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TREATMENT OF DIARRHOEA USING TRADITIONAL MEDICINES: CONTEMPORARY RESEARCH IN SOUTH AFRICA AND ZIMBABWE

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Abstract

Background: Gastrointestinal disorders, diarrhoea in particular remain a major concern in South Africa and Zimbabwe resulting in high mortality rates when left untreated. This investigation was aimed at documenting herbal medicines used in the treatment of diarrhoea in South Africa and Zimbabwe.
Materials and Methods: A review of literature on plant species used as remedies for diarrhoea in South Africa and Zimbabwe was undertaken by the use of different electronic databases such as Google Scholar, ScienceDirect, Scopus as well as library searches at the University of Fort Hare, South Africa and the National Herbarium of Zimbabwe (SRGH) in Harare, Zimbabwe.
Results: This study reported ten plant species most widely used to treat diarrhoea in South Africa and Zimbabwe. Of the lot, *Sclerocarya birrea* (A. Rich.) Hochst. was the most popular medicinal plant used as antidiarrhoeal remedy (11 literature citations) in South Africa and Zimbabwe, followed by *Elephantorrhiza elephantina* (Burch.) Skeels and *Schotia brachypetala* Sond. with eight literature citations each. The roots (47.4%) are the most frequently used plant parts, followed by bark (26.3%), leaves (21.1%) and rhizomes (5.3%).
Conclusion: The documented antidiarrhoeal activities of this repository of selected plant species against diarrhoea causing agents such as rotavirus, *Escherichia coli*, *Shigella*, *Campylobacter*, *Giardia*, *Entamoeba histolytica*, *Salmonella*, *Yersinia* and *Vibrio cholerae* calls for further investigation aimed at isolating phytochemical compounds responsible for antidiarrhoeal activities, their mode of action, and also establish their safety and efficacy. This cross-cultural acceptance of antidiarrhoeal herbal medicines and the use of the same plant species in different geographical zones serve as an indication of the importance of herbal medicines in primary healthcare of local communities.

Keywords: Antidiarrhoeal, ethnopharmacology, South Africa, traditional medicines, Zimbabwe

Introduction

Diarrhoea is one of the most common cause of illness and a leading cause of child death in the world, and remain high on the international public health agenda. The United Nations Children's Fund and World Health Organization (UNICEF/WHO, 2009) defined diarrhoea as having loose or watery stools at least three times per day or more frequently than normal for an individual. Research by Keusch et al. (2006) and Uddin et al. (2015) revealed that there are three major diarrhoeal episodes which include acute watery diarrhoea, which often results in varying degrees of dehydration. Episodes of diarrhoea lasting for more than 14 days are defined as persistent diarrhoea (Abba et al., 2009) and this episode result in malabsorption, nutrient losses and wasting, as well as bloody diarrhoea (Keusch et al., 2006). According to UNICEF/WHO (2009) and Mishra et al. (2016) mild and acute cases of diarrhoeal episodes in children lead to significant fluid losses and dehydration which may result in death. Thapar and Sanderson (2004) categorized excretion of bloody, pus and mucous stools as acute and dysentery, which is sometimes a life threatening form of diarrhoea. According to UNICEF/WHO (2009) diarrhoea is caused by a wide range of pathogens, which include bacteria, viruses and protozoa. Rotavirus is one of the major causes of diarrhoea, causing 40 per cent of hospital admissions among children under the age of five worldwide (WHO, 2008). Other major pathogens include *Escherichia coli*, *Shigella*, *Campylobacter*, *Giardia*, *Entamoeba histolytica*, *Salmonella*, *Yersinia* and *Vibrio cholerae* (Thapar & Sanderson, 2004; UNICEF/WHO 2009). Research conducted by Bhutta et al. (2013) revealed that diarrhoea accounted for 700 000 deaths in children under the age of five worldwide in 2011, making it the second leading cause of death to children of this age group. Similarly, O'reilly et al. (2012) revealed that out of the estimated 4.2 million deaths in children under the age of five in Africa in 2008, diarrhoea caused the largest proportion of 19% followed by pneumonia (18%) and malaria (16%). The impact of diarrhoeal infection is exacerbated by lack of adequate and affordable healthcare in developing countries (Keusch et al., 2006), particularly in rural and marginalized areas.

Research by Wright et al. (2006) revealed that diarrhoea is one of the leading causes of morbidity and mortality in both South African and Zimbabwean children. Previous research in the Eastern Cape province of South Africa where an estimated 72% of the population lives below the poverty line (Thornton, 2009), revealed that diarrhoea is one of the major diseases treated and managed by traditional medicines (Dambisya & Tindimwebwa, 2003). Northern Maputaland in KwaZulu-Natal province is another province characterized by high poverty levels in South Africa where diarrhoea is a major concern and herbal medicines are widely used to manage and treat diarrhoea (van Vuuren et al., 2015). Similarly, gastrointestinal diseases such as cholera, diarrhoea and dysentery are among the most prominent diseases in Zimbabwe resulting in high mortality rate if not treated promptly (Maroyi, 2013). Research undertaken by the same author in the Midlands province, Zimbabwe revealed that the highest number of medicinal plants are used for treating and managing gastrointestinal diseases (diarrhoea, cholera and dysentery), followed by sexually transmitted infections, cold, cough, sore throat and gynaecological problems. It is known that the majority of herbal medicines used as antidiarrhoeals have antispasmodic properties resulting in delaying gastrointestinal processes, suppressing gut motility,

stimulating water absorption and reducing electrolyte secretion in the process (Palombo, 2006), and these biological activities may explain the benefits of using certain herbal medicines in the treatment and management of diarrhoea.

Use of traditional medicines in sub-Saharan Africa for example is widely practiced and this practice is generally regarded as part of the African culture. Herbal medicines have played an important role in the past in the discovery and isolation of new drugs as has been the case of an antimalarial drug derived from *Artemisia annua* L. (family Asteraceae), a herbal plant used for generations in traditional Chinese medicine to treat and manage malaria (Woerdenbag et al., 1990). Research by Hostettmann et al. (2000) showed that the knowledge on the use of medicinal plants in sub-Saharan Africa is widespread and such indigenous knowledge need to be researched and documented for the benefit of both current and future generations. It is within this context that a comparative investigation of herbal medicines used to treat diarrhoea in South Africa and Zimbabwe was undertaken. The two countries are characterized by several similarities in terms of plant species distribution and utilization. Rural people in both South Africa and Zimbabwe are known to depend on plant biodiversity for food, firewood, timber and herbal medicines among other uses (Maroyi & Rasethe, 2015). According to Maroyi and Rasethe (2015), several people in the southern part of Zimbabwe and the Limpopo province in South Africa share historical kinship and linguistic ties, including the use of languages such as Venda, Tsonga and Ndebele which are spoken in both countries. Research by Leporatti and Ivancheva (2003) showed that comparative studies in different countries or regions help in exploring similarities and possible differences in plant usage caused by reciprocal exchanges that have taken place between the countries over the years. Similarly, Leporatti and Ghedira (2009) argued that such comparative analysis offer additional support to the general belief that indigenous knowledge associated with plant usage represent not only shared heritage developed over the years but also considerable mass of data that should be exploited in order to provide new and useful traditional knowledge on plant utilization.

Materials and methods

This study investigated medicinal plants used to treat diarrhoea in South Africa and Zimbabwe. Plant species included in this review have been previously documented by at least two independent studies undertaken in South Africa and Zimbabwe. Only journal articles, research papers, conference papers, theses, books, book chapters and policy documents that included information on plant identity, diarrhoea and other gastrointestinal diseases like cholera and dysentery and utilized plant parts were included in this review.

A review of literature on plant species used as remedies for diarrhoea in South Africa and Zimbabwe was also undertaken by the use of different electronic databases such as Google Scholar, ScienceDirect, Scopus as well as library searches at the University of Fort Hare, South Africa and the National Herbarium of Zimbabwe in Harare, Zimbabwe. The following specific search terms or keywords were used to search literature sources: “herbal medicines used to treat diarrhoea, gastrointestinal diseases, cholera or dysentery”, “medicinal plants used to treat diarrhoea, gastrointestinal diseases, cholera or dysentery”, “traditional medicines used to treat diarrhoea, gastrointestinal diseases, cholera or dysentery”. Some of the information included in this study are based on studies carried out in both South Africa and Zimbabwe (Gelfand et al., 1985; Lin et al., 2002; Mathabe et al., 2006; Appidi et al., 2008; de Wet et al., 2008; Mlambo, 2008; Bisi-Johnson et al., 2010; de Wet et al., 2010; Maroyi, 2011, 2012, 2013; Madikizela et al., 2012; Olajuyigbe & Afolayan, 2012; Semenya & Maroyi, 2012; Nkwanyana, 2013; Wintola & Afolayan, 2014; van Vuuren et al., 2015).

Results and discussion

This study recorded ten plant species that are widely used to treat and manage diarrhoea and closely related gastrointestinal diseases such as cholera and/or dysentery in South Africa and Zimbabwe (Table 1). The roots (47.4%) are the most frequently used plant parts, followed by bark (26.3%), leaves (21.1%) and rhizomes (5.3%) (Table 1). Based on literature review, *Sclerocarya birrea* (A. Rich.) Hochst., commonly known as marula in English was the most popular medicinal plant used as antidiarrhoeal remedy in South Africa and Zimbabwe (Figure 1), followed by *Elephantorrhiza elephantina* (Burch.) Skeels and *Schotia brachypetala* Sond. with eight literature citations each. In the past two decades significant progress has been made in verifying the efficacy and identifying the bioactive compounds of a wide range of antidiarrhoeal medicinal plants including the ten species documented in this study. Determination of antimicrobial activity and the active components of the antidiarrhoeal medicinal plants will provide baseline information on potential usage of extracts from these plants for the treatment of diarrhoea caused by pathogens such as rotavirus, *Escherichia coli, Shigella, Campylobacter, Giardia, Entamoeba histolytica, Salmonella, Yersinia* and *Vibrio cholerae.*

Table 1: Plant species used to treat and manage diarrhoea in South Africa and Zimbabwe

Plant species	Family	Plant parts used	References	Reported antidiarrhoeal usage in other countries
Alepidea amatymbica Eckl. & Zeyh.	Apiaceae	Rhizome, roots	Gelfand et al., 1985; Appidi et al., 2008; Mlambo, 2008; Olajuyigbe & Afolayan, 2012; Wintola & Afolayan, 2014	None found
Elephantorrhiza elephantina (Burch.) Skeels	Fabaceae	Roots	Gelfand et al., 1985; Hutchings et al., 1996; Mathabe et al., 2006; Appidi et al., 2008; Bisi-Johnson et al., 2010; Maroyi, 2011; Madikizela et al., 2012; Wintola & Afolayan, 2014	Mozambique (Bandeira et al., 2001)
Ficus sur Forssk.	Moracea	Leaves, roots	Gelfand et al., 1985; Hutchings et al, 1996;	Ghana (Neuwinger, 1994)

	e		Mlambo, 2008; Maroyi, 2011	
Mangifera indica L.	Anacardiaceae	Bark, leaves	Gelfand et al., 1985; de Wet et al., 2010; Maroyi, 2011; Maroyi, 2012; Nkwanyana, 2013; van Vuuren et al., 2015	Guianas (DeFilipps, 2004), Kenya (Njoroge & Kibunga, 2007), Nepal (Joshi & Joshi, 2000)
Pelargonium luridum (Andrews) Sweet	Geraniaceae	Leaves, roots	Gelfand et al., 1985; Hutchings et al., 1996; Bisi-Johnson et al., 2010; Madikizela et al., 2012; Wintola & Afolayan, 2014	None found
Schotia brachypetala Sond.	Fabaceae	Bark, roots	Gelfand et al., 1985; Mathabe et al., 2006; Mlambo, 2008; de Wet et al., 2010; Olajuyigbe & Afolayan, 2012; Nkwanyana, 2013; Wintola & Afolayan, 2014; van Vuuren et al., 2015	None found
Sclerocarya birrea (A. Rich.) Hochst.	Anacardiaceae	Bark, leaves, roots	Gelfand et al., 1985; Hutchings et al., 1996; Mathabe et al., 2006; Mlambo, 2008; de Wet et al., 2010; Maroyi, 2011, 2014; Semenya & Maroyi, 2012; Nkwanyana, 2013; Maroyi, 2014; Wintola & Afolayan, 2014; van Vuuren et al., 2015	Benin (Gouwakinnou et al., 2011); Mozambique (Ribeiro et al., 2010)
Terminalia sericea Burch. ex DC.	Combretaceae	Bark, root	Gelfand et al., 1985; Hutchings et al., 1996; de Wet et al., 2010; Nkwanyana, 2013; van Vuuren et al., 2015	Mozambique (Ribeiro et al., 2010); Tanzania (Moshi & Mbwambo, 2005)
Vangueria infausta Burch.	Rubiacea e	Bark, root	Gelfand et al., 1985; de Wet et al., 2010; Nkwanyana, 2013; van Vuuren et al., 2015	None found
Ximenia caffra Sond.	Ximeniaceae	Roots	Gelfand et al., 1985; Hutchings et al., 1996; Mathabe et al., 2006; Maroyi, 2011, 2016; Nkwanyana, 2013	Kenya (Gakuya et al., 2013); Namibia (von Koenen, 2001); Somalia (Claeson & Samuelsson, 1989)

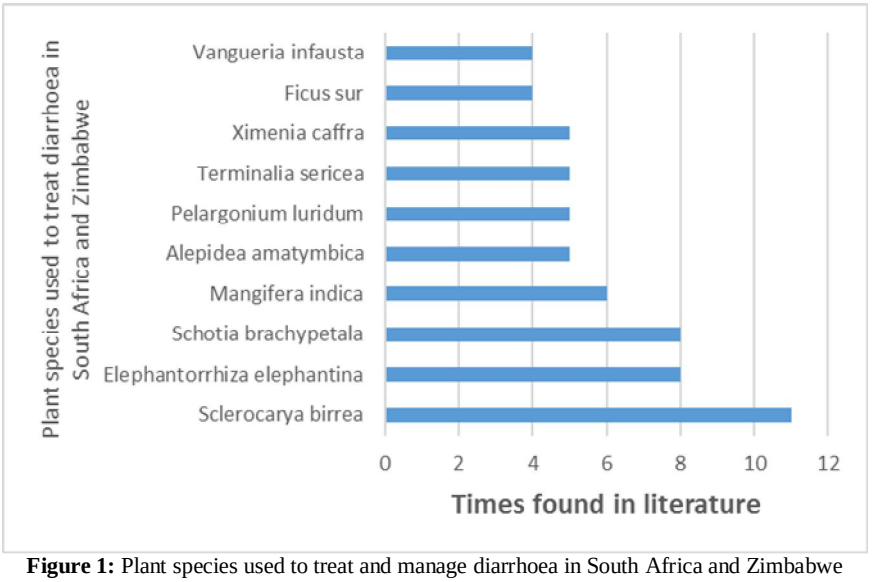

Figure 1: Plant species used to treat and manage diarrhoea in South Africa and Zimbabwe

The effectivessness of *Elephantorrhiza elephantina*, *Schotia brachypetala*, *Sclerocarya birrea* and *Ximenia caffra* Sond. as anti-diarrhoeal medicinal plants against different pathogenic microorganisms such as Gram-positive, *Staphylococcus aureus*, Gram-negative, *Salmonella typhi*, *Vibro cholerae*, *Escherichia coli*, *Shigella dysentery*, *Shigella flexneri*, *Shigella sonnei* and *Shihella boydii* was evaluated by Mathabe et al. (2006). The authors concluded that *Elephantorrhiza elephantina*, *Schotia brachypetala*, *Sclerocarya birrea* and *Ximenia caffra* have antibacterial potential and was therefore useful in the treatment of diarrhoea caused by pathogenic infections. Similarly, van Vuuren et al. (2015) evaluated antimicrobial activities of *Mangifera indica* L., *Terminalia sericea* Burch. ex DC. and *Vangueria infausta* Burch. aimed at assessing their effectiveness against diarrhoea causing pathogens which included *Bacillus cereus*, *Enterococcus faecalis*, *Escherichia coli*, *Proteus vulgaris*, *Salmonella typhimurium*, *Shigella flexneri* and *Staphylococcus aureus*. All the three species demonstrated *in vitro* efficacies with *Terminalia sericea* showing a broad-spectrum activity against five of the seven pathogens studied. The crude extracts of the leaf, stem, rhizome and root of *Alepidea amatymbica* Eckl. & Zeyh. exhibited a range of antimicrobial properties against the following Gram-positive and Gram-negative bacteria: *Bacillus cereus*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Micrococcus kristinae*, *Streptococcus pyogenes*, *Escherichia coli*, *Salmonella poona*, *Serratia marcescens*, *Pseudomonas aeruginosa and Klebsiella pneumoniae* (Wintola &

Afolayan, 2014). Solomon-Wisdom et al. (2011) provided some insight into the bacterial and fungal *in vitro* efficacies of the leaves and stem bark extracts of *Ficus sur* Forssk., which inhibited *Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Pseudomonas aeruginosa, Salmonella typhimorium and Candida pseudotropicalis* at minimum inhibitory concentration of at least 0.5 mg/ml. These authors concluded that the observed antimicrobial activities of *Ficus sur* lend some credibility to its use an antidiarrhoeal medicinal plant in Ghana.

Literature search revealed that there is enormous ethnobotanical information on how the ten species documented in this study are used by different ethnic groups as remedies against diarrhoea. *Alepidea amatymbica, Pelargonium luridum* (Andrews) Sweet, *Schotia brachypetala* and *Vangueria infausta* are mainly used as antidiarrhoeal remedies in South Africa and Zimbabwe, maybe because the majority of these species are confined to southern Africa. The following six species: *Elephantorrhiza elephantina, Ficus sur, Mangifera indica, Sclerocarya birrea, Terminalia sericea* and *Ximenia caffra* are widely used as antidiarrhoeals in South Africa, Zimbabwe and several other countries in the world (Table 1). Although *Mangifera indica*, commonly known as mango in English is exotic to both South Africa and Zimbabwe, it is a popular antidiarrhoeal medicinal plant species with a total of six literature citations. It is also a popular antidiarrhoeal medicinal plant in Guianas (DeFilipps, 2004), Kenya (Njoroge & Kibunga, 2007) and Nepal (Joshi & Joshi, 2000). Seed kernel extracts of *Mangifera indica* showed positive antidiarrhoeal activity against *Proteus vulgaris* and *Staphylococcus aureus* (Sairam et al., 2003), and on castor oil induced diarrhoea in Swiss albino mice (Rajan et al., 2012). According to Neuwinger (1994), bark or root decoction of *Ficus sur* is taken orally or as an enema for diarrhoea in Ghana. In Benin and Mozambique, bark infusion of *Sclerocarya birrea* is taken orally as remedy for diarrhoea (Ribeiro et al., 2010; Gouwakinnou et al., 2011). In Mozambique and Tanzania, root decoction of *Terminalia sericea* is taken orally as diarrhoea remedy (Moshi & Mbwambo, 2005; Ribeiro et al., 2010). *Ximenia caffra* is a common and popular medicinal and fruit tree in the dryland zone in central, eastern and southern Africa (Maroyi, 2016) with bark, leaves and roots used as diarrhoea remedy in Kenya (Gakuya et al., 2013), Namibia (von Koenen, 2001), Somalia (Claeson & Samuelsson, 1989), South Africa (de Wet et al., 2012) and Zimbabwe (Maroyi, 2011). All these observations suggest that the species documented in this study (Table 1) have potent antidiarrhoeal potential.

Treatment based on antidiarrhoeals alone or in combination with biomedicine

This study has provided crucial insights into the prevalence and profile of some important antidiarrhoeal medicinal plants in South Africa and Zimbabwe. The documented species have their antimicrobial activities investigated and in some cases the active compounds have been isolated. Eloff (1998) argued that antimicrobial compounds derived from plant species may inhibit bacterial infections through different mechanisms than the mechanism used by conventional antibiotics, and therefore, plant species with such properties could be of clinical value in the treatment of infectious diseases caused by microorganisms such as diarrhoea. The documented antidiarrhoeal activities of this repository of selected plants against diarrhoea causing agents such as rotavirus, *Escherichia coli, Shigella, Campylobacter, Giardia, Entamoeba histolytica, Salmonella, Yersinia* and *Vibrio cholerae* calls for further investigation aimed at isolating phytochemical compounds responsible for the reported activity, their mode of action, and also establish their safety and efficacy. In addition, properly designed clinical studies of these selected species are needed to ascertain the optimal dosages, formulations and evaluate their effects in humans. Such exercises as identification and verification of bioactive compounds, cellular mechanisms of action, both *in vitro* and *in vivo*, establishment of optimal doses, non-specific and specific effects, side effects and toxicity levels will go a long way in the integration of traditional medicines into Western medicine. According to Maroyi (2013), current research on the phytochemistry and pharmacological properties of medicinal plants is dominated by correlating the traditional uses of herbal medicines to their biological activities. A better understanding of these processes supported by ethnopharmacological uses is important for effective diarrhoea management and control in South Africa and Zimbabwe. Previous researchers such as Dambisya and Tindimwebwa (2003) and van Vuuren et al. (2015) are of the opinion that there is correlation between socio-demographic factors and the use of antidiarrhoeal medicinal plants in South Africa. Therefore, some of the plant species documented in this study will play an important role as main sources of primary healthcare available and accessible to all the people in South Africa and Zimbabwe, particularly the poor.

This cross-cultural acceptance of antidiarrhoeal medicinal plants and the use of the same plant species in different geographical zones (Table 1) serves as an indication of the importance of herbal medicines in primary healthcare. Understanding the role of antidiarrhoeals as well as looking to improve and support integrative models of traditional medicine practice could have a positive impact on primary healthcare outcomes for South Africa and Zimbabwe. According to Maroyi (2016), medicinal plants harvested from the wild have always been the principal sources of medicines used in primary healthcare in developing countries, including South Africa and Zimbabwe. This inventory provides baseline data on plant species widely used as antidiarrhoeals and primary publications that are specific to the uses of herbal medicines against diarrhoea. Such documentation is a crucial starting point in trying to assess the efficacy of antidiarrhoeals as well as the development of effective pharmaceutical products required to treat and manage diarrhoea in South Africa and Zimbabwe.

Conclusion

Based on literature studies and results of this investigation, one possible approach to finding novel and useful antidiarrhoeal therapeutic agents and products is to screen herbal medicines that are widely used by indigenous people or local communities to treat diarrhoea and other related diseases. Correlation between antidiarrhoeal medicinal plant species and the biological activities of some of the documented plant species have been duly observed and described. While there are still gaps in the phytochemistry, mode of action, toxicity and clinical trials of the documented species, there is no doubt that some of the documented species have potential as possible sources of pharmaceutical products for the treatment of diarrhoea and related diseases.

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