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ANALYSIS OF MICROBIAL CONTAMINANTS IN HERBAL MEDICINES SOLD IN MATEBELELAND NORTH PROVINCE, ZIMBABWE 2025

BY

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Abstract

The utilization of herbal medicines for both prevention, treatment and management of disease is on the rise in the world hence a rising costs and general inaccessibility of conventional medicines due to various factors.The preparation, storage, transportation and administration processes of herbal medicines is generally without the necessary supervisory processes and adherence to Good Manufacturing Practices is compromised. In Zimbabwe and indeed Matabeleland North Province, the use of herbal medicines is on the rise as predicted and confirmed by the World Health Organization. With this increased utilization of herbal medicines comes the likelihood of contamination during the preparatory, storage and administration stages. This is a cross sectional study which sought to analyse the extent of this contamination in order to contribute to informing the necessary interventions for achievement of safer methods and achievement of Good manufacturing Practices. 104 samples of herbal medicines sold at various sites in Matabeleland Province and 102 water samples collected at various sites as well were analyzed using Colilert method of analysis. Analysis of coliforms and E. coli in various samples of the water used to prepare these herbal medicines was carried out in duplicate using Colilert following strict manufacturer's instructions and the techniques established by Standard Methods in order to establish their presence .The study`s results revealed significant findings with regards to the safety and suitability for use for herbal medicines sold in Matabeleland North as well as the water used to prepare and compound them. The microorganisms and contaminants most commonly isolated from microbial analyses on the market herbal medicines and those directly obtained from herbalists were *S. aureus (62.5%), Salmonella spp. (44%), E. coli (32%), and P. aeruginosa (18%*). Of the 102 water samples analyzed,42 (41%) had total coliforms, and *E. coli* was observed in 46 (45%), making them completely unfit for human consumption.The liquid herbal medicine preparations administered orally were the most frequently contaminated. They are results that need to be considered by the relevant stakeholders if the safety for herbal medicines is to be improved

Key words: Herbal medicines; Contamination; Good Manufacturing Practice; *E.coli*

Declaration

I declare that this dissertation proposal is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree

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Dedication

I dedicate this dissertation proposal to my mother Margaret for so much believing in and praying for me.

List of Acronyms and Abbreviations

ANOVA Analysis of variance

AUREC Africa University Research Ethic Committee

CFU Colony Forming Units

CI Confidence Interval

GMP Good Manufacturing Practice

HIV Human Immunodeficiency Virus

IKS Indigenous Knowledge Systems

MALDI-TOF MS - Matrix-Assisted Laser Desorption Ionization Time of Flight Mass Spectrometry

MCAZ Medicines Control Authority of Zimbabwe

MOHCC Ministry of Health and Child Care

NCDs Non-Communicable Diseases

NCI National Cancer Institute

PMD Provincial Medical Director

UN United Nations

WHO World Health Organization

Definition of Key terms

Contamination- the process of making something dirty or poisonous, or the state of containing unwanted or dangerous substances

Medicine- special substance or preparation used in prevention, cure or easing of disease.

Traditional herbal medicines - naturally occurring plant and animal-based substances with minimal or no industrial processing used to treat diseases in both animals and humans.

Aseptic technique – any method used to sterilize and maintain the sterility of an object or location

Good Manufacturing Practices – a system that consists of processes, procedures and documentation that ensures manufacturing products are safe, efficacious, of good quality and effective for use . They are practices conforming to the guidelines recommended by relevant agencies.

Microbe- a microscopic living organism only visible with the use of a microscope

Human immunodeficiency virus (HIV) is an infection that attacks the body's immune system(WHO,2023)

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CHAPTER ONE - INTRODUCTION

1.1 Introduction

Traditional herbal medicine refers to ways of protecting and restoring health that existed before the arrival of modern conventional medicine (Lima et al, 2017). According to the World Health Organization (WHO) traditional medicine can be defined as native health practices, approaches, knowledge and beliefs that may be applied either singular or in combination to treat, diagnose and maintain wellbeing. It plays an important role in health care provision in the developing world and its use is also now significant in developed countries including Zimbabwe. The use of herbal medicines is widespread in Matabeleland North Province and in staying true to the WHO estimates on the general use of herbal medicines, a significant size of the population makes use of herbal medicines for their health needs

Traditional herbal medicines, being naturally occurring plant and animal-based substances with minimal or no industrial processing are used to treat diseases in both animals(Lima et al, 2017). Some people rely on these medicines to meet their total health requirements, in some cases due to the distances to conventional health facilities or due to the prohibitive costs of medicines (Seyanake J, 2006).

1.2 Background to the study

According to WHO, a third of the world's population has no regular access to essential modern medicine (Lima et al, 2017). They are therefore forced to resort to the use of traditional herbal medicines for their various day to day health needs. With a significant size of the population using herbal medicines, the processing and compounding

procedures are not informed by known scientific procedures. There are also risks associated with contamination of the medicinal products. It is estimated that approximately 80% of the population in developing countries uses traditional herbal medicines as part of their primary health care (Lima et al , 2017).

This finding highlights the importance of research to support the development of traditional herbal medicine practices that provide appropriate, safe, and effective treatments. Among the main safety risks related to herbal medicines is contamination by microorganisms of various kinds that may be adherent to either leaves, stems, flowers, seeds, or roots from which herbal medicines are then prepared. Alternatively, microorganisms can be introduced during harvesting process, handling, open-air drying, preserving, and manufacturing.

Matabeleland North is a province in western Zimbabwe. With a population of 827,645 as of the 2022 census, it is the country's second-least populous province, after Matabeleland South, and is the country's least densely populated province. Matabeleland North and Matabeleland South provinces were established in the year 1974, when the original Matabeleland Province was bifurcated. By size, it is the largest of the country's ten provinces. Matabeleland North is located on the edge of the Kalahari Basin, thereby giving it an arid climate. Matabeleland North province is the hub for coal to energy value chain investments, which will unlock up to US$1 billion under the coal and hydrocarbons focus.

Matabeleland North Province is home to the Victoria Falls which is one of the seven natural wonders of the world, an international tourist resort and a celebrated historical

area. It is home to wide variety of flora and fauna, from which the herbal medicines which are the subject of this dissertation are derived.

1.3 Justification of the study

Consumers of herbal and traditional medicines from both rural and urban settings are rarely exposed to qualitative processes that ensure or enhance the safety of the preparations. They consume products whose safety and quality are not guaranteed. This is according to the WHO Guidelines on Safety Monitoring of Herbal medicines in Pharmacovigilance systems, Geneva 2004 .The report submits that "currently, the majority of adverse events related to the use of herbal products and herbal medicines that are reported are attributable either to poor product quality or to improper use. Inadequate regulatory measures, weak quality control systems and largely uncontrolled distribution channels (including mail order and Internet sales) may have been contributing to the occurrence of such events.

In order to expand knowledge about genuine adverse reactions to herbal medicines, and to avoid wasting scare resources for identifying and analyzing adverse events, events resulting from such situations will need to be reduced or eliminated. It is therefore necessary to carry out a study to determine the extent of microbial contamination in these products, with a view for evidence-based recommendations to improve both the compounding processes and the storage conditions of the medicines before consumption.

1.4 Statement of problem

In Zimbabwe, there is significant consumption of herbal medicines due to cultural, social, and economic factors as well as the availability of a vast biodiversity of regional flora.

The Ministry of Health reports that almost 60% of the medicines consumed in the country are traditional herbal medicines (Ministry of Health).There has been a few cases reported in the mainstream media of deaths reported from consumption of sex enhancing herbal preparations in the district of Gweru(The Herald).However, data that addresses the microbial quality of these herbal medicines and their general suitability for consumption has been lacking. In the study done in Brazil , city of Macapa, contamination levels of the various bacterial species varied from one specie to another.During the compounding and preparation of herbal medicines, the compounders mostly depend on rudimentary methods to produce the herbal preparations, and lack the quality processes afforded to conventional medicines in manufacturing plants.After preparation, these medicines are not subjected to quality control and quality assurance tests in order to verify their safety and freedom from contaminants before consumption.This lack of testing mechanisms exposes users to high risks of consuming highly contaminated substances.This study aims to establish the extent of this contamination, based on analysis of samples collected in various spots in the Province of Matabeleland North.

1.5 Broad Objective

Broad objective: To analyse microbial contaminants in herbal medicines sold in Matabeleland North Province

1.5.1 Specific Objectives

1. To determine Herbal medicines most frequently used by people in Mat North Province, their Botanical names, popular names and their Reported traditional pharmacological properties and uses.

2. Quantification of both aerobic and anaerobic bacteria, identification of pathogenic bacteria of herbal medicines.

3. Identification and quantification of pathogenic bacteria in the water used in the preparation of herbal medicines consumed by the population .

4. To describe herbal medicines dosage forms sold in the Province of Mat North in the period between February to March 2024

5. To describe compounding and purification procedures used by the herbalists in Matabeleland North to prepare herbal medicines.

1.6 Research questions

(i) What Are the herbal medicines mostly sold in Matabeleland North Province

(ii) What Are the herbal medicines sold in Mat North Province contaminated with and are they safe for use?

(iii) What are the contaminants, if any?

(iv) Is the water used in preparation of herbal medicines safe for consumption?

(v) What are the compounding and purification procedures used by herbalists ?

1.7 Significance of the Study

1.7.1 To the Ministry of Health and Child Care

The findings of this study provide significant benefits for the Ministry of Health and Childcare and other stakeholders involved in health services.By finding out the safety and

quality profile of the alternative medicines that the majority of people in the province use, this provides valuable data for interventions from an informed position.This study will provide opportunity for evidence-based decisions with regards to primary health care approaches.This is crucial as WHO states that more than 80% of the population in developing nations utilize herbal medicines as their primary source of healing and treatment of various ailments.This is a significant portion of the population which the ministry will have vested interest in.

1.7.2 To regulators

It is the prerogative of the Medicines Control Authority of Zimbabwe to ensure medicines that are consumed by the population are safe, efficacious, of good quality, affordable and available.This study will therefore provide valuable information for the regulator to be aware of what is happening in the communities with a view to make inroads for regulatory measures to be taken for all forms of medicines, including herbal preparations.

1.7.3 To herbalists and communities at large

This study will provide details of how unsafe their preparation methods are and seek ways of improving. This can provide a window for further health education and awareness campaigns for safe preparation of herbal medicines in the province.

1.7.4 To Academia

This study contributed significantly to the academic community by expanding the existing body of knowledge on the contaminants that are found in herbal medicines. It served as a valuable resource for future researchers, providing insights into effective strategies for improvement of herbal medicines preparation methods in order to improve

their safety. By advancing knowledge in this field, the study offers a foundation for further research and exploration of related topics.

1.7.5 To the student

The research experience gained from conducting this study served as a valuable learning opportunity for the researcher, contributing to their academic and professional development. Additionally, completing this project fulfilled the academic degree requirements, enabling the student to progress toward their qualification goals in the field of healthcare.

1.8 Delimitation of the study

The study was conducted in Matabeleland Province, it is where the researcher is on field attachment, hence the study was restricted to that area. Furthermore, the study was unable to cover any other province due to budgetary constraints. The researcher would have preferred to increase the number of samples; however, this was not possible as the analysis process was paid for. This restricted the sample's geographic scope, which affected how broadly the results could be applied. Results that are more broadly generalizable and relevant to other regions may be obtained by extending the range.

1.9 Limitation of the study

The study was carried out in Matabeleland Province where customs and cultural factors are significant when herbalists prepare medicines. Applicability of the findings to other settings and other Provinces with different cultural norms may pose challenges. Selection of samples was also convenient as there were from either known herbalists or the market place

CHAPTER 2: REVIEW OFRELATED LITERATURE

2.1 Introduction

This chapter will do a review of related literature to the study underway. It explores the history of the use of herbal medicines all over the world and specifically Africa and how the use of plant products has evolved over time. The use of herbal medicines has been beneficial to mankind .Traditional herbal medicine refers to the ways of protecting and restoring health that was in existence before the arrival of modern conventional medicine.

2.1.1 Uses

The World Health Organization (WHO) has a definition of traditional medicine as native health practices, approaches, knowledge and beliefs that may be applied either singular or in combination to treat, diagnose and maintain wellbeing (Lima et al, 2006). It plays an important role in health care provision in the developing world and its use is also now significant in developed countries including Zimbabwe. The use of herbal medicines is widespread in Matabeleland North Province.

Traditional herbal medicines are naturally occurring plant and animal-based substances with minimal or no industrial processing that are used to treat diseases in both animals. Some people rely on these medicines to meet their total health requirements, in some cases due to the distances to conventional health facilities or due to the prohibitive costs of medicines.According to WHO, a third of the world's population has no regular access to essential modern medicine (Lima et al, 2006).In parts of Africa, Asia and Latin

America, it is estimated that about half of the population faces shortages of minimum healthcare; due mainly to inadequacies in healthcare financing by the governments.

Inadequacies in healthcare financing by governments poses for glaring inequities in healthcare delivery in developing countries. Heavy burdens of communicable diseases (HIV/AIDS, malaria, TB, pneumonia, diarrheas') coupled with the advent of growing threat of non-communicable diseases (NCDs) such as diabetes, cancer, hypertension, ischemic heart diseases; amongst many others, torment lives in developing countries.

The use of ethnomedicinal plants contribute to primary healthcare of people of the area that they are found and thus contribute a rich health to human beings.About 80% of people living in rural settings in developing countries use traditional herbal medicine for their primary health care needs and, generally, a number of cancer patients have been found to be using traditional medicine as primary therapy and/or as complementary medicine.

Medicinal plants, which can also be called medicinal herbs or herbal medicines, generally refers to plants or plant parts (in form of leaves, stems, flowers, roots, etc.) that are used for their therapeutic properties.These plants contain various chemical compounds, alkaloids, flavonoids, terpenoids, and phenolic compounds, which contribute to their medicinal properties.They have played a crucial role in traditional medicine systems, including Ayurveda,Traditional Chinese Medicine (TCM), and Indigenous healing practices.The significance of medicinal plants lies in their potential to provide a wide range and extent of therapeutic benefits.They have been used for the treatment or prevention of various diseases, digestive disorders, respiratory ailments, skin conditions, and even chronic illnesses like diabetes and cardiovascular diseases (Lima et al, 2006).

A number of anticancer agents of plant origin, such as Taxol, vincristine, vinblastine, etoposide, irinotecan and topotecan, are being used in clinical practice.Researches on ethnomedicine used to treat cancer continue to be pursued world over and the National Cancer Institute (NCI) is playing a huge role in research on medicinal plants used to treat cancer(Shehzad , 2013).The about 35,000 plant samples from 20 countries and screened, approximately, 114,000 extracts for anticancer activity.All these efforts are because plant medicine plays a pivotal role in drug discovery and development.These researches are also meant to substantiate the medicinal claims and, on the other hand, help come up with well packaged finished drug products with well-defined dosage regimens for patients (Shehzad , 2013).

Treatment of the disease and many other ailments with herbal medicines has been associated with deterioration of quality of life as well as induction of fatigue and some peripheral neuropathy; among a number of significant adverse effects.Thus, development of medicines which offer optimal therapy of a condition and not have a negative impact on the quality of life of patients is of great importance and is more desirable as a medicine component.It is important to analyse what is contained in the herbal preparations beyond the known active ingredient.It has been suggested that many patients tend to complement or, in some instances, shun their conventional therapy with/for traditional medicine in an effort to either minimize adverse effects or hasten the healing process(Katerere et al, 2019)

Herbal medicines are natural compounds derived from various parts of plants, such as leaves, bark, roots, seeds, or flowers, which parts have been used for centuries in traditional herbal medicines in the world to treat and address a wide range of health concerns and illnesses.The Global demand for use of herbal medicines and remedies has

also been rising over the years, and is an area growing into a multibillion-dollar industry. Healthline, Nutrition estimates this figure to be 60 billion.Not all flowers, barks or roots from plants are useful as remedies.

It has already been shown that medicinal plants have been in use for centuries as sources of remedies and treatments for different ailments.It has also been shown that the therapeutic properties of these plants have been recognized and utilized by different cultures around the world.In recent years, there has been a resurgence of interest in medicinal plants as alternatives to synthetic drugs principally due to their potential effectiveness and minimal side effects.They are therefore, a worthy alternative because as plants, they also possess antioxidant, anti-inflammatory, antimicrobial and anticancer properties.Therapeutic properties of medicinal plants exhibit the diverse therapeutic properties they do essentially due to the presence of bioactive compounds. This chapter will detail some of the commonly recognized therapeutic properties associated with specific medicinal plants.

2.2 Uses of specific Botanical plant species

Introduce 2.2 and link it with 2.2.1.

2.2.1 Analgesics and Anti-inflammatory Properties:

Certain medicinal plants, such as the Willow bark (Salix spp.) and Turmeric (Curcuma longa), possess analgesic capabilities which help alleviate pain.Moreover, plants like Ginger (Zingiber officinale) and Boswellia (Boswellia serrata) have anti-inflammatory properties, reducing inflammation and swelling (Lima et al 2006)

2.2.2 Antimicrobial and Antiviral Properties

Many medicinal plants, including Garlic (Allium sativum), Echinacea (Echinacea purpurea), and Tea tree (Melaleuca alternifolia), exhibit both antimicrobial and antiviral properties (Katerere 2014).These properties are of importance in combating various pathogens, including bacteria, fungi, and viruses.

2.2.3Antioxidant and Anti-aging Properties:

Medicinal plants rich in antioxidants, such as Green tea (Camellia sinensis), Ginkgo (Ginkgo biloba), and Aloe Vera, help neutralize any harmful free radicals, thereby reducing oxidative stress and preventing cellular damage. These properties contribute to anti-aging effects and can help protect against chronic diseases. (Lima et al 2006)

2.2.4 Digestive and Gastrointestinal Health

Several medicinal plants, like Peppermint (Mentha Piperita) and Ginger (Zingiber Officinale), have been known to relieve digestive issues, such as indigestion, nausea and bloating. They can promote digestion, alleviate discomfort, and generally support overall gastrointestinal health.

2.2.5 Immunomodulatory Effects

Some medicinal plants, such as Astragalus (Astragalus membranaceus) and Echinacea (Echinacea spp.), possess immunomodulatory properties, promoting the immune system's

function.These plants can help improve the body's defence mechanisms against infections and diseases.It is also a treatment used for its adaptogenic properties, which assists the body cope with both physical and mental stress.It is also believed to increase vitality, boost the immune system and help improve cognitive function. (Katerere T ,2019).

2.2.6 Turmeric (Curcuma longa)

Turmeric has as its component, curcumin, a potent anti-inflammatory compound. It has wide uses in traditional medicine and has shown promise in managing many conditions, including arthritis, inflammatory bowel disease, and certain types of cancer.

2.2.7 Aloe Vera

Aloe Vera can be described as a succulent plant known for its soothing and many healing properties.It is used to treat burns, wounds, and skin conditions due to its antimicrobial and anti-inflammatory properties.

Medicinal plants have been valued for their therapeutic properties for many centuries. They offer a rich and diverse source of natural compounds that possess various beneficial effects on human health.As scientific research advances, the potential of medicinal plants in modern medicine continues to be explored.However, it is crucial to approach their usage with caution, considering factors such as accurate dosage, potential interactions with concurrent medications, and individual variability (Katerere et al, 2019). Put full stops on your work

Integrating traditional knowledge with scientific evidence provides a balanced approach towards utilizing the therapeutic properties of medicinal plants for the betterment and improvement of human health (Katerere et al 2019).

2.2.8 Healing Practices

The use of medicinal plants for healing purposes is a practice deeply rooted in human history.Traditional healing systems, such as Ayurveda, Traditional Chinese Medicine, and Indigenous African medicine, have relied on the therapeutic properties of various plants for the treatment and prevention of disease.Here are some of the popular herbal preparations along with their main benefits and uses (Maroyi and Mosina, 2014).

2.2.9 Lavanga (Syzygiumaromaticum)

Lavanga is the dried flower bud of Syzygiumaromaticum, a tree cultivated in many parts of the world and also to a considerable extent in African dry regions such as Matabeleland North. Flower buds are collected bi-annually in the months of October and February when they have changed colour from green to crimson, and are dried carefully and separated from their peduncles.Clove is a fragrant floral bud, appears in black or brown color, widely used in Indian cuisines.Its known pungent aroma and flavour are very familiar from its other use as a culinary herb. The oil extracted from cloves is widely used as a home remedy for toothache.The oil is also used as a local analgesic for hypersensitive dental cavities and in conventional medicine, a mixture of clove oil and zinc oxide has use in dentistry as a temporary filling for tooth cavities (Maroyi et al, 2014).

2.2.10 Haridra (Curcuma longa Linn.)

Haridra is a dried rhizome of a medicinal plant that grows a height of 2 to 3 feet in height with funnel-shaped yellow flowers. Haridra also known as turmeric powder is bright yellow in colour.It has an earthy aromatic and spicy fragrance with a slightly bitter taste. Turmeric is a significant spice in India,Western Europe as well as Africa with lots of medicinal value(Maroti et al , 2014). Plants are gathered annually for their rhizomes which are used either fresh or ground into powder form.

Turmeric is traditionally used locally and orally in sprain and swelling resulting from it. It is also known to have both anti-inflammatory and analgesic properties and may be used as traditional herbal remedies for Primary Health Care in inflammation induced joint pain and any related symptoms. In recent analytic studies, the three major curcuminoids found in turmeric have been found to limit the activity of chemicals and the enzymes responsible for inducing and maintaining inflammation (Katerere 2016).

2.2.11 Kapikacchu Mucuna pruriens

Kapikacchu is a herbaceous and twinning annual plant that is found throughout Asia, Africa especially in the hills and vleis.It has hairs on its pods , hairs that are similar to that of monkeys.Most of the Ayurvedic remedies described in literature for treating sexual dysfunctions and infertility contain Kapikacchu seeds as one of the important ingredients. Two types of Kapikacchu seeds are described – wild and those cultivated.The wild variety has better utility in clinical practice than the cultivated one and black seeds are considered better than white ones (Warrier PK et al 1995).

2.2.12 Gandhaka ointment (ointment of Sulphur)

Gandhaka ointment is a useful preparation made form Gandhaka (Sulphur), mixed with Tila oil (sesame oil) and Siktha (bee wax). Both the internal and external use of purified Gandhaka is mentioned in Ayurvedic classics .External use of Sulphur possesses both parasiticidal and fungicidal property attributed to the formation of hydrogen sulphide and pentatonic acid.Tila consists of dried seeds of Sesamum Indicum Linn, a herb extensively cultivated throughout the plains of India, North and Southern Africa.Tila oil extracted from sesame seeds has uses in skin diseases such as erysipelas, vitiligo, hemorrhoids, gout, gonorrhea, alopecia, dental disease, burn, etc.

Bee wax is obtainable from the honey comb of the natural bees.Generally, in conventional pharmaceuticals, it comes as an ingredient of paraffin ointment. Dermatological and cosmetic applications are probably the most common uses for bee wax as well as its extracts.Its effects on tissue regeneration and renovation have been well studied.Together with its bactericidal and fungicidal properties bees wax provides many benefits in various uses and applications in cosmetology. In plastic surgery too, bee wax extracts are used for improved wound healing and reduced scar tissue formation (Warrier et al 1995).

2.2.13 Surana [Amorphophallus campanulatus

Surana powder is a simple formulation produced from dried forms of Amorphophallus campanulatus, a stout, herbaceous plant cultivated throughout the vast plains of Asia and Africa.This medicinal plant is named so owing to its ability to combat many diseases like piles.It has found extensive daily use and benefit in treating and relieving pain in piles.(Warrier et al ,1995).

2.2.14 Butea monosperma

Butea Monosperma, which is also known as Palasha in the local Indian Language is a deciduous, medium-sized tree with somewhat crooked trunk, irregular branches,is found in the dry deciduous forests, open grasslands and scrub forests of tropical zones.Its mature fruits when ripened are collected before the rains commence in the rainy season, either from the tree or off the ground, dried in the shade and dried up.

Properly preserved seeds are flat, kidney-shaped, dark reddish brown, thin, glossy; and rich in fixed oil with a faint odour and a slightly acrid and bitter taste when eaten. Optimal potency of the seed and its powder lasts for a period of approximately four months.Its main uses are as a remedy for common ailments like worm infestation, skin diseases, etc. The formulation is listed with given indications and directions for use in the Ayurvedic Pharmacopoeia of India.Tribal communities make significant use of fresh or dried seeds of Palasha in the form of a concoction of a powder mixed with other herbs for the management of parasitic worm infestation (Warrier et al 1995).

2.2.15 Shatpushpa (Anethum sowa Roxb. ex Flem.)

Tribal communities use dried ripe fruits of Shatpushpa in the form of a decoction or powder or boiled with milk either singular or mixed with other herbs for various female health problems occurring during menstruation and after child birth(Warrier PK et al , 1995).The plant is cultivated in Africa`s tropical and subtropical regions with its fruits collected near the end of winter, dried in the shade and kept in dry and non-humid environments.Properly preserved fruits are dark brown and rich in essential oil with a faintly aromatic odour, warm and slightly sharp taste which resembles that of caraway. Optimal potency of the herb and its powder lasts for a period of about 12 months.

Shatpushpa powder is useful for the alleviation of painful menstruation.Painful menstruation, or period pain which is also known as dysmenorrhea, is a common problem of women in the reproductive age group.There are several causes attributed to this very common condition among women of child bearing age , such as congenital malformation of the genital tract, mechanical obstruction, bacterial infection, vascular congestion and sometimes psychogenic causes.The nature, severity and time of pain vary from one individual to another depending on the underlying cause, tolerance capacity as well as the individual's own perception of the condition.

Pain may occur at different times before, during and after the menstrual flow. Sometimes, it may occur in-between the menstrual sessions.The pain can be dull and continuous with a sense of heaviness in the pelvic region and not infrequently intermittent and spasmodic but still disruptive.Anxiety, stress and unsatisfied sexual stimulation contribute significantly to induce or aggravate dysmenorrhea without any explained structural or pathologic cause (Warrier, PK et al 1995).

2.2.16 Withania somnifera Dunal. Ashvagandha

Ashvagandha is a perennial shrub, found in waste lands, cultivated fields as well as open grounds.It is widely cultivated in India and Africa. he roots ,which are the parts of interest, are collected in winter, washed and cut into short pieces.Ashvagandha is one of the most commonly used medicinal plants in Indian and other Asian as well as African countries medicine for a varied range of physical and psychological ailments.It finds mention in almost all classical compendia of Indian medicine, particularly in the context of rejuvenation therapy(Warrier PK et al , 1995).

The plant is well known for its tonic, anti-stress and vigour and vitality-enhancing properties.The root of the plant is used as such after grinding into powder form or in combination with other medicinal plants in various kinds and forms of formulations mentioned in official formularies and pharmacopoeia.A lot of scientific work has been done and documented on Withania somnifera proving it to be useful for various uses as an immunomodulator, antioxidant and adaptogen.

Dhattura is a popular medicinal plant of India and African regions and is documented for its anti-lice efficacy when used topically in the classical Ayurvedic literature, describes the use of Dhattura seeds for the treatment of Yuka (lice) and Liksha (nits).The plant is enlisted in the Ayurvedic Pharmacopoeia of India as providing pharmacopoeia standards and the various uses of the plant parts and seeds.The Dhattura plant grows as a wild weed throughout India and Parts of Africa.Generally the plant is an erect and succulent annual herb or shrub about one meter in height with purplish branches and triangular ovate

leaves, bell-shaped flowers having slight purplish colour outside and white inside and round,often thorny fruits.Dhattura seeds are generally light brown to yellowish brown in colour, often odourless, kidney shaped, about 0.6 centimeters in length and 0.4 centimetres in width, compressed, flattened and thickened towards the curved edge. They have a bitter and acrid taste (Warrier, PK et al 1995).

2.2.17 Symplocos racemosa Roxb- Lodhra

Lodhra powder is a single-ingredient powder ground from dried stem bark of an evergreen tree Symplocos racemosa Roxb, which is approximately 6 to 8.5 metres tall, found abundantly in plains and lower hills.The bark of Lodhra tree is used orally or as a topical application in the form of a vaginal douche.The formulation is mentioned in classical Ayurvedic texts for use in conditions that present with increased discharge like diarrhoea, dysentery, leucorrhoea, excessive menstrual bleeding, hemorrhagic disorders, and conjunctivitis.The bark, also useful as a medicinal part, has astringent, styptic, cooling, anti-inflammatory as well as anti-microbial properties and is used in various Ayurvedic formulations meant for the management of excessive vaginal discharges (Warrier PK et al, 1995).

Scientific studies over the years have shown that Lodhra bark has an inhibitory effect on the growth of various forms of bacteria, Micrococcus pyogenes var. aureus, E. coli, and enteric groups of microorganisms.

Ajamoda powder is useful for joint pain. Joint pain or arthralgia is caused by inflammation or degeneration of tissues in one or more joints of the body.When associated with stiffness, swelling and painful joint movement the disease is called

arthritis. Joint pain can be a manifestation of acute febrile illnesses, trauma, and excessive mechanical stress, a variety of medical conditions elsewhere in the body or a more serious form of disabling arthritis which may be infective, non-infective or at times degenerative. While they are many, the common non-infective joint diseases with joint pain as a major symptom are rheumatoid arthritis, osteoarthritis, gout, and non-specific inflammatory arthritis such as psoriatic arthritis.Rheumatoid arthritis can be described as a chronic, systemic inflammatory disorder that affects various tissues and organs, but principally attacks the joints producing an inflammatory synovitis that often progresses to destruction of the articular cartilage and ankylosis of the joints(Warrier PK et al, 1995).

Although the cause of rheumatoid arthritis is unknown, auto-immunity is the top factor and plays a pivotal role in its chronicity and progression.The general onset of rheumatoid arthritis in many of the patients is insidious.Morning stiffness is its characteristic feature and before the involvement of the joints the patient may complain of a variety of symptoms such as tiredness, fatigue, general malaise, low grade fever, etc.Generally, the small joints of fingers or toes are initially involved initially, then it spreads to either the wrists, elbow, shoulders, ankles or knees.

The temporo-mandibular joint and sterno-clavicular joint may at times also be affected. As the disease progresses, so does the pain and swelling of the joints .Swelling of the proximal inter-phalangeal joint and the associated muscular atrophy gives rise to the spindled shape of the fingers exhibited by many of the patients.Suggestive clinical features with consistent radiological changes, high erythrocyte sedimentation rate and a positive rheumatoid factor test are usually the investigations that help in diagnosing the disease (Warrier, PK et al 1995).

2.2.18 Picrorhiza kurroa or hellebore powder

The hellebore powder is used particularly for treatment of jaundice. Jaundice can be described as a yellowish discoloration of the sclera (white part of the eyes) and skin caused by high levels of bilirubin in the blood.It is a major symptom and sign of serious disease of many organ systems;however most important among them being the liver. Jaundice is generally associated with yellowish urination which reflects excessive excretion of bilirubin in the urine as well.There is a direct correlation or relationship between the blood levels of bilirubin and the extent of tissue discoloration.Jaundice is a reflection of a deranged state of bilirubin metabolism (Warrier PK et al).

Bilirubin is a waste product produced in the body from the globin part of red blood cells, which is released from the destruction of the old red blood cells and remains in the blood after iron is filtered. It is the liver that is responsible to remove bilirubin from the blood by conjugating it and then secreting bilirubin containing bile into the intestine via the bile duct.Jaundice may result from the following three main conditions.Due to over-production of bilirubin thereby exceeding the normal capacity of the liver to remove it from the blood.This kind of jaundice is found in excessive breakdown of red blood cells which may be due to their defective formation, or due to the effect of toxins or certain drugs which causes a large amount of bilirubin to be released into the bloodstream.It can also be as a result of the functional disturbance of the liver that prevents removal, conversion or secretion of bilirubin. It is one of the cardinal characteristics of hepatitis.

Blockage of the bile ducts causes reduced flow of bile and bilirubin from the liver into the intestines. It is then seen in conditions in which bile ducts get obstructed due toany of the causes, either gall stones, cancer or inflammation (Warrier et al Eds).

2.2.19 Piper longum Linn powder

This popular herbal remedy is utilised for management of different types of headache. Headache can be defined as pain in the head or upper neck.It can present as a symptom of an underlying serious disease or it can be a disease itself.Headache can be due to a number of causes.Common benign causes of headache include: migraine, refractory error, mental tension, sinusitis, flu, viral fever, typhoid, or any such disease.Some of the serious and life-threatening causes of headache may include cerebral hemorrhage, sub arachnoid haemorrhage, intracranial space occupying lesions(tumour), acute and chronic meningitis, brain abscess, etc.

Trigeminal neuralgia can also be a difficult and intractable cause of headache though it may not be life threatening.Sudden and severe headache associated with symptoms like high fever, vomiting, convulsion, visual symptoms, stiffness in the neck and loss of consciousness is an emergency and warrants urgent medical attention, while mild to moderate headache without any specificity can be managed with simple remedies such as Piper longum (Warrier et al 1995).

2.2.20 Pongamia pinnata

This plant is also known as Karanja but has the botanical name Pongamia pinnata Linn. It is a medium sized tree with a short bole and spreading crown and found almost throughout Africa and generally up to an altitude of 1200 metres. Karanja seeds are used as oral preparations as well as for external use in various types of skin aliments that include fungal skin disease.Seed oil is highly revered for medicinal purposes and is indicated for local application in scabies, herpes, leucoderma and other skin diseases.This remedy is also enlisted in Ayurvedic pharmacopoeia of India for management of various skin diseases that present with different symptoms.

Chronic fungal infection of the skin, hair, or nails is caused by particular species of fungi such as Trichophyton, Microsporum and Epidermophyton.In the layman's terms, the condition is called "ringworm" or tinea infection which is extremely common in children. Ringworm is characterized by round lesions (rings) and ringworm infection has various names depending on the site of infection of various body sites such as; tinea corporis (body), tinea pedis (feet), tinea unguium (nail), tinea capitis (scalp) or tinea cruris (groin). It is highly contagious and can spread easily from one person to another through contact with the infected person, animal, and objects like contaminated toilet articles, clothing, pool surfaces, showers, locker rooms and even soil. Acquisition of ringworm appears to be favoured by minor trauma (including that incurred during wrestling), maceration and generally poor hygiene of the skin.Heat , moisture and humidity help fungi grow and

thrive, which makes them more common in areas of frequent sweating as well as skin folds in groins or between toes (Warrier et al 1995).

2.2.21 Kiratatikta [Swertia chirata (Roxb. ex Fleming)

Kiratatikta powder , after grinding to a fine powder consists of dried, matured pieces of whole plant of Swertia chirata (Roxb. ex Fleming). It grows to a height of 0.6-1.25 metres in height and is generally found in temperate Himalayas at an altitude of between 1200-3000 metres from Kashmir to Bhutan and Khasia Hills in Meghalaya.The plant is collected after flowering , which it does it during July to October and dried in the shade. One of its important uses is to treat various forms of fever.

2.2.22 Triphala or the Indian gooseberry

It is an important herbal preparation used as decoction for diseases of the eyes that present as eye discharge. Liquid discharge from the eye other than tears, with or without burning sensation and itching, is found in many eye conditions and can also be due to environmental pollutants or dust.Mostly, eye discharge is a common symptom in the inflammatory and allergic conditions of the eye. In viral conjunctivitis, the eye becomes red or presents as bloodshot and it is the irritation that then causes discharge but this condition may not last more than 10 days or so, if uncomplicated and proper hygienic care is taken.Bacterial conjunctivitis is generally not common, but wherever it develops as thick eye discharge of white, yellow or greenish colour; it is strictly advisable to seek medical attention.

Cigarette smoke, chemicals ,chlorine in swimming pool water and chemicals in make-up materials are some of the common causes of what then presents as eye discharge. In such cases, eye discharge and many such other associated symptoms appear on contact with the irritant and do not last for long.Specific medication is not required however it is the cause of eye irritation that should be avoided.Thin watery discharge coupled with itching and burning in the eyes is mainly due to allergy or irritants and it is sometimes very uncomfortable.it may be necessary to determine the cause of the allergy through allergan tests.For eye discharge, the simple principles of treatment recommended in Ayurvedic literature follows the standard which is to avoid the causative factor and also palliate the symptom with medicines having antagonistic properties.

Triphala decoction is one such medicine which is widely popular and considered effective in alleviating various eye symptoms including that include discharge, inflammation and irritation (Warrier, PK et al 1995).

Eczema is anall-encompassing term that denotes different types of allergic skin inflammation usually of chronic origin.The symptoms of eczema commonly range from itching, reddened and dry skin.Since the skin is itchy, prolonged scratching will lead to a leathery thickening of the affected skin.Cracking and weeping of the skin may also occur and open sores may become infected with all sorts of infection, though the causes of eczema have not been fully determined, the following list provides some insight as to the triggers for eczema: Family history: there is a genetic component to this disease that's passed from generation to another.Irritants can be any of the following and many others-exposure to industrial solvents, chemicals, vehicle lubricants, soaps, cement, detergents, cleaning products, rubber gloves and even cosmetic lotions and creams, into contact with the skin.

Allergy:strong reactions to particles called allergens can cause violent skin eruptions which present as heaves and hives. Chronic dry skin: dry skin that is left un-moisturized for a long time can develop into eczema especially in extreme cold weather. Poor circulation: more common in persons of old age and affecting mostly the lower limbs. Obsessive compulsive disorder: habitually rubbing or scratching of the skin surface. Reaction to an infection: some fungal, parasitic, bacterial and viral infections can cause either localized eczema or one that spreads. Stress: stress causes the immune system to be compromised causing increased susceptibility to skin conditions that then present as eczema.

Traditional Herbal Remedies for Primary Health Care in Diet: some have found a simple act such as modification to diet extremely useful in maintaining remission periods. Unknown factors: some forms of eczema are triggered by unknown reactions of the immune system from unknown sources .They are then observed after eruption.Though eczema is generally not easy to control, allergic component of eczema can be controlled to some extent by regular internal as well as external use of the herbal Albizzia lebbeck or Shirisha,which is widely mentioned in Ayurvedic classics and is used in clinical practice at large by traditional and herbal practitioners.

2.2.23 Darlic or Allium Sativum or Lashuna oil for earache

Pain in the ear is one of the very uncomfortable symptoms of disease which may be due to the local causes in the ear or may even relate to external causes.The earache and the pain may increase on lying down due to increased blood supply to the ear in such a position.The general causes of earache can be: Exposure to extreme temperatures of cold weather.Exposure to pressure changes during an activity such as diving or swimming

and air travel.Picking or unnecessarily probing the ear canal can also cause earache.Lashuna (Allium sativum Linn.) Lashuna oil comprises of cloves of garlic heated and mixed with mustard oil.Both Lashuna and mustard oil used in combination are commonly used drugs almost in every kitchen and are well known for their medicinal properties in the traditional medicine of the Asian and African regions.Lashuna is comprised of bulbs of Allium sativum Linn, a perennial bulbous plant, cultivated as an important condiment crop.It is used for various uses but mainly used for facial paralysis, lock-jaw, flatulence, colic, arthralgia and dental caries.The oil of Lashuna is used for skin rashes and also as an ear drop(Warrier et al , 1995).

Sarshapa consists of dried seeds of Brassica campestris Linn, an erect, stout, simple or branched, glaucous, annual herb, which grows to a height of 50 to 60 cm tall, commonly cultivated in Bengal, Bihar and Punjab, also found occasionally in many other wastelands and fields. The oil of Sarshapa can also be used in the form of a gargle and is also applied with rock salt for ailments such as dental caries.In addition, it is also used for massage for increasing muscular strength or the enhancement of the colour and complexion of the skin.

2.2.24 Hollarenapubescens or Coneru in English Kutaja powder for diarrhea.

Diarrhoea can defined as the passage of abnormally loose or unformed stools at an increased frequency, and denotes a change in the normal bowel movement. It is a symptom of various disease conditions of the gastrointestinal system and is often classified as a disease itself.Diarrhoea can either be acute and chronic depending on its causes. Acute diarrhea is the one that lasts for hours or days and the number of bowel movements usually exceeds three per day.The causes of acute diarrhoea are varied and

can be either infectious or non-infectious.The usual clinical features of acute infective diarrhoea are more frequent than normal stools, sometimes with blood and mucous, pain during passing stools, abdominal pain, vomiting and fever.Severe diarrhoea leads to quick dehydration, which manifests itself as apprehension, cold clammy skin, rapid pulse, deep and rapid respiration, inelastic skin, sunken eyeballs, dry tongue, scanty urine and reduced blood pressure.Untreated acute diarrhoea is fatal.The non-infectious category of diarrhoea has many causes some of which can be drugs such as antibiotics, certain antidepressants, antacids, bronchodilators, chemotherapeutic agents, laxatives, non-steroidal anti-inflammatory drugs, etc., and spurious diarrhoea, which follows chronic constipation especially in people of old age and also in association with psychological stress.

Chronic diarrhoea lasts for weeks or months and may present as either persistent or recurrent.The etiology of chronic diarrhea is usually traced to structural and functional disorders of the gastrointestinal tract itself .The clinical features of chronic diarrhoea are either persistent or recurrent with intervening periods of return to normalcy or constipation.The Stool volume may be large or small and may be any of watery, loose, bulky or frothy.Diarrhoea may be accompanied by abdominal pain or discomfort as well as abdominal distension.Systemic symptoms such as fever, anorexia, weight loss, generalized weakness and general body malaise may also be present.

Untreated chronic diarrhoea can lead to malabsorption syndrome and eventually malnutrition. It is always important to understand and correctly diagnose the underlying cause of diarrhoea so that the right treatment can be planned and effected.However, uncomplicated diarrhoea due to indigestion and infection can be managed with Kutaja powder taken together along with necessary dietary precautions. Kutaja [Holarrhena

antidysenterica (Roxb. ex Flem.) Wall. Kutaja ground into powder is a simple formulation prepared from the stem bark of Holarrhena antidysenterica (Roxb. ex Flem).

Wall, a small to medium-sized tree, found throughout Asia and Africa.The stem bark is collected from old trees , ranging from 8-12 years old trees during the middle of rainy season at the peak of their growth and succulence and again at the end of winter by hewing and peeling and separating it from the attached wood.The stem bark is generally bitter in taste and used in Ayurveda for the treatment of gastrointestinal disorders, particularly diarrhoea and dysentery.Most of the Ayurvedic formulations described in literature and various commercially marketed formulations for diarrhoea essentially contain Kutaja as one of their main ingredients , with many others for different purposes.

2.2.25 Piperacea , or Long pepper or Pippali pow used for cough.

Cough is a reflex phenomenon characterized by a sudden, violent expulsion of air from the mouth, with or without sputum, after deep inspiration and concurrent closure of the glottis.This is the most frequent respiratory symptom in humans.Coughing is an important way to keep the throat and airways clear of foreign bodies and particles. However, involuntary excessive coughing means there is an underlying cause that compels the person affected to cough more frequently.The cough may be either dry or productive. In dry cough there is only explosive sound with no or little material coming out from the airways due to irritation.

Whereas a productive cough is one that brings up phlegm , sputum at times mixed with pus or blood or both.Cough can be either acute or chronic , depending on the time it takes to set in and resolve.Acute cough usually appears suddenly, goes away within 2-3 weeks

and is often due to common cold, flu, or sinus infection or all at once.Chronic cough lasts for any period longer than 2 to 3 weeks and is a symptom mostly of respiratory tract disease or any such lung disease.Besides respiratory infections namely tuberculosis, other common causes of cough include chronic tobacco smoking, naso-bronchial allergy, bronchial asthma, chronic bronchitis with or without airway obstruction, lung abscess, bronchiectasis and bronchogenic tumours, reflux disease of gastrointestinal system, air pollution, heart failure, valvular heart disease and certain medicines used for the treatment of high blood pressure that induce the cough reflex.

The diagnosis of the cause of cough is essential before definitive therapy and management is initiated.Painful cough in association with fever is a symptom of respiratory tract infection. Intermittent, ineffectual and exhausting cough also occurs in chronic bronchitis and bronchial asthma and it is generally worst at night or on waking.Cough may also be loose and readily productive of sputum in bronchiectasis and early stages of bronchial cancer.Cough usually aggravates with changes in temperature or the general weather.The explosive character of normal cough is lost in laryngeal paralysis or other disease.

A short troublesome cough of old people due to chronic bronchitis recurs every winter and it is referred to as winter cough.Cough due to smoking is usually dry and irritating mainly due to the irritants from the cigars. Clinical and radiological evaluation before diagnosis and management is usually diagnostic in a large majority of cases. While definitive therapy may wait diagnosis, symptomatic treatment usually provides relief of the cough and other symptoms .(Plant drugs for liver disorders management. Indian Drugs. 1995. Warrier, PK et al Eds).

2.2.26 Phyllanthus emblica or Amalaki powder

This herbal preparation is used for its effectiveness in managing acidity and gastritis. Heartburn which is known to be due to excessive secretion of gastric acid or its reflux to the food pipe along with delayed gastric emptying and fermentation of the already swallowed food.Gastric acidity and inflammation of the stomach is called gastritis, which later produces common symptom of burning sensation in the middle part of the upper half of the abdomen, while acid reflux causes throat and heartburn and delayed gastric emptying with fermentation leading to gaseous distension of abdomen as well as belching.These abnormalities lead to symptoms such as nausea,vomiting ,loss of appetite,indigestion and in some cases mild to moderate upper abdominal pain and distress.Frequent dietary irregularities and ingestion of irritant materials like too spicy and sour foods, alcohol and analgesic drugs like aspirin are the known causes of acidity and gastritis.

Mental stress also significantly aggravates the symptoms of acidity and gastritis. Improperly treated acidity may degenerate to peptic ulcer due to damage in the mucosal lining of the stomach and duodenum. Judicious use of Amalaki ground into fine powder is effective in successful management of acidity and gastritis with certain do's and don'ts on its use.It is advisable not to overeat and have long gaps between one meal and another. Small frequent meals of soft and easily digestible food items are the recommended way to feed.Consumption of raw and leafy vegetables, fried, spicy, sour, salty, heavy and improperly cooked food, sheep's milk, alcohol, curd, sesame seeds should be avoided at all costs if acidity is to be prevented.

The Use of vegetables with bitter taste such as bitter gourd, banana f lowers, and pumpkin, pomegranate, honey, boiled and cooled water and food grains like wheat, rice and barley is beneficial in patients with acidity and gastritis as it alleviates both the cause and the

pain.Suppression of natural urges, particularly of vomiting and passing stools should be avoided or kept to a minimal.

2.2.27 Amalaki (Phyllanthus emblica Linn.)

The formulation and herbal preparation is made from the dried mature fruits of Amalaki, which is a small or medium-sized tree found abundantly in mixed deciduous forests and cultivated in gardens and home yards in Africa and Asia pacific.Ripe fruits are then collected in late winter or early summer and are dried under shade and minimal moisture and humidity.Dried fruits are then separated from the seeds and kept in airtight plastic bags or boxes under dry storage conditions before grinding. (Warrier et al 1995).

2.2.28 Berberis Arustata or Daruharidra decoction for conjunctivitis

Inflammation of the conjunctiva that leads to redness of the eye is called conjunctivitis. Conjunctiva is a thin, transparent mucous membrane that covers the under surface of the eye lids and it extends from the eye lids to cover the anterior part of the eyeball up to the margin of the cornea.Common symptoms of conjunctivitis are redness, itching, stickiness, foreign body sensation, irritation, watering from the eyes and oftentimes intolerance to bight light.Vision is generally maintained but a slight blurring may occur if excess secretions form a film over the cornea itself. Conjunctivitis may begin in one eye but often spreads to involve both of the eyes in no time.

Conjunctivitis is most commonly due to viral and sometimes infections of bacterial origin but it can also result from allergic reactions or from many other factors such as chemical irritants, air pollution, smoke, shampoos, dirt, swimming pool chlorine or noxious

fumes.Rarely, underlying chronic inflammatory conditions may lead to persistent conjunctivitis. The infectious form of conjunctivitis is very common in young children and is highly contagious , easily passed from one individual to the next.Traditionally, homemade remedies have been used with marked success for soothing inflamed eyes with uncomplicated symptoms, minor infections, or allergies.Treatment consists primarily of cleansing the eyes with washing water and preventing the condition from spreading.

2.2.29 Daruharidra (Berberis aristata D.C.)

Daruharidra is a shrub or small tree of less than a meter in height, distributed in the temperate and subtropical parts of Asia, Europe and America as well as Africa. Daruharidra has been in use (as eye drops/ointment) for centuries for general prophylactic or preventative as well as curative purposes in common eye ailments like conjunctivitis. It is a significant ingredient of many traditionally used formulations meant for local ophthalmic use, commonly used and solidified extract called Rasanjana.These drug forms are used through oral ingestion , locally as well as for topical ocular preparation.

The Antimicrobial activity of B. aristata is well demonstrated and documented against a variety of bacteria, fungi, protozoas, helminths, chlamydia and viruses.The alkaloid berberine is known to possess anti-microbial properties against both gram positive and gram-negative bacteria found on surfaces.

It has already been shown that Medicinal plants have been used for centuries as a source of remedies and treatments for various ailments in humans.It has also been shown that the therapeutic properties of these plants have been recognized and utilized by different

cultures around the world.In recent years, there has been a resurgence of general interest in medicinal plants as alternatives to synthetic drugs due to their potential effectiveness , safety and minimal side effects and adverse events after utilisation.

2.3 Bioavailability and Pharmacokinetics

Another challenge in utilizing medicinal plants is understanding their various bioavailability and pharmacokinetic properties which are varied.Many bioactive compounds present in herbal plants exhibit poor solubility, low absorption, and rapid metabolism properties thereby leading to reduced efficacy(Antarkar , 2011).These are some of the basic principles that the herbalists involved in preparation of herbal medicines need an appreciation of in order to improve on their formulae.Formulation approaches such as nanoencapsulation, prodrug design and drug deliverysystems canimprove the bioavailability and targeted delivery of medicinal plant compounds, thereby increasing their therapeutic potential and uses.

Many herbal medicines that were useful during the Covid 19 pandemic, there are papers that have been published that refer to how general indigenous knowledge systems and the use of herbal medicines was critical in the management of Covid 19 during the pandemic (Kugodera 2020).Zumbani (Lippia javanica) use became popular in countries like Zimbabwe, with almost everyone using it either in tea, drinks, porridge or steaming in an effort to control the spread of the disease.It is believed that Lippia javanica contains high zinc content that will fight against the virus, reducing viral replication, and boosting the human immune system. Other common trees commonly in use include Sclerocarya berrea due to its high content of vitamin C in fruit skin and Moringa (Moringa oliefera), used as an immune booster. Several people were using indigenous knowledge in fighting against

Covid-19 with few in rural areas adopting the use of scientific methods. The most popular methods included steaming water, Zumbani (Lippia Javanica) salt solution and concoctions from a mixture of several tree parts picked from the trees. Leaves and stems of Lippia. Javanica are also sold as herbal medicines in the medicinal plant "muthi" markets in South Africa (Moeng 2014). Traditionally, Lippia Javanica is commonly used to treat general fever, malaria and repel insects throughout its distributional process. (Maroyi & Mosina, 2014). The same Lippia Javanica is, therefore, being used in Zimbabwe by steaming several times per day as it is believed that the shrub contains zinc which is potent against viruses (Mafengu et al., 2021; Verma et al., 2020; Vroh, 2020). In some cases, dry leaves of Lippia Javanica were noted as being used as tea leaves and consumed as such in the management of Covid 19 symptoms.

Senayake (2006) believe that herbal medicine use stems from the comprehensive knowledge of a particular society and community , knowledge passed on from generation to generation. As a form of science, general indigenous knowledge systems and herbal medicine use has spearheaded the emergence of robust primary healthcare systems in most African countries (WHO, 2008). This role has encouraged continuity of life from one generation to the other in diverse cultural and societal spheres amidst the many challenges the continent faces (Lima et al., 2017).

Sahai (2013) postulated that IKS dissemination of medicinal plants differs from one place to another depending on the flora and agroecological regions.To this effect, Rifiati et al. (2018) advised that traditional herbal medicines use may have been side-lined, and ignored, in the education curriculum, hence the reason why modern communities have failed to fully acknowledge its contribution to orthodox scientific knowledge.The majority of African populations have poor access to basic healthcare facilities, services

let alone modern conventional medicines.The use of traditional herbal medicines as primary healthcare in providing native remedies in response to diseases has been appreciated for several decades even before the eruption of the current Covid-19 pandemic (WHO, 2000).This observation justifies the need for embracing traditional remedies to combat the infectious diseases currently being faced worldwide.William (2013) postulated a need to obtain consent for commercialization of traditional herbal medicines from indigenous communities.

In Southern African countries, for instance, Muzah (2016) noted an intrinsic relationship between knowledge systems and Mupfura/Amarula (Sclerocarya birrea).The Sclerocarya birrea tree, otherwise known as the Amarula tree, has been referred to as the 'tree of life' because it provides several important human needs (food and medicine) (Maroyi, 2013).Maroyi further notes that its various parts , barks, leaves, and roots, cure many ailments including sore eyes, diarrhoea, and influenza. It can, therefore, be possible to use existing Indigenous knowledge to explore how the same barks can be used as a remedy to Covid-19 pandemic.This discovery will subsequently be of help in an African context and will gradually be accepted by Western countries commercialization of IKS and traditional herbal medicines in Zimbabwe and beyond .It can be done through various protocols such as copyrights agreements, open access and collective sharing of realized profits by indigenous communities and commercial entities.

Furthermore, Maunganidze (2016) declared that Article 24 of the UN Draft Declaration (2018) provides the right to "indigenous medicines and health practices" by way of preserving "vital medicinal wildlife and minerals".Due to economic hardships in Zimbabwe, modern drugs are now out of reach for many poverty-stricken households resulting in most families sorely depending on traditional medicines for their health

remedy needs.The risk of infection, and death, from Covid-19 was exacerbated by severe food shortages, perennial job action by medical personal due to poor wages and lack of personal protective equipment.These factors, among others, contributed to a dramatic rise in the Covid-19 spread, and high fatality rate in the country.

In the past, communities using IKS, were able to manage and survive pandemics that bedeviled livelihoods at the time.Traditionally, collective effort was used, coupled by support received from traditional leaders and spirit mediums.Thus, IKS were used to cure diseases using medicinal plants, taken for granted by the current generation in most communities.Against the aforesaid, there is need to document traditional knowledge entrenched in Zimbabwean societies' socio-cultural and economic fabrics , which by the way are many.Maroyi (2013) indicated that IKS are generally not well documented in Zimbabwe.Documentation of IKS in the use of traditional medicines ensures the preservation, conservation and sustainable use of the flora and fauna in managing as well as controlling pandemics of different sizes .

Covid 19 affected communities beyond borders and it is important to have a look at what other countries used for the control, and appreciate how the use of traditional herbal medicines was critical in the control of the world`s largest pandemic.In Madagascar, a combination of Artemisia, ginger, garlic, paw-paw leaves, Neem leaves, oranges, and lime, have been used to fight against the Covid-19 pandemic.These were mixed and boiled for approximately 30 minutes and then used for steaming and inhaling to fight against the virus.As already indicated, in Zimbabwe, Zumbani (Lippia Javanica) was boiled for at least 15 minutes, and either steam-inhaled or consumed orally as Covid-19 organics.The use of steaming and steam inhalation clears the virus in the throat and lungs, dealing with any difficulties in breathing or clearing any irritants on the throat.

Orisakwea et al. (2020) reported that researchers in Madagascar used mixed remedies to fight Covid-19 through oral drinking.This method was similarly reported The Dyke 15(2) Andrew T. Kugedera et al in countries such as Nigeria, Cameroon, and Zimbabwe, where people mixed various indigenous tree parts , leaves, roots, flowers, and twigs to fight the coronavirus (Fokou et al., 2020; Orisakwea et al., 2020; Bhebhe & Rukuni, 2021).The Coronavirus was first regarded as a lung disease, but it was later discovered that it affects the whole body, as such, and for most African communities, needs the herbal remedies given that they quickly move to all body parts (Orisakwea et al., 2020).

Most of the used herbal remedies, contain phenolic compounds, antioxidants and bioflavonoids, which are antiviral in nature and help improve the immune system.Herbal remedies in Africa, and across the globe, are a real option to control the coronavirus. t was noted that most people prepare different drinking recipes such as mixing onion (Alium Cepa) with lemon and orange juice for drinking a number of times in a day. (Fokou et al., 2020).Alium Cepa can be placed on a pillow during the night to freshen breathing air and open airwaves.The same concept can also be applied in stages to Covid-19 patients with breathing challenges.The mixing of Alium Cepa with Lippia javanica and eucalyptus oil was commonly done during the night for steaming.This was reported as improving breathing, and removing mucus from the lungs.For some, daily drinking of warm water solution was done to create a harsh environment in the body in order to halt the replication of the virus.

In Cameroon, most people were reported as undertaking steaming, eating garlic, onions, Moringa leaves, and Mango (Mangifera indica) leaves in porridge, and tea, to fight the coronavirus (Fokou et al., 2020). In Zimbabwe, peppermint, garlic, water, and honey were commonly used daily to fight the coronavirus infections (Bhebhe & Rukuni, 2020).

Both the infected and uninfected people used the remedies as means of controlling the spread of the virus. Most of the remedies used contain secondary metabolites such as bioflavonoids, steroids, polyphenols, antioxidants and terpenoids, which are all antiviral, and can reduce viral power, replication and minimize the spread of the virus (Kwape et al 2016; Khanna et al., 2020). Flavonoids were effective in controlling SARS-CoV (Yu et al., 2012) and thus can also be used in controlling coronavirus. This fact was supported by Khanna et al. (2020) and Adem et al. (2020), who reported that polyphenols and flavonoids are essential and effective in controlling coronavirus.

The covid-19 pandemic affected many countries' health systems, and became a significant threat to human security compared to other diseases such as the deadly diseases notably HIV/AIDS, cancer, and diabetes.African governments need to adopt innovative management of the health systems through the inception of IK and herbal medicines to fight the Covid-19 (Olawale & Olaopa, 2019).Cancer, and sexually transmitted infections (STIs) (Green, 2012; Ellen & Harris, 2020).The effectiveness of herbal remedies in treating other diseases made it well accepted by many people in the treatment of coronavirus, and the high rate of recoveries from the coronavirus suggested that herbal remedies were effective in fighting the coronavirus.The western and orthodox scientific means appeared to have failed to produce sustainable ideas in controlling the coronavirus as it had taken long to develop a vaccine.The vaccines also failed to show effectiveness as populations continued to be infected, and rely on herbal remedies to boost their immunity, and find life again.The herbal medicines knowledge system is a local idea rooted in a particular place and can be borrowed to other places by many people but can only be understood by its effectiveness by people in the area it was developed (Ellen & Harris, 2020).

Nee and pawpaw leaves, ginger, garlic, moringa, lemon grass and marula tree have been widely used in Africa and globally in the management of respiratory ailments. Studies have demonstrated a reduced risk of covid-19 infection in participants receiving neem capsules, which demonstrates its potential as a prophylactic treatment for the prevention of covid-19 infection (Nesari et al., 2021). However, the findings warrant further investigation in clinical trials. Pawpaw leaves and Pawpaw Leaves Extract (PLE) has been proposed as a complementary alternative medicine to combat the hyper coagulation related to venous and arterial thrombotic complications and to restore platelet level after a thrombocytopenic event commonly seen in severe covid-19 patients (Shukor & Shukor, 2020).

Ginger is a flowering plant whose rhizome, ginger root or ginger, is widely used as a spice. Garlic is a plant in the Allium (onion) family (Orish, Orisakwe, Chinna, Eudora and Nwanaforod, 2020).These leaves and roots of plant materials therefore have been used as aqueous decoctions were the acclaimed anti-covid−19 remedies with notable antioxidant and anti-inflammatory properties were found to be beneficial.The effectiveness of Neem has been proved and has been adopted by many people in Madagascar and in other countries.China Drugs Discovered in Cuba, the drugs were successfully used to treat Covid-19 where treatment of the dengue virus was witnessed. The Neem tree (Azadirachta Indica) Leaves of the tree were mixed with other plants, boiled, and people drank to treat malaria and many diseases.The same concept was used to treat around 40 diseases in Kenya.Roots were also boiled and used to fight against coronavirus.Charcoal added in water and left for a few hours.Water collected can be used orally to cure diseases in animals, especially poultry and in humans.People drink the water, and it is believed that it fights against the virus, although there is no scientific evidence to prove it.

Lemongrassand pawpaw leaves People mix lemon juice, pulp and fruit skin with pawpaw leaves and boil.The concoction is taken orally, and it has been reported to cure the influenza virus, and many people use it to fight against coronavirus.Moringa tree or Moringa Olifera contain high protein content, which people believe boosts the immune system through enzyme production, which hydrolyses toxic substances (Nwonwu, 2020). People use bark, leaves and flowers, and pods to add water, porridge, and tea, orally fighting against diseases like HIV/AIDS and coronavirus.

2.4 The Marula tree (Sclerocarya birrea subsp Caffra).

The tree fruit skin contains high vitamin C content, which is used to fight against coronavirus as it is antiviral.Humans' consumption of dried fruit skin of the tree boosts the immune system and fights against coronavirus.Some people crush dried fruit skins and use them as soda, porridge supplements to fight against coronavirus.To improve the use of herbal remedies and their effectiveness, African governments need to fund the commercialization of herbal medicines in most of these countries as well as improve their use (Kugedera et al).

These remedies can be used to produce tablets that are effective against the many viruses Still, there is a need to do laboratory experiments to develop quantities of antioxidants, bioflavonoids, phenolic compounds, zinc and vitamin C in these remedies. It can only be done by legalizing herbal remedies, funding and research (Thomford et al., 2018; Dzobo & Chirikure, 2021).Research in herbal medicines use can be central in advancing the effectiveness of herbal remedies and medicines used in controlling disease.

There are also herbal Medicines identified by spirit mediums, diviners and herbalists can be subjected to laboratory tests in order to establish their efficacy.The drugs and vaccines can be distributed to end users through both traditional and modern channels such as herbalists and pharmacies harvested by those qualified for such a task as they are believed to have been 'cleansed' by spirit mediums to create a proper link between the people, and the spirits. Another problem is lack of scientific support, and resources required to commercialize the IK in medical circles.There is no supported link between Indigenous herbal and scientific knowledge. Absence of these links makes it difficult to convince people who are devoted to orthodox science to believe in herbal medicines use.All these accessions are supported by the non-existence of legal, and constitutional protection of IK and the lack of data bank of general IKS in many countries.This challenge might be a severe deficiency for Zimbabwe.

William (2013) identified this challenge as a databank that helps profile various IKS from various communities.This issue is of concern as the country is losing the aged group with IKS, who are succumbing to chronic disease and old age.Hence, a library will prevent bio-prospectus from stealing present Indigenous knowledge in Zimbabwe.There is also no proper documentation, legal and constitutional frameworks for Indigenous Knowledge systems towards commercial management of diseases in Zimbabwe.The Zimbabwean constitution has no single provision that recognizes the existing IKS explicitly as compared to other African countries such as Kenya (The Kenyan Constitution, 2010 Article 69).Legal protection encourages IKS based innovation hence promoting commercialization. In Zimbabwe, traditionalists are hesitant to share their knowledge and expertise in the treatment of covid-19 or any other disease.They are afraid of losing their

knowledge and expert knowledge to companies and scientists from more technologically developed countries.

Biopiracy, which is the unauthorized commercialization of the general Indigenous knowledge and genetic resources without the authorization and benefit of indigenous populations has been on the increase globally and it is this that many fear. (Swiderska, 2016).Without doubt herbal medicines and their knowledge plays an important role in the prevention and control of disease in African setups, including Zimbabwe. Lippia Javanica has been used for many years to treat coughs and colds as well as aching muscles. However, lack of documented data, attested instructions as well as quantities to be used according to ages and other health parameters has been a challenge for its wider adoption and use.

Traditional systems of medicines, as already indicated, including herbal medicines, have been used for many centuries for health care by people in countries of the South-East Asia Region, Africa as well as in other parts of the world.Traditional medicine continues to be a valuable source of remedies that have been used by millions of people around the world to secure their health.Records of herbal medicine use date back to more than 6000 years ago.It has been developed from empirical experiences and from observations made by people who use them. It embodies age-old wisdom and knowledge accrued over thousands of years, and forms an integral part of the social and cultural heritage of peoples and communities.The system has been inherited and handed down from one generation to the next through custom and tradition. Since the concept of “Health for All” through primary health care (PHC) was launched at the International Conference on Primary

Health Care at Alma-Ata in 1978, there has been a global movement to realize universal health-care coverage in the whole world.

Despite all the advances made in the health sector, equitable health care coverage; availability, accessibility and affordability to conventional health care and services are quite often beyond the reach of many ,people who are marginalized and underserved. Moreover, the present upsurge in the use of traditional medicines or complementary and alternative medicine – generated after the Alma-Ata International Conference – has become a major global phenomenon.This development bodes well for a more comprehensive health care delivery and health sector reform in facing new challenges in PHC due to demographic, economic, environmental, as well as social challenges that have a negative impact on health and development.

The revitalization of primary health care in late 2000s onwards was yet another clarion call for governments, health and development workers and the world community to protect and promote the health of all people.In these efforts, the rich resources of traditional and herbal remedies are available and accessible to all who choose to use them – by tradition or cultural acceptance in the far and remote corners of countries or by choice of those in the affluent urban communities where there is a desire to return to nature and to use natural remedies in taking care of their own health.The global health scenario is facing new challenges due to climate change and economic down-turns that are now threatening health development.It is therefore crucial that all systems of medicine – whether conventional or traditional – in so far as they are beneficial and not deleterious to the health and well-being of the people must play their respective roles in promoting health, preventing disease, in protecting the sick, and in rehabilitating the infirm.It is through these concerted efforts that tangible gains can be realized.

Herbal medicine can be prepared using several various methods. Some of the methods include:

Capsules, in which the herb is ground into a powder and packed in a capsule for use.
Infusions: dried or fresh herbs, usually aerial parts, steeped in boiling water
Decoction: usually harder plant material, boiled on the stove for longer than infusions3
Syrups: herbs incorporated into a thick, sweet liquid that can be taken orally or through sips.

Archaeological evidence indicates that the use of medicinal plants dates back to the Paleolithic age, approximately more than 60000 years ago.Written evidence of herbal remedies dates back over 5,000 years to the Sumerians, who compiled lists of plants for use as medicines.Some ancient cultures wrote about plants and their medical uses in books called herbals. In ancient Egypt, herbs are mentioned in Egyptian medical papyri, depicted in tomb illustrations, or on rare occasions found in medical jars that contain some trace amounts of herbs. In ancient Egypt, the Ebers papyrus dates from about 1550 BCE, covering more than 700 compounds, mainly of plant origin as well as a few of animal origin.

The earliest known Greek herbals came from Theophrastus of Eresos who, in the 4th century BCE, wrote in Greek Historia Plantarum, from Diocles of Carystus who wrote during the 3rd century BCE, and from Krateuas who wrote in the 1st century BCE.All these Greek scholars documented the use of herbal medicines in one form or another, confirming the use from that very early age. Only a few fragments of these works have survived to this day , but from what remains, scholars noted close relationship and overlap

with the Egyptian herbals.Seeds likely used for herbalism were found in archaeological sites of Bronze Age China dating many years back .Over a hundred of the 224 compounds mentioned in the Huangdi Neijing, an early Chinese medical document are herbs. Herbs were also commonly used in the traditional medicine of ancient India, where the principal treatment or prevention for diseases was diet. De Materia Medica, originally written in Greek by Pedanius Dioscorides of Anazarbus, Cilicia, a physician and botanist, is one example of herbal writing used over centuries until the 1600s and is found in the archaeological records (Siva Krishan, 2018).

The use of herbal remedies is more prevalent in people with both chronic diseases, such as cancer, diabetes, asthma, and end-stage kidney disease as well as those with acute conditions.Multiple factors such as gender, age, ethnicity, education and social class are also shown to have association with prevalence of herbal remedies use and utilization.

Herbal preparations are made from the various parts of plants, ranging from leaves , the bark , flowers or the roots.Examples are Leaves of Eucalyptus Olida being packed into a steam distillation unit in order to gather its essential oil.There are many forms in which herbs can be administered, the most common of which is a liquid consumed as a herbal tea or a (possibly diluted) plant extract , or made into a paste for topical application.
Herbal teas, or tisanes, are the resultant liquid of extracting herbs into water, though they are made in a few different ways depending on the intended purpose. Infusions are hot water extracts of herbal medicines, such as chamomile or mint, through steeping. Decoctions are the long-term version of boiled extracts, usually of harder substances like roots or the bark.Maceration is the cold infusion of plants with high mucilage-content, such as sage or thyme to make a thick preparation.To make macerates, plants are chopped

and added to cold water.They are then left to stand for approximately 7 to 12 hours (depending on herb used). For most macerates, 10 hours is enough.

Tinctures are alcoholic extracts of herbs, which are generally stronger than their equivalent , herbal teas. Tinctures are usually obtained by combining pure ethanol (or a mixture of pure ethanol with water) with the herb components ,leaves or the bark. A completed tincture would have an ethanol percentage of at least 25% (sometimes up to 90%).On the other hand,non-alcoholic tinctures can be made with glycerin but it is believed to be less absorbed by the body than alcohol-based tinctures and has a shorter shelf life. Herbal wine and elixirs are alcoholic extract of herbs, usually with an average ethanol percentage of 12–38%.

Extracts include liquid extracts, dry extracts, as well as nebulisates. Liquid extracts are liquids with a generally lower ethanol percentage than tinctures.They are usually made by vacuum distilling already made tinctures.Dry extracts are extracts of plant or animal material that are then evaporated into a dry mass.They can then be further refined to a capsule or tablet form.

The exact composition of a herbal product is influenced by its method of extraction. A tea will be rich in polar components because water is also a polar solvent. Oil on the other hand is a non-polar solvent and likewise , it will absorb non-polar compounds. Alcohol lies somewhere in the middle.

Many herbs are applied topically to the skin in a variety of forms , ointments or liquid form.Essential oil extracts can be applied to the skin and are usually diluted in a carrier oil which acts as the vehicle in which the medicinal component is held.Many essential oils can burn the skin or are simply too high a dose to be used straight; diluting them in

olive oil or another food grade oil such as almond oil can allow these to be used safely as a topical application without causing harm to the skin(Antarkar 2011).

Salves, oils, balms, creams, and lotions are other forms of topical delivery mechanisms that are used extensively.Most topical applications come as oil extractions of herbs. Taking a food grade oil and soaking herbs in it for anywhere from weeks to months allows certain phytochemicals to be extracted into the oil or delivery stsyem.This oil can then be made into salves, creams, lotions, or simply used as an oil for topical application as it is safe in that form.Many massage oils, antibacterial salves, and wound healing compounds are compounded in this way and it is an effective mechanism for maximum results(Antarkar 2011).

2.5 Safety

Safety is a very critical component in the utilization of herbal medicines and this cannot be overemphasized. It is the basis of this very study

Compounds such as Datura stramonium has been used in Ayurveda for various treatments, but contains alkaloids, such as atropine and scopolamine, which may cause severe toxicity.Consumption of herbs may therefore cause adverse effects. Furthermore, "adulteration, inappropriate formulation, or lack of understanding of plant and drug interactions have led to adverse reactions that are sometimes life threatening or lethal." (Amadi et al , 2019).Proper double-blind clinical trials are needed to determine the safety and efficacy of each plant before medical use.Although many consumers believe that herbal medicines are safe because they are natural, herbal medicines and synthetic drugs may interact, causing toxicity to the consumer.Herbal remedies can also be dangerously

contaminated, and herbal medicines without established efficacy, may unknowingly be used to replace prescription medicines.

Standardization of purity and dosage is not mandated in many countries of the world, including Zimbabwe and the United States, but even products made to the same specification may differ as a result of biochemical variations within a species of plant(Amadi et al, 2019). Plants have chemical defense mechanisms against predators that can have adverse or lethal effects on humans. Examples of highly toxic herbs include poison hemlock and nightshade. They are not marketed to the public as herbs, because the risks are well known, partly due to a long and colorful history in Europe, associated with "sorcery", "magic" and intrigue (Amadi et al, 2019).

Although not frequent, adverse reactions have been reported for herbs in widespread use. On occasion serious untoward outcomes have been linked to herb consumption.A case of major potassium depletion has been attributed to chronic licorice ingestion, and consequently professional herbalists avoid the use of licorice where they recognize that this may be a risk.Black cohosh has been implicated in a case of liver failure. Few studies are available on the safety of herbs for pregnant women, and one study found that use of complementary and alternative medicines are associated with a 30% lower ongoing pregnancy and live birth rate during fertility treatment (Wilson 2022).

Examples of herbal treatments with likely cause-effect relationships with adverse events include aconite (which is oftentimes a legally restricted herb), Ayurvedic remedies, broom, chaparral, Chinese herb mixtures, comfrey, herbs, containing certain flavonoids and other compounds like germander, guar gum, liquorice root, and pennyroyal.

Examples of herbs that may have long-term adverse effects include ginseng, the endangered herb goldenseal, milk thistle, senna (against which herbalists generally advise and rarely use) aloe vera juice, buckthorn bark and berry, cascara sagrada bark, saw palmetto, valerian, kava , St. John's wort, khat, betel nut, the restricted herb ephedra, and guarana(Brown 2014).

In some countries, formalized training and minimum education standards exist for herbalists, although these are not necessarily uniform or standardised within or between countries. In Australia, for example, the self-regulated status of the profession (as of 2009) resulted in variable standards of training, and numerous loosely formed associations setting different educational standards.One 2009 review made the conclusion that regulation of herbalists in Australia was needed to reduce the risk of interaction of herbal medicines with prescription drugs, to implement clinical guidelines and prescription of herbal products, and to assure self-regulation for protection of public health and safety of the same .

In the United Kingdom, the training of herbalists is done by state-funded universities offering various levels including Bachelor of Science degrees in herbal medicine. In the United States, according to the American Herbalist Guild, "there is currently no licensing or certification for herbalists in any state that precludes the rights of anyone to use, dispense, or recommend herbs."However, there are U.S. federal restrictions for marketing herbs as cures for medical conditions, or essentially practicing as an unlicensed physician who administers these on own initiative.

CHAPTER 3 -METHODOLOGY

3.1 Introduction

A cross-sectional study design was chosen due to its suitability. A methodology best suited for a study type is meant to bring out the best results under investigation where observations are made at single point of time.

3.2 Study design

This was a cross-sectional study at Matabeleland North Province, Zimbabwe 2023. This study design suited the type of my study as data about samples was collected from various sites simultaneously at a single point in time.With this approach, we were able to observe variables without influencing or manipulating the process.

3.3 Study area

Samples were collected from various points in the Province of Matabeleland North, Gwayi, Lupane, Bulawayo city, and Lobengula Street.The Matabeleland North Province is located in the western part of the country and it borders Zambia to the North. As of the 2022 census, it has a population of 827,645 people1. Matabeleland North is bordered by Matabeleland South and Bulawayo to the south, Midlands to the east, Mashonaland West to the northeast, Botswana to the west, and Zambia to the north, which is separated from Zimbabwe by the Zambezi River. It has an area of 75,025 square kilometers (28,967 sq m), amounting to 19.2% of the total area of Zimbabwe. In terms of area, it is the largest the country's ten provinces.Matabeleland North is located on the edge of the Kalahari Basin, giving it an arid climate.These climatic conditions determine the type of flora and fauna that grows in the area, from which the herbal medicines under study were derived.

3.4 Study population

All types of herbal medicines used by the voluntary participants, from different sites in the province were studied.The period of study was February 2024 to March 2024.

3.5 Sample size and sampling technique

A non-probability sampling technique was used where were conveniently sample a total of 104 herbal medicines samples with oral or topical administration which were collected and submitted for analysis at a laboratory in Bulawayo .

Samples processing procedures

We used Aseptic technique for collection of samples and transportation to the analysing site in Bulawayo city water samples used in the preparation of homemade herbal medicines were collected and subjected to analysis, bacterial and fungal counts, identification of the species using the British Pharmacopeia standards was done. Quantification of aerobic bacteria, identification of pathogenic bacteria of herbal medicines and of water used in the preparation of the herbal medicines consumed by the population in the region under study.

For water analysis, Colilert method was utilized. By definition, the Colilert method is a water testing technique that simultaneously detects and quantifies both total coliforms and Escherichia coli (E. coli) in water samples within 24 hours. Important points to note about Colilert are that it is a technique used to assess water quality in various contexts, including drinking water, wastewater, as well as water sources.

It is a procedure recognised by WHO in the Standard Methods for Examination of Water and Wastewater (R. Kaufmann, 2009). It is so, for a number of reasons some of which are the following:

1.Ease of Use: Unit-dosed packaging eliminates the need for media preparation and makes it ready for instant use.

2Rapid Results: Detects coliforms and E. coli simultaneously in 24 hours or less. No confirmations needed.

3.Identifies E. coli specifically, reducing unnecessary public notifications due to non-target organisms. Suppresses up to 2 million heterotrophs per 100 mL.

4.**Principle:** Colilert uses proprietary Defined Substrate Technology (DST) with nutrient-indicators (ONPG and MUG). Coliforms metabolize ONPG, turning it yellow. Coli metabolize MUG, creating fluorescence. On-coliforms are selectively suppressed by the Colilert matrix. (R. Kaufmann, 2009)

5.Experimental procedure We Added reagent to the sample and incubate at 35°C±0.5°C for 24 hours. Results are read as follows, colourless = negative and yellow signifies total coliforms.The presence of coliform bacteria indicates potential or actual contamination with faecal matter, which poses a great risk to human health.On the other hand, the absence of coliform does not guarantee that the water is safe for consumption as other pathogens may be present (Kaufmann, 2009).

3.6 Inclusion and exclusion criteria

Liquid, semisolid or solid preparations of herbal medicinal products administered orally singularly or in combination, topically with or without further pharmaceutical processing stored in their original container in the case of commercial products or collected in sterile bottles in the case of homemade herbal medicines were collected for analysis in this study.Herbal medicines with other routes of administration and use or those that were delivered in unsuitable bottles such as non-sterile or different from the original were excluded from the study.

3.7 Handling and transportation of specimens

Using aseptic techniques, 10 mL (liquid) and 10 g (semi-solid or solid) of samples from each herbal preparation were collected using a sterile screw-capped bottle. 102 water samples used to prepare liquid herbal medicines were collected by immersing a 100-mL sterile screw-capped bottle in a home water container of the herbalists that were accessible.

3.8 Bacterial and fungal counts

The microbial quantities, including the isolation and identification of pathogenic bacteria and fungi from the selected herbal medicines, were determined according to the regulations of the British Pharmacopoeia and WHO standards, (2011).The analyses were used to quantify the number of bacteria and fungi isolated that are able to grow aerobically in either 1 g or 1 mL of the sample.For anaerobic bacteria, utilised was the Matrix-Assisted Laser Desorption Ionization Time of Flight Mass Spectrometry (MALDI-TOF MS) technology.It is a technique that is useful in identifying, quantifying anaerobic

microorganisms in clinical laboratories with a fair measure of accuracy. In a certain meta-analysis done elsewhere but covering 6685 strains of anaerobic bacteria at other settings, MALDI-TOF MS achieved an 84% accuracy at the species level and 92% accuracy at the genus level , signaling how accurate this method was (Croxatto et al 2013).

3.9 Identification of Bacteria

For purposes of bacterial isolation and identification of the same , the samples were diluted in water, according to the solubility, and homogenized by vigorously mixing and then analyzing the samples.

The microbial quantities , including the isolation and identification of pathogenic bacteria from both samples obtained from the market places as well as the home-made herbal medicines, was tested according to WHO standards(Biochel , 2011). The tests were used to quantify the number of bacteria and fungi isolated that are able to grow aerobically in 1g or 1mL of the sample.

The samples were homogenized by mixing vigorously, with or without previous maceration, of 1-g (semisolid or solid samples, soluble in water- when the product was water soluble or tween- when the product was fat soluble- 1% sample solution) or 1-mL (liquid samples) quantities of samples were transferred to 9mL of casein-peptone. Then serial dilutions followed in order to achieve an appropriate concentration and uniformity. Briefly, serial dilutions were made, and viability was assessed using the pour plate method on tryptic soy agar or alternatively dextrose agar for bacterial counts.All the dehydrated media were prepared according to the manufacturer's instructions and seeded and incubated at 37°C for 2 days for bacterial screening and at 25°C for 7 days for fungal screening.At the end of the incubation period, the number of colony-forming units per

gram (CFU/g) was calculated using the formula , multiplying the average number of colonies by the dilution factor.

The obtained CFU/g of sample was compared with the WHO standards that have specific stipulations. Samples that presented bacterial growth greater than 105CFU in 1g of herbal medicine were considered unsatisfactory or inadequate according to WHO guidelines for both aerobic and anaerobic bacteria.The expected range of bacterial contaminants will include Escherichia coli, Salmonella spp., Pseudomonas aeruginosa and Staphylococcus aureus.At the end of the incubation period, pathogenic bacterial isolates were preliminarily characterized by their colony morphology, Gram staining, and biochemical tests (oxidase, gas and catalase production).

For analysis of Escherichia coli, Salmonella spp., Pseudomonas aeruginosa and Staphylococcus aureus, MacConkey agar cetrimide agar, EMB agar, mannitol salt agar, Brilliant Green, and triple sugar iron agar culture media were used.

3.10 Statistical analyses

An SPSS package was used to analyse the data collected, the descriptive statistics of variables (mean and standard deviation) were assessed.

3.11 Ethical consideration

The study did not involve human subjects; however, the necessary approvals for any study of this nature were obtained including the AUREC approval and Provincial Medical Director's approval. The Provincial Medical Directors permission was sought on 13

February and it was granted on the 14th of February, thereby paving way for preparations for sample collection.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the crucial findings of the study that was carried out in Mat North for the analysis of herbal medicines sold in the province from February to March 2024. The data were presented in tables, displaying frequencies and percentages for each variable.The results also present the specific objectives as laid out in Chapter 1 and the results of the analysis done.

4.2.Commonly used herbal medicines, botanical names and traditional therapeutic use

The table 4.1 below summarized the botanical names and therapeutic usages of the most common herbal remedies in this study.

Table -4.1:Botanical names of herbs and their therapeutic uses

Botanical name	Common name	Pharmacological uses
Sclerocarya Berria	Amarula	Diarrhea , influenza
Eucalyptus Olida	Eucalyptus oil	Inhalation for respiratory infections
Lippia Javannica	Zumbani	Respiratory infections
Datura stramonium	Datura	cramps
Allium sepa	Mango leaves	Indigestion
Mentha piperita	Peppermint	Bloating
Melaleuca alternifolia	Tea tree oil	Burns , topical antimicrobial
Aloe babadensis	Aloe Vera	Treatment of burns
Camelia sinensis	Green tea	antioxidant
Allium sativa	Garlic	antioxidant
Zingiberofficinale	Ginger	nausea and vomiting in pregnancy

Uses and characteristics of homemade herbal medicines sold in different markets

Majority of the herbal remedies sold are either in liquid used by oral route or in topical route in semisolid form (table 4.2).Most remedies used by oral route were in Liquid form and mostly used for condition associated with indigestion while for topical rout category the most common are Semisolid form used for Antipruritic effect .

Table 4.2:Uses and characteristics of homemade herbal medicines (N=104)

Pharmaceutical form	**Therapeutic use**	**Herbalist herbal medicine n (%)**	**Market herbal medicine n (%)**	**Total N (%)**
Oral Category				
Solid	Decongestant	2(1.9)	6(10)	8(7.6)
Semisolid	Burns	1(0.9)	0	1(3.8)
Liquid	Indigestion	28(26.9)	55(62.5)	83(7)
Topical Category				
Solid	Decongestant	4(3.8)	0	4(3.0)
Semisolid	Antipruritic	2(1.9)	14(13.4)	16(15.3)
Liquid	Diarrhea	5(4.8)	8(7.6)	13(12.5)
Total		24(100)	80(100)	104

4.3 Identification and Quantification of bacteria in herbal medicines.

Level of contamination of each sample and the specific contaminants was determined as follows.At the end of the incubation period, pathogenic bacterial isolates were preliminarily characterized by colony morphology, Gram staining, and bio chemical tests (oxidase, gas and catalase production).For the evaluation of the extend of microbial contamination, the total number of viable bacterial and fungal colony-forming units per gram (CFU/g) were determined.

Among the 104 samples of samples from the market and those obtained directly from herbalists 51.5% had bacterial growth and 35.6% had observable fungal growth, independent of acceptable limits of contamination .A total of 31.8%of samples exceeded the safety limits (CFU/g$\leq 10^5$)according to WHO guideline for aerobic bacteria, including16.7%of the homemade herbal medicines and 15.1% of the commercial herbal medicines .It was also found that 23.5%of samples exceeded the safety limits for fungal growth.The liquid herbal medicine preparations administered orally were the most frequently contaminated.The microorganisms most commonly isolated from microbial analyses on the market herbal medicines and those directly obtained from herbalists were S. aureus (62.5%), Salmonella spp. (44%), E. coli (32%), and P. aeruginosa (18%). (Table - 4.3)

Table 4.3:Pathogenic bacterial species isolated from herbal medicines

Herbal Medicine				Bacterial isolates			
Preparation	**Use**	**Forms**	**Samples %**	**E.coli [a]N (%)**	**Salmonella Spp [a] N (%)**	**Aeruginosa [a] N (%)**	**Staphylococcus aureus [b] N (%)**
Herbalists` medicines	**Oral [a]**	Solid	11 (10.5)	2 (1.5)	2(1.5)	0(0)	4(3.0)
		Semisolid	3 (2.8)	0 (0)	0 (0)	2 (1.5)	1 (0.8)
		Liquid	14 (13)	13(12.)	21(15.9)	11(8.3)	27 (20.4)
	Topical	Solid	4 (3.8)	4(3.0)	4 (3.0)	0 (0)	2 (1.5)
		Semisolid	1 (0.96)	3(2.3)	5(3.8)	0 (0)	9 (6.8)
		Liquid	4 (3.80)	2(1.5)	4 (3.0)	0 (0)	3 (2.3)
	Total		**37 (35.6)**	**52 (39)**	**36 (69)**	**13 (25)**	**46 (88)**
Market medicine	**Oral [a]**	Solid	17 (16.3)	1(0.8)	0 (0)	2 (1.5)	8(6.1)
		Semisolid	4 (3.8)	0 (0)	0 (0)	0 (0)	0 (0)
		Liquid	43 (41)	2 (1.5)	4(3.0)	2 (1.5)	6 (4.5)
	Topical	Solid	3 (3)	0 (0)	0 (0)	0 (0)	0 (0)
		Semisolid	12 (11.5)	0 (0)	4 (3.0)	0 (0)	3 (2.3)
		Liquid	31 (29.8)	3 (2.3)	2 (1.5)	2 (1.5)	2 (1.5)
	Total		**67 (64.4)**	**80 (60.6)**	**10 (12.5)**	**6 (7.5)**	**19 (23.8)**
Grand Total			**100 (104)**	**34 (32)**	**46 (44)**	**19 (18)**	**65 (62.5)**

4.4 Determination of the total viable bacterial and fungal counts (CFU/g) in samples.

The table 4.4 below , shows the total aerobic and anaerobic counts of bacteria isolated in the different dosage forms of the herbal medicines samples , which dosage forms range from solid , semi-solid , liquid preparations.Samples that presented bacterial growth greater than 10^5 CFU in 1 g of herbal medicine were considered unsatisfactory or inadequate according to WHO guidelines for aerobic bacteria.

Table 4.4: **Determination of total viable bacterial and fungal counts (CFU/g) in samples.**

Herbal medicine				**WHO Acceptable limits**			
Unacceptable WHO limits (CFU/g ≥10^5) count/g or ml				**(CFU/g ≤10^5) [a] count/g or ml**			
				Total viable aerobic bacterial count	**Total viable fungal count**	**Total viable aerobic bacterial count**	**Total viable fungal count**
Preparation	Use	Forms	Samples % (n)	% (n)	%(n)	%(n)	%(n)
Herbalists' preps	Oral	Solid	3.8 (4)	1.5 (2)	1.5 (2)	2.3(3)	3(4)
		Semisolid	1.0 (1)	0 (0)	0 (0)	0.8 (1)	0.8 (1)
		Liquid	7.69 (8)	10.6 (14)	3.0 (4)	10.6 (14)	3.0 (4)
	Total	Solid	0.96 (1)	0.8 (1)	0 (0)	1.5 (2)	1.5 (2)
		Semisolid	0.96 (1)	0 (0)	0.8 (1)	0 (0)	0.8 (1)
		Liquid	4.80 (5)	0 (0)	1.5 (2)	1.5 (2)	1.5 (2)

	Total		19 (20)	12.9 (17)	6.8 (9)	16.7 (22)	10.6 (14)
Market	Oral	Solid	5.76 (6)	0.8 (1)	1.5 (2)	3.0 (4)	3.0 (4)
Herbal							
medicines							
		Semisolid	1.92(2)	0 (0)	0 (0)	0 (0)	0 (0)
		Liquid	44.(46)	6.0 (8)	3.0 (4)	8.3 (11)	8.3 (11)
	Topical	Solid	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
		Semisolid	2.88 (3)	0 (0)	0 (0)	1.5 (2)	1.5 (2)
		Liquid	25.96 (27)	0 (0)	0 (1)	2.3 (3)	3.8 (5)
	Total		80.76 (84)	6.9 (9)	5.3 (7)	15.1 (20)	16.7 (22)
Grand			100 (104)	26 (19.7)	16 (12.1)	42 (31.8)	31 (23.5)
Total							

4.5 Analysis and quantification of Microbialsamong watersamples used to prepare herbal medicine (E.coli)

Of the 102 samples analyzed, 42 (41%) had total coliforms, and E. coli was observed in 46 (45%), making them completely unfit for human consumption (WHO standard, CFU/ml) (Table 4.5)

Table 4.5 Coliforms and E. coli detection in water samples used to prepare homemade herbal medicines (N = 102).

Parameters	Numbers (N)	Percentage %

coliforms		
Yes	42	41%
No	60	58%
E. coli		
Yes	46	45%
No	56	55%

4.6 Description of herbal medicines dosage forms sold in the Province

The herbal medicines sold and consumed in the province vary from solid preparations, semi solid and liquid preparations.Some are powders; however, those were not part of this study and were not analyzed.These dosage forms are the same as those found in conventional preparation processes for conventional medicines. Katerere et al (2019) confirms this when he describes dosage forms for traditional herbal medicines used on the African continent.The medicines are package in different containers from bottles , old reusable other products containers .

4.7 Description of the compounding and purification procedures used by the herbalists

The compounding processes used by the herbalists to prepare medicines are varied. However, the common trend is the use of mortar and pestle in order to reduce particle size , sieving , sun drying , heating , vaporization , sedimentation. These processes are done using rudimentary equipment that mimics the modern equipment in conventional processes mostly done in pharmaceutical plants.This is what Katerere et al(2019) also say about compounding procedures for traditional medicines in African settings.

What this study also confirmed is that Herbal medicines that are extensively used in Zimbabwe and Matebeleland North Province due to the country's diverse plant population, go through these same preparatory stages before they are ready for use or consumption.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1Introduction

The widespread use of herbal medicines in the province as well as the ways used to prepare them has been shown in this study.This study has also shown how widespread the contamination of these preparations is, including by faecal matter

5.2 DISCUSSION

This section will focus on the specific objectives as set out at the beginning of the study . This study sought to determine the herbal medicines most frequently used by people in Mat North Province, their Botanical names, popular names and their reported traditional pharmacological properties and uses.The herbal medicines mostly used in the province were identified, as well as their pharmacological properties.Vast as it may be , the study attempted to ensure the mostly used plants and their extensive use is recognized.

The quantification of both aerobic and anaerobic bacteria, identification of pathogenic bacteria of herbal medicines were accomplished , with the results showing that both aerobic bacteria and anaerobic bacteria are common habitats of the herbal medicines prepared and used in the community.The study also sought to identify and quantify the pathogenic bacteria found in the water used in the preparation of herbal medicines consumed by the population.The dosage forms for the various herbal medicines was also described, as well as the compounding and purification procedures used by the herbalists. The discussion will continue with these specific objectives in detail

5.2.1 Herbal medicines frequently used: Botanical names, traditional pharmacological properties.

While there is a wide range of herbal medicines mostly used in the province , this study identified the following as commonly in useLippiaJavannica (Zumbani) , Sclerocarreaberria , Mentha piperita for various ailments .The dosage forms range from solid, semi solid as well as liquid preparations.Moreover, plants like Ginger (Zingiber officinale) and Boswellia (Boswellia serrata) exhibit anti-inflammatory effects, reducing inflammation and swelling (Lima et al 2006).That there are medicines that are commonly used in a certain geographical area compares well with a similar study done in China (L Zhang et al 2018).The herbalists also add flavours to the preparations to enhance palatability.This finding also aligned with a study done by P Vishwakarma, et al 2022.

5.2.2 Quantification of both aerobic and anaerobic bacteria, identification of pathogens

This was done for all the samples , with the number of coliforms formed for each and every specie of bacteria identified. The quantities isolated in the samples tested compare favouratively with a similar study done at Macapa , Brazil.It was important for this study to include the water used in the preparation due to the possibility of it being the source of bacterial contamination.Water samples were also subjected to the same testing procedure as the one for the medicinal samples . The results compare favouritively with the results for a similar study done at Macapa , Brazil wherein the same range of microbial isolates were identified , ranging from Staphylococcus , E. Coli , Pseudomonas .

This is significant because the water utilized in the preparations can be the source of microbial contamination . This is the same result obtained in the study at Macapa , Brazil . Our findings are similar to the ones obtained in Nigeria , the highest bacterial load recorded (3.54 × 1012 cfu/mL) was reported in Nigeria by Igbeneghu and Lamikanra. The samples in this study were sourced from unregulated herbal medicines on the market and from home settings. Similarly, another study by Nwankwo and Olime, which investigated microbial contamination in registered herbal preparations on the Nigerian market.

In a study conducted in Nigeria by Tatfeng et al., it was noted that ‘schnapps’ and palm wine–based preparations were mostly contaminated with Bacillus spp. (aerobic spore bearers), while water-based preparations had several bacterial isolates, including Staphylococcus spp., Pseudomonas aeruginosa, Escherichia coli , Proteus mirabilis, Enterococcus faecalis, Serratia marcescens, Staphylococcus aureus, and Bacillus spp.

In a review of similar studies by Wisdom Ahiabor , review also identified Staphylococcus aureus, Bacillus spp., Pseudomonas spp., and Salmonella spp. as commonly reported bacterial pathogens (60%, 54%, 46%, and 44% of included studies respectively) from herbal medicines used in Africa.These findings are consistent with findings from low–and middle–income countries in other regions.

Studies conducted by Opuni et al. and De Souza Lima at al. identified Salmonella spp., Bacillus spp., Pseudomonas aeruginosa and Staphylococcus spp. as common bacterial pathogens in herbal medicines.These organisms which are also indications of faecal contamination, reveal poor hygiene conditions in the preparation and storage of these herbal medicines, thus making them unsafe for consumption.In the review by Wisdom Abhoir et al review, they identified diarrheal toxins produced by Bacillus cereus in herbal medicines from South Africa.

5.2.4 Description of the herbal medicines dosage forms sold in the Province

The herbal medicines sold and consumed by the people of Matabeleland North province range from solid , semi solid to liquid preparations .The samples collected for analysis were in these dosage forms , which dosage forms are for conventional medicines .In a similar study done in Nigeria by Igbenhegu , the dosage forms used for analysis were the same, solid , semi solid and liquid preparations.

5.2.5 Description of the compounding and purification procedures used by the herbalists

The compounding processes used by the herbalists to prepare medicines are varied. However, the common trend is the utilization of mortar and pestle in order to reduce particle size , sieving , sun drying , heating , vaporization , sedimentation . These processes are done using rudimentary equipment that mimics the modern equipment in conventional processes mostly done in pharmaceutical plants.This is what Katerere et al(2019) also say about compounding procedures for traditional medicines in African settings.

What this study also confirmed is that Herbal medicines are extensively used in Zimbabwe and Mat North Province due to the country's diverse plant population, great sociodiversity, and conventional wisdom originating from different ethnic backgrounds (indigenous, African,). Ahiabor et al did a similar study involving Africa countries and this assessment is consistent with their findings. The studies were done in Nigeria , Ghana , Cameroon .

Presently, herbal medicines are used along with synthetic medicines to reduce health care costs for those individuals who have limited access to modern health care facilities because these individuals do not have health insurance coverage and do not have much education.Herbal medicines are inexpensive treatment options because they are easy to prepare or purchase in street markets that are common in both the rural and urban communities of Mat North.Because of gradual devaluation of the knowledge associated with traditional health care-related practices, health surveys conducted in several countries have demonstrated greater use of herbal medicines as a mainstream practice as well as the easily accessible and less costly option.

While Herbal medicines are an inexpensive treatment option-they have a high risk accumulated at various preparation and storage stages.Safety issues remain significant, proliferation of microbial contaminants mainly result from failure to control moisture levels during storage, preparation and failure to control temperatures of liquid dosage forms of the finished products.

It is also important to explain the various properties of the medicines sold , their mode of action as well as benefit to the human body.In compounding these preparations ,pharmacovigilance of these is important and required for more documentation of information on methods of prep, administration, more effective monitoring of these processes, sell and consumption .Evidently the risk of consuming contaminated herbal medicines is confirmed, endangering public health and patient safety.These findings dovetail with a similar study done in Macapa, Brazil by Miranda et al, 2017 though theirs focused on elderly only.Shadia and Abdel –Aziz 2016 , talk about the extreme dangers of poorly prepared medicines for consumers and how these pose a great danger to all those who consume the products.

5.3 Conclusion

The study revealed that there are some herbal medicines more frequently used than others. The study in Macapa , Brazil also has the same conclusion , that some herbal medicines have more uses than others and their frequency of use are different(Sousa Lima et al,2020) The Sclerocarya berria is quite popular as an ingredient in many of the herbal medicines prepared in Mat North. Others include Zumbani, Echinacea and Moringa.These herbal medicines are consumed not only because of their therapeutic properties for the respiratory tract but also because of their calming and relaxing effects, which makes them multifunctional herbs.Generally, herbal medicines are used for treating simple ailments

such as digestive or respiratory diseases and general pain, whereas synthetic medicines are primarily used for blood pressure problems, general pain, as well as endocrine and nutritional diseases(Katerere et al , 2019).

The integration of plant-based medications into the primary health care system of developing countries has seen expansion over the years, and in acknowledgement of this expansion and popularity being gained by these, the WHO has recognised their use. However, their safety for use remains a concern as efforts to ensure this safety has been neglected.

Bacterial and fungal contamination are frequent, especially in homemade herbal medicines, with CFU/g levels above recommended national and international standards. Herbal medicines in liquid pharmaceutical form for oral use presented the highest microbial contamination, and they were also the most consumed products among the population.Presumably, the proliferation of microorganisms may also result from the failure to control moisture levels of herbal medicines during transportation and storage

In addition, most medicinal plants are prepared in an open environment in nonhygienic conditions, using rudimentary tools and processes that gradually lead to contamination with enteric pathogens of public health importance.In the present study, of the 104 herbal medicine preparations, 45% were above the limit of acceptable bacterial counts according to WHO standards, indicating a risk in the consumption of the analysed products(WHO 2017). In other studies, bacterial counts were measured in herbal materials, preparation containers and herbal medicines, indicating risks associated with the consumption of such products.

Microbial analyses detected the presence of E. coli, Salmonella spp. and P. aeruginosa, which are all indications of faecal contamination, revealing poor hygiene conditions in the preparation and storage of these herbal medicines.The presence of bile-tolerant gram-negative bacteria belonging to the family Enterobacteriaceae is also an important indicator of hygienic precariousness, inadequate processing or both pre and post-processing contamination.Pathogens of this family are generally causative agents of foodborne diseases including diarrhoea increasing the risk for consumers to develop intestinal tract infections (Nwankwo et al 2018).

Since the detection of E. coli is indicative of faecal contamination, it can be concluded that the herbal medicines that contained this microorganism were contaminated directly or indirectly by human or animal faeces and were therefore unsuitable for consumption (Krishnan 2007).

The analyses of these samples also detected the presence of S. aureus, which can cause staphylococcal gastroenteritis, scalded-skin syndrome, and folliculitis, among other diseases. A study that also evaluated the microbial quality of herbal medicines showed similar results, with 32% of samples contaminated with E. coli, 44% of samples contaminated with Salmonella spp., and 62.5% of samples contaminated with S. aureus. Pathogenic bacteria, such as E. coli, Salmonella spp., Shigella, S. aureus and P. aeruginosa, were also found in other studies of a similar nature.These contaminations were probably caused by unsafe collection, transportation, drying, preparation, storage or dispensing processes of the herbal medicines.

The quality of the water used in the preparation of herbal medicines is also a component of interest as it may have contributed to the high level of bacterial contamination observed for the homemade herbal medicines.Drinking water should be free from pathogenic

microorganisms and bacteria that indicate faecal contamination. However, 42% of the water samples used for the preparation of herbal medicines were not safe for consumption. A similar study done in Kaduna Metropolis yielded a similar result , at 41%. The problem may be related to the lack of basic sanitation and the inadequate management of human and animal excreta incorporated into the soil, which are the most important factors in the contamination of water sources.The water quality and notions of hygiene are likely related to the differences in the contamination of pathogenic bacteria in the herbal medicines and herbal medicine products identified in this study.

Characterization of fungal colonies, although not specific, was important in assessing the risk of the analysed products.Microscopic analysis suggested fungal contamination that was similar to another study that demonstrated the presence of fungal species known to be able to produce mycotoxins that are harmful , such as Aspergillus Niger, Aspergillus flavus and Aspergillus parasiticus.These species pose a risk when present in products that are taken orally and pose a great deal of danger to consumers of such products. Many studies carried out before have also demonstrated the presence of mycotoxins in preparations derived from medicinal plants.The severity of mycotoxins depends on the toxicity, degree of exposure, age and nutritional status of the individual and the possible synergistic effects of other chemical agents to which they are exposed or are concurrently taking.

The need for Good Manufacturing Practices in pharmacies or industries that handle herbal medicines cannot be overemphasized.Beyond just compliance, following the current national and international legislations and regulatory standards ensures safe preparation , storage and transportation of herbal medicines.It is also essential to monitor all establishments that market herbal medicines through post marketing surveillance systems by checking that they have a license from Zimbabwe Traditional Medicines Association

or the Directorate within the Ministry of Health and Child Care, for this trade and that the products are properly registered and authorized for consumption.

In search of solutions for the irrational use of herbal medicines, programs were created to provide standards for the correct use of medicinal plants and select them according to their efficacy and safety, replacing the routine empirical use carried out by communities. These initiatives, however, were not sufficient to guarantee the triad of efficacy, safety, and quality of the products used in herbal medicine, resulting in the marketing and consumption of products that may not necessarily meet the minimum criteria of microbial quality standards.Other countries that generally utilize use of herbal medicines have also faced issues of quality in compliance in herbal medicines because of the presence of pathogenic bacteria in the products.This dynamic shows that quality standards and minimum product safety criteria have not yet been achieved in this field of complementary medical practice, which probably is as a result of reduced teaching on herbal medicines in medical schools and pharmacy schools.

Pharmacovigilance of medicinal plants is also important and requires the collection of more information on the methods of preparation and administration, adverse events, contraindications and precautions for a more informed and better risk-effectiveness ratio. The need for more effective monitoring of the commercialization and consumption of herbal medicines by both elderly and young individuals has become very critical.The risks are real , significant and cannot be downplayed.Strategies for health education in communities, campaigns and workshops for people on the safe use of these therapies are essential for public health and patient safety.These activities can be led by the Ministry

of Health and Child Care as the ministry responsible for public health and safety in the country.

5.4Recommendations

This study demonstrated the presence of aerobic bacteria and fungi above the acceptable limits as well as the presence of pathogenic bacteria in samples of herbal medicines used by the people in Mat North Province.These findings demonstrate important risks for the people, risks associated with the use of herbal medicines and the need for surveillance and the establishment of stricter control procedures in the production/preparation and marketing of these herbal medicines to guarantee quality.

These steps will help to avoid additional risks to the people of Matabeleland North Province in the consumption of herbal medicines, which is a common cultural health care habit in this region and the country. Control programs for the sale of these herbal medicines should be implemented by Ministry (MOHCC) and the Medicines Control Authority of Zimbabwe (MCAZ) to prevent or reduce the consumption of products outside the minimum standards of quality. In addition, campaigns linked to primary health care units or family health programs with the aim of guiding the proper preparation of herbal medicines (avoiding microbial contamination) can also be helpful.

5.5 Dissemination of results

The results of this study were disseminated to The Provincial Medical Director and the Provincial Health Executive members on 08 April 2024.The results were also disseminated to the PHT and stakeholder ministries at the complex.The MCAZ and the Traditional Medicines Directorate were contacted with a view to set a date for dissemination of the same.

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AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

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Ref: AU3210/24

25 March, 2024

GAMUCHIRAYI JEREMIAH MATANDIROTYA
C/O Africa University
Box 1320
MUTARE

RE: ANALYSIS OF MICROBIAL CONTAMINANTS IN HERBAL MEDICINES SOLD IN MATEBELELAND NORTH PROVINCE, ZIMBABWE 2024

Thank you for the above-titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC3210/24
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** March 25, 2024
- **EXPIRATION DATE** March 25, 2025
- **TYPE OF MEETING**: Expedited
  After the expiration date, this research may only continue upon renewal. A progress report on a standard AUREC form should be submitted a month before the expiration date for renewal purposes.
- **SERIOUS ADVERSE EVENTS** All serious problems concerning subject safety must be reported to AUREC within 3 working days on the standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

AFRICA UNIVERSITY
RESEARCH ETHICS COMMITTEE (AUREC)
APPROVED
P.O. BOX 1320, MUTARE, ZIMBABWE

Yours Faithfully

MARY CHINZOU
ASSISTANT RESEARCH OFFICER: FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE

Number your appendices e.g Appendix 1: ……

Appendix 2: …..

PMD MAT NORTH

Mhlahlandlela complex

Bulawayo

ATT : PROVINCIAL MEDICAL DIRECTOR- Mat North

13/02/24
Approved

RE : Request for Approval to conduct Research in Mat North Province

The above refers.

I am a student studying towards the attainment of Master of Public Health with Africa University and on attachment at the Provincial Medical Directorate , Mat North Province . My Supervisors are Dr Kuretu (Field supervisor) and Dr Maibogue (Academic Supervisor). I wish to carry out a study titled "Analysis of contaminants of herbal Medicines sold in Mat North Province". I therefore request your approval to conduct this study , which aims to ,among other things establish and analyse the contaminants in herbal medicines sold at various sites in the Province , investigate the purification processes at compounding stages as well as investigate the risks associated with consumption of such preparations . The chemical and bacteriological analysis of microbial content will be done at Lancet Laboratories

Looking forward to your favorable response

Yours faithfully

Matandirotya

Gamuchirayi J. Matandirotya

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COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

P.O. BOX 1320, MUTARE, ZIMBABWE – Cell: (+263) 780079459 E
MAIL: salissoum@africau.edu,

03, March, 2024

To whom it my concern

Dear Sir

Re: Permission to submit to AUREC for GAMUCHIRAYI JEREMIAH MATANDIROTYA

Program: Master of Public Health

This letter serves to confirm that I have supervised the above mentioned student and he has satisfied all the requirements of the college and he is ready in conducting research on

ANALYSIS OF MICROBIAL CONTAMINANTS IN HERBAL MEDICINES SOLD IN MATEBELELAND NORTH PROVINCE, ZIMBABWE 202

Your facilitation is greatly appreciated

Thank you

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