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Ethnopharmacological study of plants from Pondoland used against diarrhoea

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ABSTRACT

Ethnopharmacological relevance: Waterborne diseases such as diarrhoea are common world wide, including in Bizana, South Africa where the majority of rural dwellers depend largely on water from unprotected sources. The people from Bizana use medicinal plants as their first line of health care to cure and prevent diarrhoea.
Aim of the study: To record and document plants used for the treatment of diarrhoea in Bizana, to evaluate antibacterial and anti-inflammatory activities of selected plant extracts as well as to perform genotoxicity testing of evaluated plants.
Materials and methods: An ethnobotanical approach was used to select plants used for treating diarrhoea in Bizana for pharmacological assays using questionnaires. Nine plants were selected for bioassays based on their frequency index and the fact that they have never been evaluated against diarrhoea causing-microorganisms. The petroleum ether (PE), dichloromethane (DCM), 70% ethanol (EtOH), and water extracts were evaluated for antibacterial (Gram-positive *Staphylococcus aureus*, Gram-negative *Escherichia coli* and *Shigella flexneri*) activity using the microdilution technique, their ability to inhibit COX-1 and COX-2 enzymes. Genotoxicity was evaluated using the *Salmonella* microsome assay.
Results: This study revealed that 34 plant species belonging to 27 families are used for the treatment of diarrhoea in Bizana. The extracts showed good inhibitory activity with MIC values ranging from 0.39 to 12.5 mg/ml. The best activity was exhibited by DCM extracts of *Rapanea melanophloeos*, and EtOH extracts of *Ficus craterostoma* and *Maesa lanceolata* with MIC values of 0.098 mg/ml. The inhibitory activity against COX-1 enzyme was higher than COX-2, with 19 plant extracts for the former and 7 for the latter. All the tested plant extracts were not mutagenic at all concentrations tested against all tester strains of bacteria.
Conclusion: In view of the fact that the plants were selected based on their ethnobotanical usage for treating diarrhoea, the activities reported here goes a long way in validating the plants for traditional use.

1. Introduction

Diarrhoea is one of the main causes of morbidity and mortality in children especially those infected with HIV worldwide (WHO, 2010). Diarrhoea kills about 2.2 million people yearly and 1.5 million of those are children under the age of five especially in developing countries. About 78% of these deaths occur in Africa and South-East Asia (Barbosa et al., 2006; WHO, 2009, 2010). A significant number of deaths are due to a single genus of bacteria, *Shigella*, which causes dysentery or bloody diarrhoea (Mathabe et al., 2006). An estimated 80% of deaths are due to acute watery diarrhoea, 10% for persistent diarrhoea and another 10% for dysentery (Mathabe et al., 2006).

Diarrhoea, in many cases results from contaminated food caused by *Salmonella typhi*, *Campylobacter jejuni* and *Escherichia coli*, and contaminated water sources caused by *Giardia intestinalis* and *Cryptosporidium parvum* (Mathabe et al., 2006). The use of oral rehydration therapy, breast feeding for children, zinc and other macronutrients for managing diarrhoea are recommended by the World Health Organization (WHO) (Mathabe et al., 2006). However, there is an increase in the incidences of resistant pathogens such as *Staphylococcus aureus* to main stream antibiotics. There is also the emergence of multi-drug resistant Gram-negative bacteria, which has raised much concern within the research community (Watson and Preedy, 2008). Therefore action to counteract resistant bacteria should be taken to reduce the problem by developing a better understanding of the mechanisms of resistance and development

Abbreviations: 4NQO, 4-nitroquinoline-N-oxide; ATCC, American type culture collection; CFU, colony forming units; COX, cyclooxygenase; DCM, dichloromethane; DPM, disintegrations per minute; DW, dry weight; EtOH, 70% ethanol; FI, frequency index; HIV, human immunodeficiency virus; INT, iodonitrotetrazolium chloride; IPNI, International plant names index; MH, Mueller–Hinton; MIC, minimum inhibitory concentration; *N*, total number of informants; NB, nutrient broth; NRF, National Research Foundation; NU, Natal University; PE, petroleum ether; UKZN, University of KwaZulu-Natal; WHO, world Health Organisation.

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Fig. 1. Map showing geographical position of Bizana (study area), in the Eastern Cape province, South Africa. Map obtained from AfriGIS (Pty) Ltd., Google Tele Atlas 2011(C).

of new drugs (Nascimento et al., 2000). An important source of new drugs could be traditional medicinal plants.

Most people in developing countries use traditional medicine to treat all kinds of diseases including diarrhoea (Lin et al., 2002) and South Africa is no exception. In South Africa there is great cultural diversity, and several ethnic groups, which has resulted in massive use of medicinal plants throughout the provinces (Light et al., 2005). Each culture group in South Africa has different medical solutions for the prevention and curing of the same disease (Street et al., 2008). Diarrhoea is often associated with low standards of living, poor access to clean water sources, sanitation and infrastructure. Waterborne diseases are common in Bizana because the population depends largely on water from unprotected sources, often shared with domestic animals. The Pondoland people (*AmaMpondo*) around Bizana have a strong tradition of using medicinal plants. People in Bizana use several medicinal plants to cure diarrhoea (locally known as "*Utyatyazo*" in *isiXhosa*).

Several researchers have conducted different types of research including laboratory and survey-based methodologies in many parts of South Africa to evaluate the effectiveness of traditional medicine used in the treatment of diarrhoea (Lin et al., 2002; Mathabe et al., 2006; Appidi et al., 2008; Fawole et al., 2009; Bisi-Johnson et al., 2010). There is, however, still a lot of undisclosed ethnobotanical data that still needs to be collected from the knowledge holders and the data needs urgent documentation as most of the traditional knowledge about plants and their uses is fast disappearing as a consequence of socio-economic and land use changes. Thus, the aims of this research were to record and document medicinal plants that are used for treating diarrhoea in Bizana, Pondoland in the Eastern Cape and to evaluate their antibacterial, anti-inflammatory activity and genotoxicity of the selected plant species against diarrhoea-causing microorganisms.

2. Materials and methods

2.1. Study area

The study area is based in Bizana (formerly known as Mbizana), a rural district located in the north eastern extent of Eastern Cape, in Pondoland, South Africa (Kepe, 2005). The area is dominated by grasslands. According to the 2001 census, the population of Bizana was approximately 244,506 (Mbizana a Spatial Development Framework – Final Draft Document, 2005). Each village is headed by a headman who reports to the chief. Pondoland lies between uMtata River to the south, and uMtamvuna River to the north (Kepe, 2003). The citizens of the region speak a *Xhosa* dialect known as *isiMpondo* and thus known as *AmaMpondo*, a group that successfully resisted colonial rule, there by showing the courage and tenacity which they can undergo to protect their livelihoods (Kepe, 1997). As a result the settlements are loosely scattered throughout the entire area and are surrounded by arable grazing land.

2.2. Ethnobotanical approach to select plants for bioassays

An ethnobotanical approach was used to select medicinal plants for pharmacological and safety evaluation used for the treatment of diarrhoea in six rural areas of Bizana, Pondoland, Eastern Cape in South Africa (Fig. 1). The information used for the treatment of diarrhoea in the study area was collected from traditional healers, herbalists, elderly people and the young men and women using a questionnaire. The survey was performed after seeking permission from the local authorities. Interviews and discussions were carried out using a local language (*isiXhosa*) for easy communication with the participants. The interviews were conducted at homesteads where rural people live and work, and by appointment, using a structured questionnaire to document the plants that