ADDIS ABABA UNIVERISITY
SCHOOL OF GRADUATE STUDIES

ETHNOBOTANICAL AND ETHNOPHARMACEUTICAL STUDIES ON MEDICINAL PLANTS OF CHIFRA DISTRICT, AFAR REGION, NORTH EASTERN ETHIOPIA

A thesis submitted to the School of Graduate Studies of the Addis Ababa University in partial fulfillment of the requirements of the Degree of Master of Science in Pharmaceutics

By

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January 2004

ACKNOWLEDGEMENTS

Above all, I would like to thank my Lord and Savoiur Jesus Christ for His infinite grant throughout my life. Also thanks be to Saint Virgin Mary, Saint Urael and Saint Gabriel for their prayer towards me.

I'm greatly indebted to my advisors Prof. Tsige Gebre-Mariam and Dr. Kaleab Asres for their incalculable advises guidances, devoted assistance and encouragements throughout my stay in the School.

The encouragements I got from Ato Awell Wagris, Ato Sedik Mohammed, Ato Musa Ali and W/t Kediga Ali are worth mentioned here. Also I'd like to thank my father Ato Seifu Sahle-Dingel, my mother, W/o Bire Asfaw, and my sister, W/t Helen Debebe, for their moral support during my study.

This work wouldn't be possible without the participation of traditional healers of Chifra District, staff of Chifra Health Centre, Chifra Woreda Economic Development Office, Afar National Regional State Health Bureau, School of Pharmacy and that of Ato Melaku Wondafrash. So, I'm thankful to all of them.

Last but not least is my appreciation to the Afar National Regional State Health Bureau and Addis Ababa University for sponsoring my study and funding my research work, respectively.

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ACRONYMS

WHO -World Health Organization

TM-Traditional medicine

TMPs-Traditional medicine practitioners

HIV-Human Immunodeficiency Virus

MOH -Ministry of Health

Abstract

Medicinal plants have not been well studied, tested or documented in Afar region, North Eastern Ethiopia. Most of the information is still in the hands of the traditional healers. A study was carried out during Nov.2002 – May 2003 to explore ethnobotanical information on the use of medicinal plants by Afar people in 13 rural communities of Chifra District, Afar Region, North Eastern Ethiopia. Based on the information found from ethnic leaders, 29 traditional medicine practitioners were interviewed by using pre-tested semi structured questionnaire. A total of 70 plant species were reported for their medicinal use in the district. Of these, 33 were fully identified by their botanical name, 10 at generic level and 27 couldn't be identified and were recorded only by their vernacular names. 15% of the identified species belong to the family Fabaceae. Among 144 ethnoformulations reported, the majority were liquid preparations followed by unprocessed herbs and powder. The most widely used solvent to prepare the formulations was water. Size reduction, extraction and filtration were the most commonly employed unit processes in the formulation. Intranasal route of administration was frequently used next to oral route. Polyherbal preparations were common in order to have synergistic or summation effect. Although there is difficulty of determining accurate dose, the practitioners have an idea of dose and frequency of herbal preparations. Side effects are reported only for Aloe sp in therapeutic dose. Most of the oral herbal drugs are contraindicated for pregnant women. The practitioners have no idea of drug interactions and shelf life of the reported plant species. The data were analyzed using the concept of healer consent in order to identify culturally important medicinal plants. The medicinal uses of the plants were grouped into 9 disorder categories to have the factor of informant's consensus (Fic) for each group. Accordingly, snakebite had the highest value (0.53) indicating the dependence of the practitioners on certain plants for the indication. The most frequently

recorded medicinal plants of the Afar people were Aloe sp. used for the treatment of “Urribaqla”, malaria, abdominal cramp, TB and pasterlosis; Acalypha sp. for snakebite, blackleg, anthrax, “Barelitta”and impotence. The medicinal plants were assessed using published phytochemical and pharmacological data. Of the fully identified 33 medicinal plant species, the claimed medicinal uses of the six were in good agreement with other similar studies and pharmacological activity tests reported elsewhere. The medicinal uses of most of the reported plant species have not been documented in other parts of the country. This study underlines the need for further exploration of ethnobotanical information in the region and the results will be used as a basis for subsequent studies on pharmacology, phytochemistry and toxicology of medicinal plant.

1. INTRODUCTION

1.1 Traditional medicine

The World Health Organization (WHO) defines traditional medicine (TM) as "the total combination of knowledge and practices, where explicable or not, used in diagnosing, preventing or eliminating physical, mental or social diseases which may rely exclusively on past experience and observation handed down from generation to generation, verbally or in writing" [1]. WHO also specifies traditional African medicine as "the sum total of practices, measures, ingredients and procedures of all kinds whether material or not which from time immemorial had enabled African to guard against diseases, to alleviate his suffering and to cure himself" [2].

TM has been utilized by the majority of the world population for thousands of years. Until the beginning of the 19^{th} century, all medicines were traditional. Yet, in many developing countries, it is true that for the majority of rural population, TM is the only primary or any other kind of health care available [3]. For more than 80% of the population in Africa traditional medicine is the first, if not the only health care system available in the poor and rural areas. In recognition of this fact, WHO underlined the potential role that TM may play in reinforcing the health care through the primary health care approach in developing countries [2].

1.1.1 History of traditional medicine

Guided by taste and experience, early societies developed a means of healing by using plants, animal products and minerals that were not mostly among their usual diet. The physical evidence of herbal remedies goes back some 60,000 years to a burial site of a Neanderthal man uncovered in 1960 in a cave in Northern Iraq. In this cave, scientists found what appears

to be the remains of an ordinary human bones, and analysis of the soil around these revealed extraordinary quantities of pollen that could not have been introduced accidentally at the burial site. Rather, it is assumed that someone from the cave community had consciously made eight species of plants to surround the dead body, seven of which are medicinal plants still used throughout the herbal world [4,5].

One of the earliest records of the use of herbal medicine is that of Chaulmoogra oil from species of *Hydnocarpus gaertn*, which was known to be effective in the treatment of leprosy. Such use was recorded in pharmacopoeia of the Emperor Shen Nung of China between 2730 and 3000 B.C. Similarly, seeds of opium poppy (*Papaver somniferum* L.) and castor oil seeds (*Ricinus communis* L.) were excavated from some ancient Egyptian tombs, which indicated their use in that part of Africa as far back as 1500 B.C. Suffice it to say that some 5000 years back, man was well aware of medicinal properties of some plants growing around him [6].

The Arab medicine known as Unani system of medicine had its origin in the fifth and fourth centuries B.C under the patronage of Hippocrates in Greece and later expanded by the great teachers such as Aristotle, Theophrastus, Dioscorides, and Galen, etc. Then, this body of knowledge moved to Rome, Alexandria and to the Arab countries and got the name "The Arab (Unani) or Greco-Arab system of medicine". In the Ayruvedic medical system that is believed to have been in practice for 2000 years mainly in India, 582 herbs and 600 remedies were described in the early book on internal medicine and in the book of surgery, respectively [4].

According to medical history, Hippocrates born in 460 B.C. was the first Greek to regard medicine as a science and he is now referred to as the father of medicine. His materia medica consisted essentially of herbal recipes, some 400 simple remedies having been combined and

described by him. Theophrastus of Athens was another famous Greek, who was born in 370 B.C. produced a number of manuscripts including the famous Historic plantarium. Both these early doctors administered various vegetable drugs including myrrh and frankincense. At that time preparation of aromatic roots and flowers were also used for treating many ailments [5,6].

In the middle ages, the writings of Galen (Born in 131 A.D.) became popular. He is considered today to be the most distinguished physician of antiquity after Hippocrates. He treated diseases essentially by the use of herbs, and those who followed his methods eventually developed the sect known as "Eclectics" who employed herbal as well as mineral substances in treating the sick. Allopathic as well as homeopathic systems of medicine today are based on doctrines expatiated by Galen [6].

The use of many medicinal plants in Europe in the 14th century was based on the doctrine of signature or similars developed by Paracelsus (1490-1541), a Swiss alchemist and physician. According to this doctrine, healing herbs have features made by God identifying the plant with specific disease or part of the body. For example, plants with heart shaped leaves were good for treating heart disease [6].

1.1.2 Global perspective of traditional medicine

Trends in the use of traditional and complementary medicine are on the increase in many developed and developing countries. In the USA, it was estimated that 42.5 million visits were made to herbalists in 1990, contrasting with the 388 million actual visits to primary health care physicians [7]. In 1992, 20 million patients in Germany used homeopathy,

acupuncture as well as chiropractic and herbal medicine as the most popular forms of complementary medicine. In Australia in 1998, about 60% of the population used complementary medicine, 17,000 herbal products had already been registered and a total of US $650 million was spent on complementary medicine [1].

The herbal medicine market has expanded tremendously in the last 15 years and the total annual sale of herbal medicines is still growing over the counter sales of herbal medicines in the USA and Canada during which it showed growth rate of 15%. In Europe, the sales of herbal products have been referred as "Europe's growth market" which amounted to USD 1.4 billion in 1992 [7]. In Malaysia, it is estimated that about US $500 million is spent every year on TM, compared to only about US $300 million on modern medicine. In 1996 the total annual sale of herbal medicines reached US $14 billion worldwide [1].

In China traditional medicines account for 30 – 50% of total medicinal consumption and the total sales of their herbal medicines amounted to USD 2.5 billion in 1993. In addition, China exported medicinal herbs in 1993 with an estimated value of USD 40 million. Within China the traditional systems of health care are incorporated into the formal component of national health care [7]. In 1991, there were 530,000 medical and technical personnel in traditional Chinese medicinal field. There were more than 2,000 hospitals of traditional Chinese medicine, and 170,000 beds within the hospitals. Also, there were more than 160 scientific research institutions of traditional Chinese Materia Medica, forming a scientific research system. There were more than 2,000 factories of manufacturing medicinal herbs, producing more than 4,000 kinds of ready-made Chinese herbal medicine every year [8].

In India, where 75% of the population depend on herbal preparations in 1991, 540 plant species were reported to be used in different formulations [9]. In 1995, there were 250,000

registered TM practitioners, the majority having received training in degree graduating college [7].

1.1.3 Traditional medicine in Ethiopia

The introduction of modern medicine to Ethiopia dates back to the 16th century during the regime of Emperor Libne Dingel (1508-1540). The first government run modern health care was established in 1906 with the opening of Menelik II Hospital in Addis Ababa. Since then the government has taken the formal responsibility of delivering health care to the population and health institutions were established in the different regions of the country. However, the growth and development of modern health care in Ethiopia as a whole has been very stunted and to date, its coverage is less than 50% of the population. The vast majority of the rural populations, therefore, still depend on TM and its practitioners [10].

The antiquity of Ethiopian TM could not be established with certainty due to lack of adequate historical sources. The early report on the Ethiopian TM practices was the one provided by Francisco Alvares in the early 16th century in which he mentioned that, Ethiopians knew the use of bleeding and cupping besides various herbs as purgatives [4]. However, Pankhurst noted that, it would seem reasonable to assume that the country's medical lore was then already well established [11]. He also added that, despite the probable long established nature of Ethiopian traditional remedies, the earliest known texts are the Geez "Matshafa Faws" of mid-seventeenth century and "Matshafa Madhanit" of the early 18th century. These medical texts contain several references to plants, animal products and minerals as well as magic and superstition [11].

A medicinal plant initially taken from Ethiopia, *Hagenia abyssinica* Gmel. (Kosso in Amharic) was introduced into the international world of medicine as an age-old tested medicament. Richard Pankhurst wrote at length how crude extract of this plant began to be utilized in Europe. He wrote that "the first foreign medical man to interest himself in Kosso" is a French physician called Dr. A Brayer around 1816 [12]. Brayers' first acquaintance with Kosso was from a contact he had with an old Armenian merchant called Karabet in Constantinople (now Istanbul) who told him that the "... Ethiopians cured themselves with the aid of the flowers of a plant which ... was known by the word which also signified the taenia itself " [12].

The root barks of another tree known locally as “Waginos” (in Geez) were used by people living in northern Ethiopia for many centuries for treating dysentery. A British traveler and amateur physician called James Bruce who stayed in Ethiopia from 1769 - 1771 was attacked by dysentery when he was about to leave Ethiopia. He tried to cure himself with the help of the medicines he had brought along from Europe but was not successful. When observing that he would not be able to make it to Europe traveling through the hot landmass of Sudan and Egypt, the chief of Ganhar of Shanqilla informed him to take a well-established local drug known as “Waginos”. The root barks of this plant were cleaned, dried in the sun, and ground into powder. James Bruce was then made to take two spoonfuls of the powder with camel's milk. After the sixth or seventh day Bruce regained his health and was able to continue his journey to England. On his way back, he took some of the powder and fruits of “Waginos”; the powder, he used whenever his companions and himself fell sick and the fruits were delivered to a botanist at the British Museum called Daniel Solander, who, noting that it represented a taxon not known in Europe then had it planted in several British gardens. The

plant was later named *Brucea antidysenterica* J.K Miller in honor of James Bruce and with the specific epithet indicating the medicinal property of the plant [13].

Ethiopia is the home of many nationalities and remarkably diverse flora, including numerous endemic species that are utilized in the different traditional medical practices of which the two systems are important to our concern [14].

The first one consists of "folk medicine" in which the flow of information about the therapeutic effect of a number of plants circulates freely within the community. For example, most dwellers of a village make use of Kosso (*Hagenia abyssinica*) or kurjan seeds (*Myrsine africana*) sold in the markets as anthelmentics without having to consult any specialist. Such widely grown plants as *Taverniera abyssinica,* eucalyptus, ocimum, rue, garden cress (R*epidum sativum*), etc., are used by almost every one in the community to treat a patient who sustains injuries, headache, flu or stomachache [14].

The second category consists of a system in which the traditional medical practitioner undergoes a prolonged informal training or an "apprenticeship" during which the concept of disease, methodology of diagnosis and the plants used in the treatment of the ailments are passed on from father usually to the elder son or from teacher to pupil. The traditional healers, the product of this system, are what we might consider as professional practitioners dealing with a wide range of health problems or specialists treating just a few serious cases. Owing to the strict secrecy, the information retained by these healers is more reliable and less susceptible to distortion than is the case with folk medicine. However, this should not lead to the assumption that once the knowledge is acquired it remains static. Traditional medicinal knowledge is dynamic and the practitioners make every effort to widen their scope by

reciprocal exchange of limited information with each other or through reading either one of the traditional pharmacopoeias written in Arabic or Geez.

The plants employed in the survival strategies of lower animals are carefully observed and accepted as new therapeutic agents after repeated testing. Curiosity has also been a major force in the discovery of plants with new medicinal properties. For example, exotic species with bitter, sour or pungent characteristics are tried on animals or on members of the family and on the practitioner himself. The overall functioning of the body and its reaction to the drug are carefully observed before the prospective plant is added to the existing list of therapeutic agents [14].

The widespread use of TM among both urban and rural population in Ethiopia could be attributed to cultural acceptability, its attributed efficacy against certain types of diseases, physical accessibility and economic affordability as compared to modern medicine. In view of this development and its ultimate integration of TM with the modern system is believed to have significant impact in the expansion of the health care coverage. In recognition of its importance as an alternative health resource readily available to both urban and rural communities, a coordinating office for TM was established in the Ministry of Health (MOH) in 1979. The office was mandated to coordinate nation wide activities such as phytochemical screening, clinical evaluation of traditional health practices and surgical procedures, etc. Despite its ambitious and rhetoric objectives, the MOH however, accomplished very little over the years in the development of TM [10].

A renewed interest in the development of TM came about with the assumption of power by the Transitional Government of Ethiopia in 1991, which issued new health and drug policies

in 1993. In these policies TM is highlighted as one of the priority areas. The policies state that "Due attention shall be given to the development of the beneficial aspects of TM including related research and its gradual integration into modern medicine" [15,16].

After a somewhat circuitous development passage, the Ethiopian government, with World Bank assistance started to implement the first "Conservation and sustainable use of medicinal plants" project in Sub-Saharan Africa. The overall objective of the project is to initiate support for conservation, management and sustainable use of medicinal plants for the human and livestock health care [17].

Since Ethiopia is conscious of the loss of its genetic resources, especially in this case where such resources are the primary, if not the only, source of health care for rural and urban poor population; different research institutions and researchers are performing studies on medicinal plants of Ethiopia in order to develop pharmacopoeia of different regions of the country, formalize extraction; standardization, safety and efficacy, dosage and formulations of phytomedicine.

Nowadays, studies on TM in Ethiopia can be summarized as ethnobotanical, ethnopharmacological and standardization and formulation of phytomedicine.

a) *Ethnobotanical studies*: The documenting of medicinally important plants is mainly aimed at developing database for further studies and conservation of the plants. Ethnobotanica studies in Northern Ethiopia [18], central plateau and Rift valley of Ethiopia [19], Shirka district [20], South and Central Ethopia [21] Butajira and Addis Ababa [22,23], Jabitehan woreda, W. Gojjam [24], Central Shoa and S.W Ethiopia [13], "Zay" people [25],

"Kereyu" people [26], Boosat woreda [27], two Woredas of Southern Tigray [28] and Afar [29] are among the studies, which documented some medicinal plants of Ethiopia.

b) *Ethnopharmacolgical studies*: Based on the ethnobotanical studies or claims of traditional medicine practitioners, researchers are screening the pharmacological activity and phytochemistry of medicinal plants. These studies include anthelmentic [30-34], antimicrobial [35-39], antimalarial [40-44], antiretroviral [45] and antipyretic and antiinflammatory [46] screening of the herbal drugs. Most of the studies indicate that the plants are promising for the claimed medicinal uses.

c) *Standardization and formulation*: Since standardization and formulation studies require advanced technologies and well-trained pharmaceutical technologists with an interest on herbal drugs, little is done in the area. The works that can be mentioned are those done by the Department of Pharmaceutics, School of Pharmacy, Addis Ababa Univerisity. Launching postgraduate programme in the department has made significant contribution to the works done. Preliminary studies on *Plumbago zeylanica* [47], *Dodonea viscosa* [48] are two examples of the studies carried out on topical preparations of herbal drugs for dermatological disorders. Apart from topical preparations, the extract of seeds of *Glinus lotoidos* has been standardized and formulated as tablets for its anthelmentic activity [30, 49].

1.2 Study of medicinal plants: Ethnobotany and ethnopharmacology

1.2.1 Importance of Ethnobotany

Since its conception in 1895 "Ethnobotany" has proved a rather difficult term to define. Harshberger regarded it as simply "the use of plants by Aborgian people". Yet during the century, which has, intervened considerable attention has focused not only on how plants are used, but also on how they are perceived and managed, and on the reciprocal relationships between human societies and the plants on which they depend. As a result, ethnobotany has been repeatedly redefined [50]. Recently Martin defined ethnobotany as "all studies (concerning plants), which describe local people's interaction with the natural environment" [51].

Since the early ethnobotanical studies in Aborgian plant use, the scope of the subject has expanded enormously, encompassing the botanical aspect of a number of ethnoscientific fields including ethnomedicine, ethnotaxonomy and ethnoecology as well as the anthropological and botanical study of material culture and subsistence mode. For the sake of clarity, six major fields of investigations are distinguished: ethnoecology, traditional agriculture, cognitive ethnobotany, material culture, traditional phytochemistry and palaeoethnobotany. Of necessity, each of these areas of ethnobotanical study draws from a theory and techniques of a range of established disciplines, several of which may be pertinent to any given project [50].

The study of TM is broadly divided into three main approaches: medical anthropology which examines cultural aspects of human health and disease; medical botany which studies the

nature and application of plants used within traditional medical systems; finally, ethnopharmacology which involves the conventional chemical and pharmacological analysis of the traditional remedies, including those based on plants.

Based on the above approaches ethnobotanical studies of medicinal plants are done primarily for three reasons, which can be divided into an ethnological, documentation and pharmaceutical motivation [52].

Ethnological

Here scientists are curious about the people and the plants they use, and record all the information they can get. In research from this perspective, it is important not to be subjective and not to have too many opinions about the uses. One is looking at the way people use plants, for which purpose and from what conviction, as well as describing how the plants are put to purpose. The anthropologist is not really interested in the effectiveness of the uses by the local people, nor should he be interested in improving their situation [50,51].

Documentation

In many developing countries, medicinal plants have not been well studied, tested or documented. Most of the information is still in the hands of traditional healers and knowledge of healers is either lost or passed to generation by the word of mouth. Thus, ethnobotanical research attempts to document the knowledge of the healers in the community in order to reserve it for future use.

Most of the time it is impossible to document all the knowledge of traditional healers. Hence critical observations of TM practices of the community should made, for the selection of

plants that are worth documenting. If useful descriptions of TM practice of a certain community is to be documented as many healers as possible should be interviewed to obtain information on the use of medicinal plants, traditional healers consensus and preparation procedures and rituals, if any, associated with the treatment [52].

Pharmaceutical

The other motivation ethnobotanists can have is the search for chemicals that can be used in modern medicine. It is well known that several important drugs originated from plants. It is estimated that 250,000 flowering species grace the earth, of these less than 0.5% have been studied exhaustively for their chemical composition and medicinal values. In a world with limited financial resources, it is impossible to screen each of remaining species for biological activity [53]. Therefore, ethnobotanical research is fundamental in screening those plants that may possess potential biological activity.

On the basis of plant collections, and using a preliminary in vitro anti-HIV screen, Balick provided evidence to indicate which ethno-directed plant collections may well prove more efficient than random sampling methods. This would therefore suggest that ethnobotanists might be able to identify significantly higher numbers of lead compounds, which exhibit a required bioactivity compared with plants selected at random [50].

1.2.2 Ethnopharmacology in drug discovery

Ethnopharmacology as a specifically designated field of research has had a relatively short history. The term was used in 1967 as a title of a book on hallucinogens

"Ethnopharmacologic search for psychoactive drugs" and is nowadays much more broadly defined:

"The observation, identification, description, and experimental investigation of the ingredients and the effects of the ingredients and the effects of such indigenous drugs is a truly interdisciplinary field of research which is very important in the study of traditional medicine. Ethnopharmacology is thus defined as the interdisciplinary scientific exploration of biologically active agents traditionally employed or observed by man." [54].

This definition draws attention to the evaluation of indigenous uses and does not explicitly address the issue of searching for new bioactive drugs (drug discovery). Here we look at different processes involved in drug discovery.

The discovery process is composed of several stages. The first stage must be the reported use of a naturally occurring material for some purpose, which can be related to a medicinal use. Consideration of the cultural practice associated with it is important in deciding possible bases of the reputed activity. If there is an indication of genuine effect, then the material needs to be identified and characterized according to scientific nomenclature. It can then be collected for experimental studies, usually comprising some tests for relevant biological activity linked with isolation and structure determination of any chemicals present, which might be responsible for the observed activity. These various stages are discussed in detail below.

Information sources

The most reliable type of information arises from in-depth studies carried out by field workers living in that particular community of a particular ethnic group on the use of local plants and

other materials. This usually comprises frequent communication with the local population, preferably in their own language. It should be noted, however, that an extensive knowledge of TM may reside with only a few people and a focus on this group would yield greater results.

Before such knowledge can be investigated scientifically, the information provided will often need clarification and translation into scientific terms of particular importance. The correct identification of the species used can be very difficult due to a lack of or poor quality sample specimens. Illustrations as well as language difficulties can also be additional barriers. However, data on the part used, time of collection, method of preparation of formulation and methods of application are also necessary since they all affect the nature and amount of any biologically active compounds. Any restriction on use due to time of year may be important since they may indicate low levels or high levels of active compounds. Similarly, any type of individuals excluded from being treated may indicate groups at risk due to age, gender or occupation [55,56].

Scientific investigations

Extraction:

The extract used for testing should approximate as closely as possible to that obtained from the traditional process. In many cases, this will be simple extraction with hot water. But a variety of other solvents as well as various additives may be used in the treatment of materials before use. In most instances however, it is likely that fairly polar compounds will be extracted, although the solubility of less polar substances may be increased considerably due to solubilizing compounds [55, 56].

Test for activity:

In most instances of modern drug discovery carried out by industrial and academic research groups, a particular assay, or series of in vitro bioassays, designed on the basis of the biochemistry or molecular biology of the disease, is used to test the extract. In these situations, the ethnopharmacology has little relevance to the tests used except that it provides a number of screening samples selected on the basis of their traditional use for the disease in question [55, 56].

Chemical examination:

Chemical examination should be linked with tests for biological activity and it is probably only a happy accident of history that the many alkaloidal drugs were developed from traditional medicines, without the need for bioassay guided fractionation because the alkaloids were present in fairly high amounts and they were relatively easy to obtain in a purified state. For many other traditional medicines, where activity is not due to alkaloids, it has been much more difficult to separate the activities from all the other compounds [56]. Chemotaxonomic approach increases the proportion of plants that screen positively, thus saving research time and money. Specific secondary metabolites, such as flavonoids, are often restricted in distribution, being found only in groups of related plants. For example, isoflavnoids are common in species of the Fabaceae, but are found in few other plant families. Of the over 5500 types of alkaloids known, many are confined to a single genus or subfamily. Only a single alkaloid has been found in the many species of Bombacaceae tested so far, but the Solanaceae, Rubiacea and Ranunculaceae are the source of hundreds of distnict forms [51].

The presence of different secondary metabolites in a plant can be screened by the use of appropriate chromogenic reagents after separation [56].

A typical example of success reported in drug discovery based on ethnopharmacological approach is the discovery of artemisinin. *Artemisia annua* is a plant which was recorded during 281-340 AD for treating malaria [57]. In 1976, artemisinin compounds were identified and their mechanism of action elucidated. Artemisnin acts against malarial parasite in a very different way from quinine and most of the synthetic quinoline antimalarials. Several large trial studies have shown the efficacy of artemisinin but the more soluble analogue artemether and artesunates are now widely used and are recommended by WHO as antimalarias in chloroquine resistant areas [58].

1.3 Objectives of the present study

General objective

- To document the ethnobotanical and ethnopharmaceutical knowledge on medicinal plants of Afar people.

Specific objectives:

- To identify major medicinal plants used by Afar people for the treatment of human and animals diseases;
- To document the knowledge of indigenous people on medicinal plants as regard their use, formulation, dosage, precaution, side effects and drug interactions;
- To evaluate the claimed activities of medicinal plants used by traditional medicine practitioners of Afar people: Chifra District using published phytochemical and pharmacological information;
- To enumerate problems related to the traditional medicine practice of the Chifra District and suggest possible solutions;
- To collect specimens of major medicinal plants used by traditional medicine practitioners of Afar people: Chifra District.

2. METHODS

2.1 Description of the study area

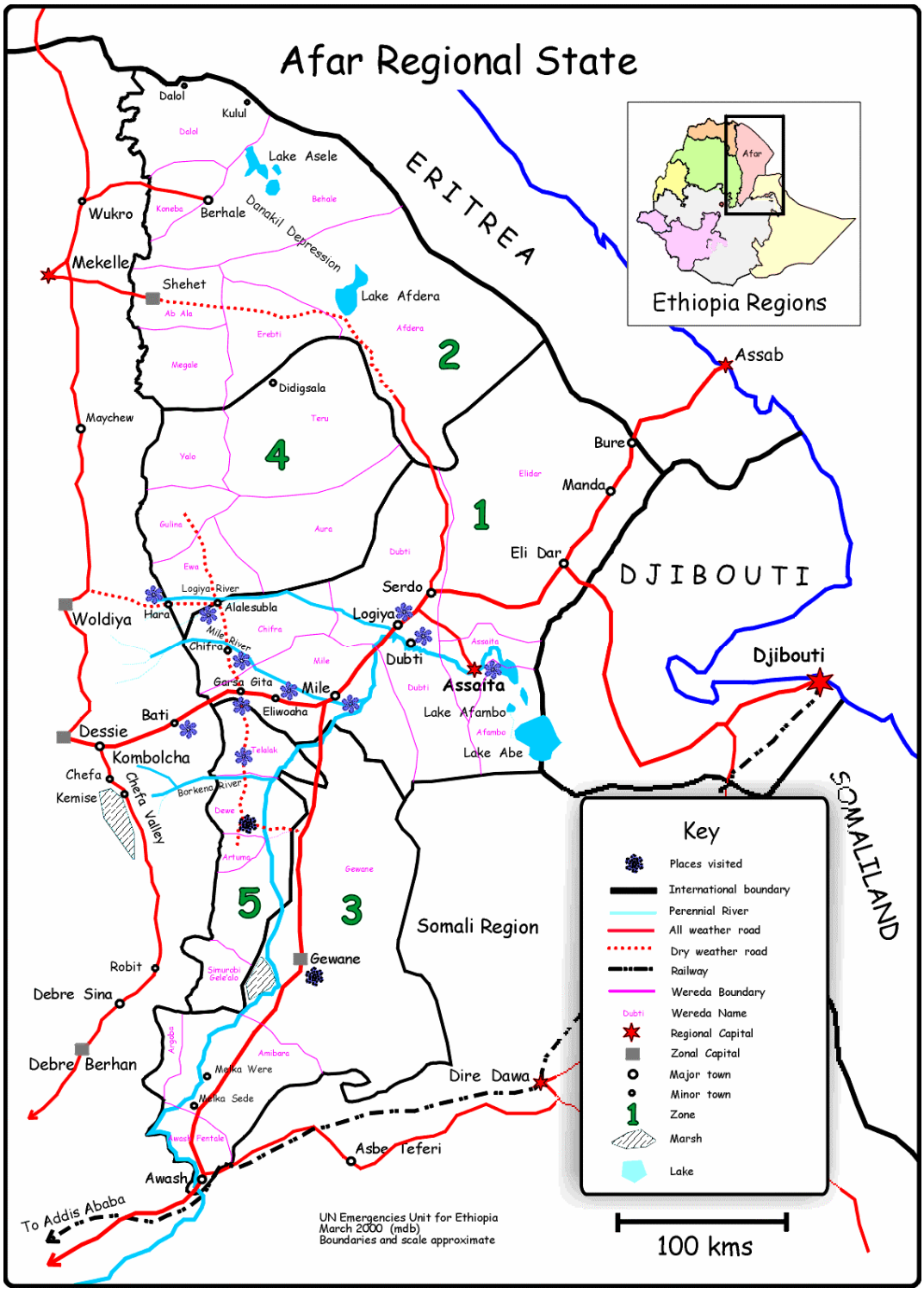
Location

Afar National Regional State with a total area of 85,410 km^2 lies between 8^0 40'13" to 14^0 27' 29" N latitude and 39^0 51'13" to 42^0 23'03" E longitude in the rift valley. The topography of the region varies from hilly escarpments in 1,000-1,500 meter to lowland plains that fall in the altitude range of 0-100 meters. Nationally, the region is bordered with Tigray in the North, Amhara in the West, Oromya and Somali National Regional State in the South and East. Internationally, it bordered with Eritrea in the North and Djibouti in the East [59].

The study area, Chifra district is one of the six districts of Zone 1 of Afar Region bordering with Dubti and Mile Districts in the North and Northeast, respectively. It lies to the East of North Wollo Zone of the Amhara Region and southeast of Zone 4 of Afar Region [59]. The map of the study area is shown in Fig.2.1.

Population

The population of Afar National Regional State, during the study period, extrapolated from the 1994 People and Housing Census of Ethiopia was estimated to be 1,301,001 of whom 56% were males and 44% females with sex ratio of 126:100. Over 90% of the population lives in rural areas leading a nomadic and semi nomadic life style. 85,446 people live in Chifra District, 48,286 males and 37,160 females [60].



Study area

Fig 2.1: Map of the Afar National Regional State

Health service

Infrastructure

During the study period, the region had 2 hospitals, 8 health centers, 45 health stations, 56 health posts, 4 private drug stores and 45 rural drug vendors to serve more than 1.3 million people. The two hospitals had a combined functional bed capacity of 120. Most of the health institutions were maldistributed, understaffed and poorly equipped. Moreover, these are neither accessible nor useful for the majority of the seasonally mobile and socio-economically disadvantaged population of the region. In fact, Chifra District had only one health center, one health station, one health post to serve its population [61, 62].

Human resource

There are a total of about 215 health workers to serve more than 1.3 million people of the region. The majority of these are health assistants followed by nurses and midwife nurses. Chifra District had only 2 nurses, 1 midwife nurse, 4 junior nurses, 1 junior pharmacy technician, 1 laboratory technician and 2 frontline health workers [61,62].

Disease prevalence

The ten leading causes of outpatient visit in Chifra Health Center are shown in Table 2.1. Malaria is the most prevalent disease in the study district .It was number one causes of outpatient visit in Chifra Health Center in 2001/2002. Acute respiratory tract infection and infection of skin and subcutaneous tissue were the second and third causes of outpatient visits in the health center, respectively [61].

Table 2.1: Ten leading causes of outpatient visit in Chifra Health Center, (2001/2002).

No.	Diseases	Number of patients diagnosed
1	Malaria	3698
2	Acute respiratory tract infection	422
3	Infection of skin and subcutaneous tissue	402
4	All other respiratory tract infections	378
5	All other urinary tract infections	275
6	Bronchitis and unqualified pneumonia	260
7	All other infectious and parasitic diseases	215
8	Gastritis	213
9	Other helmentic infestations	193
10	Bronchopneumonia	166

2.2 Selection of the district and rural communities (Kebeles)

The district was selected out of the total 29 districts of the Region by convenience sampling technique, where as the 13 rural communities (Kebeles) among the 19 were selected based on the information obtained from health workers and ethnic leaders about the number of traditional medicine practitioners in the rural communities and their experience.

2.3 Selection of informants

Village meetings were held in each target village of the 13 rural communities and the aims and objectives of the survey were discussed. Both volunteer and recommended traditional

medicine practitioners were identified as potential informants and subsequently participated in personal interviews.

2.4 Ethnobotanical and ethnopharmaceutical data collection

Ethnobotanical data were collected in 13 rural communities of Chifra District during Nov. 2002 - May 2003. Fieldwork was focused on collecting information on medicinal plants use, the general ethnographical data as well as on the preparation of dried herbarium specimens and collection of samples for further analysis.

The informants (specialists in herbal medicine) were first asked about themselves and their experience as healers. In a more structured interview, the healers were asked about the use (s), preparation of plants, as well as their concept of mechanism of action, drug interaction, storage, side effects of the herbal preparations. Next, during excursion to the surrounding areas, the specialists showed the plants they use for their pharmaceutical preparations. Here, the interviews were conducted in places where the informants were comfortable.The interviews were conducted by the investigator with the help of translators who are nurses and animal health professionals.

At the end of each interview, specimen of plants mentioned for medicinal uses were collected and identified. Voucher specimens of these medicinal plants are stored at the National Herbarium, Department of Biology, Addis Ababa University.

During the course of the study, each informant was visited at least twice in order to verify the relevance of the information.

2.5 Analysis of ethnobotanical data

In order to analyze the cultural importance of an individual species, the reports obtained were categorized into relatively well-defined ethnomedical categories.

The consistency of the use-reports within the category was evaluated numerically using the factor of informant's consensus, Fic, which gives the relationship between the number of use-reports in each category (n_{ur}) minus number of taxa used (n_1) and the number of use reports in each category minus one as described by Leonti et al. [63].

Thus, Fic is determined as follows:

$$Fic = \frac{(n_{ur} - n_1)}{(n_{ur} - 1)}$$

A value close to 1 indicates a high intracultural consensus i.e., more healers use the same species. A value close to zero indicates a high variation in the use of species.

A more detailed analysis of the published phytochemical and pharmacological information was conducted to species with more use reports. To get data on published phytochemical and pharmacological information on the species, literature searches were performed via: Medline, Chemical Abstracts, Biological Abstracts, Biblioline and NAPRALERT.

3. RESULTS

3.1 Sociodemographic characteristics of respondents

The present study revealed that, the majority of the traditional medicine practitioners found in the district were males, 27 (93.1%) aged 23-77 years and with an average age of 48. All of the respondents were Muslims. Only three of the healers (10.35 %) got formal education. Four healers (13.8%), attended informal education (Koran). Concerning occupation, none of the informants practice traditional medicine as their only means of income. Most of the healers are pastoralists. Two of the healers (6.9%) were guards of health institutions of the district, one was a religious leader (3.45%) and one of the practitioners (3.45%) was chairman of the district's Afar National Democratic Party (Table 3.1).

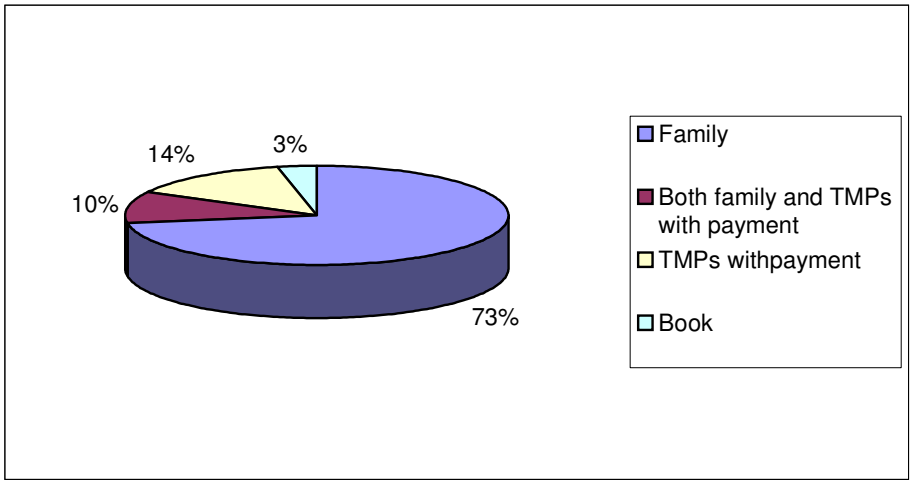
3.2 Source of healing wisdom and experience of traditional medicine practitioners

The majority of the healers, 21 (73 %) indicated that they acquired their healing wisdom from their family, 14 % of them from traditional healers with payment, and 10 % of them from both family and other healers with payment. Only one of the healers cited a book as his source of wisdom (See Fig 3.1).

The experience of traditional healers practice in the district ranges from 3 - 40 years, the average being 21 years (See Appendix 1).

Table 3.1: Sociodemographic characterstics of traditional medicine practitioners (n=29) of Chifra District, (2002/2003).

Characteristics		Frequency
1.	Sex	
	Male	27
	Female	2
2.	Education	
	No education	22
	Islamic basic education	4
	Primary education	3
2.	Religion	
	Muslims	29
3.	Occupation	
	Pastoralist	25
	Guard	2
	Religious leader	1
	Head, political party	1
4.	Age (years)	
	21-30	2
	31-40	5
	41-50	14
	51-60	5
	61-70	1
	71-80	2



Key: TMPs: Traditional medicine practitioners

Fig 3.1: Sources of healing wisdom of traditional healers (n=29) of Chifra District, Afar, (2002/2003).

3.3 Ailments treated by the healers

Both human and livestock diseases are treated by healers of the district. Human ailments that are commonly handled by the healers include “urribaqla”*, snakebite, impotence, malaria, “baxalitta”**, “sassactu”***, retained placenta and wounds. Anthrax, blackleg, tuberculosis and render pest are those diseases of livestock that are treated by the healers.

*Urribaqla (urri-Children, baqla- disease) – it is a disorder characterized by abdominal extension, loss of body weight, vomiting, stool with bad smell, loss of hair, fever and falling of the patient

**Baxaliita- it is a disorder characterized by edema on the leg and face, itching, and nightmare.

*** Sassactu – It is a disorder characterized by headache, wound of pupil, sometimes leading to blindness.

Table 3.2: Common ailments treated by traditional medicine practitioners (n=29) of Chifra District, Afar, (2002/2003).

Ailments	Frequency
Human disorders	
Snakebite	13
Malaria	9
Urribaqla	7
Impotence	6
Baxalitta	6
Wounds	5
Retained placenta	4
Livestock diseases	
Anthrax	4
Blackleg	3
Tuberculosis	3

3.4 Plant collection

Since about 90% of the plants were perennials they can be collected throughout the year. 10% of the plants grow during the rainy season only and hence collected during this period. Almost all practitioners suggested that herbal drugs should not be collected at midday. Most healers specify different days for collection of different herbal drugs. Also, the healers follow different ritual procedures such as performing prayer from the Koran, putting coins under the plant to be collected.

3.5 Plant part(s) used

According to the present survey, the most widely used plant part is the leaf accounting for 43.9% of the reported ethnoformulations, followed by root, whole plant, stem bark, latex, seed, aerial part and stem (See Fig 3.2).

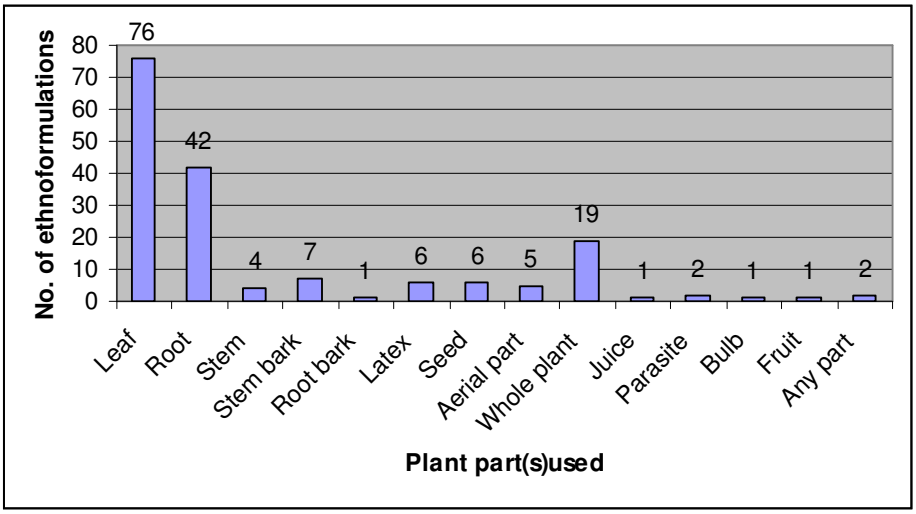


Fig 3.2: Plant part(s) used by Afar traditional healers in Chifra District for the treatment of human and animal ailments.

3.6 Plants and their claimed medicinal use

The study revealed that about 70 plant species find applications by the traditional medicine practitioners of selected rural communities of Chifra District. Among these species, 33 were fully identified by their scientific name and 10 at generic level and the remaining 27 could not be identified and were recorded only by their vernacular names. Those that were identified at species level represent 29 genera distributed in 18 families. 15% of the plant species belong to

the family Fabaceae. Of the reported herbal drugs, 48 were used against human ailments, 9 plants against cattle diseases and 13 plants for both human and veterinary diseases. Among 48 species used for human ailments, 14 plants were used for the treatment of snakebite and 12 plants to treat "Urribaqla". The healers reported that one species could be used for the treatment of different ailments as in the case of *Aloe* sp, which is used for the treatment of malaria and "Urribaqla".

Most of the herbal drugs that are claimed to have medicinal use for cattles are reported to be used for blackleg, which account for 33.3% of the total species used for cattle diseases.

3.7 Ethnoformulations and dosage forms

The documented 70 species of medicinal plants were reported to be formulated in 144 ethnoformulations including unprocessed herbs for the treatment of human and veterinary ailments (Appendix 2&3). The majority of the dosage forms were liquid preparations (59%) followed by unprocessed herbs (23%) (See Fig 3.1).

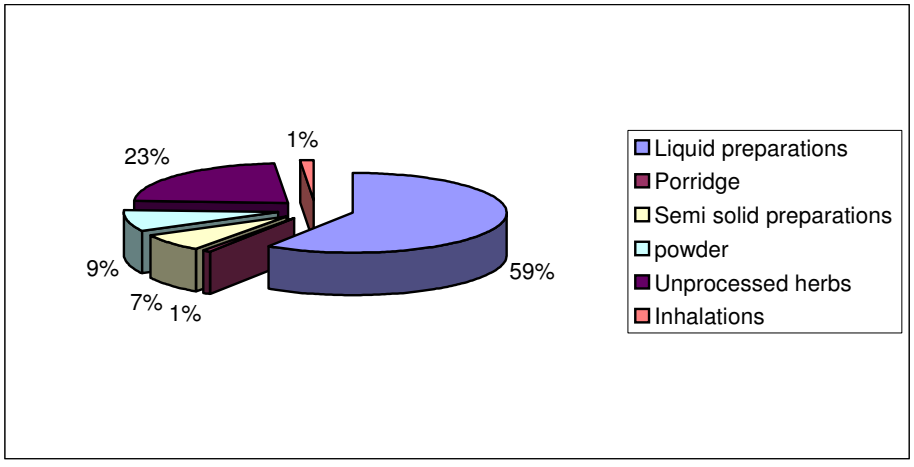


Fig 3.3: Herbal dosage forms prepared by traditional healers of Afar people: Chifra District, (2002/2003).

3.7.1 Solvents and additives

In almost all the ethnoformulations that involved the use of solvents (vehicles), the solvent used is water. Milk was also reported to be used as a vehicle. Incorporation of different additives accounts for 16 % of the ethnoformulations. The additives include butter, honey, sugar, goat and camel milk (Table 3.3).

Table 3.3: Solvents and additives used in ethnoformulation of traditional healers of Afar people: Chifra District, (**2002/2003**).

Solvents and additives	**Number (%) of ethnoformulations**
Water	77(53.4%)
Butter	7(4.9%)
Milk	6(4.2%)
Honey	4(2.8%)
Sugar	3(2.1%)

Solanum incanum juice	2(1.4%)
Blood of goat	1(0.07%)

3.7.2 Combination of herbal drugs

In 18 of the total 144 ethnoformulations, it was noted that more than one herbal drug is incorporated (See Table 3.4).

Table 3.4: Combined herbal drugs and the corresponding indications as reported by traditional medicine practitioners of Afar people: Chifra District, (2002/2003).

No.	Combined herbal drugs	Indications
1	*Zaleya pentandra* (leaf), *Indigofera sp* (Whole plants)	Malaria
2	*Zaleya pentandra* (leaf), *Senna italica* (Whole plant)	Malaria
3	"Baddahafu" (Whole plant), *Salvadora persica* (root) and *Lycium shawii* (root)	Malaria
4	"Xaxaabaxes" (leaf), "Adrakumele" (leaf)	Baxaliita
5	*Solanum coagulans* (whole plant), "Xabboli" (whole plant)	Urribaqla
6	"Gaandamira" (root or leaf), "Bakarru" or *Acalypha* sp. "Baaxobarbare" (leaf)	Impotence

7	*Heliotropium rariflorum* (whole plant), "Waraabekala" (Whole plant)	Snakebite
8	*Commicarpus plumbagineus* (root), "Subaci" (leaf), "garonta" (root), *Balanites aegyptica* (leaf), *Solanum coagulans* (seed)	Urribaqla
9	*Acacia mellifera* (leaf) and "garonta "(leaf)	Arthritis
10	"Qubaabulto" (root), *Coffea arabica* (seed)	Diarrhea
11	"Subaci" (leaf*), Sericomposis pallida* (root)	Urribaqla
12	"Qadgento" (root), "Subaci" (leaf)	Tuberculosis
13	"Garsa" (leaf), "Qatoori" (stem), "Bisilto" (leaf), *Aloe* sp. (leaf)	Blackleg
14	Parasite that grows on *Boscia coriacea, Solanum incanum* (fruit), "Baroberu" (Whole plant)	Blackleg
15	*Salvadora persica* (root), *Tamarix apylla* (root) and *Aloe* sp. (leaf)	Tuberculosis
16	*Balanites aegyptica* (root), "Subaci" (leaf), *Cissus quadrangularis* (root)	Anthrax
17	"Waraabekala" (leaf), *Acalypha* sp. "Baxobarbare" (leaf)	Anthrax
18	*Xanthium strumarium* (leaf), *Acalypha* sp. "Baaxobarbare" (root)	Anthrax

3.7.3 Unit processes employed in the ethnoformulations

According to the healers the most commonly used unit process in ethnoformulations of the district is size reduction; and followed by extraction (eg. maceration). Mixing, filtration and drying are also employed in different formulations.

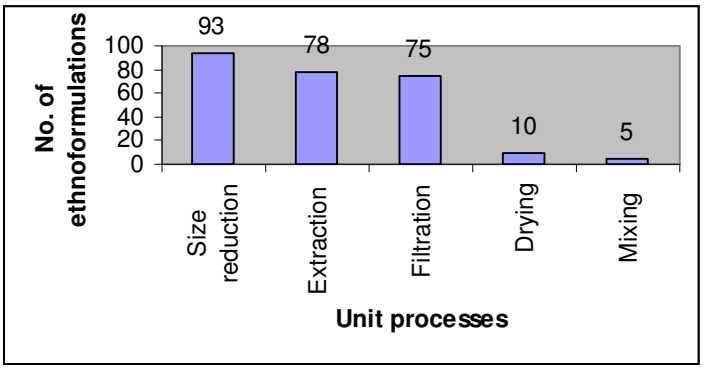


Fig 3.4: Unit processes employed in the ethnoformulations of herbal drugs used by traditional medicine practitioners of Afar people: Chifra District, (2002/2003).

3.8 Routes of administration

This survey also documented that most of the remedies are given orally, followed by intranasal and topical routes of administration. Various routes of administration used for the ethnoformulations are shown in Fig 3.5.

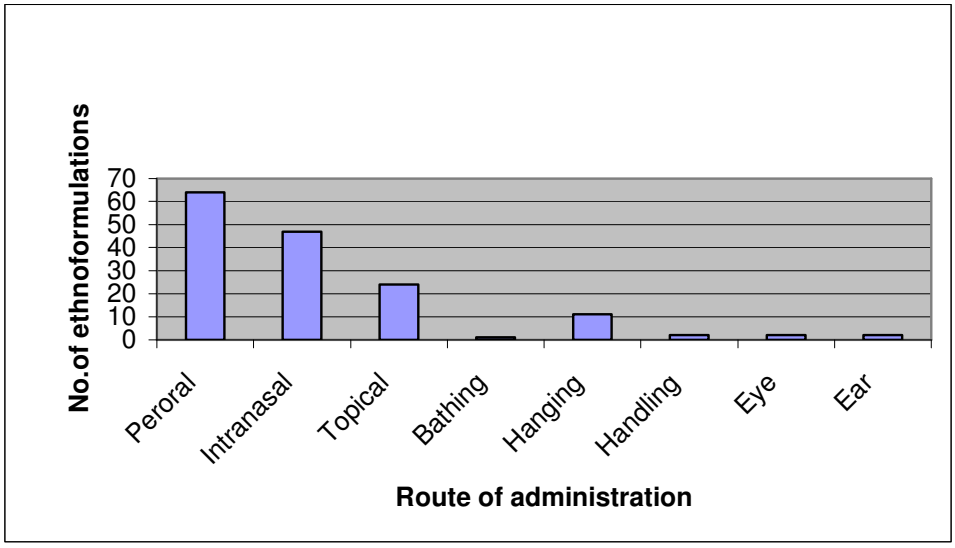


Fig 3.5: Routes of administration of ethnoformulations (n=154) of herbal drugs used by TMPs in Chifra District, Afar, (2002/2003).

3.9 Dosage

This study evidenced that the traditional healers of Afar, Chifra District, are aware of dose and frequency of drugs to be administered. They determine the dose and frequency depending on different conditions of the patient (pregnancy, body weight and age) similar to conventional western medicine. However, it was observed that there is a difficulty in determining the accurate dose of herbal preparations, as measurements are done by approximation.

For herbal drugs that are to be hanged to the hip of a woman or the tail of a camel, the amount of the herbal preparation is not specified. The duration of the application of such herb to be hanged is till the patient is cured. The plant that is hanged on the roof of the room for the treatment of retained placenta, “Galsalto” is recommended to be removed from the roof soon after the placenta is expelled. If the hanged herb is not removed following the expulsion of the placenta, it is believed that the cervix of the patient remains open.

In most of the liquid preparations, the amount of the final product to be administered is well stated by the healers. Whereas, the amount of part of the plant that is used in the preparation is expressed by ambiguous terms as "small" and "large" amount. Independent of the size of the plant used, dose is also expressed simply as "whole plant".

Liquid preparations that are used for snakebite are recommended to be drunk whenever the patient feels thirsty.

Traditional healers of Afar also express the dose of the herbal preparation by the number of leaves of the medicinal plant. For example, two informants expressed the dose of *Balanites rotundifolia*, which is used for the treatment of malaria in terms of number of leaves. One of the respondents recommended 8 or 9 leaves (for adult) and 4 leaves (for children) for 4 days. Such dosage regimen is administered as extracts of the specified leaves, or in some cases the leaves are directly eaten.

3.10 Precautions, contraindications and side effects

According to healers of Chifra District, some oral herbal drugs are contraindicated for pregnant patients. For instance, *Aloe* sp. that is claimed to have antimalarial activity is contraindicated for pregnant women. No contraindication or precaution is indicated for herbal drugs, even for patients with hepatic, cardiac and renal disorders as well as for the elderly and infants.

Almost all traditional healers (96.6%) report the side effect of the therapeutic dose of the herbal drugs to be nil. Only one healer mentioned *Aloe* sp. to cause nausea, vomiting and diarrhea in its therapeutic dose.

3.11 Drug interactions

According to this study, none of the drug interactions (herbal drug- herbal drug, herbal drug-modern drug, herbal drug-food) was indicated by the healers of the district except for

synergestic reactions in poly herbal preparations and interaction of *Moringa oleifera* with milk.

3.12 Storage and stability of herbal drugs

Asked on how they store herbal drugs, the healers responded that they don't normally store herbal drugs. They collect fresh material and formulate their drugs. As the maximum duration of storage of liquid formulations is only two days, the healers have no idea of "shelf life". For such formulations, the patient is requested to collect his medication every other day until he is cured.

3.13 Informant's consensus

In this study, *Aloe* sp. was cited by 31.3 % of the healers for different ailments followed by *Senna italica* (17.3 %), *Indigofera* sp. (24.1%), and *Acalypha* sp. (27.6%). Plants including *Jatropha glauca, Cissus quandragularis* and *Acacia mellifera* were cited by only one healer for their claimed medicinal uses (See Table 3.6).

As shown in Table 3.7, different ethnomedical categories of illness show different levels of cultural consensus. Fic value was the highest (0.53) in the category of snakebite. Also malaria and impotence had highest Fic values, 0.47 and 0.4, respectively. Gastrointestinal disorder and "Urribaqla" had low Fic values.

Table 3.5: The 12 commonly used plants in traditional medicine of Afar people: Chifra district and their uses, (2002/2003).

No.	Plant Species	No of citation	No of different uses	Indications
1	*Zaleya pentandra* (L.) Jeffrey "Abuuri"	5	3	'Urribaqla", malaria, snakebite
2	*Senna italica* Mill."Sete Ayrowagit"	5	3	Snakebite, "baxalitta", malaria
3	*Indigofera* Sp.	7	4	Snakebite, "baxalitta",

	"Wende Ayrowagit"			malaria, H. zoster
4	*Acalypha* sp. "Baxobarbare"	8	5	Snakebite, "baxalitta", Blackleg, anthrax, impotence
5	*Solanum coagulans* Forssk"Cantialulus"	5	3	Eye wound, "urribaqla", "baxalitta"
6	"Garonta"	5	4	Vomiting, rheumatism, epitasis, "Urribaqla"
7	*Kanahia laniflora* (Forssic) R-Br "Leehamohcaxa"	5	6	Render pest, anthrax, TB, "dingetegna", headache, arthritis
8	"Malikannoor"	5	1	Snakebite
9	*Aerva javanica* "Olayto"	5	4	Retained placenta (human) "dingetegna", snake bite, abdominal cramp
10	*Aloe* sp "Quureyta"	10	5	'Urribaqla", malaria, abdominal cramp, TB, pasterlosis
11	*Acalypha* sp "Subaaci"	6	4	'Urnbaqla", anthrax, headache, bleeding
12	"Waraabekala"	5	2	Snakebite, anthrax

Table 3.6: Number of species used, use report, factor of informant's consensus of ethnomedical categories of Chifra district: Afar, (2002/2003).

Ethnomedical Category	**Number of species used**	**Use report (n = 29)**	**Fic**
Snakebite	14	31	0.53
Malaria	9	16	0.47
Impotence	7	11	0.40

Arthritis, Rheumatic disease, Headache	7	9	0.33
Infectious diseases (other than malaria) and wound healing	13	16	0.20
Gastrointestinal disorders	6	7	0.17
Urribaqla	12	14	0.15
Livestock diseases	18	26	0.32

4. DISCUSSION

4.1 Sociodemographic characteristics of respondents

The average age of traditional medicine practitioners (TMPs) in the district was less than the average age of Arab practitioners in Middle East region [64]. The difference in the ages may be due to difference in life expectancy of the two regions. The age of 48.3% of the traditional healers was less than the average age of the practitioners. Unlike central Ethiopia, there isn't any problem of unwillingness of the new generation to acquire the knowledge of TM [65]. Therefore, the risk of loss of ethnobotanical knowledge can be minimum.

In Chifra District, traditional healing practice is not the only source of income for traditional medicine practitioners. The major reason could be payment free practices. Furthermore, the practice appeared to be a bit disorganized and hence limited the practice. The most impressive income of the practitioners from their practice is due to dispensing of herbal drugs for impotence. A drug for impotence costs 120.00 Birr per head and it is because of the enormous cost of the drug that the TMPs were unwilling to show the plants. One of the shepherds estimated the cost of herbal drug for impotence by saying, "The Afar people do not show plant used for impotence even if you give them 2 camels", and a camel may cost up to 2000.00 Birr.

4.1.2. Source of healing wisdom and experience of traditional medicine practitioners

The source of healing wisdom for most of TMPs is family, as mentioned above. This is in good agreement with different studies done in central Ethiopia [65] and Arab practioners in the Middle East [64]. Also the importance of family in acquiring traditional healing practice is mentioned by a study carried out in Tanzania [66]. The contribution of the Bible, the Koran, and religious institutions in acquiring the wisdom is well observed in other studies but in this study there was no mention of their contribution except for one healer who refered to the Koran from which he learnt about a plant [67, 68].

Since most of TMPs of the district acquired their knowledge of traditional medicine practice at their early age, the average number of years of experience was 21, which is almost equal to that of Arab practioners in the Middle East [64].

4.3 Ailments treated by traditional medicine practitioners

Generally, the ailments reported to be handled by the TMPs of the district are those disorders most prevalent in the district. It is interesting to note that while snakebite is common problem in the district, it is not indicated in the 2001/2002 report of the health center as a prevalent condition. This could be attributed to the preference of herbal drugs by the public to counteract snakebite.

Herbalists reported that there are ailments locally called "*urribaqla"*, "baxallita", and "sassactu", which are common disorders in the district but the health professionals in the district were unable to associate them with actual diseases. One of the practitioners mentioned "urnbaqla" as "Yesemayu", a name by which it is called in Amhara Region, Ethiopia.

4.4 Collection of medicinal plants

As it might be expected TMPs carry out the identification of plants before collection. The practitioners have an outstanding approaches and methods in identification of the plants. They use color of flowers, smell of leaves, height and thickness of stem, number of roots, presence or absence of latex and type and size of fruits during identification. All of the traditional healers know the geographical location of medicinal plants based on their past experience.

Almost all TMPs collect medicinal plants at specified time of the day and none of the healers collect medicinal plants at midday. According to the healers this is done in order to keep themselves from evil spirits that may be hiding the plant during this time of the day. All TMPs prefer to collect medicinal plants in the morning. Similar reports are documented in the study done in central and northern Ethiopia [13]. Similarly in Tanzania it is documented that TMPs claim TM to be effective only if the plants are collected in certain time of the day or

moon cycle [66]. Unlike the above practices, a survey in western Gojjam indicated that all practitioners collect medicinal plants at any time of the day [26].

Regarding days of the week, except for a few, all healers mention their day of preference to collect medicinal plants. The reason for selection of days was attributed to the doctrine of their ancestors. Some traditional healers highly depend on these days for efficacy of the herbs and others choose as the best day for healing practice. Some TMPs collect medicinal plants on the same day whereas; some practitioners have specific days for specific medicinal plants.

Although the practitioners are not aware of it, there is increasing evidence that the components of secondary plant metabolites vary appreciably throughout the day and night. Daily variation of poppy, hemlock, lupin, broom, the solanaceous plants and ergot have been reported [56]. Therefore, upon testing of claimed activities, it is worth collecting plant material as recommended by the practitioners.

Though practitioners correlate collection season only with availability of plants, the season at which each drug is collected is usually a matter of considerable importance, as the amount, and sometimes the nature of the active ingredients is not constant throughout the year.

As in most parts of the country, there are different ritual procedures followed by practitioners of the district to collect medicinal plants. The practitioners do not consider the plant as simple physical entity. Most of the herbalists (93.1%) feel that the action of plants depends not only on its inherent properties, but also on the relationship between the collector and the plant itself. Among the procedures, performing prayers from the Koran, throwing seven pieces of stone on the medicinal plant, putting some coins under the plant, protecting oneself from the

shadow of the plant are the most common ones. The reason for these procedures is the belief that "jini" (evil spirit) hide in the plant, and if such ceremonies are not performed, the evil spirit will kill their cattle. Performing prayers from the Koran before collection of medicinal plant is also practiced in Somali [69]. In western Gojjam, reading some paragraphs from the Bible is commonly practiced to keep away evil spirits that may hide in the medicinal plants [24]. Somali TMPs also protect themselves from the shadow of medicinal plants to be collected [69].

In addition to the procedures mentioned above,a special procedure is reported to be followed upon collection of *Kanahia laniflora*, a plant that grow inside rivers. Upon collection, the TMPs cut the plant by using "*Jille"* (Knife used by the people of Afar) and dive into the river and collect the plant. This procedure is also performed in order to keep oneself from evil spirit.

Only few of the herbalists (6.9 %) of the district do not give great importance to the ritual procedures (rules of ancestors).

4.5 Plant part (s) used

The most widely used part of plant for the preparation of herbal remedies in the Chifra was the leaf. Similar studies among "Zay" people [25], in two woredas of southern Tigray [28], in Addis Ababa and Butajira [23] and in Peru [70], indicate that leaf is the major plant part used in traditional medicine practice whereas, studies in Shirka district [20], in northern Ethiopia [53], in the central plateau and rift valley of Ethiopia [19], in Jabitehnan woreda, western Gojjam [24], Tabora Region, Tanzania [71] and Nepal [72] documented root to be the most extensively used plant part in the preparation of herbal remedies. As regsrds conservation, the traditional medicine practice has little contribution to destruction of the plant species, mainly

because collection of leaves does not pose a greater danger to the existence of an individual plant as compared to the collection of under ground parts, stem or whole plant.

4.6 Ethnoformulations and dosage forms

4.6.1 Solvents and additives

Most of the TMPs in the study district use water as the only vehicle unlike practitioners in other parts of the country [24, 73]. Hydroalcohol (local brewery) is not used as a solvent for religious reasons. Similarly, Arab traditional medicine practitioners of Golan Heights and West Bank region do not use alcohol as extracting solvent [74]. The use of water as the only solvent may entail that some plants used in TM may not show desired biological properties if their active ingredients are non polar.

Honey, sugar, milk of goat and camels are used as additives in ethnoformulations of the district. The rationale behind the use of honey and sugar is just to make the formulation palatable and that of milk is explained to increase the medicinal value of the drug. The traditional healers in Afar recommended milk to potentiate the medicinal value, unlike most of TMPs of Ethiopia who recommend it as antidote in case of toxicity.

4.6.2 Combination of herbal drugs

12.5% of the ethnoformulations were polyherbal preparations. The sanity of the TMPs to the incorporation of more than one herbal drug is in order to have a potentiation or summation effect of the medicinal plants. One of the traditional healers expressed the combination of "Weraabekala" and “Barobarbare*” (Acalypha sp.*) for the treatment of anthrax as "it is like

combining milk with milk curd". The synergistic or potentiation effect of one medicinal plant on the other is also claimed by healers of rural Central Ethiopia [23], Gonder [18] and the people of “Zay” [25].

The importance of synergistic or summation effect of herbal drugs has been proved on a research conducted in the UK on a mixture of ten traditional Chinese medicinal herbs for oral treatment of non-exudating atopic eczema in children. In a placebo controlled double blind trial carried out on 47 selected children, the traditional Chinese therapy was found to be effective as judged by Western medical trial. Efficacy was attributed to the combination of the ten herbal drugs and not to one specific herb [7]. But administration of polyherbal preparations could lead to complications. High toxic drugs with short term, long term or cumulative effect could be prescribed.

4.6.3 Unit processes

In most of the herbal drugs of the district fresh forms of the plants were used. For the rest of the drugs, processing starts with sun drying that may be followed by pounding, after which the material is ground using a local grinding stone. The sun drying is done un-hygienically on bare ground exposing the drugs to possible contamination. The process could also be wasteful and much material may be lost during all stages of the processing. In order to improve the hygiene and safety of herbal medicines, it may be necessary to use drying racks.

A unit process that is employed in most of the formulations is size reduction, which enables to increase the surface area of the plant material. As a result, extraction of the active principles is facilitated. Simple processing technology needs to be introduced to prevent contamination.

Extraction is also a popularly used unit process by TMPs of the district. Since the solvent used for extraction is water, non-polar compounds may not be extracted in sufficient amount due to their hydrophilicity. Therefore, hot water extraction (digestion) and extract with hydroalcohol, whenever applicable may be recommended in order to obtain those active compounds that may not be extracted with pure water.

4.6.4 Dosage Forms

The predominant dosage reported to be used by healers form in this survey was found to be liquid preparations. This agrees with the report in Korup area, Cameroon [70], Northern Ethiopia [73], Addis Ababa and Butajira [23], "Zay" people [25], Central Shoa and southwestern Ethiopia [13], and Jabitahnan woreda, W. Gojjam [24], Bulamogi, Uganda [75]. The reason for the popularity of liquid preparations may be ease of formulation. Unprocessed herbs are the second commonly used dosage form. Boiling of medicinal plants and using the ensuing vapors to steam patients is the less frequently reported dosage form.

4.7 Routes of administration

In Chifra District TM practice, the popular route of administration is peroral (PO). Concurrent with this fact, similar studies in "Zay" people [25], Jabitehna woreda, W.Gojjam [24], Shirka District, Arsi [20] and northern Ethiopia [73] indicated that peroral adminstration was common. Although in other studies topical route of administration is common next to PO, this study indicated intranasal route of administration to be the second commonly used route of administration in the district, accounting 30.7 % of the routes of administrations. According to the study, this route of administration is employed for diseases that attack the brain. The healers believe that the drugs administered via this route reach the brain quickly and easily.

Surprisingly, for the treatment of snakebite and retained placenta, the medicinal plants are tied above the bitten area and at the hip or abdomen of the patient, respectively. Although methods of the treatment have nothing to do with the indications, TMPs believe and witness that the methods are effective. The effectiveness of the plants administered through such routes may be doubtful. In addition, the belief of the healers for the effectiveness of the herbs as antidote for snakebite could have probably arisen due to the non-toxic nature of the venom of the snake [76]. Hanging of the plant in the treatment of retained placenta is not limited to the hip of the women but also on the roof of the room in which the patient sleeps. Therefore, placebo effect could be the best explanation.

4.8 Dosage

Difficulty of accurate measurement of dose of herbal drugs has been observed in the present study. For most of the ethnofomulations, the expression of dose is ambiguous."Whole plant" is one of the expressions that indicate the possibility of variation in dose of an ethnoformulation. "Whole plant" can lead to variation in the amount of extract and active constituents thereof, unless specific amount of each part of the plant is indicated.

With regard to frequency, in some liquid preparations the patient is ordered to drink whenever he feels thirsty. Obviously this implies that there is difference in frequencies of taking herbal preparations and hence total amount taken by different patients.

4.9 Contraindications, precautions, side effects

The only side effects reported in this study are those of *Aloe* sp.which may include nausea, vomiting and diarrhea. The reason could be attributed to the laxative effect of *Aloe* sp. [77]. Even though practitioners do not believe that the medicinal plants do not possess any side

effects in therapeutic doses, it is unlikely that the plants are free of side effects. Therefore, side effects of the plants should be closely observed and documented. In Shirka District, Arsi Zone, side effects of medicinal plants have been reported [20].

Recognition of contraindications of some oral drugs to pregnant women is one strong point of the practitioners in the disrict. The practitioners prohibit the use of oral herbal preparations to pregnant women. They believe that all drugs reach the fetus.

4.10 Drug interactions

In this study neither herb-modern drug nor herb-herb interaction was reported, except for synergestic reactions in poly herbal preparations, which are combined to give synergistic or summation effects. It does not mean that there were no interactions, but absence of integration of traditional herbal medicine to the conventional system of treatment resulted in unawareness of the interactions.

Patients may be simultaneously treated with prescription and herbal drugs. Therefore, safety and efficacy of combined herbs with prescription drugs should be well studied. Thus, TMPs as well as health workers should be trained on the importance of taking precautions to avoid possible interactions.

Herb-modern drug or herb-herb interactions are either pharmacokinetic or pharmacodynamic interaction. Pharmacokinetic interaction refers to the fluctuation in bioavailability of herbal drug molecules in the body as a result of changes in absorption, distribution, metabolism and elimination. Pharmacodynamic interaction on the other hand refers to how drugs actually

behave inside the human body i.e., the fluctuation in bioavailability of ingested substance as a result of synergistic or antagonistic interaction between herb-drug molecules.

4.11 Informant's consensus and claimed activities

The factor of informant's consensus for different ethnomedical categories indicates that the practitioners depend on certain number of species for the treatment of snakebite, malaria and impotence. Whereas, for disorders like "Urribaqla", the practitioners use various plant species for their treatment.

4.11.1 Medicinal plants used for malaria

Malaria is the most prevalent disease in the study district, being the first among the ten top diseases treated in the health center in the year 2001/2002.

Ethnobotanical information about different medicinal plants that are used for the treatment of malaria in Ethiopia is documented by different researchers (Appendix 5). However, most of the plants reported by healers of Chifra District to have antimalaral activity were not documented before.

Aloe sp.

Aloe sp. (Liliaceae) is the most frequently claimed plant for the treatment of malaria by healers of the district. The plant is also used by TMPs of Wolayta [78] and Central Shoa and southwestern Ethiopia [13] for its antimalarial activity. *Aloe chabaudii* Schon., *Aloe excelsa* Berg. and *Aloe greatheardii* Schon. are also used for the treatment of malaria in Zimbabwe [79].

The antiplasmodial activity and toxicity data on 34 *Aloe* species indicated the genuine biological activity of the plants. Most of the methanol extracts of the 34 species have been found to possess antimalarial activity with values ranging between IC_{50} of 32 and 77 $\mu g\ ml^{-1}$. The most commonly found bioactive compound in these plants was the anthrone C-glucoside homonataloin that inhibited the chloroquine-resistant *Plasmodium falciparum* strain with an IC_{50} value of $13.46 \pm 1.36 \mu g\ ml^{-1}$ [80].

In addition to their claimed antimalarial activity, it is interesting to note that aloes have been reported to have a wide spectrum of biological activity including antiinflammatory [81-83], antifungal [84], hormone regulatory [85], antidiabetic [86,87], wound healing [88] and hypotensive [89].

Balanites rotundifolia

Next to *Aloe* sp., the leaves of *Balanites rotundifolia* (Balanitaceae) (See Fig. 4.1) are the most frequently recommended herbal drugs for the treatment of malaria in the district. Similarly, extracts of this plant are also used for the treatment of the disease in Zone 2 of the Afar Region [90].

Fig.4.1: Photograph of *Balanites rotundifolia*

Moringa oleifera

*Moringa oleifera (*Moringaceae*) (Fig. 4.2) is* also claimed by one healer of the district to have antimalarial activity. In Elsavador, the plant is used as antibiotic and antitumor. The lipophilic extract of leaves of the plant has been shown to have antiplasmodial activity with an IC_{50} value of 7.8µg/ml against chloroquine sensitive strain (Pow) and 15.4µg/ml against

chloroquine resistant strain (Dd2) [91]. This is in good correlation with the use of the plant in the study area.

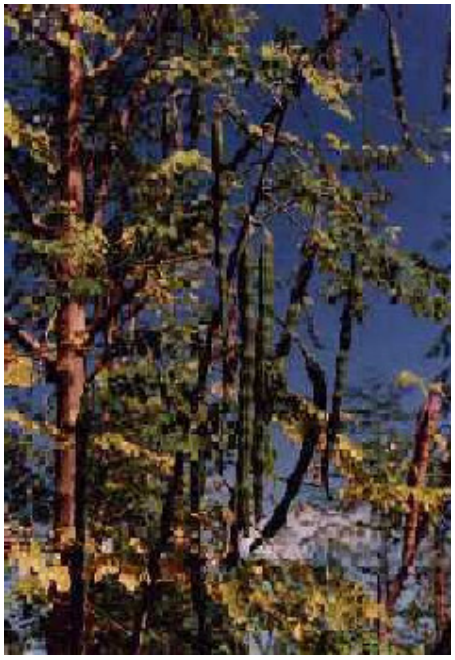


Fig.4.2*:* Photograph of *Moringa oleifera*

Salvadora persica

Salvadora persica (Salvadoraceae) in combination with "Baddahafu" is used for the treatment of malaria in the study area. The plant is also claimed to have antimalarial activity in Sudan. Based on the claim, the antiplasmodial activity of different extracts of *Salvadora persica* against *Plasmodium falciparum* NF 54 strain were tested and found to have an IC_{50} of 0.6 μg/ml for the stem and 0.7μg/ml for the leaves [92].

Toxicity of the leaf of *Salvadora persica* was evaluated using brine shrimp lethality test and LC_{50} value found to be greater than 1,000 ppm [93]. Investigation of the toxic effects of the

extract of *Salvadora persica* for thirty days on the reproductive system of the mouse indicated that the extract has adverse effects on male and female reproductive system and fertility [94].

4.11.2 Medicinal plants used for infectious diseases (other than malaria) and wound healing

The Fic value for this group of herbal drugs is 0.20 indicating that people in the study area depend on variety of species for the treatment of infectious diseases and wound healing. The plants claimed to have beneficial effect against infectious diseases and wound healing include *Acacia nilotica*, *Aristolochia bracteolate* and *Commicarpus plumbagineus.*

Acacia nilotica

One healer of the district reported about the use of the stem bark of *Acacia nilotica* (Fabaceae) for the treatment of tonsillitis. Similar claims have been reported by a survey of medicinal plants of Tabera Region, Tanzania [71]. In the Tanzanian traditional practice the plant is used for the treatment of tuberculosis, pneumonia, gonorrhea and small pox [95]. Ethnobotanical study in Zimbabwe reported the plant to be most frequently used for the treatment of sexually transmitted diseases (STDs) [96]. The antimicrobial activity of the plant extract showed that it is active against *S. aures, E. coli and* gonococcus [95]. The methanolic extract of the plant showed significant inhibition of gram- positive and gram-negative bacteria [96], whereas, the ethanolic extract of the plant displayed activity against gram-positive bacteria only [97].

Apart from its antibacterial activity, the plant possesses antifungal activity, and molluscicidal activity against schistosomiasis transmitting snails *Bulinus truncatus* and *Biomphalaria*

pfeifferi and cercarcidal and miracicidal activity against *Schistosoma mansoni* [98,99]. Also, the methanol extracts of the bark and pods of *Acacia nilotica* and aqueous extracts of *pods of A. nilotica* inhibited HIV-1 Protase replicate activity [100].

A nilotica has also been reported to possess antiplasmodial activity *in vitro* against *Plasmodium falciparum* 3D7 (chloroquine sensitive) and Ddz (chloroquine resistant and pyrimethamine sensitive) with an IC_{50} value of less than 5μg/ml. Bioassay guided fractionation of *Acacia nilotica* revealed that the ethylene extract possessed the highest activity (IC_{50} =1.5μg/ml) [101].

Fig.4.3: Photograph of *Acacia nilotica*

A. nilotica extract had an inhibitory effect on carrageenan induced paw edema and yeast-induced pyrexia in rats and produced a significant increase in the hot plate reaction time in mice. Flavonoids, polysaccharides and organic acids may be mainly responsible for its

pharmacological activities [102]. Also, a steroid 3β-acetoxy-17β-hydroxy-androst-5-ene isolated from aerial parts of *A. nilotica* (L.) showed dose-dependent anti-inflammatory activity against TPA-induced mouse ear edema [103].

Aristolochia bracteolata

The whole plant of *Aristolochia bracteolata* Lam. (Aristolochiaceae) is used for the treatment of wound in Chifra District. In a study done elsewhere, it has been reported that the leaves of this plant are used by the native tribes and villagers of the Chittoor District of Andhra Pradesh in India for the rapid healing of cuts and wounds. This claim was supported by a scientific study. The ethanol extract of the shade-dried leaves of *A. bracteolata* Lam. was studied for its effect on wound healing in rats, using incision, excision and dead-space wound models, at two different dose levels of 400 and 800 mg/kg body wt./day. The plant showed a definite, positive effect on wound healing, with a significant increase of the level of two powerful antioxidant enzymes, superoxide dismutase and catalase, in the granuloma tissue [104]. The plant was also shown to have antiplasmodial activity with an IC_{50} value of less than 5µg/ml against *Plasmodium falciparum* 3D7 (chloroquine sensitive) and Ddz (chloroquine resistant and pyrimethamine sensitive) strains [102].

Several fractions of the methanolic extract of the rhizome and the leaves of other species of the genus, *A. paucinervi* collected in Morocco were screened for antibacterial activity using the agar dilution method against 14 reference bacterial strains. Only 3 fractions showed an activity against at least one of the microorganisms tested [105]. Apart from antibacterial activity, all the fractions with the exception of aqueous fraction exhibited antifungal properties. The hexane fraction was the most effective, whereas the butanol fraction was the

least active. The most susceptible fungi were *Epidermophyton floccosum* and *Trichophyton violaceum*, and the least susceptible were *T. mentagrophytes* and *T. rubrum* [106].

The root and the stem of *A. heteropylla* were shown to contain novel sesquiterpene esters of aristolochic acid, aristoloterpenate-I, -II, -III, and -IV [107]. Investigation of the root and the stem of *A. cucurbitafolia* Hayata resulted in the isolation of seven sesquiterpenes, adolins A, B, C, D and E together with sesquiterpenes, aristolactone and manshurolide [108].

Roots of *A.indica* Linn. have been shown to possess anti-inflammatory and diuretic activities. The leaves are used to treat cholera and intermittent fevers in children. Tuberous roots are used for the treatment of snakebite [109]. Also, root tuber of *A. tagala* Cham. is used for snakebite by the Kani tribes of Kerala, India [110].

Some of the compounds known to occur in the root and stem of *A. elegans* includes tetralones, aristelegone-A, aristelegone-B, aristelegone-C, and aristelegone-D; isoquinoline, pericampylinone-A; biphenyl ethers, aristogin-A, aristogin-B, aristogin-D, and aristogin-E; three lignans, aristelegin-A, aristelegin -B, and aristelegin-C; and a dimer, aristolin [111]; biphenyl ether, aristogin C, and two porphyrins, aristophylls A and B [112].

The systemic use of *Aristolochia* species, which is known to contain aristolochic acid is problematic because of severe toxicological risks. Its reduction products are highly mutagenic and carcinogenic [63].

Commicarpus plumbagineus

The leaf of *Commicarpus plumbagineus* (Cav) (Nyctaginaceae) is used for the treatment of ringworm in the district. Its use for skin disorder was reported by the "Zay" people [25].

4.11.3. Medicinal plants used for livestock diseases

Anthrax, blackleg, tuberculosis, render pest and pasterlosis are animal diseases that are treated by healers of Chifra District. 20% of all plant species claimed to have medicinal properties in the district are related to livestock medicine with Fic value of 0.32.

Most of the ethnoformulations for livestock disease in the district are administered intranasally, perorally or both intranasally and perorally except for *Calotropis procera*, which is applied topically for prevention of blackleg.

Calotropis procera

The latex of *Calotropis procera (*Ascelepiadacea) is among the herbal drugs used in livestock diseases. The peculiar character for this herbal drug is its use for prevention purpose. The drug was recommended for prevention of blackleg by one healer. In a similar ethnobotanical study, it was reported that the plant is used for the treatment of blackleg by "Zay" people [25]. The photograph of the plant is shown in Fig. 4.4.

The latex and ethanolic extract of the leaves of *Calotropis procera* growing in Ethiopia were tested for their antimicrobial activity against *S.aureus, E.coli, Bacillus cereus, Proteus mirabilis, Proteus vulgaris, Klebsiella pneumoniae, Shigella dysenteriae* and *Pseudomonas aeruginosa* and were found to have significant activity [113].

Fig.4.4: Photograph of *Calotropis procera*

The antimicrobial activity of *n*-butanol extract of *Calotropis procera* flowers proved to be the most effective against eight pathogenic bacteria using the paper disc diffusion method [114,115]. Ethanolic extract *C.procera* displayed a remarkable antibacterial activity against both gram-positive and gram-negative bacteria [116].

Strong antimicrobial activity at a concentration of 250 µg/ml was exhibited by the water soluble extract of the leaves of *C. procera* against *Clostridium perfringens* and *S. faecalis*; the interface layer extract against *Klebsiella ozaenae*; the petroleum ether soluble extract against *P. aeruginosa*; and the methanolic extract against *S.typhii* [117].

Extracts from latex, leaves and flowers, collected from Agdez, Morocco, were tested against *Candida albicans, C. krusei, C. tropicalis, C. parapsilosis, Torulopsis glabrata, Aspergillus fumigatus, A. flavus, A. niger* and *Scopulariopsis brevicaulis* and the snail, *Bulinus truncatus*. Yeasts were more susceptible than fungi to the extracts. Ethyl acetate and *n*-butanol extracts

of flowers were highly effective against *C. albicans*. The ethanolic extract of the latex showed strong molluscicidal effects against *B. truncatus* with LD_{50} value of 36 ppm [118].

Kanahia laniflora

In the district, *Kanahia laniflora* (Ascelepiadacea) is the most popularly used medicinal plant for the health of livestock. TMPs witness that the herbal drug helped them in keeping the health of their cattle during the drought of 2002/03 in Ethiopia. *K. laniflora* is a broad-spectrum herbal drug used for the treatment of TB, anthrax and render pest in the district. However, the leaf, stem, root, and fruit extracts were found to have no antimicrobial activity [119].

The root, stem, leaves, and fruit of the plant contain cardiac glycosides, reducing sugars, and aminoacids. Phenols, flavonoids are found in the stems, leaves, and fruits. Ketoses were found in the stems and fruits, and starch in the roots and stems. The study also indicated that the plant has sympathetic stimulation, CNS depression, diuretic activity and peripheral vasodilation, psychotropic activity and metabolic toxicity [119].

Solanum incanum

In combination with *Boscia coriacea*, the fruits of *Solanum incanum* (Solanaceae) are used for the treatment of anthrax. The claimed medicinal use is not mentioned in African medicinal plants and other ethnobotanical studies in Ethiopia. However, based on the information gathered from traditional medicine practitioners of Guruve District, Zimbabwe, the plant is one of the most frequently used plants for the treatment of STDs [96]. Also, the plant is employed in East and Southern Africa for the treatment of skin diseases, general infections, abdominal pains, fever, stomachache and indigestion [120].

In addition the fruit of *S. incanum* is used for the treatment of dandruff, skin diseases, sores and wounds in Tanzania [96]. In Ethiopia, the fruit juice is used by peasant farmers to control ticks [121]. The plant is known to contain steroids and steroidal alkaloids. The pharmacological action of solanine and related steroidal alkaloids includes antifungal, analgesic and cytotoxic properties [122].

Cissus quadrangularis

The root of *Cissus quadrangularis L. (*Vitaceae) is among the herbal drugs claimed to have activity against anthrax in combination with *Acalypha sp*. In Uganda, the leaf or stem of the plant is used for bone setting [75].

Salvadora persica

The community in Afar Region uses *Salvadora persica* (Salvadoraceae) as toothbrush. Its use as oral hygiene toothbrush is also common in different parts of Africa and Eastern countries [123]. For this reason intensive researches were performed on its antimicrobial activity.

Using disc diffusion test, it was found that the extract of the leaves has a considerable antibacterial effect on several oral aerobic bacteria with comparable results to known antibiotics [93]. It was also found that it has antimicrobial effect on *S. fecalis* at 50% concentration of the aqueous extract of *S. persica* by using blood agar [124] and ditch plate method [125].

In addition, the aqueous extract of roots of *S. persica* at a concentration of 15% and above was shown to have a fungistatic effect for up to 48 hours. This antimycotic effect was

proposed to be due to one or more of the root contents which included chlorine, trimethylamine, alkaloid resin and sulfur compounds [126].

Jatropha glauca

The root of *Jatropha glauca* (Euphorbiaceae) *is* among the herbal drugs used for the treatment of livestock TB in the district. However, a study indicates that the plant has toxicity. The toxicity of *J. glauca* was studied by giving the dried or minced plant to Nubian goats, Desert sheep or Zebu calves by mouth or stomach tube. The clinical, haematological and pathological changes indicated that the plant reduced the ability of the liver to synthesize protein, although there was no evidence of interference with the excretion of bilirubin. Kidney dysfunction and haemoconcentration also occurred. In doses of 0.5 to 10 g/kg/day, the plant killed goats after dosing for periods ranging from 1 day to 2 weeks. Calves were less susceptible [127].

The comparative susceptibility of the snail vector of intestinal schistosomiasis, *B. pfeifferi* to the action of extracts from Saudi Arabian *J. glauca* was studied. Methanol and chloroform extracts of *J. glauca* was the most promising from the molluscicidal point of view with LD_{50} values in the range 10 - 100 ppm [128].

***Acalypha* sp.**

Acalypha sp. “Baaxobarbare” and *Acalypha* sp. “subaci” are used for the treatment of anthrax by TMPs of Chifra District. In TM of Guatemala, *A. guatemalensis* is used in the treatment of microbial infections. This extracts of this plant showed activity against *P. aeruginosa*, *Trypanosoma cruzi* or *Leishmania* spp [129].

An activity directed fractionation of a 50% aqueous ethanol extract of *A. wilkesiana* and *A. hispida* leaves collected in Nigeria resulted in the isolation of gallic acid, corilagin and geraniin as the compounds responsible for the observed antimicrobial activity. Quercetin 3-O-rutinoside and kaempferol 3-O-rutinoside were also isolated from the inactive fraction of *A. hispida* [130].

Phytochemical studies on the powdered leaves of *A. racemosa* revealed the presence of alkaloids, tannins, flavonoids and terpenes. Antimicrobial activities of cold water, hot water and methanolic extracts were studied against standard organisms (*E. coli*, *S. aureus*) and a clinical isolate (*C. albicans*). The cold-water extract showed better antibacterial activity than the hot water and methanolic extracts. Similarly, *S. aureus* was more susceptible than *E. coli*, but *C. albicans* was completely resistant to the extracts [131].

Water, ethanol, chloroform and hexane extracts of *A. wilkesiana* leaves were investigated for *in vitro* antimicrobial activities by agar-diffusion and tube-dilution techniques. The water and ethanol extracts inhibited the growth of standard and local strains of bacteria and fungi including *S. aureus, T. rubrum, T. mentagrophytes, C. albicans and A. flavus*. The aqueous extract did not exert any inhibitory action on *K. pneumoniae* and *P. mirabilis* while the ethanol extract was active. The aqueous extract was found to be bacteriostatic while the ethanolic extract was uniformly bactericidal [132].

Four successive solvent extracts of the whole plant *A. indica* were tested for post-coital antifertility activity in female albino rats. Of these, the petroleum ether and ethanol extracts were found to be most effective in causing significant anti-implantation activity. The antifertility activity was shown to be reversible on withdrawal of the extracts [133].

A cyanogenic glycoside, acalyphin, 3-cyano-3-β-D-glucopyranosyloxy-2-hydroxy-4-methoxy-1-methyl-6 (2,3- dihydro) pyridone was isolated from the aerial Parts of A. *indica* [134].

Balanites aegyptiaca

In Chifra District, the root of *B. aegyptiaca* (Balanitaceae) *(Fig. 4.5) is* used for the treatment of render pest and anthrax. In East Africa, it is widely used as anthelmintic. In addition, the root is used in various folk medicines for the treatment of abdominal pain and as purgative while the bark is employed as a fish poison and also as a remedy for malaria and syphilis. The root, bark, kernel and fruit have been shown to be lethal to molluscs [135]. In Sudanese folk medicine it is used to treat jaundice [136].

Fig.4.5: Phtograph of *Balanites aegyptiaca*

Its antimalarial and molluscidal activity is well studied [137-140]. *In vitro* antiplasmodial test of the dichloromethane and methanol extract of stem bark of the plant showed antimalarial activity with an IC_{50} between 0-49 μg ml^{-1} and 50-99 μg ml^{-1} [140]. *B. aegyptiaca* has been

tested for toxicity to the snail *Biomphalaria pfeifferi*, intermediate host of *Schistosoma mansoni*, the causal agent of bilharziasis and showed the greatest toxicity at 10 mg of powder/litre and 100% mortality at 100 mg/liter [137].

Different parts of the plant contain several steroidal saponins. For example, its root and bark of it contain balanitin 1-7 [141,142], the mesocarp of the fruit, 26-O-β-D-glucopyranosyl-(25R)-furost-5-ene-3β, 22,26-triol- 3-O- [α-L-rhamnopyranosyl-(1→2)]-[β-D-xylopyranosyl-(1→3)]-[α-L-hamnopyranosyl- (1→4)]-β-D-glucopyranoside and its 22-methyl ether, 26-O-β-D-glucopyranosyl-(25R)-furost-5-ene-3β, 22,26-triol3-O-(2,4-di-O-α-L-rhamnopyranosyl)-β-D-glucopyranoside and its methyl ether [143].

Flavonoid glycosides, quercetin 3-glucoside, quercetin 3-rutinoside, and 3-glucoside, 3-rutinoside, 3, 7-diglucoside and the 3-rhamno galactoside of isorhamnetin were identified from the leaves and branches of Egyptian *B. aegyptiaca*. Only 3-rutinoside and 3-rhamno galactoside of isorhamnetin were recorded from the fruit of the plant [144]. From an ethanolic extract of the epicarps, the flavonol glycosides, isorhamnetin-3-O-robinobioside and isorhamnetin-3-O-rutinoside were isolated and identified [144].

Tamarix aphylla

Tamarix aphylla (Tamaricaceae) is recommended for the treatment of tuberculosis in Chifra District. In Arab TMPs of Golan Heights and West Bank region the leaf of the plant is used for the treatment of fever. Both the leaves and seeds are also used as antiinflammatory [74].

4.11.4. Medicinal plants used for arthritis and inflammatory disorders

The Fic value for this group of herbal drugs is 0.33. The drugs claimed to have medicinal use for the disorders of this class include *Senna italica, Calotropis procera, Acacia mellifera, Withania somnifera, Aerva javanica, Acalypha sp, and "Garonta" and Commicarpus plumbagineus.*

Aerva javanica

In Afar TM *Aerva javanica* (Amaranthaceae) (Fig. 4.7) is used for wound healing which could be due to its tannin content. A study shows that A. *javanica* collected from Egypt contains sterols, flavonoids, tannins, saponins, chlorides, sulfates, reducing sugars, carbohydrates and glycosides [145].

Fig.4.6: Specimen of *Aerva javanica*

Phytochemical screening of the aerial parts of *A. javanica* and *A. lanata*, growing in Egypt, revealed the presence of carbohydrates and/or glycosides, tannins, saponins, alkaloids and/or nitrogenous bases, unsaturated sterols and/or triterpenes and flavonoids. The motility of rabbit intestine and their anticholinergic activity against isolated guinea pig ileum were studied. The aqueous extracts of the plant exhibit dose-dependent smooth muscle relaxant effects, and significant antispasmodic activity [146].

The flavonol glycoside, isorhamnetin 3-O-β-[4'''-*p*-coumaroyl-α-rhamnosyl-(1→6) galactoside], has been isolated from *A. javanica* along with its unacylated derivative, its kaempferol analogue and various common kaempferol, quercetin and isorhamnetin glycosides [147].

Withania somnifera

Among the plants, which are used for the treatment of arthritis in the study district, *Withania somnifera* (L.) Dunal (Solanaceae) (Fig. 4.7) is mentioned for the treatment of fever, chills and rheumatism in West Africa folk medicine [120]. Preliminary study done on traditional medicinal plants sold in nineteen markets in Ethiopia also reported that the plant is used in rheumatism [19]. The medicinal use recommended by Afar traditional medicine practitioners and those documented in the literature are in agreement with the results of pharmacological study done on the constituent of *W. somnifera,* Withaferin A, is known to produce suppression of adjuvant induced arthritis in rats and locally induced graft (lymphocyte) versus host reaction in chicks [120].

Aqueous extract of the roots of *W. somnifera* has however, been reported to have immunostimulatory effect [120]. This report appears to be contradictory to the immunodepresant effect mentioned above. The likely explanation given by the authors was that the herbal drug that is employed as an adaptogenic agent possesses components with both stimulatory and depressant action on the immune system [120]. In addition, the plant was shown to have antitumor activity [148].

Two steroidal lactones of the withanolide-type,5β,6α,14α,17β,20β -pentahydroxy-1-oxo-20S, 22R-witha-2, 24-dienolide and 6α,7α-epoxy-5α,14α,17α,23β-tetrahydroxy-1-oxo-22R-witha-2,24-dienolide, were isolated from the fruits of *W. somnifera* growing in Southern Egypt, together with two coumarins, scopoletin and aesculetin, the triterpene,β-amyrin, and phytosterols, viz. stigmasterol and sitosterol [149].

Fig.4.7: Phtograph of *Withania somnifera*

Acacia mellifera

The leaf of *Acacia mellifera* (Fabaceae) is used in the treatment of arthritis in Chifra. In Tanzania the bark of the plant is used for the treatment of syphilis, pneumonia, malaria, sterility and stomachache, while the root is used in the treatment of impotence [96]. The antibacterial activity extracts of the bark of *A. mellifera* showed activity against *S. aures* but no activity against *E. coli* [96].

Calotropis procera

The root bark of the plant is used for the treatment of headache in the district. The claimed activity could be justified as studies done elsewhere indicate that the *n*-butanol and aqueous extracts of *C. procera* produced antipyretic effects of 82.17 and 79.4%, respectively [150].

The crude dry latex of *C. procera* was shown to possess a potent antiinflammatory activity. The antiinflammatory activities of the petroleum ether, acetone, methanol and aqueous extracts of the dry latex of *C. procera* were tested in the carrageenan induced rat paw oedema model. All the fractions were found to exhibit antiinflammatory activity but highest inhibition of oedema was found to be greatest with the acetone and aqueous extracts [151].

In another study, it was reported that a single oral dose of dry latex (DL) ranging from 165 to 830 mg/kg produced a significant dose dependent analgesic effect against acetic acid induced writhings. The effect of DL at a dose of 415 mg/kg was more pronounced as compared to a 100-mg/kg oral dose of aspirin. On the other hand, DL (830 mg/kg) produced marginal analgesia in a tail-flick model that was comparable to aspirin. The analgesic effect of DL was

delayed by 1 hour by naloxone at a dose of 0.5 mg/kg, i.p., which completely blocked the analgesic effect of morphine (10 mg/kg, i.p). [152].

4.11.5. Medicinal plants used for snakebite

***Indigofera* sp.**

The leaf of *Indigofera sp. "Male Ayrowagit"(Fig. 4.8)* is the most frequently recommended herbal drug as antidote for snakebite. In a similar survey in Bulamogi, Uganda, *I. arrecta* A. Rich. and *I. garckeana* Vatke are documented as antidote for snakebite [75].

Fig.4.8: Specimen of *Indigofera* sp.

Senna italica

Senna italica (Fabaceae)(See fig. 4.9) is also reported for its use in snakebite treatment. Other species of senna -*Senna occidentalis* (L.) Link, *Senna siamen* (Lam.) and *Senna singueana*

(Del.) Lock are recommended as antisnake venom by TMPs in Uganda [75]. Also, *Senna dariensis* is reported to have neutralizing ability against the hemorrhagic effect of *Bothrops atrox* venom [153].

Fig.4.9: Specimen of *Senna italica*

Various plant parts of *Cassia italica* and *Cassia siamea (Senna siamea)*, collected from India, were shown to possess antimicrobial activities against both gram-positive and negative bacteria as well as fungi [154].

4.11.6. Medicinal plants used for "Urribaqla"

Urribaqla (Urri-Children, baqla- disease) is a local name for a disorder characterized by abdominal extension, loss of body weight, vomiting, stool with bad smell, loss of hair, fever and loss of balance of the patient. Twelve plant species are used for the treatment of the

disorder. The Fic value for “urribaqla” is 0.15 indicating the use of various plant species for the treatment of this ailment.

Trigonella foenum graecum L.

The seeds of *Trigonella foenum graecum* L. (Fabaceae) (Fig. 4.10) are used for the treatment of “Urribaqla”. Since some of the symptoms of the disorder are stomach disorders, the claim is in accord with the use of the plant for general stomach disorder in African traditional medicine, and stomach and intestinal pain in Arabian traditional medicine of the Golan Heights and West Bank regions [74].

In North Africa, Golan Heights and West Bank regions the seeds of *Trigonella foenum graecum* are used as oral antidiabetic [74]. Chemically the seeds contain trigonellin (N-methyl nicotinic acid), choline, nicotinic acid and diosgenin. Essential oil, mucilage and fixed oil are also the major components of the seeds [99]. Trigonelline has been shown to counteract the hypoglycemic effect of cortisone given 2hr before or simultaneously. Nicotinic acid and coumarin are also hypoglycemic.

Fig.4.10: Photograph of *Trigonella foenum graecum* L

4.11.7. Medicinal plants used for gastrointestinal disorders

Diarrhea, vomiting and abdominal cramp are treated with medicinal plants, which are administered orally. The Fic value for this group of diseases is 0.17 indicating the use of various plant species for the treatment of the ailment.

***Aloe* sp.**

Aloe sp. is one of the plants that is reported for the treatment of abdominal cramp. The claimed use may be in agreement with its use as a source of laxative drugs [77].

Aerva javanica

The roots of *Aerva javanica* are recommended for the treatment of abdominal cramp. "Dingetegna" is also reported to be treated by the root of the plant.

Coffea arabica

As has already been mentioned, the seeds of *Coffea arabica (Rubiaceae)* in combination with "Qubaabulto" are used for the treatment of diarrhea in the district. Similar studies done in Addis Ababa and Butajirra also reported that the plant is used for the claimed activity [23].

4.11.8 Medicinal plants used for impotence

In Chifra District*, Acalypha* sp. "Baaxobarbare"; leaf of "Bakarru"; whole plant and root of *Sedderra hirsute;* roots, stembark and leaves of "Gaandamira"; "Bikiltafri" *Euphorbia* sp. "Inddaqto"; "Masada" and "Muxikabbuxe" are herbs recommended for impotence.

At least in one of the plants Doctrine of signature is applied. The root of “Muxikabbuxe” has a shape of penis and testicles, as a result of which they use the plant for impotence.

CONCLUSIONS

This work is the first ethnobotanical and ethnopharmaceutical study in Chifra District, Afar Region, North Eastern Ethiopia. A total of 70 species were reported for their medicinal uses despite the fact that the study has not covered all the rural communities of the district. The climatic condition of the district is a bit different from those areas where ethnobotanical surveys were conducted by different researchers in Ethiopia before this time. Therefore, most of the species reported in this work are not reported previously in another similar ethnobotanical surveys conducted.

Literature review made on the identified species of the plants included in this survey resulted in confirmation of their traditional use for some plants, indicating the potential of the region for herbal drugs. Furthermore, this analysis also pointed out the important knowledge gaps about the bioactive constituents and full biological activities of some of the species.

The documentation can be used as a baseline data for a series of further pharmacological screening works against a variety of claimed activities with subsequent phytochemical studies.

It is also observed that there are practices that need closer monitoring and improvement for better service. Such practices may include unhygienic handling of plant and their products and difficulty of measuring accurate and reproducible doses. Furthermore, in the district's traditional medicine practice, it is also common to see different ritual procedures practiced by healers alongside managing diseases with herbs.

Finally, the literature review on those plants revealed that some of the plants have got certain degree of toxicity. Hence, it is worth noting of the likely untoward effects of the plants besides their potential for treatment of different ailments.

RECOMMENDATIONS

The following are suggested for further work.

This survey has shown the potential of the region for ethnobotanical knowledge about traditional medicine. Therefore, further work should be conducted to explore the potential of the different districts of the region to preserve this knowledge.

Pharmacological screening work to confirm the traditional application of these plants should be done. But, during screening, it is important to notice ethnoformulations and mimic the practices used by the practitioners in the region.

In order to improve the services rendered by healers, they should be provided with small equipment to perform different unit processes employed in the ethnoformulation of the herbal drugs.

Further work should be done pertaining to the side effects, drug-herb, herb-herb and herb-food interactions for better treatment.

In the study district, there are few number of health facilities with poor facilities. Therefore, it may be helpful to integrate the practice with the modern health care delivery by creating awareness on the integrated services to health professionals and healers.

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ANNEX 1. Name, age, sex, years of experience, occupation and address of informants.

Ser No.	Informant's name	Age	Sex	Exper. in years	Occupation	Residence address (Kebele)
1	Arba Hati	56	M	15	Guard	Chifra town
2	Ware Halifa	50	M	10	Pastoralist	We'ama
3	Mohammed Megamo	38	M	20	Head, ANDP	Chifra zuria
4	Hummed Ali	46	M	20	Pastoralist	Mesgid
5	Beru Kebere	50	F	20	Pastoralist	Mesgid
6	Badeo Ali	50	M	35	Pastoralist	Tegrina Awagere
7	Hussein Ali	56	M	12	Pastoralist	We'ama
8	Ahmed Hawenu	50	M	10	Pastoralist	Afuma
9	Mohammed Hati	35	M	10	Pastoralist	Fecah
10	Haloo Moe	43	M	25	Pastoralist	Hasemay
11	Haji Hummed Kedir	77	M	37	Religious leader	Mesgid
12	Welinbera Seid	50	M	30	Pastoralist	Askuma
13	Haji Abdu Adem	72	M	40	Pastoralist	Mesgid
14	Seid Ali	64	M	4	Pastoralist	Mesgid
15	Ahmed Mohammed	32	M	19	Pastoralist	Awagerana
16	Moe Gurelle	50	M	30	Pastoralist	Gergera
17	Abdella Gura	57	M	37	Pastoralist	Jara
18	Ali Keloyta	50	M	25	Pastoralist	Mesgid
19	Meai Egahala	25	M	8	Pastoralist	Afuma
20	Fatuma Mohammed	45	F	20	Pastoralist	Awagera
21	Ware Negasso	44	M	14	Pastoralist	Tagrina Awagera
22	Abdulehab Hummed	44	M	14	Pastoralist	Gelalekelo
23	Abdu Mohammed	60	M	40	Pastoralist	Anderkello
24	Mohammed Derssa	48	M	18	Pastoralist	Gelalekelo
25	Yofis Buruk	55	M	25	Pastoralist	Anderkello
26	Mohammed Kedir	23	M	3	Pastoralist	Hasamaye
27	Arba Abdu	46	M	14	Pastoralist	Yabledorra Adear
28	Abo Abdu	40	M	32	Pastoralist	Fecha
29	Ali Hussein	35	M	10	Guard	We'ama

APPENDIX 2: Vernacular names, scientific names, family, part(s) used, claimed medicinal use, routes of administration and ethnoformulations and applications of medicinal plants used by traditional healers of Afar people: Chifra District for treatment of human disorders.

(Key: - ROA -Routes of administration, PO-Per Oral, IN - Intra Nasal, Top - Topical, Hang. – Hanging, Hand. – Handling, Inh – Inhalation, Af-Afaraf, Am- Amharic Sd-Seed, Rt- Root, Wp- Whole plant, Lf- Leaf, Bb-Bulb, Sb-Stem bark, Lx- Latex, Rb- Root bark, Ap- Aerial part, An-Any part, Ft-fruit, St-Stem)

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulation and application of the herbal drug
Abish [Am]	*Trigonella foenum Graecum L.*	Fabaceae	Sd	Urribaqla*	PO	The seed of the plant is pounded. The powder is then soaked in goat's milk and drunk and applied topically to the joints. Next day, the patient is massaged with butter of black cow.
Abuuri [Af]	*Zaleya pentandra (L) Jeffrey*	Aizoaceae	Rt	Urribaqla	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk.
			Wp	Urribaqla	IN	The fresh whole plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Wp	Urribaqla	IN	The fresh whole plant is pounded and then soaked in water until it becomes black. It is decanted and the solution administered intranasally.

* Urribaqula (urri-Children, baqla- disease) – it is a disorder characterized by abdominal extension, loss of body weight, vomiting, stool with bad smell, loss of hair, fever and falling of the patient

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Abuuri [Af]	*Zaleya pentandra (L) Jeffrey*	Aizoaceae	Wp	Malaria	PO, IN	The fresh whole plant is pounded with fresh leaf of *Indigofera sp*. or *Senna italica* and then soaked in water for some minutes. It is decanted and administered intranasally and drunk.
			Lf	Snakebite	Top.	The fresh leaf of the plant is pounded and applied to the bitten area.
Abuuri [Af]	*Zaleya pentandra (L) Jeffrey*	Aizoaceae	Rt	Snakebite	IN	The fresh root of the plant is pounded and then soaked in water for 30 minutes until it turns to black color. It is decanted and the solution administered intranasally.
Aben Bays [Af]			Lf	Sassactu**	Eye	The fresh /dried leaf of the plant is pounded and then soaked in water. It is decanted and the solution applied to the eye.
Adrakumele [Af]			Sd	Baxaliita***		See "Xaxaabaxes"
Amqadda [Af]	*Heliotropium longifolium(DC)*	Boraginaceae	Lf	Epitasis	IN	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
FemaleAyrowagit [Af]	*Senna italica Mill.*	Fabaceae	Wp	Snakebite	PO, Top.	The fresh whole plant is pounded and then soaked in water. It is decanted and the solution drunk and the residue applied to the bitten area.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulation and application of the herbal drug
FemaleAyrowagit [Af]	*Senna italica Mill.*	Fabaceae	Lf	Snakebite	Top.	The fresh leaf of the plant is pounded and then applied to the bitten area.
			Lf	Snakebite	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk whenever the patient feels thirsty.
			Lf	Baxaliita	Top.	The fresh leaf of the plant is pounded and then incorporated with juice of *Solanum incanum* and applied to the bitten area.
			Lf	Malaria		See *Zaleya pentandra*
Male Ayrowagit [Af]	*Indigofera sp.*	Fabaceae	Rt	Dingetegna #	PO	The root of the plant is chewed.
			Wp	Snakebite	PO, Top.	The fresh whole plant is pounded and then soaked in water. It is decanted and the solution drunk and the residue applied to the bitten area.
			Lf	Snakebite	Top.	The fresh leaf of the plant is pounded and then applied to the bitten area.
			Lf	Snakebite	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk whenever the patient feels thirsty.
	# dingetgna –A symptom characterized by abdominal spasm.					

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Male Ayrowagit [Af]	*Indigofera sp.*	Fabaceae	Lf	Baxaliita	Top.	The fresh leaf of the plant is pounded and then incorporated with juice of *Solanum incanum* and applied to the bitten area. .
			Lf	Wound due to Herpes Zoster	Top.	The fresh leaf of the plant is pounded and applied to the wound.
			St	Baxaliita	Top.	The fresh leaf of the plant is pounded and applied to the wound.
Baaxobarbare [Af]	*Acalypha* sp.	Euphorbiaceae	Lf	Snakebite	IN, PO	The fresh leaf of the plant is pounded and then soaked in water for an hour. It is decanted and the solution administered intranasally and drunk.
			Lf	Snakebite	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and one liter of the solution is drunk.
			Rt	Snakebite	IN	The fresh root of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Lf	Baxaliita	IN	The fresh root of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Rt	Anthrax		See *Xanthium strumarium*
			Lf	Impotence		See “Gaandamira”
			Lf	Anthrax		See “Warabekalla”

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Baddahafu [Af]			Wp	Malaria	PO, IN, Top	The fresh whole plant is pounded with fresh root of *Salvadora persica* and *Lycium shawii* and then soaked in water. It is decanted and the solution drunk and administered topically and intranasally weekly for three weeks.
Bakarru [Af]			Lf	Impotence		See "Gaandamira"
Bangi [Af]	*Xanthium strumarium* L	Asteraceae	Lf	Anthrax	IN, PO	The fresh leaf of the plant is pounded with the root of "Baaxobarbare" and then soaked in water for some time. It is decanted and the solution drunk and administered intranasally.
Beyli beylo [Af]			Rt	Snakebite	PO	The fresh or dried root of the plant is chewed.
Bikiltafri [Af]	*Sedderra hirsute* Hall.f.	Convolvulaceae	Lf	Snakebite	Top, Hang	The leaf of the plant is applied to the bitten area and hanged above the wound.
			Wp, Rt	Snakebite	Top, Hang	The fresh whole plant is pounded and then soaked in water for 2 hrs. It is decanted and the solution drunk and the root of the plant is hanged above the bitten area.
		Convolvulaceae	Wp	Impotence	PO	The fresh whole plant is pounded. Sugar and goat's milk are added to it and the solution drunk.
			Rt	Impotence	PO	The root of the plant is chewed.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Bunna [Am]	*Coffea arabica*	Rubiaceae	Sd	Diarrhea		See "Qubaabulto"
Calmala [Af]	*Polygala obtusissima* Chod.	Polygalacea	Wp	Snakebite	PO	The fresh whole plant is pounded and then soaked in water for an hour. It is decanted and the solution drunk. Also, the plant is hanged above the bitten area.
			Lf	Common Cold	Inh.	The fresh leaf of the plant is pounded, kept in handkerchief and inhaled.
Cantiqaluulus [Af]	*Solanum coagulans* Forssk.	Solanaceae	Wp	Urribaqla	IN	The fresh whole plant is pounded and then soaked in water until it turns to black solution. It is decanted and the solution administered intranasally. On the second day the whole plant of "Xabboli" is formulated and administered as *Solanum coagulans*.
			Sd	Baxaliita	Top	The seed of the plant is pounded and then applied to the wound.
			Lf	Baxaliita	Top	The leaf of the plant is chewed and applied to the wound.
Gaandamira [Af]			Rt, Lf	Impotence	PO	The fresh leaf /root of the plant is pounded and pasted with honey and administered orally. *

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Gaandamira [Af]				Impotence due to fear	PO	In addition to * the fresh leaf of "Bakarru" is pasted with butter and eaten. **Or**
					IN	The leaf of "Baaxobarbare" *(Acalypha sp) is* soaked in water for some time. It is decanted and the solution given intranasally.
			Sb	Impotence	PO	The stem bark of the plant is chewed.
			Rt	Snakebite	PO	Fresh or dried root of the plant is chewed.
Galaqto [Af]	*Calotropis procerra* (Ait) f.	Ascelepiadacea	Rb	Headache	I N	The fresh root bark of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
Garonta [Af]			Sb	Vomiting	PO	The stem bark of the plant soaked in water. It is decanted and the solution drunk.
			Ap	Arthritis	Top	The fresh aerial part of the plant is burnt. The charcoal is mixed with butter and applied to the joints.
			Lf	Arthritis		See *Acacia mellifera*
			Rt	Urribaqla		See *Commicarpus plumbagineus*
Gansalto [Af]	*Barleria* sp.	Acanthaceae	Lf, St	Retained placenta	Hang	The leaf and stem of the plant is hanged to the roof of the room in which the patient sleeps.

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Gansalto [Af]	*Barleria* sp.	Acanthaceae	Wp	Impotence	PO	The whole fresh plant is pounded. It is soaked in water and decanted and porridge is made with the solution and eaten.
Gaydabaxaaxaa [Af]	*Solanum somalense*	Solanaceae	Sd, Rt	Urribaqla	IN	The fresh root and seed of the plant is pounded and then soaked in water for some time. It is decanted and the solution given intranasally.
			Sd	Urribaqla		See *Commicarpus plumbagineus*
Hedalusayto [Af]	*Lycium shawii* Roem and Schult	Solanaceae	Rt ,Lf	Urribaqla	IN	The fresh leaf and root of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Rt	Malaria		See "Baddahafu"
Inddaqto [Af]	*Euphorbia* sp.	Euphorbiaceae	Lx	Impotence	PO	The latex of the plant is mixed with milk of camel and drunk.
Karbati [Af]	*Commicarpus plumbagineus* (Cav) Stand	Nyctaginaceae	Lf	Arthritis	Top.	The fresh leaf of the plant is pounded and applied to the joints.
			Lf	Ring worm	Top.	The fresh leaf of the plant is applied to the infected area.
Kasalto [Af]	*Acacia nilotica* (L.)Willd.ex.Del.	Fabaceae	Sb	Tonsillitis	PO	The inner surface of the stem bark of the plant is pounded and then soaked in water for an hour. It is decanted and the solution applied to the tonsillitis.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Kookaxawto [Af]	*Withania somnifera* (L.) Dun.	Solanaceae	Lf	Arthritis	IN, Top	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally and the residue applied to the swollen part of the body.
			Rt	Urribaqla	IN	The root of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
			Lf	Epitasis	IN	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
Kottumayyu [Af]	*Helotropium rariflorum* Stocks	Boraginaceae	Wp	Snakebite	PO, Bath.	The fresh whole plant is pounded with whole plant of "Waraabekala" and then soaked in water. It is decanted and the patient takes bath with the solution and drunks small amount of the solution.
Leehamohcaxa [Af]	*Kanahia laniflora* (Forssk.) R.Br.	Ascepiadaceae	Lf	TB	IN, PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally and small amount is drunk.

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Leehamohcaxa [Af]	*Kanahia laniflora* (Forssk.) R.Br.	Ascepiadaceae	Ap	Head ache and Arthritis	IN	The fresh or dried aerial part of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
			Ap	Anthrax	IN	The fresh or dried aerial part of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
Maalikannoor [Af]			Rt	Prevention of snakebite	Handl	The root of the plant is handled.
			Rt	Snakebite	Hang	The root of the plant is hanged above the bitten area.
			An	Prevention of snakebite	Handl	Any part of the plant is handled.
			An	Snakebite	PO, Hang	Any part of the plant is pounded. It is boiled and drunk. Or any part of the plant is hanged above the bitten area.
Makisano [Af]	*Senna alexanderia* Mill	Fabaceae	Lf	Abdominal cramp	PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and the solution drunk.
Maqaydu [Af]			St	Sassactu	IN	The fresh stem of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Markaqto [Af]	*Acacia mellifera* (Vahl.) Benth	Fabaceae	Lf	Arthritis	Top	The fresh leaf of the plant and leaf of G*aronta are* pounded and then incorporated with milk of goat, dung of wild animals and dust and applied to the joints with left hand.
Masada [Af]			Lf, Rt	Impotence	PO	The fresh leaf and root of the plant is pounded and then pasted with honey or milk of goat and administered orally.
Muxikabbuxe [Af]			Rt	Impotence	PO	The root of the plant is eaten and milk of goat drunk.
			Rt	Impotence	PO	The root of the plant is chewed with honey for three days one week before sexual intercourse.
Muxitabbri [Af]			Lf, Rt, Sd	Urribaqla	IN	The fresh leaf, root and seed of the plant are pounded and then soaked in water. It is decanted and administered intranasally.
Ormayto [Af]			Lf	Wart	Top	The dried leaf of parasite of "Ormayta" is pounded and then is pasted with butter and applied to the wart.
Olayto [Af]	*Aerva javanica* (Burm.f.) Juss ex Schullt	Amaranthaceae	Rt	Retained placenta	Hang	The root of the plant is hanged on the hip of the patient.
			Rt	Dingetegna	PO	The root of the plant is chewed.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Olayto [Af]	*Aerva javanica* (Burm.f.) Juss ex Schullt	Amaranthaceae	Rt	Snakebite and wound	PO,	The root of the plant is burnt. The charcoal mixed with butter and applied on the bitten area.
					IN,	The root of the plant is hanged above the bitten area.
					Top	The fresh root of the plant is pounded and then soaked in water for some time. It is decanted and the solution drunk and administered intranasally.
			Rt	Abdominal Cramp	PO, Hang	The fresh root of the plant is squeezed with teeth and the juice swallowed. Also, the root is hanged on the abdomen of the patient.
Qablis [Af]	*Jatropha glauca* Vahl.	Euphorbiaceae	Rt	TB	IN, PO	The fresh root of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally orally.
Qadgento [Af]			Sb	Wound	Top	The dried stem bark of the plant is pounded and applied on the wound. Or The stem bark of the plant is boiled in water. It is decanted; butter is added to the solution and the wound washed with it.
Qaleyti [Af]			Rt	Snakebite	PO	The root of the plant is eaten and then cooked butter is taken orally. Also dust from the root of the plant applied on the bitten area.
Qubaabulto [Af]			Rt	Diarrhea	PO	The fresh root of the plant is pounded, boiled with the *Coffea arabica* and administered orally.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulation and application of the herbal drug
Quureyta [Af]	*Aloe* sp.	Liliaceae	Lx	Urribaqla	PO	The latex of the plant is mixed with water and drunk.
			Lf	Malaria	PO	The leaf of the plant is boiled in water and drunk.
			Lx	Malaria	PO	The latex of the plant is taken orally.
			Lf	TB		See *Salvadora persica*
			Lf	Abdominal Cramp	PO	The dried leaf of the plant is pounded and then soaked in water. It is decanted, sugar added to the solution and drunk.
			Lx, Lf	Malaria	PO	The latex of the plant is mixed with water and drunk. Also the leaf of the plant is eaten.
			Lf	Malaria	PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and administered orally.
Qaalayto [Af]	*Balanites rotundifolia* (Van Tiegn.) Blatter	Balanitaceae	Lf	Malaria	PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted, sugar added to the solution and drunk.
			Lf	Malaria	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Qaalayto [Af]	*Balanites rotundifolia* (Van Tiegn.) Blatter	Balanitaceae	Lf	Malaria	PO	The fresh leaf of the plant is pounded and then soaked in water until its color turns to black. It is decanted and the solution administered orally.
						The fresh leaf of the plant is eaten.
Qadayto [Af]	*Salvadora persica* L.	Salvadoraceae	Rt	Malaria		See "Baddahafu"
Qadayto [Af]	*Salvadora persica* L.	Salvadoraceae	Rt	TB	PO	The root of the plant is pounded with the root of *Tamarix aphylla* and leaf of *Aloe sp*. and then soaked in water. It is decanted and the solution administered orally.
Rigidqadoyta [Af]			Sb	Tonsillitis	PO	The stem bark of the plant is chewed and swallowed.
Saaganto [Af]	*Tamarix aphylla* (L.) Karst	Tamaricaceae	Rt	TB		See *Salvadora persica*
Shiferaw	*Moriga oleifera*	Moringaceae	Lf	Amoebiasis	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk.
			Lf	Malaria	PO	The fresh leaf of the plant is pounded and then boiled in water. It is decanted and the solution drunk before meal.

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Subaaci [Af]	*Acalypha* sp.	Euphorbiaceae	Lf	Urribaqla	IN	The fresh leaf of the plant is pounded and then soaked in water for an hour. It is decanted and the solution administered intranasally.
			Lf	Head ache, arthritis, Malaria	Inh.	The dried leaf of the plant is pounded and then added into a dish containing water, the dish is heated over fire and the smoke inhaled.
			Lf			See *Commicarous plumbagineus*
			Lf	Anthrax	IN, PO	The fresh leaf of the plant is pounded with small amount of root of *Balanites aegyptica and Cissus quadrangulari.* and then soaked in water for an hour or two. It is decanted and administered intranasally and orally.
			Rt	Bleeding due to abortion	Hang	The root of the plant is hanged to the abdomen of the patient.
			Lf	Urribaqla		See *Sericomposis pallida*
Subla [Af], Sholla [Am]	*Ficus* sp.	Fabaceae	Sb	Wound	Top	The stem bark of the plant is heated in hot plate; it is pounded and applied to the wound.
Suesue [Af]	*Aristolochia bracteola* Lam.	Aristolochiacea e	Wp	Wound	I.N, P.O Ear, Top.	The whole plant is pounded and then soaked in water. It is decanted and administered orally, intranasally, to the ear and wound of the patient.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Suesue [Af]	*Aristolochia bracteola* Lam.	Aristolochiacea e	Lf	Baxaliita	PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution drunk.
Taqsi [Af]	*Leucas* sp.	Lamiaceae	Lf	Snakebite	IN	The fresh leaf of the plant is pounded and then soaked in water. It is filtered through garment and the solution administered intranasally.
Tikibleyta [Af]			Lf	Sassactu	IN	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
Uddayto [Af]	*Balanites aegyptiaca*	Balanitaceae	Rt	Anthrax		See *Acalypha* sp
			Lf	Urribaqla		See *Commicarpus plumbagineus*
			Lx	Epilepsy	IN	The latex of the plant is administered intranasally.
Wakrikoqos [Af]	*Solanum incanum* L.	Solanaceae	Juice of Ft	Baxaliita		See *Senna italica* and *Indigofera spp*
			Lf	Epitasis	IN	The leaf of the plant is put in the nostrils.
(Waraabekala) [Af]			Ap	Snakebite	PO	The fresh or dried aerial part of the plant is pounded and then soaked in water for an hour. It is decanted and the solution drunk whenever the patient feels thirsty.

Appendix 2 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Waraabekala) [Af]			Lf	Snakebite	PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and the solution drunk whenever the patient thirsty. Also cooked butter and camel's milk are given on the second and the third days of the treatment respectively.
Waraabekala) [Af]			Lf	Anthrax	PO, IN	The fresh leaf of the plant is pounded with Acalypha sp. "Baxobarbare" and then soaked in water. It is decanted and the solution administered both orally and intranasally.
Waraabekala) [Af]			Ap	Snakebite	PO	The fresh aerial part of the plant is pounded and then soaked in water for some time. It is decanted and the solution drunk whenever the patient feels thirsty.
			Wp	Snakebite		See *Heliotropium rariflorum*
Xabbooli [Af]			Lf	Snakebite	PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and the solution drunk.
			Wp	Malaria (Children)	IN	The whole fresh plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Wpt			See *Solanum coagulans*

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Xaxaabaxes [Af]			Lf	Baxaliita	Top.	The fresh leaf of the plant is pounded with leaf of "Adrakumele" and applied on wound directly. Or the leaf of the plant is applied to the wound.
			Lf	Hepatitis	PO	The leaf of the plant is boiled with tea; sugar is added to it and the solution drunk.
Xiinawayto [Af]			Lf	Baxiliita	Top	The leaf of the plant is chewed and spat to the wound repeatedly.
			Lf	Infection of the pulp space	IN	The fresh leaf of the plant is pounded and then soaked in water for thirty minutes. It is decanted and the solution administered intranasally.
			Lf	Baxaliita	IN	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution applied intranasally.
Xiinawayto [Af]			Rt	Wound due to bullet	Hang	The fresh or dried root of the plant is hanged on the neck of the patient.
Xoxxobi [Af]	*Justica schimperiana* (Hochst.ex Nees) T. Anders	Acanthaceae	Wp	Retained placenta	PO	The fresh whole plant is pounded and then soaked in water for some time. It is decanted and the solution drunk.
Xoyto [Af]	*Ruellia patula* Jacq.	Acanthaceae	Lf	Ear wound	Ear	The fresh leaf of the plant is pounded and then soaked in water until the solution turns black. It is decanted and the solution applied to the ear.
Xukanxuksussi [Af]	*Jasmium* sp.	Oleaceae	Lf	Gingivitis	PO	The leaf of the plant is eaten.

Appendix 3: Vernacular names, scientific names, family, part(s) used, claimed medicinal use, routes of administration and ethnoformulations and applications of medicinal plants used by traditional healers of Afar people: Chifra District for the treatment of livestock disorders.

(Key: - ROA -Routes of administration, PO-Per Oral, IN - Intra Nasal, Top - Topical, Hang. – Hanging, Hand. – Handling, Inh – Inhalation, Af-Afaraf, Am- Amharic Sd-Seed, Rt- Root, Wp- Whole plant, Lf- Leaf, Bb-Bulb, Sb-Stem bark, Lx- Latex, Rb- Root bark, Ap- Aerial part, An-Any part, Ft-fruit, St-Stem)

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulation and application of the herbal drug
Anna [Af]			Bb	Anthrax	IN	The fresh bulb of the plant is pounded. It is soaked in water, decanted and the solution administered intranasally.
Ayteneba [Af]	*Boscia coriacea Pax.*	Capparidaceae	Lf	Blackleg	IN	The fresh parasite that grows on *Boscia coracea*, whole plant of "Baroberu" and fruit of *Solanum incanum* *p*ounded together and then soaked in water. It is decanted and the solution administered intranasally.
Baaxobarbare [Af]	*Acalypha* sp.	Euphorbiaceae	Rt	Anthrax		See *Xanthium strumarium*
			Lf	Anthrax		See "Warabekalla"
Baaxobbaru [Af]	*Parthenium hysterophorus* L.	Asteraceae	Wp	Blackleg		See *Bascia coriaca*

Appendix 3 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Bangi [Af]	Xanthium strumarium L	Asteraceae	Lf	Anthrax	IN, PO	The fresh leaf of the plant is pounded with the root of "Baaxobarbare" and then soaked in water for some time. It is decanted and the solution drunk and administered intranasally.
Bisilto [Af]			Lf	Pasterlosis		See "Garsa"
Garsa [Af]			Lf	Pasterlosis	I.N	The leaf of the plant is pounded with stem of "*Qatoori"*, leaf of "Bisilto" and *Aloe sp*. and then soaked in water for some time. It is decanted and the solution administered intranasally.
Galaqto [Af]	Calotropis procerra (Ait) f.	Ascelepiadacea	Lx	Prevention of Blackleg	Top	The latex of the plant is mixed with butter and applied to the skin of the cattle.
Leehamohcaxa [Af]	*Kanahia laniflora* (Forssk.) R.Br.	Ascepiadaceae	Lf	Render pest	IN	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally.
			Lf	TB	IN, PO	The fresh leaf of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally and small amount is drunk.

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Leehamohcaxa [Af]	*Kanahia laniflora* (Forssk.) R.Br.	Ascepiadaceae	Ap	Anthrax	IN	The fresh or dried aerial part of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
Musruuga [Af]	*Cissus quadragularis* L.	Vitaceae	Rt	Anthrax		See *Acalypha sp*
Qablis [Af]	*Jatropha glauca* Vahl.	Euphorbiaceae	Rt	TB	IN, PO	The fresh root of the plant is pounded and then soaked in water. It is decanted and the solution administered intranasally orally.
Qadgento [Af]	*Salvadora persica* L.	Salvadoraceae	Rt	TB	IN	The fresh root of the plant is pounded with leaf of "Subaci" and then soaked in water for some time. It is decanted and the solution administered intranasally.
Quureyta [Af]	Aloe sp.	Liliaceae	Lf	TB		See *Salvadora persica*
Qatoori [Af]			Lf	Pasterlosis		See "Garsa"
Saaganto [Af]	*Tamarix aphylla* (L.) Karst	Tamaricaceae	Rt	TB		See *Salvadora persica*
Subaaci [Af]	Acalypha sp.	Euphorbiaceae	Lf	Anthrax	IN, PO	The fresh leaf of the plant is pounded with small amount of root of *Balanites aegyptica and Cissus quadrangulari.* and then soaked in water for an hour or two. It is decanted and administered intranasally and orally.

Appendix 3 continued …..

Vernacular name of the plant	Scientific name of the plant	Family	Part(s) used	Claimed medicinal use	ROA	Ethnoformulations and application of the herbal drug
Uddayto [Af]	Balanites aegyptiaca	Balanitaceae	Rt	Render pest	IN	The fresh root of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally.
			Rt	Anthrax		See *Acalypha* sp
Urramo [Af]			Lf	Blackleg	IN, PO	The fresh leaf of the plant is pounded and then soaked in water for some time. It is decanted and the solution administered intranasally (for preventive purpose) and orally (for curative purpose).
Wakrikoqos [Af]	*Solanum incanum* L.	Solanaceae	Ft	Blackleg		See *Boscia coriacea*
			Lf	Anthrax	PO, IN	The fresh leaf of the plant is pounded with Acalypha sp. "Baxobarbare" and then soaked in water. It is decanted and the solution administered both orally and intranasally.
Xoyto [Af]	*Ruellia patula* Jacq.		Wp	Retained placenta (Camels)	Hang	The whole plant is hanged on the tail of the camel.

APPENDIX 4: Vernacular name, scientific name, family and collection number of medicinal plants collected from Chifra District, Afar Region

Vernacular name of the plant	Scientific name of the plant	Family	Collection number
Abuuri [Af]	*Zaleya pentandra* (L) Jeffrey	Aizoaceae	LT - 001
Amqadda [Af]	*Heliotropium longifolium(DC)*	Boraginaceae	LT - 002
Ayteneba [Af]	*Boscia coriacea* Pax.	Capparidaceae	LT - 003
FemaleAyrowagit [Af]	*Senna italica* Mill.	Fabaceae	LT - 004
Male Ayrowagit [Af]	*Indigofera sp.*	Fabaceae	LT - 005
Baaxobarbare [Af]	*Acalypha sp.*	Euphorbiaceae	LT - 006
Baaxobbaru [Af]	*Parthenium hysterophorus* L.	Asteraceae	LT - 007
Bangi [Af]	*Xanthium strumarium* L	Asteraceae	LT - 008
Bikiltafri [Af]	*Sedderra hirsute* Hall.f.	Convolvulaceae	LT - 009
Calmala [Af]	*Polygala obtusissima* Chod.	Polygalacea	LT - 010
Cantiqaluulus [Af]	*Solanum coagulans* Forssk.	Solanaceae	LT - 011
Galaqto [Af]	*Calotropis procerra* (Ait)f.	Ascelepiadacea	LT - 012

Vernacular name of the plant	Scientific name of the plant	Family	Collection number
Gansalto [Af]	*Barleria* sp.	Acanthaceae	LT - 013
Gaydabaxaaxaa [Af]	*Solanum somalense*	Solanaceae	LT - 014
Hedalusayto [Af]	*Lycium shawii* Roem and Schult	Solanaceae	LT - 015
Inddaqto [Af]	Euphorbia sp.	Euphorbiaceae	LT - 016
Karbati [Af]	*Commicarpus plumbagineus* (Cav) Stand	Nyctaginaceae	LT - 017
Kasalto [Af]	Acacia nilotica (L.)Willd.ex.Del.	Fabaceae	LT - 018
Kookaxawto [Af]	Withania somnifera (L.) Dun.	Solanaceae	LT - 019
Kottumayyu [Af]	*Helotropium rariflorum* Stocks	Boraginaceae	LT - 020
Leehamohcaxa [Af]	*Kanahia laniflora* (Forssk.) R.Br.	Ascepiadaceae	LT - 021
Makisano [Af]	*Senna alexanderia* Mill	Fabaceae	LT - 022
Markaqto [Af]	*Acacia mellifera* (Vahl.) Benth	Fabaceae	LT - 023
Musruuga [Af]	*Cissus quadragularis* L.	Vitaceae	LT - 024
Qablis [Af]	*Jatropha glauca* Vahl.	Euphorbiaceae	LT - 025
Olayto [Af]	*Aerva javanica* (Burm.f.) Juss ex Schullt	Amaranthaceae	LT - 026

Appendix 4 continued….

Vernacular name of the plant	Scientific name of the plant	Family	Collection number
Quureyta [Af]	Aloe sp.	Liliaceae	LT - 027
Qaalayto [Af]	*Balanites rotundifolia* (Van Tiegn.) Blatter	Balanitaceae	LT - 028
Qadayto [Af]	*Salvadora persica* L.	Salvadoraceae	LT - 029
Saaganto [Af]	*Tamarix aphylla* (L.) Karst	Tamaricaceae	LT - 030
Shiferaw	*Moriga oleifera*	Moringaceae	LT - 031
Subaaci [Af]	Acalypha sp.	Euphorbiaceae	LT - 032
Subla [Af], Sholla [Am]	Ficus sp.	Fabaceae	LT - 033
Suesue [Af]	*Aristolochia bracteola* Lam.	Aristolochiaceae	LT - 034
Taqsi [Af]	Leucas sp.	Lamiaceae	LT - 035
Uddayto [Af]	*Balanites aegyptiaca*	Balanitaceae	LT - 036
Wakrikoqos [Af]	*Solanum incanum* L.	Solanaceae	LT - 037
Xoxxobi [Af]	*Justica schimperiana* (Hochst.ex Nees) T. Anders	Acanthaceae	LT - 038
Xoyto [Af]	*Ruellia patula* Jacq.	Acanthaceae	LT - 039
Xukanxuksussi [Af]	*Jasmium* sp.	Oleaceae	LT - 040

APPENDIX 5. Some medicinal plants of Ethiopia claimed to have antimalarial activity.

(Key: Am-Amharic, T-Tigregna, O-Oromifa, G-Geez Sd-Seed, Rt- Root, Lf- Leaf, Ft-fruit, St-Stem, Bk-Bark)

No	Botanical name	Vernacular name	Plant part	Ref.
1	*Aloe spp*. (Liliaceae)	Eret (Am)	Rt, Bk	13
2	*Buddleja polystachya* Fresen (Loganiaceae)	Anfar (Am)	Lf	13
3	*Calpurnia aurea* (Ait) Benth (Fabacceae)	Digita (Am) sifara (T) sofellu (o)	Ft or Lf	13
4	*Cior arietinum* L. (Fabaceae)	Shembra (Am)	Ft&Lf	13
5	*Clerodendron myricoides* (Hochst) R.B. Br. Ex vatke (verbenaceae)	Mesirich	Rt	13
6	*Cucumis prophetarum* L.	Yemidir Emboi (Am)	Rt	13
7	*Dodonaea angustifolia* L.F (Sapindaceae)	Kitkita (Am)	Ft	13,24
8	*Euclea schimpen* (Dc.) Dandy (E benaceae)	Dedeho (Am)	Fr	24
9	*Gossypium barbadense* L. (Malvaceae)	Tit (A)	Rt & Bk	13,24
10	*Lobelia gibberoa* Hemsl (Campanulaccae)	Jeberra (Am)	Bk	13
11	*Myrica salicifolia* Hochst ex A. Rich (Myricaceae)	Shinet (Am)	Rt	13
12	*Rubia cordifolia* L. (Rubiacea)	Inchibir (Am)	Rt	13

No	Botanical name	Vernacular name	Plant part	Ref.
13	*Securidaca longepedunculata* Freser (Polygalaceae)	Etse Menabe (G)	Rt	13
14	*Terminalia brownii* Fres (Combretaceae)	Weiba (T)	Rt	13
15	*Vernonia amygadalina* Del (Compositae)	Girawa (Am)	Lf	13,155
16	*Withania somnifera* (L.) Don (Solanaceae)	Gizawa (Am)	Lf	13,155
17	*Lepidium sativum* L.(Brassicaceae)	Feto (Am)	Rt	19,24
18	*Hagenia abyssinica*	Kosso (Am)	Sd	19
19	*Embelia schimperi*	Enkoko (Am)	Ft	19
20	*Allium Sativum* L. (Alliaceae)	Nech shinkurt (Am)	Bk	24
21	*Carica papaya* L.(Caricaceae)	Papaya (Am)	St	24
22	*Croton macrostachys* Hochst ex. Del(Euphorbiaceae)	Bissana (Am)	Lf	24,155
23	*Gnidia involucrate* stend Ex. A. Rich (Thymelaceae)	Beto (Am)	Rt	24
24	*Jasminium abyssinium* Hochst (Oleaceae)	Tenbelel (Am)	St, Lfs	24,156
25	Justicia schimperiana T. Ander (Acanthaceae)	Simiza (Am)	Lf	24
26	*Phytolaca dodecandra* (Phytolacaceae)	Endod (Am)	Lf, Rt	24,156

APPENDIX 6. Semi structured questionnaire for healers of Chifra District to collect ethnobotanical and ethnopharmaceutical data.

A. Instruction to data collectors

- Please greet the respondents following the culture of Afar people.
- Explain the aim of the study with special emphasis to its importance for traditional healers and Afar people.
- Don't forget to listen the respondent about issues other than your concern.
- Conduct the interview in places where the informants feels comfortable.
- Use both Latin and Geez alphabets to write the vernacular name of the plants.
- Ask the respondents to show you the medicinal plants.

B. Socio demographic characteristics of healers

Name _____

Age _____

Sex_____

Occupation_____

Address_____

Education _____Specify_____

Language known_____

Experience as traditional healer _____years

Source of healing wisdom_____

C.Diseases treated by the healer

1. _____

2. _____

3. _____

4. _____

5. _____

D.Assessment of ethnobotanical and ethnopharmaceutical data

No	**Questions**	**Yes**		**No**
1	Vernacular name of the plant_____			
2	What is the growth form of the plant?			
	a. Tree			
	b. Shrub			
	c. Herb			
	d. Liana			
	e. Parasite plant			
	f. Aquatic			
	Others, specify_____			
3	If parasite, what is the host? _____			
4	If trees, height and bulk _____ Bark description_____			
5	Flower color, if any _____			
6	Fruit description, if any_____			

№	Questions	Yes		No
7	Smell of flower if any_____			
8	Which part of the plant is used?			
	a. Root			
	b. Leaf			
	c. Stem			
	d. Fruit			
	e. Root bark			
	f. Stem bark			
	g. Flower			
	h. Herb			
	i. Seed			
	j. Small twinges with leaves			
	Other, Specify			
9	Mode of use			
	a. Fresh			
	b. Dried			
10	Time of plant collection			
	a. Dusk			
	b. Down			
	c. Any time			
11	Day of plant collection			
	a. Specific day, if any, specify			

	b. Any day of the week			
12	Is there any ritual procedure followed for collection of the plants?			
13	If yes to Q. 12 a. Please mention the procedure _____ b. Rationale behind the procedure			
14	In which season f the plant collected?			
	a. Karima			
	b. Gilal			
	c. Dedda			
	d. Sugum			
	e. Hagos			
15	What are the claimed medicinal uses of the plant? a. _____ b. _____ c. _____			
16	Is the drug (herb) mixed with another drug (herb) or other additive?			
If the response to incorporation of another drug is Yes fill the description of the plant in a separate questionnaire and attach as annex.				
17	If Yes to Q.16 Please mention them with importance of their incorporation a. Additives_____ b. Drugs_____			

№	Questions	Yes		No
18	What dosage forms are used to deliver the medicine?			
	a. Powder			
	b. Juice			
	c. Decoction			
	d. Tea			
	Others, Specify_____			
19	Please provide detailed procedure for the ethnoformulation? (For each medicinal use) _____			
20	What is the rationale behind the route of administration used? _____			
21	What do you think is the mechanism of action of the drug? _____			
22	What are you going to do if treatment fails upon the use of the drug? _____			
23	Container /s used for storage of the formulations? _____			
24	What is the recommended storage condition of the formulation? _____			
25	For how long can you keep the formulations without deterioration? _____ _____			

№	**Questions**	**Yes**		**No**
26	Is there any observed Traditional medicine – Traditional medicine interaction?			
27	If yes to Q. 22 mention the interaction _____			
28	Is there any observed Traditional medicine –modern drug interaction?			
29	If yes to Q. 24 please mention the interaction _____-_____			
30	Is there any observed Traditional medicine –Food interaction?			
31	If yes to Q.26 please mention the interaction _____			

Other Relevant Information

_____

Table 1 Indications, Route of administration, Dose, duration and antidotes of _____

Indication	Stage of illness	Diagnosis	Route of administration	Dose and duration			Antidote, if any
				Adult	Pediatric	Geriatric	
1	Mild						
	Serious						
	Chronic						

Table 2 Side effects, Contraindications, Precautions and recommendation in pregnancy of_____

Indication	Stage of illness	Side effects	Contraindications	Precaution	Recommendation in pregnancy
1	Mild				
	Serious				
	Chronic				

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