantities are not measured accurately and the extracts are made on a large scale by boiling plant material with liquid in large pots over a fire. The resulting extract is kept for about a week, being discarded when a noticeable colour change occurs. Mixtures are made by pouring hot water on to the plant material and drinking the resultant extract immediately (Ashidi *et al.*, 2010). Occasionally the patient uses the aqueous extract for bathing the affected area. Poultices are made with mashing the fresh plant material with a small amount of water and palm oil, and then rubbing the resulting mass on to the affected area, or leaving it in contact with the skin for several hours by means of a supporting cloth. In all instances the amount administered to the patient is not very accurately measured, so dosage is very difficult to estimate (Ashidi *et al.*, 2010). In the recent years, research on medicinal plants has drawn a lot of attentions globally for its versatile applications. Medicinal plants are the wealthiest bio- resources of drugs of traditional system of medicines, modern medicines, food

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supplements, nutraceuticals, folk medicines, pharmaceutical intermediates and chemical activities for synthetic drugs. Scientific experiments on the antimicrobial properties of plants and their constituents have been documented in the late 19th century (Tumpa *et al.*, 2015).

Plants therapeutic effects on organisms

Traditional medicine based on phytotherapy may supplement and offer alternatives for animal disease control, in particular for resource-poor breeders. More studies are needed to describe the effectiveness of these ethno botanicals. The preservation of the traditional know-how, but also of the medicinal plants themselves, is essential for safety of the cultural heritage and biodiversity of the entire African regions (Vitetta *et al.*, 2012).

Consequently, the bacteria that colonize the Gastrointestinal tract (GIT) achieved a number of functions that include (1) regulating the normal development and function of the mucosal barriers (2) assisting the maturation of immunological tissues, which in turn promotes immunological tolerance to antigens from foods/environment or potentially pathogenic organisms (3) controlling nutrient uptake and metabolism and (4) stopping the propagation of pathogenic micro-organisms (Vitetta *et al.*, 2012). Changes in the profile of resident GIT bacteria may reduce their beneficial functions and affect the regulation of GI immune and inflammatory responses. Hence, in addition to its inherited composition of genes, the GIT micro biota and the effects of the environment may establish prime factors in the causation of disease as alluded to more than half a century ago (Vitetta *et al.*, 2012).

More so, Saponins are secondary compounds produced mainly by plants, but also by lower marine animals and some bacteria. They form an unchanging foam in aqueous solutions (Walker *et al.*, 2018). Saponins demonstrated to have a more dramatic effect on the activity of rumen protozoa than the component sapogenin confirming the importance of the glycoside in the activity of Saponins in the rumen. Saponins occur in different parts of the plants such as the roots, tuber, bark, leaves, seed, and fruit. Generally they are found in tissues that are most defenceless to fungal or bacterial attack or insect predation, as such they are a subclass of the large and chemically assorted group of phytoanticipin and phytoprotectant metabolites produced by plants (Walker *et al.*, 2018). Subsequently, the gut micro flora/ micro biome are closely linked to human health and disease. The segregation of enteric pathogens by these commensal microbes partially depends upon the production of bioactive compounds such as short-chain fatty acids (SCFAs) and polyunsaturated fatty acids (PUFAs). These key intestinal microbial by products are vital to the maintenance of a healthy gut microbial community. Moreover, SCFAs and PUFAs play multiple dangerous roles in host

defence and immunity, including anti-cancer, anti-inflammation, and anti-oxidant activities, as well as out-competition of enteric bacterial pathogens. The microbes involved in production of these beneficial intestinal components, and their biological functions, precisely trigger to their immunomodulation and interactions with enteric bacterial pathogens. Finally, advanced to the potential applications of these fatty acids with regards to food safety and human gut heal (Peng and Biswas, 2017). Shiga toxin-producing *Escherichia coli* (STEC) is an enteric pathogen that have been linked to occurrences from food-borne and waterborne sources. STEC causes human gastrointestinal illnesses with diverse clinical ranges, alternating from watery and bloody diarrhoea to haemorrhagic colitis. In some rare cases, infection can result in the life-threatening, haemolytic uremic syndrome (HUS), and it is thought that Shiga toxins (Stx) are the key virulence factors contributing to the development of (HUS) (Amézquita *et al.*, 2018).

The ethno botanicals surveys of medicinal plants species, were important for consequent chemical and pharmacological bio prospections (Baldé *et al.*, 2016). Moreover, the presence of several flavones and phenolic acids, which have radical scavenging properties. The potential protective role of pinocembrin and pinostrobin and extracts from buds *Populus nigra* and *Populus berolinensis* against AgNPs induced inflammation and cytotoxicity in HGF-1 cells. In addition, the antioxidant properties of poplar bud extracts have been demonstrated. *P. berolinensis* buds showed the highest activity in both the in vitro model and in the bio autographic tests (Poblocka-Olech, Inkielewicz-Stepniak, & Krauze-Baranowska, 2019). The effectiveness of anti-inflammatory and antioxidant drugs in treating inflammatory and neurodegenerative disorders has been widely documented (Houghton *et al.*, 2007; Howes and Houghton, 2003). Many studies demonstrated the anti-inflammatory, antioxidant and AChE inhibitory activities of various crude orchid extracts. Approximately five species of South African orchids are used to treat inflammatory conditions. *Polystachya ottoniana* is also used to soothe pain experienced in teething babies and to treat diarrhoea. *Ansellia Africana* is also administered as an antimicrobial while *Eulophia* species such as *Eulophia cucullata* and *Eulophia ovalis*, are used primarily to relieved pain. Investigation has shown that *Cyrtochis arcuata* treat diabetes and skin infections as well as *Tridactyle tridentata* treat psychological disorders such as madness. Two orchid species; *B. scaberulum* and *E. hereroensis*, used in South African traditional medicine were also included as they were being traded around the world. Orchid extracts that displayed significant effects in an anti-inflammatory, antioxidant and AChE inhibitory assays may have potential natural plant product targets in the treatment of inflammatory and neurodegenerative -tive disorders. Extracts include: *A. africana*, *Et OH*

root, *B. scaberulum* DCM root, *Cyrtorchis. arcuata* methanolic root, *E. hereroensis* DCM tuber, *E. petersii* DCM stem and *T. tridentata* DCM root extracts. The Et OH root extract of *B. scaberulum* exhibited the most potent selective inhibitory effect on COX-2, while the DCM tuber extract of *E. hereroensis*, was the only extract to significantly inhibit both COX enzymes (Chinsamy, Finnie, & Van Staden, 2014). Preliminary tests suggest significantly higher levels of Gallo tannin content in *A. africana*, and *E. hereroensis* methanol root extracts. This may account for the significant anti-inflammatory activity. Similarly, the presence of condensed tannins in *E. hereroensis* root and *B. scaberulum* stem/root extracts may explain the observed anti-inflammatory effects. The potent anti-inflammatory and antioxidant effect of *E. hereroensis* and *E. petersii* supports the use of species from this genus for inflammatory-related symptoms in South African traditional medicine. The overall % ant of *Prosopis pubescens* pseudo bulb and root extracts was greater than 90%, which might validate the use of species from this genus as substitutes to *P. ottoniana*, to treat certain inflammatory disorders. Flavonoids in the pseudo bulbs and roots of *P. pubescens* may have contributed to the antioxidant effects. During the survey of leaf flavonoid content in Orchidaceae, (Chinsamy, et al., 2014), as well as isolated xanthones, mangiferin and isomangiferin from five species of Polystachya and Maxillaria. The author also detected that there was no pattern of flavonoid distribution within the family Orchidaceae, and geographical location played a noteworthy role in the presence of flavonoid compounds. All four species record some flavonoid content in primary studies, shared similar sharing ranges; and are all epiphytic species. Plant compounds such as flavonoids, naphthoquinones, alkyl amides and phenolic phenyl-propane derivatives represent the usual compounds found in certain natural products that are responsible for COX inhibition (Chinsamy, et al., 2014). The presence of flavonoids in *B. scaberulum* and *T. tridentata* may clarify the potent activity observed in the anti-inflammatory and AChE inhibitory assays. The medicinal value of flavonoids includes; anti-inflammatory, antifungal, antioxidant activities and wound healing. The wound healing efficacy of *Oncidium flexuosum*, an epiphytic orchid used in Brazilian traditional medicine for inflammation and wounds, was attributed to the presence of flavonoids and tannins (Chinsamy, et al., 2014).

Diversity of gastrointestinal species and their activities on different plants materials

Escherichia coli represents a spectrum of host relationships that can range from mutualism to opportunistic and specialized pathogenesis explicit examples by which strains of commensal *E. coli* are known to modulate host immunity. Studies in germfree guinea pigs, chickens, and piglets were the first to describe that replicating *E. coli* could stimulate both mucosal and

systemic immune responses. Since then, most studies looking for ways to define specific interactions between the host immune system and *E. coli* have focused on isolates such as the probiotic strain *E. coli*, which provides protection against Salmonella and pathogenic *E. coli* O157:H7 infections in mice via competition over nutritional resources and may further help immune regulation by encouraging the expansion of plasmacytoid DC, small intestine as compared to germfree mice (Clavel *et al.*, 2017). In contrast to the immunoregulatory and protective effects of *E. coli*, other human commensal *E. coli* are hypothesized to contribute to the development of intestinal inflammation in a subset of Crohn's disease (CD) patients. These opportunists are known collectively as Adherent and Invasive *E. coli* (AIEC). AIEC strains are generally defined by their ability to stick to and conquer epithelial cells, replicate inside macrophages and induce tumour necrosis factor (TNF) production from macrophages *in vitro*. Although detailed *in vivo* studies defining the immunological response induced by these strains are still needed, one recent study sophisticatedly demonstrated that the IgA-coated AIEC strain A2 isolated from CD patients with peripheral spondyloarthritis (SpA), an extra intestinal display often found in patients with active IBD, induced both mucosal and systemic Th17 responses in germfree mice as compared to non-AIEC *E. coli*. Induction of such Th17 immunity required the *E. coli* to harbour the virulence associated metabolic t seems that in this occurrence the pathobiont alters host responses such that the host- micro biota balance tips from tolerance to inflammatory (Clavel *et al.*, 2017).

More so, no effects recorded as inquired from the respondents of the listed plants, which were stated to be used in the grounding of 55 medical remedies for treating diseased animals. Virtually half of the plants were reported for use in all common ruminants, i.e. cattle, sheep and goats, and the vast majority of the remaining arrangements were aimed at cattle only. Only 2 plant species were for exclusively for sheep and goats, and one plant species, *Passiflora foetida* L., was used specifically for preventing diseases in poultry, while *Olex subscorpioidea* Oliv. Was also indicated for deworming dogs. The most common plants used by breeders were *Cassiasieberiana* DC., *Khaya senegalensis* (Ders) A. Juss, *Diospyros mespiliformis* Hochst. ex A. DC., *Sterculia setigera* Del, *Bridelia ferruginea* Benth, *Guiera senegalensis* J F Gmel., *Opilia amantalea* Roxb., *Saba senegalensis* (A. DC.) Pichon and *Vitellaria paradoxa* CF Gaertn. These plant species are more often used to delight gastroenteritis and skin diseases. This may be explained by the prevalence of parasitic gastroenteritis and ticks (Koné *et al.* .., 2008).

Moreover, the routes of administration of these herbal therapies were essentially oral, followed by topical applications and drops to treat ears or eyes. For most of the remedies, the dose depended on age or breed of the sick animal. For applications in liquid form, the recommended quantities seemed to be a function of body size, and were generally 0.25 l for sheep and goats, 0.5 l for calf and 1 l for cattle. The 25 plants species were used as ethno veterinary medicinal plants out of 44 were testified for the first time in Côte d'Ivoire. The knowledge revealed that, only the remaining 19 species had been recorded in previous ethno veterinary surveys for veterinary care in West Africa, including Northern Côte d'Ivoire or in Africa as a whole (Koné *et al.*, 2008). However, these plants had been described for the treatment of other diseases. Only 5 species, namely *Maytenus senegalensis*, *Mitragyna inermis*, *Khaya senegalensis*, *Vitellaria paradoxa* and *Anogeissus leiocarpus*, had been reported for the same therapeutic indication in the previous ones, namely against diarrhoea and infection with intestinal worms. The later, traditional property has been linked to the auspicious anthelmintic activity of *Khaya senegalensis*, *Vitellaria paradoxa* and *Anogeissus leiocarpus*. The survey revealed that the stem bark of *K. senegalensis* was used to treat a host of diseases. That observation is in full agreement with the statement of who recognized the great importance of *K. senegalensis* in traditional veterinary medicine in Africa. In Nigeria, this plant species one of the most common plants used for treatment of trypanosomiasis in domestic animals (Koné *et al.*, 2008). The three strains of the test organism (*S. aureus*) were more liable towards *Penicillin g* than the tea extract. Also, the restraint of the microorganisms by *Pen. g.* increased with increasing concentration of *Pen g* (Esimone *et al.*, 2006).

On the other hand, increasing concentration of the tea extracts bring about in decreasing activity (Esimone *et al.*, 2006). The active components in the crude extract may be acting synergistically to produce antimicrobial effects, the disparity between the activities of the extracts and the normal antimicrobial drug, may be due to the combinations of bioactive compounds present in the extract compared to the pure compound contained in the standard antibiotic. Thus a standard drug had the highest zone of inhibition of 29mm. Methanol and ethyl acetate are polar solvents, since they showed the highest antibacterial activities. Some of the principal antibacterial components of plants were suggested being polar compounds. While most of the identified components with antimicrobial activity extracted from plants were aromatic or saturated organic compounds which are more soluble in polar solvents such as water and methanol. However water extracts were less potent (Mushore and Matuvhunye, 2013).

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Antibacterial pharmaceuticals are not accessible to the majority of the people who need them. The use of botanical medicines is generally on the rise in many parts of the world (Bbosa *et al.*, 2007).

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The antibacterial activity could be due to different classes of compounds. Some of the classes of compounds acknowledged in the crude extract, include; alkaloids and triterpenoids, have been reported to possess antibacterial activity (Bbosa *et al.*, 2007). The increased occurrence of resistance to commonly used antibiotics has led to the search for newer, cheap, and easily cheap drugs in the management of infectious diseases. Although conventional drugs are popular, however, herbal medicine continued to be practiced due to richness of certain plants in varieties of secondary metabolites such as alkaloids, flavonoids, tannins, and terpenoids which have been stated to have antibacterial activities. Different studies showed different concentrations of the methanolic extracts of the leaves and barks of *Psidium guajava*, leaves of *Mangifera indica* and fruits and seeds of *Carica papaya* showed antimicrobial activities against all the isolates of bacteria (*Bacillus cereus*, *Bacillus subtilis*, *Escherichia coli* and *Salmonella typhi*) (Tumpa *et al.*, 2015).

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Moreover, STEC infections are usually acquired by ingestion of contaminated food, water, or by contact from person to person. A large portion of STEC infections have been attributed to the consumption of undercooked contaminated food, frequently meat and dairy products. In particular, ground meat is considered a common transmission vehicle of STEC due to the ease of cross- contamination during preparation. Also, the uneven spreading of STEC throughout the substrate results in an inefficient killing of this pathogen in ground beef after heat exposure during cooking (Amézquita *et al.*, 2018). The results of the MIC and MBC on the MRSA isolates confirmed the antimicrobial potency of the plant extracts as previously observed by the disc diffusion assay. This gives confidence to the findings of other workers on antimicrobial studies of *P. guajava*. (Anas *et al.*, 2008). In a related study, recorded higher activities in the methanolic extract of *P. guajava* leaves than in the aqueous extract, though both extracts were susceptible to MDR clinical isolates of *S. aureus*. The antibacterial activity of organic extracts and essential oils of *P. guajava* leaves was also examined, and the methanolic extract showed the highest inhibition against shrimp isolates and type strains of *S. aureus*, *E. coli* and *Salmonella spp* (Nneka *et al.*, 2016). *Salmonella paratyphi* is Gram-negative, rod shaped, facultative anaerobe, non-encapsulated, non-spore forming, flagellated and motile bacteria. Three serotypes of *Salmonella paratyphi* were described; *Salmonella paratyphi* A, B and C worldwide. *Salmonella paratyphi* transmission is through faecal oral route or via eating of

unclean food/water as well as coming in contact with chronic asymptomatic carriers. The *S. paratyphi* caused enteric fever which is an important health issue in many developing countries. The incidence is increasing globally particularly in endemic regions such as certain provinces in China and Pakistan. The disease mortality rate is up to 30 and 90% of deaths is due to enteric fever occur in Asia. Humans are the only reservoir and natural host for *S. paratyphi*. The *S. paratyphi* can be isolated from paratyphoid fever patients' blood for diagnosis. Paratyphoid fever is highest in teenagers and young adults as compared to typhoid fever that is common in children as being highlighted by (Panezai *et al.*, 2018).

Nevertheless, the DNA was extracted from culture through DNA purification kit (Hiper Bacterial Genomic DNA Extraction Teaching Kit). The final PCR product was run on 1.5% agarose gel and observed under UV light (Panezai *et al.*, 2018). Consequently, Out of reasonable number of the samples collected about 55% were positive and 45% negative for *S. paratyphi*. Gender wise distribution result showed that the male (34%) were more affected with paratyphoid fever as compared to age wise distribution which concurrently revealed that *Salmonella paratyphi* was high in 20-30 years (38%) followed by 10-20 years (9.16%) and 1-10 years (7.5%) age group patients. Race wise distribution results of paratyphoid fever cases were significantly high (25.41%) in Pashtoon followed by 15.83% in Baloch, 8.33% in Punjabi and 5.41% in Hazara. The 40% paratyphoid fever were observed in patients with a very low income status, 9.16% (Panezai *et al.*, 2018). PCR based identification of specific gene used to sense *Salmonella Paratyphi*. All isolates of *Salmonella paratyphi* used to produce the specific size of 329 base pair fragment of flic-a gene as carried out by (Panezai *et al.*, 2018).

16 Genomes and ETEC strains profile

The bacteria and genomes of 118 ST-expressing ETEC strains isolated from indigenous children, adults in endemic areas, travellers, and soldiers were considered. The strains belonged to a previously published collection of 362 whole genome sequenced ETEC strains (von Mentzer *et al.*, 2014) and were used for nucleotide sequence extraction of STp and STh sequences, using the Gen Bank accession numbers M58746.1 and M18345.1, respectively. The ST ETEC strains were collected over a period of 31 years (1980–2011), worldwide; Argentina, Bangladesh, Bolivia, China, Egypt, Guatemala, Indonesia, Japan, Mexico, Morocco and Thailand (Joffré *et al.*, 2016). The preliminary phytochemical components of methanolic and water extracts of *P. guajava* stem bark contained carbohydrates, cardiac glycosides, tannins and proteins at high concentration while reducing sugar, alkaloids, Saponins and oil were

present in moderate concentration, steroids and terpenoids were present at low concentrations. This study indicated that *P. guajava* is an important source of tannin, cardiac glycosides and Saponins (Nneka *et al.*, 2016). The MIC and MBC were determined on earlier tested MRSA isolates. The MIC results reported that five of the isolates were inhibited by the methanol extracts with activities ranging from 62.5 to 125 µg/ml while seven were inhibited by the water extracts between 125 and 500 µg/ml. The MBC results showed that five of the isolates were susceptible to the methanol extracts within the range 62.5 to 125 µg/ml and five of the isolates were susceptible to the water extracts within the range 125 to 250 µg/ml. The results of the MIC and MBC on the MRSA isolates long-established the antimicrobial potency of the plant extracts as previously observed by the disc diffusion assay. This gave credence to the findings of other workers on antimicrobial studies of *P. guajava* (Nneka *et al.*, 2016).

Conclusion

The use of medicinal plants in the treatment of diseases has generated renewed interest in recent times, as herbal preparations are increasingly being used in both human and animal healthcare systems. Diarrhoea is one of the common clinical signs of gastrointestinal disorders caused by both infectious and non-infectious agents and an important human and livestock debilitating condition, therefore, collection of plants supported in folklore as having beneficial medicinal applications (Gotep *et al.*, 2011).

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