Addis Ababa University
School of Graduate Studies
School of Pharmacy

Ethnopharmacological Survey of Medicinal Plants among the Hamer Ethnic Group, Hamer Woreda, South Omo Zone, SNNPR, Ethiopia and Evaluation of a Selected Plant for its Antimalarial Activity

By
Biniam Paulos (B. Pharm)

July, 2012

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Thesis Submitted to the School of Graduate Studies, Addis Ababa University, in Partial Fulfillment for the Requirement of the Degree of Masters of Science in Pharmacognosy

By

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Under the Supervision of Kaleab Asres (PhD), Department of Phamaceutical Chemistry and Pharmacognosy and Teferi Gedif (PhD), Department of Pharmaceutics and Social Pharmacy

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Abstract

Health seeking behaviour of people around the globe will be affected by different socio-cultural and economical factors. People in Ethiopia, particularly tribal people have long history of using medicinal plants as a major component of their traditional medical practices over many centuries to satisfy their health care needs. The transfer of this sort of knowledge from generation to generation is mainly effected by words of mouth. Cross-sectional survey was conducted to document ethnopharmacological information of the Hamer semi pastoralists by using semi structured questionnaires administered to eight traditional healers/key informants and one thousand six hundred household (HH) respondents supplemented by eight focus group discussions (FGDs).

The majority (84%) of HH respondents were males, 94.4% of whom suffered illnesses in the last two weeks recall period and had taken action. The prevalence of the use of traditional medicine among the Hamer community was found to be very common as indicated by FGD participants, key informants and HH respondents. HH respondents reported that traditional medical practices are their first choice when family members get sick. Females' preference of traditional medical practices was higher than males. The main reasons for the preference of the community members to traditional medical practices include its effectiveness, low cost and ease of availability. A total of sixty medicinal plants were reported and collected along with their local names, indication(s), parts used and method of preparations.

The health seeking behavior of the Hamer ethnic group is affected by different socioeconomic and cultural factors. There is also a strong indication for traditional medical practices and use of plant materials to treat various ailments and health problems among the study population. Therefore, due attention should be given to these traditional medical practices.

The ethnopharmacological survey part of this study revealed that *Aloe otallensis* Baker., an indigenous Ethiopian plant, was among the most widely used medicinal plants by the members of the Hamer Ethnic Group. The plant is used for the treatment of malaria and wound healing. Malaria, a diseases caused by protozoan parasites is a major obstacle to the socioeconomic

development of several developing countries including Ethiopia. The phytoconstituents of *A. otallensis* studied by thin layer chromatography (TLC) and its antimalarial and antioxidant activities were assessed by *in vivo* four day *Plasmodium berghei* suppressive test and 1,1-diphenyl-2-picrylhydrazyl (DPPH) assay, respectively. The study revealed the presence of picataloside (2,8-*O*,*O*-di (β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphtalene) in the exudate of *A. otallensis,* which was isolated from the plant for the first time.

The study further showed that the leaf exudate of the plant possesses maximum antimalarial activity (60.7% suppression) at a dose of 300 mg/kg. Similarly, at a dose of 100 mg/kg the isolated compound suppressed *P. berghei* parasites by 47.9%. Both the exudate and the isolated compound displayed comparable radical scavenging activity possessing IC_{50} value of 26.9 and 26.2 µg/ml, respectively in DPPH assay. The results of the present study do seem to justify the traditional use of *A. ottalensis* for the treatment of malaria.

1. Introduction

1.1 Background

The use of natural products as medicinal agents dates back to prehistory (Karou *et al*., 2007). Plants have formed the basis of traditional medicine (TM) systems which have been used for thousands of years. TM refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat or to diagnose and prevent illnesses or maintain well-being (WHO, 2003).

According to the literature, the first record on medicinal plants, written on a hundred clay tablets in cuneiform are from Mesopotamia, and dates from about 2600 B.C. Amongst the approximately 1000 plant-derived substances used, were oils of *Cedrus* species (cedar) and *Cypressus sempevirens* (cypress), *Glycyrrhizza glabra* (licorice), *Commiphora* species (myrrh), and *Papaver somniferum* (poppy). All these plants are still used today for the treatment of ailments ranging from cough and cold to parasitic infections and inflammations (Newman *et al.*, 2000).

It is also reported that Egyptian medicine dates back to about 2900 B.C., but their best known pharmaceutical record is "Ebers Papyrus" written in about 1500 B.C which includes over 700 drugs (mostly plants, animal organs and some minerals) and formulae such as gargles, snuffs, poultices infusions, pills and ointments, with beers, milk, wine, and honey being commonly used as vehicles (Karou *et al*., 2007).

In addition to this, the Chinese *Materia Medica* (CMM) has been extensively documented over centuries with the first record dating from about 1100 BC, reporting the uses of over 600 medicinal plants. The philosopher and the natural scientist Theophrastus (372-288 B.C.) in the "History of Plants" began the scientific classification of plants and dealt with the medicinal qualities of herbs. Ibn Al Baita (1197-1248) listed over 1400 drugs and medicinal plants in *Corpus of Simples* (Karou *et al.*, 2007).

Despite this historical background, ethnopharmacology was initiated by the missionaries in the colonial period interested in the use of pharmacologically active plants, like the Jesuits in the 16th century Latin America (Anagnostou, 2005). However, ethnopharmacology in a modern sense only became possible with the scientific ability to study the effects of substances and extracts on model systems. Consequently, Claude Bernard (1813-1878), who conducted detailed studies on the pharmacological effects of curare, has to be considered as one of the first researchers of this tradition (Heinrich and Gibbons, 2001).

Ethnopharmacology is defined as an interdisciplinary area of research that deals with the identification, description, observation and investigation of ingredients used in various recipes of traditional medicine and their effect on animal models. It is also the study of the relevant forms of knowledge, practice and cultures implementing them (Brunht and Holmested, 1981; Janardhanan and George**,** 2006).

Throughout the world, people use many wild and cultivated species of plant for food, medicine, clothing, shelter, fuel, fiber, for income generation and for the fulfillment of cultural needs. There is a growing recognition that biological diversity including medicinal plants is a global asset of tremendous value to the present and future generations (Shingu, 2005).

WHO estimates that as much as 80% of the world's populations, especially those living in tropical countries rely almost exclusively on herbal products as the main form of medications. Indeed, for millions of Africans, traditional healers, who use botanical medicines predominantly, are their only contact with medicine of any kind, particularly, in the rural areas where hospitals are rare and health professionals are few (WHO, 2005; Agyare *et al.*, 2009).

In addition to this, in industrialized countries, adaptations of traditional medicines (TM) often termed complementary or alternative medicine (CAM) also play an important role in the health care system of 20% of the population. For example, in the United States, 158 million adults use CAM and according to the USA commission for alternative and complementary medicines, US$

17 billion was spent on traditional remedies in 2000. In the United Kingdom, the annual expenditure on CAM was US$ 230 million. Also in China, TM accounted for about 40% of all health care delivered (WHO, 2003).

The Ethiopian people have been using medicinal plants to treat different diseases over many centuries, and the religious and secular pharmacopoeia had been compiled since the 15th century. Medicinal plants are the integral part of the variety of cultures in Ethiopia and resulted in medical system pluralism (Pankhurst, 1965).

The studies of the tribal indigenous knowledge of plants and their local use is often linked to purpose-specific characteristics of plants mainly, efficacy to correct harmful symptoms or to eliminate casual factors associated with particular conditions which constitute an important and preliminary aspect of ethnopharmacological research (Baquar, 1995; Byg *et al*., 2006).

Lefèvre (2008) proposed three approaches to study traditional medicine, corresponding to three operational views of traditional medicine.

1. A selection of pharmacologically interesting plants; the plants used in traditional medicine against a particular illness were selected by the population precisely because they were effective against it.
2. A pre-selection of pharmacologically interesting plants; the plants can have a use in pharmacy even though the latter may not correspond to their local use.
3. An anti-selection of pharmacologically interesting plants; the plants have been identified as being toxic.

1.2 Importance of ethnopharmacological survey

1.2.1 Drug discovery

Knowledge of plant bioactivity has been accumulated by experimentation over centuries by people living in intimate association with their environment. Therefore, ethno-directed research is very useful in drug discovery and development (Cox and Balick, 1994; Heinrich and Gibbons, 2001). For example, during 1950-1970, approximately 100 plant based new drugs were introduced in the USA drug market including deserpidine, reseinnamine, reserpine, vinblastine

and vincristine which are all derived from higher plants. From 1971 to 1990 new drugs such as ectoposide, E-guggulsterone, teniposide, nabilone, plaunotol, Z-guggulsterone, lectinan, artemisinin and ginkgolides appeared all over the world. Between 1991 and 1995, 2% of the drugs introduced in the global market including paciltaxel, toptecan, gomishin, irinotecan etc. were of plant origin. Plant based drugs provide outstanding contribution to modern therapeutics; for example: serpentine isolated from the root of Indian plant *Rauwolfia serpentina* in 1953, was a revolutionary event in the treatment of hypertension and lowering of blood pressure. Vinblastine isolated from the *Catharanthus roseus* (Farnsworth *et al*., 1967) is used for the treatment of Hodgkins, choriocarcinoma, non-Hodgkin's lymphomas, leukemia in children, testicular and neck cancer. Vincristine is recommended for acute lymphocytic leukemia in childhood advanced stages of Hodgkin's, lymophosarcoma, small cell lung, cervical and breast cancer. Podophyllotoxin is a constituent of *Podophyllum emodi* currently used against testicular, small cell lung cancer and lymphomas (Samy and Gopalakrishnakone, 2007).

Despite the remarkable progress in synthetic organic chemistry of the twentieth century, research on plants with medicinal properties and identification of the chemical components responsible for their activities have corroborated the traditional uses of ancient healing wisdom and lore and have proven the enduring healing potential of many plant medicines even in today's hi-tech community (Babu *et al*., 2009) and over 25% of prescribed drugs in industrialized countries are derived directly or indirectly from plants. This percentage can reach 50% when the over-the-counter market is taken into consideration (Newman *et al*., 2000; Gurib-Fakim, 2006).

One of the reasons for researchers to be interested in natural products is the increase of microbial resistance to antibiotics that threatens public health on a global scale as it reduces the effectiveness of treatments and increases morbidity, mortality, and health care costs (Coast *et al*., 1996). Evolution of highly resistant bacterial strains has compromised the use of newer generations of antibiotics (Quave *et al*., 2008). Although active constituents may occur in lower concentrations, plant extracts may be a better source of antimicrobial compounds than synthetic drugs (Cox and Balick, 1994).

Most of these plant-derived drugs were originally discovered through the study of traditional cures and folk knowledge of native population. Some of these could not be substituted despite the enormous advancement in synthetic chemistry. However, very few drugs from higher plants have attained any prominence in conventional medical practice in the last couple of decades even with the increasing interest in phytomedicine. Essentially, ethnopharmacology has already played important role in the development of conventional medicine and is likely to play more significant role in the years to come (Gilani and Rahman, 2005).

So, search for new pharmacological compounds is one of the most important factors of mankind's survival through the ages, including the improvement of life's quality, especially in the last century where there is current target-rich, lead-poor scenario (Falcao *et al*., 2006; Hudaib *et al*., 2008); and the goals of using plants as sources of therapeutic agents are:

- To isolate bioactive compounds for direct use as drugs, e.g., digoxin, digitoxin, morphine, reserpine, taxol, vinblastine, vincristine; and
- To produce bioactive compounds of novel or known structures as lead compounds for semisynthesis to produce patentable entities of higher activity and/or lower toxicity, e.g., *Echinacea* species, *Tanacetum parthenium*, *Allium sativum*, *Ginkgo biloba* and *Hypericum perforatum* (Fabricant and Farnsworth, 2001).

As a result of this, interest in phytomedicine is renewed during the last decade and many medicinal plant species are being screened for pharmacological activities (Kunwar *et al.*, 2009) and natural products are promising candidates for drug discovery and they still continue to play an important role in future small organic compound drug development programs (Newman and Cragg, 2007).

1.2.2 Contribution to primary health care

In this first decade of the 21th century, immense advances in human well-being coexist with extreme deprivation in many parts of the world (WHO, 2006). Inequities in availability, accessibility and affordability of health care have increased, between as well as within populations the world over (Payyappallimana, 2010). In the recent past there has been a growing interest in traditional complementary and alternative medicine (TCAM) and their relevance to

public health both in developed and developing countries. Diversity, flexibility, easy accessibility, broad continuing acceptance in developing countries and increasing popularity in developed countries, relative low cost, low levels of technological input, relative low side effects and growing economic importance are some of the positive features of TM (WHO, 2002).

The vast majority of the population continues to use TM in Africa, Asia and Latin America and many governments in these regions have incorporated TM practices to help meet their primary health care needs. In industrialized countries, almost half of the population now regularly use some form of TCAM (United States, 42%; Australia, 48%; France, 49%; Canada, 70%), and considerable use exists in many developing countries (China, 40%; India, 70%; Chile, 71%; Colombia, 40%; up to 80% in African countries) (Bodeker and Kronenberg 2002, WHO, 2002). Globally, about 85% of the traditional medicines used for primary healthcare are derived from plants (Ignacimuthu *et al.*, 2006).

In this context, there is a critical need to mainstream TM into public health care to achieve the objective of improved access to healthcare facilities because traditional healers and traditional medicines continue to play a key public health role contributing to availability of human resources in countries where the population to physician ratio is high (Payyappallimana, 2010). Hence, ethnopharmacological information plays an important role in this, particularly when the literature and fieldwork data have been properly evaluated (Awadh *et al.*, 2004).

1.2.3 Economic benefits

Annual world market of herbal medicine based on TM is estimated at US $60 billion (WHO, 2002) and it is steadily growing. The United Nations Development Programme (UNDP) estimates that the value of pharmaceutical products derived from developing world plants, animals and microbes is more than US $30 million per year (Ndenecho, 2009).

Medicinal plants are also the alternate sources of income for the underprivileged communities apart from their role in ethnobotanical and primary health care system (Dobriyal *et al*., 1997; Lacuna-Richman, 2002). Hence, critical understanding and rebuilding of such communities has become imperative to strengthen their livelihood (Poonam and Singh, 2009). In addition, as the

economic importance of traditional knowledge and medicinal plants based products and services are growing they provide employment opportunities to various sections of people (Payyappallimana, 2010).

1.2.4 Preserving cultural heritage and natural resources

Tribal people around the world possess unique knowledge of the natural resources on which they depend, including tremendous botanical expertise. Indigenous peoples are the "faculty", keepers of the cumulative knowledge of generations; the plants they utilize are the "stockroom" of potential medicines. Less than 1% of indigenous cultures have been surveyed for their knowledge of medical plants and other natural products (Prance, 2000).

WHO has shown great interest in documenting the use of medicinal plants by tribes from different parts of the world (Kaido *et al.*, 1987). Accordingly, many developing countries have intensified their efforts in documenting ethnomedical data on medicinal plants. Once these ethnomedical preparations are scientifically evaluated and disseminated properly, people will be better informed regarding efficacious drug treatment and improved health status (Manandhar, 1987).

In addition to this, it should be noted that many medicinal plants face danger of extinction. Over-exploitation of such plants in order to satisfy industrial and export demands can aggravate the risk (WHO, 2002). So, proper documentations of these medicinal plant species may reduce the danger of such threat.

1.3 Statement of the problem

Plants are used worldwide for the treatment of diseases, and novel drugs continue to be developed through research from plants. There are more than 20,000 species of plants used in traditional medicines, and these are all potential reservoirs for new drugs (Hamamouchi, 2002).

Over the past decade, there has been a dramatic increase in the demand for medicinal plants for use in TM and CAM in both developing and developed countries (UNCTAD, 2000). The world market for herbal remedies and knowledge the estimate was US$ 60 billion in 2000 (WHO,

2002). However, the increased demand for medicinal plants has resulted in over-exploitation of some of these resources and has contributed to the degradation of wild plant habitat in many parts of the world. According to WHO, recognition of traditional medicine is an important policy step for supporting the development of TM, including to ensure its safety and effective use, and help combat the over-collection leading to unsustainable use of medicinal plants (WHO, 2001;WHO, 2002).

In African societies, the tradition of collecting, processing and applying plants and plant-based medications have been handed down from generation to generation (Lev and Amar, 2000). The increasing use of traditional therapies demands more scientifically sound evidence for the principles behind therapies and for effectiveness of medicines (Patwardhan *et al.,* 2005).

With this increasing popularity and awareness of the significance of ethnic and traditional knowledge in the development of therapeutics, it is necessary to ascertain the appropriate use of herbal medicines by practitioners, as some side effects may occur with TM and can sometimes be serious. Also, in the current scenario of globalization, information technology and knowledge system on TM have significant importance (Abbott, 2005; Janardhanan and George, 2006).

Regardless of this in the past, little attention has been paid to the historical development of such orally transmitted, indigenous knowledge systems. It is often apparent and argued that they are under the threat of disappearing, but continuity and change in traditional, orally transmitted knowledge systems about medicinal (and food) plants has only rarely been at the focus of research projects (Heinrich *et al.,* 2009).

In spite of the advent of the modern medicines, tribal populations are still practicing the art of herbal medicine (Azaizeh *et al.,* 2003). Since the majority of people in developing countries depend on treatments given by traditional healers, it is possible that this trend will continue for the future to come due to the fact that financial resources are diminishing in the social sector while the demand and cost for health services, has steadily escalated (WHO, 2010). In addition, the increasing scarcity of medicinal plant species represents a trend that should be addressed

immediately; otherwise many medicinal plant species that have sustained rural people for centuries may be lost forever. Thus, policies and procedures that enable medicinal plants to be used sustainably must be developed to check this threat (Shingu, 2005).

Apart from the benefits that TM/CAM provides, countries also face challenges in the development and implementation of the regulation of TM/CAM and herbal medicines. These challenges are related to regulatory status, assessment of safety and efficacy, quality control, safety monitoring and lack of knowledge about TM/CAM within national drug regulatory authorities (WHO, 2005).

In addition to this, the knowledge of the use of medicinal plants and their properties which was transmitted from generation to generation (Lev and Amar, 2000) between older and younger generation is not always assured (Anyinam, 1995).

Ethiopia, like other developing countries has low health care coverage especially, the inaccessible poor of the country highly relies on traditional medicines for its primary health care needs. In Ethiopia, about 800 species of plants are used in the traditional health care system to treat nearly 300 physical and mental disorders, and remains to be the main resource of treatment for a large majority of the people. Medicinal plants occur throughout the country's diverse highland and lowland areas (Edwards, 2001).

The documentation of traditional medicinal plants used by the Ethiopian people is limited compared to the extent of variety of cultures and diversity of the terrain. Furthermore, the majority of these studies are focused only on the herbalists and Ethiopian medico-religious manuscripts without regarding the existing traditional knowledge and practices of common people (Abebe and Ayehu, 1993). This trend might ignore the study on the level of knowledge in the society; affect the documentation and the search for medicinal plants conserved and administered by the local people (Teklehaymanot, 2009).

In the light of the above, assessment or investigation and documentation of knowledge of indigenous people on the use and management of medicinal plants would fill the gap of indigenous knowledge on medicinal plants. Moreover, the presence of natural and anthropogenic factors affecting the losses of valuable medicinal plants calls for the need to document the eroding medicinal plants and the associated knowledge. Thus, the purpose of this study is to assess traditional medicinal plants knowledge specifically with regard to gender, age, educational and economical status and to document the knowledge and the uses of medicinal plants used by the Hamer ethnic group in South Omo Zone, Southern Ethiopia, who are semi-pastoralist and rely largely on traditional medical practices for their health care needs. To the best of our knowledge, there is no previous survey on the Hamer ethnic group with regard to documentation of their traditional medical system. So, it is hoped that the survey will provide baseline data for further study on the Hamer ethnic group with regard to traditional medical system of the community.

2 Objective of the study

2.1 General objective

To document ethnopharmacological information of the Hamer ethnic group with respect to the use of plants in South Omo Zone, Southern Ethiopia and to conduct phytochemical and biological activity studies of a selected plant

2.2 Specific objectives

- To document ethnopharmacological information of medicinal plant used for the treatment of disorders of human and domestic animals among the Hamer ethnic group;
- To collect and identify specimens of medicinal plants used by the Hamer community and preserve them; and
- To conduct phytochemical and biological activity studies on a selected plant.

3 Methods and materials

3.1 Ethnopharmacological survey

3.1.1 Study area and socio-economic settings

Hamer Woreda is one of the nine woredas in South Omo Zone, Southern Nation Nationalities and People Region (SNNPR). The woreda is estimated to cover 731,565 hectares of land. It is 770 km far from Addis Ababa or 540 km from Hawassa, the capital of SNNPR. The boundaries are Bena-Tsemay on the north, Kenya-Kuraz-Borena of Oromia on the south, Part of Bena-Tsemay and Parts of Borena of Oromia on the east and Kuraz woreda on the west (Hamer Woreda Culture, Tourism and Government Communication Office, 2010).

Dimeka is the capital of the woreda. There are 59,160 people (29,466 female and 29,694 male) living in the woreda. 80% (46,532) belong to the Hamer ethnic group; 11.2% (6,840) to the Erbore ethnic group; and 2.47% (1,464) to the Kara ethnic group. A total of 3,210 people live in Dimeka and Turmi (neighboring) towns. The remaining 55,950 live in rural areas (ECSA, 2007).

There are two kindergartens (one in Dimeka and the other in Turmi) and 7 primary schools in Hamer Woreda, including one complete full cycle (1-8 grade) primary school and one high school (9-10 grade). One school serves 4 to 5 kebeles, and in some cases more. Most schools are located in towns and along main roads, and the more inaccessible areas have none. As a result, children walk on average 5 km to get to school. It is estimated that 66% of the population lead a pastoral life. The other 34% depend on cattle rearing and small-scale farm activities. Livestock is the most important form of wealth (Beyene, 2005; Hamer Woreda Culture, Tourism and Government Communication Office, 2010).

The Woreda has three health centers and eight health posts and eight veterinary clinics at community level but pastoralists of South Omo Zone face a multitude of health related challenges owing to the incidence of epidemics resulting from harsh environmental conditions, low-level health education. Harmful traditional practices, poor coverage of health services and

low level of health facilities further exacerbate the health status of the population in the woreda (Hamer Woreda Culture, Tourism and Government Communication Office, 2010).

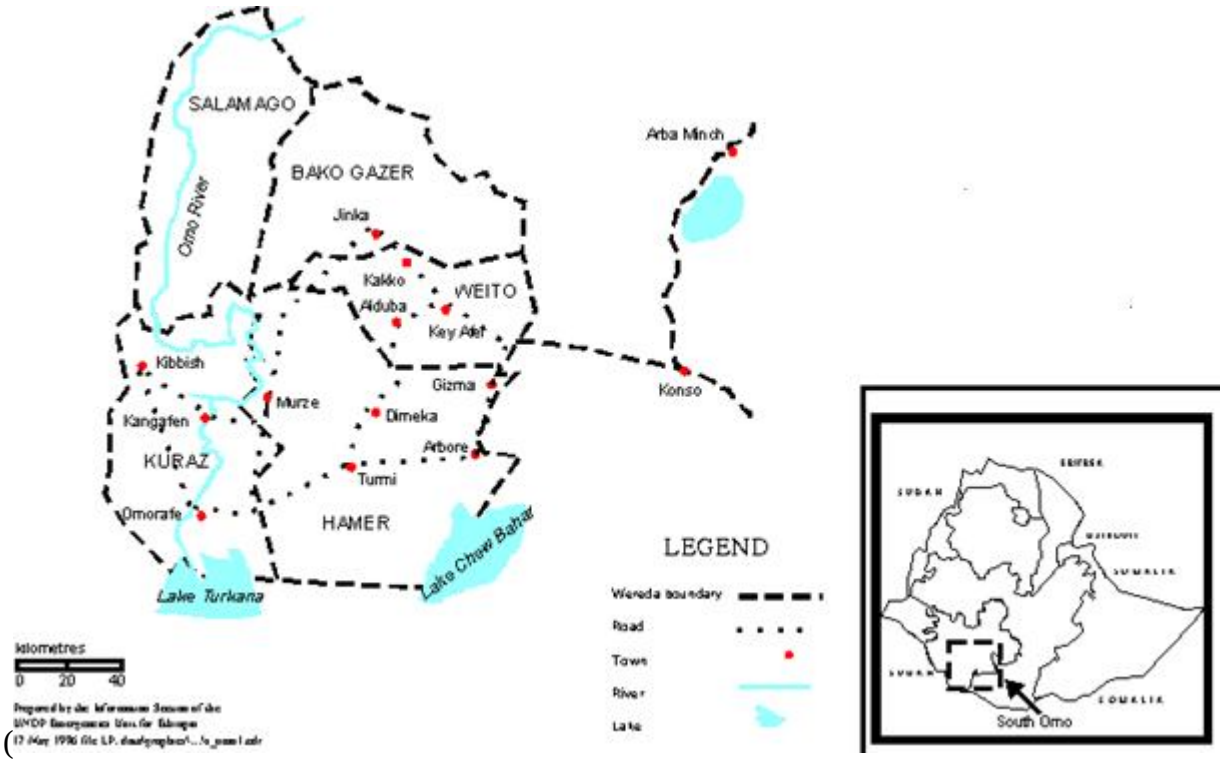


Figure 1. The map of Hamer Woreda (Hamer Woreda Culture, Tourism and Government Communication Office, 2010).

3.1.2 Study design

Cross-sectional survey using semi-structured questionnaires (one for household (HHs) and the other for traditional healers/ key informants) supplemented by focused group discussions (FGDs) was conducted in eight kebeles of Hamer Woreda between December 2009 and January 2010 to investigate ethnopharmacological knowledge among the Hamer ethnic group.

3.1.3 Sampling and sample size determination

3.1.3.1 Sampling

The study population constituted members of the Hamer ethnic group, who reside in Hamer Woreda. The sampling method employed is described in Annex III**.**

Hamer Woreda has thirty five kebeles out of which eight kebeles were selected by simple random sampling. 200 households were selected from each kebele by using cluster sampling technique. Since households were final sampling units for the household survey, the respondents were head of the house (husband), wife and other members of the family who were above eighteen years of age and available during data collection period. A total of 1,600 respondents were included in the study.

One traditional healer was selected from each kebele based on their reputation in healing practices, which was obtained from community leaders, kebele administrators and community elders. One focused group discussion was held in each selected kebele.

3.1.3.2 Sample size determination for HHs survey

Sample size was determined by using the following formula (Le, 2003):

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where, n is the sample size, Z is confidence level (at 95%, Z = 1.96) and d is margin of error (5%).

Since there was no previous data on the ethnopharmacological knowledge of the area the P value will be selected as 0.5.

$$n = \frac{1.96^2(0.5^2)}{0.05^2} = 384.16$$

To correct for the design effect "n" was multiplied by sampling stage (4); n x 4 = 384 x 4 = 1536 adding 5% contingency; 1536 + (0.05 x 1536) = 1612 ≅ 1600. Based on this n was calculated to be 1,600.

3.1.4 Data collection and management

Data collection was carried out mainly through interviews that were conducted using a semi-structured questionnaire prepared for traditional healers or key informants that were selected

from each kebele. FGDs were carried out using a guide. The participants of FGDs were elder members of the community and each group was composed of seven members. The questionnaires prepared in English were translated to Hamer, which is the local language of the studied community. Data collectors were grade 10 students with good command of the English and Hamer languages. They were trained for two days on data collection instruments, and data were collected within thirty days following the last day of training. To assure the quality of data, the questionnaires were pre-tested and collected data were checked daily by the principal investigator.

3.1.5 Variables

3.1.5.1 Dependent variables

Dependent variables include, health seeking behaviour, action taken, medicinal plant types, time of collection, method of preparations, indications, dose, side effects, contraindication, and antidote.

3.1.5.2 Independent variables

Independent variables include demographic characteristics of HH respondents (sex, age), educational status, HH size, occupation, economic status, family status and distance form health institutions.

3.1.6 Plant collection and identification

Plants were collected from December, 2009 to January, 2010 from eight kebeles of Hamer woreda. Collected parts of plants contain leaf, flower, fruit and seed. Collection number was assigned to each plant. Taxonomic identification was done by Mr. Melaku Wondafrash of the National Herbarium, Department of Biology, College of Natural Science; Addis Ababa University and voucher specimens were deposited at the National Herbarium.

3.1.7 Data entry and analysis

SPSS statistical analysis (Version 17, 2004, chi-square were used to determine the significant difference, at 95% confidence interval $P < 0.05$ considered statistically significant) was used for data entry and analysis. The qualitative data processed manually. Results were presented in the form of graphs and frequency tables.

3.1.8 Ethical considerations

Zonal, woreda and kebele officials, health officers and community leaders were informed about the objectives of the study and requested for their consent on behalf of their community and to cooperate with the investigator and data collectors during the study. Moreover, every respondent was briefed about the study and asked for their willingness to participate in the study prior to introducing the questionnaires. Information obtained from respondents are not presented by name and remained confidential. In addition, ethical clearance was granted from the Ethical Review Committee of the School of Pharmacy, Addis Ababa University.

3.2 Phytochemical and antimalarial activity studies

3.2.1 Materials

3.2.1.1 Plant material

The plant material was collected near the town of Dimeka, about 770 km south west of Addis Ababa, in Hamer woreda, South Omo Zone. The plant material was identified as *Aloe otallensis* Baker by Prof. Sebsibe Demissew of the National Herbarium, College of Natural Science, Addis Ababa University where voucher specimen (collection number) (H002) was deposited (Fig 2).

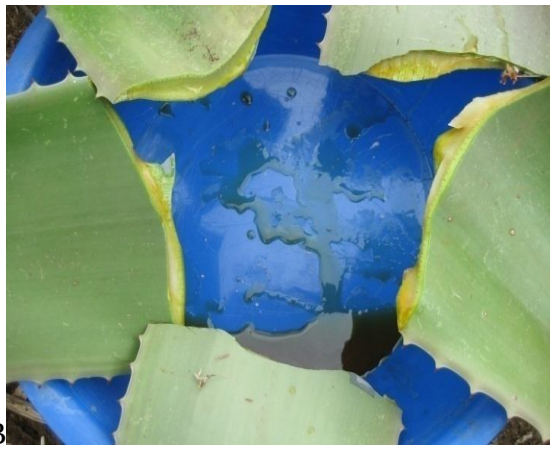
A  B 

Figure 2. The plant (A) and exudate (B) of *Aloe otallensis*.

3.2.1.2 Animals

Swiss albino mice (26 ± 4 g) of either sex were obtained from the animal house of the Department of Biology, Addis Ababa University. The animals were housed in standard cages of five mice per cage and acclimatized for a period of 10 days. The mice were maintained on standard pelleted diet and clean water *ad libitum.*

3.2.2 Methods

3.2.2.1 Thin layer chromatography (TLC) analysis

The identification of unknown compounds is an important task. TLC is a very commonly used technique in synthetic chemistry for identifying compounds, determining their purity and following the progress of a reaction. It also permits the optimization of the solvent system for a given separation problem (Hahn-Deinstrop, 2007).

Preparative thin layer plates were prepared by using silica gel (Kieselgel 60 F254, Merck, Germany) distilled water and glass plates. Five plates of dimension 20 cm x 20 cm were arranged in a row on TLC plate coater. Silica gel (60 g) was vigorously shaken in a conical flask with 120 ml of distilled water to make slurry. The slurry was then spread over the plates to make a layer with 0.5 mm thickness. After 5 min, the plates were removed from the coater and left in a open air for 45 min. Following this, the plates were heated in an oven at 110 °C for 1 h. 100 mg

exudate of *A. otallensis* was dissolved in 1 ml methanol using sonicator, was then applied as a band on TLC plates by using capillary tube.

Chloroform and methanol in a ratio of 7:3 were used as a solvent system for TLC. After development the plates were allowed to dry and the separated bands were visualized under UV light of short (254 nm) and long (366 nm) wavelength. The bands were scrapped off the plates, dissolved in methanol; filtered (Whatmann No. 1) and the solvent removed in an oven at a temperature not exceeding 40 °C.

3.2.2.2 Spectroscopic analysis

In recent years, spectroscopic techniques have come to be regarded as attractive and promising analytical tools for analyses conducted in research, control or industrial laboratories. These techniques are increasingly considered by analysts as an obvious solution. This trend stems from instrumental developments, the extensive use of computers and the development of appropriate chemometric procedures. Daily, new applications of spectroscopic techniques in the fields of chemistry, drugs, the agro-food sector, life sciences and environmental analysis are being demonstrated and published (Baeten and Dardenne, 2002).

NMR spectra were recorded on a Jeol JNM - L - 400 spectrometer operating at 400 MHz for ^{1}H and 100 MHz for ^{13}C at room temperature using DMSO-d_6 as a solvent. Signals were referred to an internal standard tetramethylsilane (TMS). Chemical shifts are reported in δ units and coupling constants (J) in Hz. ESI-MS were recorded on a Shimadzu LC-MS 2010 advanced spectrometer attached to a Shimadzu LC - 10 ADvp pump with a Shimadzu SIL-HT auto injector; a Shimadzu CTO - 10 ACvp column oven and a Shimadzu Dgu - 14a degasifier. Measurements were carried out by an electrospray ionization method with positive and negative modes. The probe voltage and CDL temperature were fixed at 1.5 kV and 250 °C, respectively. UV- Visible analysis was carried out by using T60 UV- Visible spectrometer (PG – instrument, England). The sample was diluted with ethanol until 0.17 mg/ml is obtained.

3.2.2.3 Acute toxicity test

Oral acute toxicity of the aqueous solution of the exudate of *A. otallensis* was evaluated according to OECD guidelines for testing of chemicals for their toxicity in non-infected female Swiss albino mice (OECD, 2006). Mice aged 6 to 8 weeks and weighing 26 ± 4 g were used. For the test, 10 mice were placed in two cages (five mice per cage) to be used as a test and control groups. Before oral administration of a single dose (the aqueous solution of the exudate was prepared by dissolving 45 mg of the exudate in 1 ml of distilled water) of the exudate, the mice were fasted for 24 h with free access to water and weighed. Then, the mice were given orally 0.2 ml aqueous solution of the exudate at a single dose of 1,500 mg/kg. The mice in the control group received 0.2 ml distilled water. Following administration, food but not water was withheld for extra 2 h. After treatment, the mice were observed continuously for 1 h intermittently for 4 h, and thereafter over a period of 24 h. Observation was focused on vulgar behavioural changes like feeding, hair erection, acute diarrhoea, lacrimation, mortality and other signs of toxicity manifestations.

3.2.2.4 Four-day *Plasmodium berghei* suppressive test

The method used was according to that of Knight and Peters (1980) as modified by Makindet *et al*. (1988). The blood schizontocidal activity of chloroquine (chloroquine phosphate, BDH, England), the aqueous solution of the exudate (9 mg of the exudate was dissolved in 1 ml of distilled water and the other doses were prepared by serial dilutions of each successive doses) or the isolated compound (3 gm of the isolated compound was dissolved the other doses were prepared by serial dilutions of each successive doses) were tested on parasitized male albino Swiss mice each receiving a standard inocula of 1 X $l0^7$ (0.2 ml) erythrocytes infected with *P. berghei* (ANKA strain) intraperitoneally (i.p.) on day 0. The mice were divided into ten groups of five mice per group. Three groups were given doses of 75,150 and 300 mg/kg/day of the exudate. The other three groups were given the isolated compound at doses of 25, 50 and 100 mg/kg/day. Two groups served as a positive control were given chloroquine at a dose of 25 mg/kg/day, while the remaining two groups which served as a negative control received an equivalent volume of distilled water following 1 h after infection. All the test samples and the positive control were administered on day 0 to 3. On day 4 thin blood films were made from the tail of each mouse, fixed with methanol and stained with Giemsa stain (Fine Chemicals) and

examined under the microscope to assess the activity. The average percentage suppression of parasitaemia was calculated using this formula:

$$\%\ \text{Av. chemosuppresion} = \left(\frac{\%\ \text{Av. parasitaemia in NC} - \%\ \text{Av. parasitaemia in TG}}{\%\ \text{Av. parasitaemia in NC}}\right) X\ 100,$$

where NC is negative control and TG is test group.

3.2.2.5 Antioxidant activity: 1,1-Diphenyl-2-picrylhydrazyl (DPPH) assay

DPPH radical scavenging activity of the exudate and isolated compound (BAO1) was determined by the method described by Cuendet *et al.* (1997) where 50 µL of various concentrations (100, 50, 25 and 12.5 and 6.25 µg/ml) of the exudate and 50, 25, 12.5, 6.25 and 3.125 µg/mL of the isolated compound were mixed with 5 ml of 0. 04% (w/v) DPPH solution in methanol. The mixture was incubated for 30 min in dark place. After incubation, the absorbances of the mixture were read at 517 nm on UV spectrophotometer (Jenway Model 6500, England) by using blank DPPH as a control. Vitamin C was used as a reference standard. Tests were carried out in triplicate and average values were taken. Percentage inhibition of DPPH radical was calculated using the equation:

$$\%\ I = \frac{(A_o - A_s)}{A_o} X 100,$$

where % I is percentage of scavenging, A_o is the absorbance of the control (containing all reagents except the test compound), and A_s is the absorbance of the tested samples. A dose response curve was plotted to determine the IC_{50} values. IC_{50} is defined as the concentration sufficient to obtain 50 % of maximum scavenging capacity.

3.2.3 Data entry and analysis

SPSS statistical analysis (Version 17, 2004) was used for data entry and analysis. The qualitative data was processed manually. One way ANOVA was used and $P < 0.05$ at 95% confidence interval was considered to be significant. Results were presented in the form of graphs and frequency tables.

4 Results and Discussion

4.1 Ethnopharmacological survey

4.1.1 Summary of FGDs

A total of eight FGDs were conducted. Each group contained seven members composed of elders of the community whose ages ranged from 40 to 70 years. Three of the participants attended primary education and the rest were illiterate. The discussion were held at *Ariya Kayusa, Achi Musa, Besheda, Shanko Kelema, Gediback, Asele, Lala* and *Dega keja Algan* kebekes of Hamer Woreda.

Illnesses

Malaria (*gebeze*) was the most and frequently occurring illness identified by all FGD participants in the eight kebeles. In addition, eye diseases (*afo burka*), diarrhoea (*zen*), tineasis (*berdate*), common cold (*gulfadhana*), evil eye (*chaqi*), jaundice (*ara*), skin disorders (*bishi/shelo fecha*), snake bite (*guni*) and hypertension (*lognagena*) were identified as common illnesses that threaten the community. The participants underscored that the prevalence of most of these illnesses was high during the months of December, January, February and March where drought and shortage of water become the main challenge.

Action taken during illness

The majority of the participants indicated that huge number of community members go to traditional healers during illnesses. The participants underlined that traditional healers are capable of curing diseases with minimum cost and high reliability. For example, they assert that traditional healers cure illnesses like evil eye (*chaki*), snake bite (*guni*) and hypertension (*lognagena*) for which modern medicines has no solution. In addition, geographical accessibility and cultural acceptability have made traditional healers to be the choice of health care options in case of illnesses.

In contrast, five participants from three different kebeles argued that modern medicine is their first choice if and when they seek medical care. They said that health institutions deliver health

care service following proper and evidence based diagnosis better than traditional healers. Other two participants from *Lala* kebele expressed that homemade remedies should be tried before seeking any further help.

Sources and types of TM

According to the FGD participants, plants are the major sources of TM among the Hamer community. Even though they were not keen to give examples of these medicinal plants, they said they use a large number of plants as sources of medicine. They underlined that these medicinal plants should not be shown to everybody and collected only by "special" person. However, one of the participants made it clear that there are trends of selecting plants based on their colour. For example, plants such as *fulante* (*Dichrostachys cinera* (L.) Wight & Arn.) and *guci* (*Lagenaria siceraria* (Monila) Standl.), which have pale yellow flowers are used for the treatment of jaundice (*ara*). It was observed that no special attention is given to plants with medicinal value and that they are treated in a similar way with other non medicinal plants. According to the participants, the main reason for this could be associated with the fact that, pastoralists do not usually grow or cultivate plants on a regular basis. The majority of medicinal plants are collected from wild/forest. In addition to plants, animal and minerals are used as a source of medicine for TM. Examples of such animal products include goat meat (*Qoli*), fats, milk and blood of goat and cow and bone of goat.

Besides these, there are other traditional practices which are practiced by some members of the ethnic group in the district. These include *Dunguri Qansa*, *Qolin Asheda* and *Merankal*. *Dugnuri Qansa* and *Qolin Asheda* are practiced by male member of the society and *Merankal* by both male and female members of the community. *Dunguri Qansa* is a type of practice where "Shoe Sole" is thrown and observed the way it falls to the ground. The patients will then be told what to do to get rid of their ailments. *Qolin Asheda* is a practice which involves slaughtering of a young goat and observing its intestine followed by instructing the patients to cover his/her face with the stomach content of the goat. Later on, the whole body is covered with the content of the stomach which is believed to remove the causative agent of the disease from the body. *Merankal* (witchcraft) is a type of practice which involves divine to identify and treat different types of

diseases. The participants also revealed that there are also bone setters and traditional birth attendants (usually elder women) in the district.

Knowledge transfer

The majority of the FGD participants claimed that knowledge of traditional medicines especially herbalism is handed down from elders to younger generation through word of mouth. Among the Hammer community traditional knowledge is transmitted only to the eldest son or a male member from close relatives. Otherwise, knowledge and skill of healing are held always in secret. Although the participants were aware of the menace of this type of transferring traditional knowledge and practice, they still believe that it should continue as it is to keep the dignity of their ancestors.

In the case of knowledge transfer of *Merankal*, which is associated with divine power, the practitioners carry out spiritual ceremony where their spirit tells them who should be their successor and ask their spirit to transfer their spirit to their successor. There were two FGD participants from *Lala* kebele with different perception. According to them, healers are selected by nature and god (*Burjo*) to keep the well-being of their community.

Acceptance of traditional medical practices by youngsters

Nearly all participants from *Ariya Kayusa, Achi Musa, Besheda and Shanko Kelema* kebeles expressed that young members of their community have much less interest in traditional medicine. Improved physical access to modern health institutions, the effect of modernization that comes through expansion of modern education and Christianity were mentioned by participants as the main reasons for such decline in interest by young people.

Benefits of traditional medical practices and its limitations

Most participants claimed that TMPs play crucial role in addressing the health care needs of the community. They claimed that traditional healers can easily be accessed and their cost of treatment is much lower than modern health institutions. The majority of participants believed that illnesses such as evil eye and some skin diseases like tinea do not respond well to modern

medicines compared to herbal therapies. A participant from *Besheda* kebele emphasized that those TMPs who involve divine power help the people not only to cure illnesses but also to protect their environment from drought and adversity and ensure the continued well-being of their cattle and themselves.

The participants, however, believed that TMPs have their own drawbacks. For example, doses of most herbal remedies are not known and those herbal remedies that have bitter taste and unpleasant smell may result in unwanted side effects such as nausea and vomiting. Also healers who practice *Merankal* and *Dunguri Qansa* can make people suffer by killing their cattle, making their family members ill or die if their rivals demand the same.

4.1.2 Key informants

A total of 8 respondents (seven males and one female) who belong to traditional healers of the community were interviewed. The finding of the study indicated that the majority of the healers are males. Although the number of key informants in this survey was small, similar trends were found in previous surveys (Gedif and Hahn, 2002; Tabuti *et al*, 2003; Ragunathan and Solomon, 2009; Kavi *et al*, 2009; Olatokun, 2010; Olatokun and Ajagbe, 2010). In addition to this, the dominancy of males over females in the district was observed during the FGDs. This higher number of male traditional healers than females in traditional healing practice might be associated with the trend observed within the healing practice that does not encourage women to be involved in the practice. The majority of the plants and animals used to cure and heal diseases are found in the forest or bush which is far away from the community. Thus, considering the time and effort required to collect these materials together with other socio-cultural factors such as transfer of knowledge from elders to male member of the family in secret hinder women not to involve strongly and actively in the healing practice (Gedif and Hahn, 2002; Olatokun, 2010, Olatokun and Ajagbe, 2010).

The age of the healers ranges from 33 to 70 years with an average of age of 47. Most of the healers had few years of healing experience. The results of the current survey indicated that the majority of traditional healers were above 40 years old, which is similar to other surveys reported (Gedif and Hahn, 2002; Tabuti *et al*., 2003; Agyare *et al*., 2009; Kavi *et al.*, 2009; Olatokun,

2010). The trend where the decline in the number of healers as one goes down to age groups might be due to lack of interest among youngsters to take part in TM practices. This was also supported by the finding of the FGDs. Apart from this, it appears that formal education has created a situation whereby becoming a traditional healer is no longer attractive (Bahiru, 2005). This has been a threat for the survival of TM in the community as the majority of practitioners are getting old and weak holding them back from practicing in the future (Gedif and Hahn, 2002).

Most of the healers were illiterate, and only three of the healers had received formal education. Similar results were obtained in previous surveys (Addis *et al*., 2002; Gedif and Hahn, 2002) but contradicting findings in other surveys (Agyare *et al*., 2009; Olatokun, 2010; Olatokun and Ajagbe, 2010). The low level of education together with a general lack of information (e.g. libraries, computers and internet facilities) explains why many of them still hold on to TM practices in its "traditional" way (Olatokun, 2010; Olatokun and Ajagbe, 2010).

Sources of knowledge among key informants

The majority of healers claimed that their source of knowledge and skills or powers of healing are obtained from their parents. Two of the healers reported that their source of knowledge and skill of healing are the gift of god (*borjo*). None of the healers said that they obtain their knowledge and skill through formal education in institutions. Nearly all of the participants claimed that transfer of knowledge was mainly through word of mouth. The findings of this study indicated that the main source of their healing knowledge is obtained from family members, which is similar to the finding of previous surveys (Gesseler *et al*., 1995; Addis *et al*., 2002; Gedif and Hahn, 2002; Vandebroek *et al*., 2004; Olatokun, 2010).

Illnesses treated, method of diagnosis and source of medicine

The categories of illnesses treated by traditional medical practitioners varied from common infections to complicated conditions. The most frequently treated illnesses by traditional healers were *zen, ara, bishi burka, lognagena, gebez, chaki* and *guni* (Table 1).

The causes of disease and illness according to healers were natural or human-induced. Natural diseases could be diarrhea, malaria, skin disorders … etc and human-induced illness could be the results of sorcery, spirit disturbances or breaching socio-cultural obligations and taboos, especially with regard to the ancestors.

Table 1. Illnesses and symptoms reported to be treated by traditional healers of the Hamer ethnic group, South Omo Zone, Jan – Feb 2010.

Category	Illness/symptoms
Infectious	*Silito* (tuberculosis), *gebez* (malaria), *zen* (diarrhea), fever, *korokor* (tinea), *ara* (jaundice), *berdate* (intestinal worms), *asti ajim* (toothache), *gulfadhana* (common cold), dysentery, *sal* (cough), (wounds), tonsillitis
Non-infectious	*Lognagena* (blood pressure), *chaki* (evil eye), *guni* (snake bite), asthma, male sexual impotence, muscle pain, pain associated with menstrual cycle, *meta ajim* (migraine), nature spirits , curses, fractures

Those written in italics are local name of the disease.

According to the traditional healers, visual observation and history taking were the two main methods of diagnosis. Spiritualism could also be employed whenever the patient condition is non- natural causes which could not be diagnosed by physical assessment and history taking.

The sources for healing constitute different components of traditional medical practices. The results of the present survey indicated that the majority of healers used plant and animal products to treat illnesses, while two of them used animal products combined with divine power, and only one used divine power to treat illnesses. In addition to these some traditional healers perform minor surgeries.

Mode of service delivery

The present survey indicated that all of the healers practice healing on part time basis, and the majority had healing experience of less than twenty years. In agreement with the present study,

other similar studies indicated that many traditional healers practice on a part time basis but they have experience for a long period of time (Gedif and Hahn, 2002; Tabuti *et al*., 2003; Agyare *et al*., 2009). It has been observed that long experience is needed for TMPs to be effective (Agyare *et al*., 2009).

During practices, nearly all of the traditional healers reported that they had a single assistant except one who said that he had three assistants. Only one healer reported to practice without any assistant. Assistants are mostly healers own sons or male close relatives. Similar results have been reported elsewhere (Vandebroek *et al*., 2004; Kavi *et al*., 2009). In most cases the responsibilities of the assistants were limited to preparing equipment and materials required for treatment of patients. In addition, they help weak clients who are unable to help themselves. In some cases when the healer is too old, they carry out his duties on his instructions.

None of the interviewed healers set costs for their service. They charge their customers based on the customers economic condition and relation to healers. A previous survey carried out in other parts of Ethiopia also shows that healers do not have fixed payment rate for their services (Gedif and Hahn, 2002). In other surveys, it was shown that persons who visit traditional healers are required to engage in specific communally beneficial ways following in ones effort to restore order and balance within self and the community (Tabuti *et. al*, 2003; Washington, 2010).

4.1.3 HH survey

4.1.3.1 Sociodemographic characteristics of respondents

In the HH survey, a total of 1,600 respondents were interviewed. Of these, 976 (61.2%) were males and 621 (38.8%) were females. Large number of the respondents, 1344 (84%) were between 31 to 70 years old. The majority of the respondents, 1376 (84.8%) were illiterate and 244 (15.2%) had attended primary and junior school education (Table 2). On average, a family accommodated five inhabitants. According to the respondents, 935 (58.4%) had low monthly income.

Table 2. Sociodemographic characters of household (HH) respondents of the Hamer ethnic group, South Omo Zone, Jan – Feb 2010.

Variable(s)	Frequency	Percent (%)
Sex		
Male	621	38.8
Female	979	61.2
Total	1,600	100.0
Age		
≤ 20	256	16.0
21-30	544	34.0
31-40	496	31.0
41-50	240	15.0
51-60	47	2.9
61-70	17	1.1
Total	1,600	100.0
Educational status		
Illiterate	1,356	84.8
1-4 Grade	212	13.2
5-8 Grade	32	2.0
Total	1,600	100.0
Family size		
1-3	464	29.0
4-6	640	40.0
7-9	336	21.0
>10	160	10.0
Total	1,600	100.0
Monthly income		
Low	935	58.4
Middle	453	28.3
High	212	13.3
Total	1,600	100.0

Illiterate: member of the community who can read and but not write as well as those who cannot read and write.
Literate: member of the community who can read and write.
Low income: less than five cattle, no goats and hives.
Middle income: five to ten cattle, goats and hives.
High income: more than ten cattle, goats and hives.

4.1.3.2 Perceived illnesses and action taken in the two weeks recall period

In the 8,523 people in the HHs studied, 912 illness episodes were reported in the two weeks recall period with a prevalence rate of 10.7%. Age distribution of individuals with reported illnesses shows that 454 (49.8%) were > 15 years old and 458 (50.2%) were ≤ 15 years old (Table 3).

Table 3. Actions taken against perceived illnesses in two weeks recall period among the Hamer ethnic group, South Omo Zone, Jan - Feb, 2010.

Demographic Characteristics	Action taken N (%)				
	Went to health institutions	Went to traditional healers	Took homemade Remedies	Took no action	Total
Sex					
Male	276 (58.2)	120 (25.3)	54 (11.4)	24 (5.1)	474 (52.0)
Female	210 (49.0)	135 (30.8)	66 (15.1)	27 (6.2)	438 (48.0)
Age					
≤5	168 (55.9)	34 (25.9)	35 (14.2)	10 (4.1)	247 (27.1)
5-15	146 (61.3)	23 (10.9)	4 (1.9)	38 (18.0)	211 (23.1)
15-65	171 (37.9)	196 (43.5)	81 (18.0)	3 (0.7)	451 (49.5)
≥65	1 (33.3)	2 (66.7)	-	-	3 (0.3)
Income status					
Low	279 (61.1)	125 (49.0)	74 (61.7)	37 (72.5)	533 (58.4)
Medium	123 (25.3)	87 (43.1)	39 (32.5)	9 (17.6)	258 (28.3)
High	66 (13.6)	43 (16.0)	7 (5.8)	5 (9.8)	121 (13.3)
Total	486 (53.3)	255 (28.0)	120 (13.2)	51 (5.6)	912 (100)

Illiterate: member of the community who can read and but not write as well as those who cannot read and write.
Literate: member of the community who can read and write.
Low income: less than five cattle, no goats and hives.
Middle income: five to ten cattle, goats and hives.
High income: more than ten cattle, goats and hives.

Diarrhoea 248 (27.2%), fever 229 (25.1%) and abdominal ache 217 (23.8%) were the most common reported illnesses followed by skin diseases 82 (9.0%), eye diseases 52 (5.7%) and evil eye 39 (4.3%).

The survey indicated that the majority of the patients, 861 (94.4%) had taken action. Of these, 486 (53.3%) went to health institution, 255 (27.9%) went to traditional healers and 120 (13.2%) used homemade remedies. Fifty-one patients (5.6%) did not take action in response to their perceived illness symptoms (Table 3). These finding are consistent with other works (Faltie *et al.*, 2009, Zwi *et al.*, 2009; Peng *et al.*, 2010). The reason of not taking action might be associated with "not serious enough" of the perceived illnesses and/or lack of physical access to health care facilities (Zwi *et al.*, 2009; Peng *et al.*, 2010).

The percentage of females who did not take action in response to the perceived illnesses symptoms in the last two weeks recall period were slightly higher than males, 6.2% and 5.1%, respectively. This might be due to lack of access, the burden of work on females to care for other members of the family and economic weakness that a female face in the society.

4.1.3.3 Preference to health care choices

Among the respondents, 1,027 (64.2%) reported that traditional healers are their first choice to visit when any member of their family get sick, while 573 (35.8%) indicated that they prefer to visit modern health institutions when they seek health care.

The percentage of females (68.9%), who indicated to prefer TMPs to health institutions, was slightly higher than males (61.2%) (Table 4). Higher percentage of respondents (44%)claimed to visit TMPs mainly due to lack of physical access to western medicine and health institutions, 23% due to its effectiveness, 11% due to its low cost, and 22% reported that they did not have any other option.

Overall, the study indicates that there was a high prevalence (64.2%) of HH respondents who sought help from TMPs. This is in agreement with other surveys (Ouahidi *et al.*, 2009; Teklehaymanot and Giday, 2010a). This high prevalence of seeking help from TMPs could be associated to the life style of the people. Firstly, the Hamer ethic groups are nomads/pastoralists and therefore move from one place to another following track of their cattle. Secondly, the majority of community members live in poverty and area of poor infrastructure. Thirdly, the cost of traditional medicine is very low compared to modern drugs and this is compounded with the cultural beliefs of the community that only traditional medicine is effective in combating some kind of illnesses such as evil eye (*chaki)*, snake bite (*guni*) and hypertension (*lognagena*). In addition, factors such as lack of information and community members' desire to health services that are readily available, affordable and socially and culturally acceptable play a major role for their choice (Zwi *et al.*, 2009). Hence, TM remain the mainstay in narrowing the gap of their health care needs (Yineger and Yewhalaw, 2007; Ouahidi *et al.*, 2009; Peng *et al.*, 2010;

Teklehaymanot and Giday, 2010a). These results obtained from HH respondents were also in agreement with the findings of FGDs.

4.1.3.4 Factors influencing action taken and preference to health care options

The demographic and socioeconomic status of the respondents with respect to choice of health care options as well as action taken against perceived illnesses is shown Tables 3 and 4. It can be seen that, the percentage of those who took no action decreased from 72.5% to 9.8% among low to high income groups, respectively (Table 3) indicating that economic status of HHs in the study group has significant effect on the action taken against perceived illnesses ($\chi^2 = 11.988$, df = 4, $P < 0.05$). The results also show that the majority of males had taken action. Thus, effect of sex on action taken in response to the perceived illnesses symptoms in the last two weeks recall period was found to be statistically significant ($\chi^2 = 9.677$, df = 2, $P < 0.05$).

Patterns of health service utilization and health care seeking were found to be influenced by socio-economic status, educational status, cultural beliefs and perceptions of the causes of diseases and scope for treating different conditions (Adegoke, 2004; Zwi *et al.*, 2009; Peng e*t al.*, 2010). In this study, females (69%) sought more help from TMPs than males (61.1%) for their health care. These results are in agreement with previously reported survey conducted in Ethiopia (Faltie *et al.*, 2009) but contrasts with the surveys conducted in other countries (Sudharsanam and Rotti, 2007; Bourne, 2009; Peng e*t al.*, 2010). This might be due to the enormous burden on females in the community to look after the family; long distances form health institution and poor infrastructure, low income status and the cultural belief of the community (Abouzahr, 1998; Rani and Bonus, 2003; Zwi *et al.*, 2009).

The effect of age on action taken against perceived illnesses in the last two weeks recall period was found to be significant ($\chi^2 = 170.485$, df = 2, $P < 0.05$). Accordingly, children of less than 15 years were given preference for action taken in response to the perceived illnesses and symptoms in the last two week recall period to those above the age of 15.

In terms of preference to choice of health care options, the percentage of those HH respondents who favoured health institutions in seeking medical care when a family member gets sick rose

from 31.5% to 54.7% from low income respondents to high income respondents. Likewise, those who chose TM as a first line declined from 68.4% to 45.3% in these groups (Table 4). The effect of economic status on the choice of health care options of HH respondents was found to be statistically significant ($\chi^2 = 40.347$, df = 2, $P < 0.05$).

The influence of education on choice of treatment options of HH respondents was statistically significant ($\chi^2 = 7.210$, df = 1, $P < 0.05$). For that reason literates (41.5%) prefer health institution to TM as a choice of health care more than illiterates (34.9%) (Table 3). Thus, the present survey clearly showed that income status and educational status of HH respondents could influence the choice and quality of health care needs and action taken against perceived illnesses. Those with higher economic status and literates sought modern health care services more than those with lower economic status and illiterates ($P < 0.05$). Similar trends have been demonstrated in previous studies (Faltie *et al.*, 2009; Ouahidi *et al.*, 2009; Peng *et al.*; 2010). This appears to be that people with lower socio-economic status might have problems of access to modern health care facilities as they could not afford the cost (Adegoke, 2004) and/or lack of education could also impinge on the awareness of the community members about the ailments and seeking help for health care (Zwi *et al.*, 2009; Peng *et al.*, 2010).

In the study community, percentage of females (31.1%) who sought help from health institutions was lower than males (38.8%) (Table 3), and the difference being statistically significant ($\chi^2 = 9.893$, df = 1, $P < 0.05$).

Table 4. Choices of healthcare options with respect to sociodemographic characteristics of household (HH) respondents among members of the Hamer ethnic group, South Omo Zone, Jan – Feb, 2010

Variable	Choice of health care N (%)			Total
	Health institution	Traditional healers	Homemade remedies	
Sex				
Male	380 (38.8)	434 (44.3)	165 (16.9)	979 (100)
Female	193(31.1)	140 (22.5)	288 (46.4)	621 (100)
Age				
≤ 20	91 (35.5)	148(57.8)	17 (6.7)	256(100)
21-30	245(45.0)	213(39.2)	86 (15.8)	544(100)
31-40	174 (35.1)	209 (42.1)	113 (22.8)	496(100)
41-50	96 (40.0)	103 (42.9)	41 (17.1)	240(100)
51-60	9 (19.1)	22 (46.8)	16(34.1)	47 (100)
≥61	1 (5.9)	7 (41.2)	9 (52.9)	17 (100)
Educational Status				
Illiterate	480 (34.9)	505(65.1)	391(28.4)	1,376(100)
1-4 Grade	74 (38.5)	61(31.8)	57(29.7)	192 100)
5-8 Grade	19(59.4)	8(25.0)	5(15.6)	32(100)
Family Size				
1-3	190(41)	198 (42.7)	76 (16.4)	464 (100)
4-6	207 (32.3)	243 (38.0)	190(29.7)	640 (100)
7-9	133(39.6)	76 (22.6)	127(37.8)	336 (100)
≥10	43 (26.9)	57 (35.6)	60(37.5)	160 (100)
Monthly Income				
Low	295 (31.6)	402 (42.9)	238 (25.5)	935(100)
Middle	162 (35.8)	101 (22.3)	190 (41.9)	453 (100)
High	116 (54.7)	71 (33.5)	25 (11.8)	212 (100)
Total	573 (35.8)	574 (35.9)	453 (28.3)	1,600 (100)

Illiterate: member of the community who can read and but not write as well as those who cannot read and write.
Literate: member of the community who can read and write.
Low income: less than five cattle, no goats and hives.
Middle income: five to ten cattle, goats and hives.
High income: more than ten cattle, goats and hives.

4.1.4 Plants reported to be in use

4.1.4.1 Medicinal plant species

A total of 60 different medicinal plants were reported [34 by HH respondent, 14 by traditional healers/key informants and 12 by both (Table 8)]. Fifty-one (85%) medicinal plants were fully identified, 3 (5%) were identified at genius level and 6 (10%) were not identified.

The identified plants belonged to 27 families. Among the families, Fabaceae is the most commonly reported family which comprised seven species followed by Solonaceae (six), Combertaceae and Capparidaceae (each three) (Table 8). Of the fully identified plants, more than half (52.9%) were indigenous to Ethiopia.

Among the collected plants, 68.9% were from forests or wild sources and 13.1% were cultivated or garden plants, and 18% of the plants were obtained from both forests and gardens. Large number of plants which were sources of herbal drugs were collected from the wild, a finding which is similar with the findings of other surveys conducted in Ethiopia (Flatie *et al.,* 2009; Mesfin *et al.*, 2009; Yineger and Yewhalaw, 2007; Wondimu *et al*., 2007), Kenya (Nanyingi *et al.,* 2008), Ghana (Agyar *et al.*, 2009), Brazil (Coelho-Ferreira, 2009), Serbia (Jari'c *et al*., 2007), and Malaysia (Samuel *et al*., 2010). However, in one survey conducted in Northern Ethiopia (Yirga, 2010), the majority of the medicinal plants are collected from gardens through cultivation. In general, collection of medicinal plants from forests indicates that there is little practice of keeping medicinal plants in cultivated areas or home gardens. In the context of the current survey, the reason could be associated with the life style of the community, who are by and large pastoralists. This together with poor protection of wild medicinal plant due to the ongoing mass destruction of wild vegetation for different purposes by the community and, overgrazing, is endangering medicinal plants and discourages the practice of traditional health care (Wondimu *et al*., 2007; Yineger and Yewhalaw, 2007; Agyar *et al.*, 2009;).

Most of the collected plants have been reported in the literature for their use in the treatment of various diseases. The bioactive constituents of some of the plants have also been reported, indicative of the scientific reliability of the Hamer community's indigenous knowledge of herbal

medicines (Namsa *et al.*, 2009). *Albizia anthelmentica* (A. Rich) Brogn. (Dhita), *Aloe ottalensis* (Walkanti), *Carissa spinarum* L (Akemba), *Datura metel* L (Guni Dhesha), *Maytenus senegalensis* (Lam) Excell (Sewute) and *Moringa stenopetala* (Bak.f.) Cuf (Kelanki) were among the top ten widely used plants (Table 7).

4.1.4.2 Illnesses treated by medicinal plants

Of the reported medicinal plants, the majority (85.2%) were used for treating human diseases, 6.6% were used for veterinary diseases and 8.2% for both human and veterinary diseases (Table 5). Nineteen medicinal plant species are used for skin problems, fifteen for abdominal and gastrointestinal problems (GIT) and five for jaundice (*ara*). In some cases, a single medicinal plant species is used for more than one disease. For example, *Cadaba farinosa* Forssk., *Carissa spinarum* L., *Hypoestes forskaoli* (Vahl) R.Br. and *Moringa stenopetala* (Bak. f) Cuf. are used for the treatment of more than one diseases. The use of a single medicinal plant for different disease has been reported previously (Wondimu *et al*, 2007).

More than 50% of the collected medicinal plants have been reported to be used for the treatment of diseases associated with skin/dermatological and abdominal/GIT conditions. This might be due to the high prevalence of the above diseases in the studied area. Wide usages of medicinal plants according to the disease prevalence have been reported previously (Wondimu *et al*., 2007; Teklehaymanot and Giday, 2010a).

4.1.4.3 Plants parts used

According to traditional healers and HH respondents, different parts of the plants are used. The most common plant parts used for the preparation of herbal remedies are leaves (38.0%), roots (26.6%) and barks (13.9%) (Figure 3, Table 8). These are also reported in previous surveys conducted in Ethiopia (Gedif and Hans, 2002; Giday *et al*., 2003; Wondimu *et al*., 2007; Giday *et al.*, 2009; Karunamoorthi *et al*., 2009), Kenya (Nanyingi *et al.*, 2008), Ghana (Agyar *et al.*, 2009), India (Namsa *et al.*, 2009; Rajakumar and Shivanna, 2009), Brazil (Coelho-Ferreira, 2009).

Table 5. Commonly treated illnesses with herbal remedies in household (HH) and by traditional healers among the Hamer ethnic group, Jan - Feb, 2010.

Category	Indications	Frequency
Skin/dermatological problems	Skin allergies (143), wounds (154), snake/scorpion bites (419), dandruffs (85), eczema (73), burns (112) , tumors of skin/abscess (98), fungal skin infection (44), tinea capitis (162), skin rash (itching) (41)	1,087
Abdominal and GIT problems	Diarrhoea (178), abdominal colic (267), abdominal discomfort (141)	586
Liver diseases	Jaundice (426)	426
Respiratory tract problems	Common cold (218), dry cough (123)	341
Parasitic infections	Malaria (518), intestinal helments (432)	950
ENT (Eye, nose and throat)	Eye diseases (274), toothache (463), tonsillitis (116)	853
Cardiovascular problems	Hypertension (27)	27
Others	Evil eye (303), muscle and joint pain (121), headache (118), loss of appetite (1), dysmenorrhoea (1), irregular menses(1)	545

The main reasons for the most common use of leaves and roots could be due to the fact that they act as reservoirs for exudates/secretions which are believed to contain toxins, some of which may have medicinal value to the human body, and also due to the relative ease of finding these plant parts (Cox and Balick, 1994; Giday *et al.*, 2009). The popularity of roots as a source of herbal drugs has serious consequences from both ecological point of view and the survival of the medicinal plant species (Mesfin *et al.*, 2009). Therefore, due attention must be given for this problem before the situation gets worse.

4.1.4.4 Preparation of the remedies: methods, ingredients and additives

Traditional healers and HH respondents reported that several homemade remedies are prepared by various methods. The most widely used methods include maceration, decoction and infusion

(Tables 8 -10). The majority of the preparations are simple recipes (using only one plant as ingredient), while one of the preparation contained mixture of plants. The use of simple recipes has been reported in Brazil (Coelho-Ferreira, 2009) and India (Namsa *et al.*, 2009) while Yinger and Yewhalaw (2007) came across the use of mixture of plants for the preparation of herbal remedies. The combination of more than plant in herbal preparation could increase the potency mainly due to synergistic or additive effect. Whilst majority of the remedies were prepared from freshly collected plant parts, dried parts are used to prepare very few plant drugs, a finding that was consistent with other works conducted in Ethiopia (Yineger, and Yewhalaw, 2007; Karunamoorthi *et al*., 2009), India (Namsa *et al.*, 2009) and Brazil (Coelho-Ferreira, 2009). The possible justification for the use of fresh plant material could be due to the simplicity of the method which does not require sophisticated equipments.

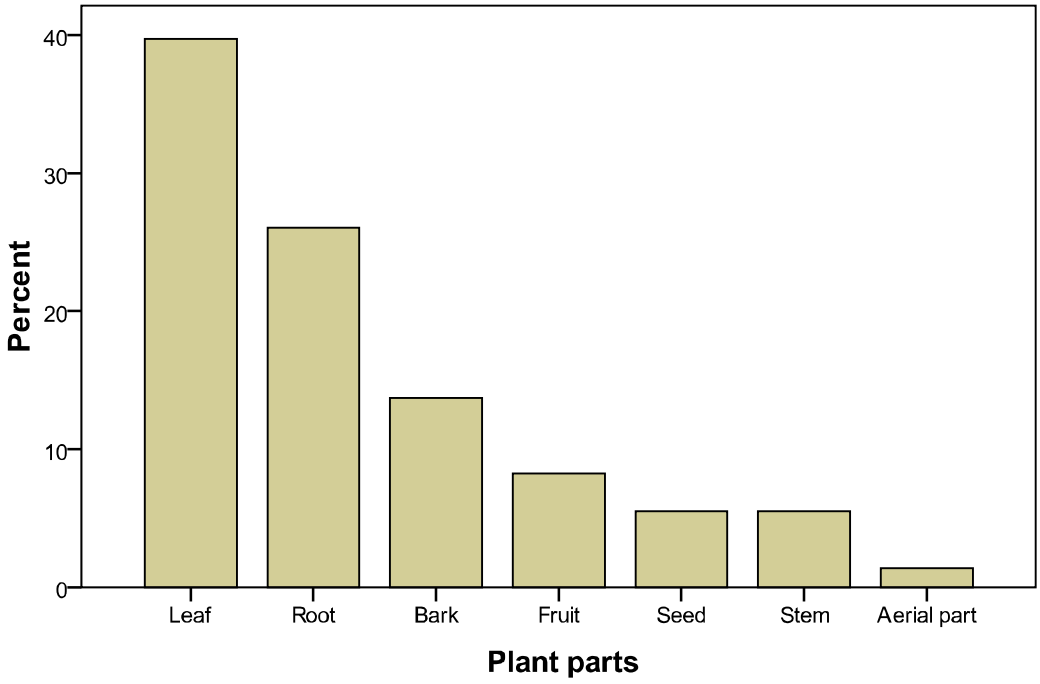


Figure 3. Plant parts used in the preparation of herbal remedies among the Hamer ethnic group, Jan - Feb., 2010.

Water like in many other surveys conducted in various parts of Ethiopia (Giday *et al*., 2003; Teklehaymanot and Giday, 2010a), Brazil (Coelho-Ferreira, 2009) and India (Namsa *et al.*,

2009), was shown to be the main solvent employed for the preparation of herbal remedies. This may be due to its relative availability, safety and relative accessibility.

Additives like honey, milk and meat were also used in preparing herbal remedies. These animal products are claimed to improve palatability mainly by masking unpleasant taste and odor. The use of honey as an additive has been reported among the Kara and Kwego communities in lower Omo river valley, in Southern Ethiopia (Teklehaymanot and Giday, 2010a). Remedies prepared form fresh plant materials are considered to be safe from the points of view of avoiding contaminations and deterioration of plant constituents.

4.1.4.5 Route of administration, safety and side effects of medicinal plants

The vast majority of the recipes were taken orally (54.9%), followed by topical (29.6%), inhalation (11.3%) and instillation into the eye (4.2%) (Figure 4). Oral route of administration of herbal drugs is the most widely used technique which has been reported elsewhere (Giday *et al*., 2003; Yineger and Yewhalaw, 2007; Mesfin *et al*., 2009; Teklehaymanot and Giday, 2010a), Kenya (Nanyingi *et al.*, 2008), India (Rajakumar and Shivanna, 2009) and Brazil (Coelho-Ferreira, 2009). The preference of oral route to administration of herbal remedies could be ease of application.

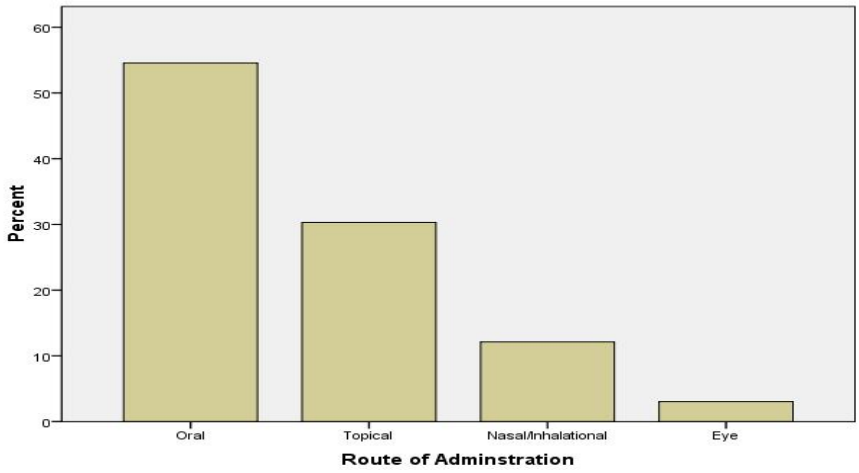


Figure 4. Routes of administration of herbal remedies among the Hamer ethnic group, Jan - Feb., 2010.

According to the current survey, most of the preparations were single dose preparations, but the dosage was poorly established. This has been described by different surveys conducted in other parts of the country (Giday *et al*., 2003; Faltie *et al*., 2009; Mesfin *et al*., 2009; Teklehaymanot and Giday, 2010a). Although the major factors that determine the amount to be given to the patient were reported to be age, physical fitness, stage of illness, pregnancy and presence or absence of any disease other than the disease to be treated, the lack of precision in dose is the major concern in herbal medicine.

Whilst HH respondents reported that medicinal plants can be collected at any time of the day throughout a year, traditional healers asserted that collection requires special day, time and season of collection. This is an indication that traditional healers are well aware of the existence of variation in active plant constituents (Cox and Balick, 1994; Tiabuti *et al*., 2003; Ndenecho, 2009).

Both HH respondents and traditional healers reported that vomiting, headache, diarrhea, abdominal colic and irritation are the most common side effects of herbal preparations (Table 6). For most of the preparations, there were no special and specific precautions taken through the course of treatment. Traditional healers are aware of the side effects of some of the herbal remedies and their antidotes, while the majority of HH respondents believed that herbal remedies are safe. The causes of the side effects might be associated with erroneous collection with regard to time and parts of medicinal plants, the poor hygienic condition in the overall process of preparing herbal remedies, and/or herbal remedies contain a cocktail of constituents/ phytochemicals in which their pharmacology is not understood clearly and might cause such untoward consequences (Barnes, 2003; WHO, 2004).

According to traditional healers, precautions are taken during the preparation of a few herbal drugs containing *Albizia anthelminitica* (A.Rich.) Brogn, *Barleria eranthemoides* R. Br., and *Chasmanthera dependens* Hoscht. For example, when putting the leaves of *C. dependens*, care should be taken not to apply the drug on the healthy teeth. Similarly, taking the bark of *A.*

anthelmenitica without mixing with porridge of sorghum is strictly forbidden. Some medicinal plants have antidotes in case of toxicity or severe side effects (Table 6).

Table 6. Side effects of medicinal plants and their antidotes reported by household (HH) respondents and traditional healers among the Hamer ethnic group, Jan - Feb, 2010 GC.

Plant name	Unwanted effect	Antidote
Aloe otallensis Baker	Vomiting, diarrhoea	Honey
Barleria eranthemoides R.Br.	Vomiting, headache	
Cadaba farinosa Forssk.	Headache	*Shoforo*
Canthium pseudosetiflorum Bridson	Vomiting	
Cissampelos pariera L.	Itching irritation/inflammation	Juice of *Sanseveria ehrenbergii* Schweinnfurth ex Baker
Cyperus distans L.f.	Nausea and vomiting	
Datura metel L	Difficulty of vision, dizziness, itching,	*Shoforo*, butter, tallow, meat soup
Datura Stramonium L.	Irritation	Butter
Euphorbia tirucalli L	Itching, irritation/burning sensation	
Gurdo/ Ardo	Irritation	
Hypoestes forskaoli (Vahl) R.Br	Headache, heartburn nausea/vomiting, nightmare	*Shoforo*
Maytenus senegalensis (Lam.) Excell	Vomiting	
Ormocarpum trichocapum (Taub.) Engl.	Itching	Butter
Plectaranthus sp.	Vomiting, diarrhoea, abdominal colic	Goat meat soup
Sansevieria ehrenbergii Schwiennfurth ex Baker	Abdominal colic	*Fersi*
Solanum incanum L	Irritation, diarrhoea, heart burn, abdominal discomfort	Honey, *Fersi*
Withania somnifera (L) Dunal	Vomiting, abdominal discomfort	

Shoforo: infusion made from coffee peel
Fersi: local drink made from sorghum powder

Table 7. Most commonly reported medicinal plants by household (HH) respondents and traditional healers among the Hamer ethnic group, Jan - Feb, 2010 GC

Plant species	Indications	No. of different use/s	No. of informants	Percentage (%)
Albizia anthelmentica (A. Rich) Brogn.	Human intestinal parasites (318)	1	318	19.9
Aloe otallensis Baker	Malaria (186), wound healing (82)	2	286	17.9
Amaranthus hybridus L	Diarhhoea (152)	1	152	9.5
Carissa spinarum L	Malaria (257), jaundice (95)	2	352	22.0
Datura metel L		1	243	15.2
Lagenaria siceraria (Mol) Standl.	Snake/scorpion bite (243)	1	372	23.3
Maytenus senegalensis (Lam) Excell	Human intestinal parasites (372)	1	217	13.6
Moringa stenopetala (Bak.f.) Cuf	Jaundice (217)	3	416	26.0
Salvadora persica L	Abdominal colic(146), malaria (261), blood pressure (9)	1	228	14.3
Solanum incanum L	Toothache/ jinjiva bleeding (228) Wound healing (67), abdominal colic (48), tooth ache (64)	3	179	11.2

Brief description of the top ten widely used medicinal plants used by the Hamer ethnic group

***Albizia anthelmintica* (A. Rich) Brown.**

Bark of *A. anthelmintica* locally called 'Dhita' is traditionally used by the Hamer people for treatment of intestinal helminthes. It has also used against malaria, antihelminthic, for stomachache and backache, and to induce vomiting and diarrhoea. It is used to induce bile release from the gall bladder in Kenya **(**Kiringe, 2006) to control helminthes parasites in human

and animal medicine in Sudan (Koko *et al*., 2000) and Ethiopia (Desta, 1995). Different pharmacological evaluations confirmed the anthelmintic activity of the plant (Koko *et al*., 2000 Gathuma *et al*., 2004; Grade *et al*., 2007; Rochfort *et al*., 2008). In addition to its anthlemintic activity, the plant also possesses antifungal effect (Runyoro *et al*., 2006). Phytochemical investigations of the plant indicated that it contains sesqiterepenes, kosotoxins (Rochfort *et al*., 2008) and saponins (Kareru *et al*., 2008).

Figure 5. Image of flowers of *Albizia anthelmintica* (A. Rich) Brown.

***Amaranthus hybridus* L.**

A. hybridus L, popularly called 'Amaranth or pigweed', traditionally used by the Hamer people for treatment of diarrhoea, is an annual herbaceous plant that belongs to the family Amaranthaceae (Akubugwo *et al*., 2008). *A. hybridus* is used to cure urinary tract infection, kidney and stomach ailments in Kenya (Cyrus *et al*., 2008). In addition, the leaf is used as source of food in Kenya and Western African countries (Akubugwo *et al*., 2008; Maiyo *et al*., 2010). Preliminary phytochemical investigation of the plant confirmed the presence of alkaloids, flavonoids, saponins, tannins, phenols, terpenoids, cardiac glycosides, steroids, hydrocyanic acid, phytic acid and traces of elements and various amino acids (Akubugwo *et al*., 2008; Maiyo *et al*., 2010). Pharmacological investigation of the plant proved that it has antibacterial activity (Cyrus *et al*., 2008; Dahiya *et al*., 2010; Maiyo *et al*., 2010), reduce toxic effects of some heavy metals (Tawari-Fufeyin *et al.*, 2008), ctytotoxic effect (Cyrus *et al*., 2008), alpha-amylase inhibitory

effect (Odhav *et al*., 2010) and i*n vitro* 5-lipoxygenase inhibition activity (Akula and Odhav, 2008).

Figure 6. Image of *Amaranthus hybridus* L.

***Carissa spinarum* L.**

C. spinarum L. (Apocynaceae) is a small spiny evergreen shrub of tropical deciduous forest (Mishra and Gupta, 2005). Traditionally, root of the plant is used by the Hamer community for the treatment of malaria and jaundice. Ethnopharmacological and ethnobotanical surveys revealed that the leaves and root of the plant are used for the treatment of various health problems including its leaf for cancer and snake bite (Ragunathan and Solomon, 2009), its root as antihelmentic (Harwansh *et al.*, 2010), purgative and to treat animal wounds infested with worms (Teklehaymanot and Giday, 2007). *C. spinarum* produce edible fruits (Teklehaymanot and Giday, 2007). Preliminary phytochemical screening of the different extracts of *C. spinarum* revealed that it contains terpenoids, flavonoids, alkaloids, tannins, saponins, steroids, sesquiterpenes of eudesmane type and several cardiac glycosides (Harwansh *et al.*, 2010; Hegde and Joshi, 2010b). It has also been reported that *C. spinarum* leaves contain urosolic acid and naringin; the root contains caffeic acid, and a germacrane derivative, carenone has been isolated from stem (Jagdeeshwar, 2005). Pharmacological studies revealed that the stem extracts of *C. spinarum* possess antioxidant, cardiotonic, hepatoprotective and antipyretic activities (Hegde and Joshi, 2010a; Hegde and Joshi, 2010b).

Figure 7. Image of the fruit of *Carissa spinarum* L.

***Datura metel* L.**

D. metel L. also known as datura plant is an annual or biennial herb belonging to the family Solanaceae (Kutama *et al.*, 2010). Its leaves are used for treating snake bite by the Hamer people. It is also reported to be used for the treatment of fever with catarrh, cerebral complications, diarrhea, skin diseases and animal bites. Its use as antiseptic, antihelmenthic, against herpetic diseases, and for healing potential on burn wounds have been reported (Priya *et al*., 2002). In addition, its leaves and roots are used for smoking to relieve asthma and has spasmodic properties (Tantivatana *et al*., 1978). Apart from these, *D. metel* has ethnoveternary use in treating rabies (Soikia and Borthakur, 2010). Preliminary phytochemical investigation of the plant showed that it contains tannins and alkaloids (Kutama *et al.*, 2010), phlobotannins, cardiac glycosides and flavonoids (Wannang *et al.*, 2009) and steroids (withametelin) (Singh *et al.*, 2001). *D. metel* is known to contain 36 tropane alkaloids and the main ones being hyoscyamine and scopolamine (Tantivatana *et al.*, 1978). Pharmacological evaluation of the plant indicated that it has antibacterial activity (Gnanamani *et al*., 2003; Okwu and Igara, 2009), antifungal (Singh *et al.*, 2001; Kagale *et al.*, 2004; Shafique and Shafique, 2008; Khan and Nasreen, 2010), herbicidal (Javaid *et al*., 2008) and hallucinogenic effects (Kutama *et al.*, 2010).


Figure 8. Image of flowers and fruit of *Datura metel* L.

***Lagenaria siceraria* (Mol) Standl.**

L. siceraria (Mol) Standl is locally called guci and commonly known as Bottle Gourd is used for the treatment of jaundice by the Hamer people. The name of the genus is derived from *Lagena*, meaning bottle. In the older literature it is often referred to as *Lagenaria vulgaris* or *Lagenaria leucatntha* (Shan *et al*., 2010). In different parts of the world it is used as a vegetable and good source of vitamin B and fair source of vitamin C (Deshpande *et al*., 2008). Traditionally, it used as vermifuge, purgative, diuretic and anti-inflammatory agent and also recommended for increasing lactation in lactating mother. It is reported to possess antihepatotoxic, antiulcer, cardiotonic and aphrodisiac properties and is a general tonic (Deshpande *et al*., 2007; Deshpande *et al*., 2008; Shan *et al*., 2010). In addition, its leaves are taken as emetic, anti-jaundice, to protect baldness, and applied on head for headache (Shan *et al*., 2010). Phytochemical investigation of the different parts of the plant indicated that it contains different primary and secondary metabolites. Analysis of the edible portion of the fruits showed the presence of protein, fat, carbohydrates, mineral matter, calcium, and phosphorus. Other mineral elements reported to be present are iron, sodium, potassium and iodine (Kubde *et al*., 2010; Shah and Seth, 2010). The fruits have been reported to contain cucurbitacin B, D, G and H, which occur as aglycones. The leaves contain cucurbitacin B, while cucurbitacins B, D and E have been reported form the roots (Kubde *et al*., 2010; Ghule *et al*., 2006). Further phytochemical investigation of the fruit revealed the presence of fucosterol and campesterol in the petroleum ether fractions (Kubde *et al*., 2010). The falvonoids that occur in *L. siceraria* were found to be flavone C glycosides (Ghule *et al*., 2007; Kubde *et al*., 2010). In addition, four D:C-friedoleanane-type

triterpenes, namely 3β-O-(E)-feruloyl-D:Cfriedooleana-7,9(11)-dien-29-ol, 3β-O-(E)-coumaroyl-D:C friedooleana-7,9(11)-dien-29-ol,3β-O-(E)-coumaroyl-D:Cfriedooleana-7,9(11)-dien-29-oic acid, and methyl 2β ,3β - dihydroxy-D:C-friedoolean-8-en-29-oate have been isolated from stem (Chen *et al*., 2008). The seeds of *L. siceraria* contain saponin (Ghule *et al*., 2007; Kubde *et al*., 2010).

Pharmacological evaluation of the fruit extract of *L. siceraria* showed that they have hepatoprotective, antioxidant, antihyperglycemic, immunomodulatory, antihyperlipidemic, cardiotonic and diuretic activities (Ghule *et al*., 2007; Deshpande *et al*., 2008; Kubde *et al*., 2010; Kumar *et al*., 2010). CNS activity of the seeds has also been reported (Pawar *et al*., 2010).

Figure 9. Photograph of the leaves and flower of *Lagenaria siceraria* (Mol) Standl.

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***Maytenus senegalensis* (Lam.) Exell**

M. senegalensis (Lam.) Exell locally called Ara Desha and traditionally used for treatment of jaundice by the Hamer people, is one of the two African shrubs or trees commonly known as spike thorns. It belongs to the family Celastraceae (Sosa *et al*., 2007; Da Silva *et al.,* 2010). Ethnobotanical surveys indicate that in Mozambique the leaves, stems and roots of the plant are used by traditional healers to treat dysentery, snake bites, wounds and respiratory diseases (Da Silva *et al.,* 2010). In Tanzania, its barks and roots are used for the management of HIV/AIDS related opportunistic infections such as herpes simplex, herpes zoster, oral candidiasis, skin rashes and tuberculosis (Kisangau *et al.,* 2007). In Central Kenya, the whole tree is used in the

management of ear, nose and throat diseases (Jorge and Busman, 2006). In Southern Ethiopia, it is used for the management of epilepsy and febrile illnesses (Mesfin *et al*., 2009). In lower Omo rift valley, Ethiopia, the Kara and Kwego communities use the leaves as a source of food (Teklehaymanot and Giday, 2010b).

Phytochemical screening of the various parts of *M. senegalensis* revealed that the plant contains alkaloids, alkanes and alkanols, terpenes, steroids and phenolic compounds. Four tannins have been isolated from stem-bark of *M. senegalensis* (Hussein *et al*., 1999; Muregi *et al*., 2007). Matu *et al*. (2003) have reported the presence of the triterpenes β-amyrin, lupenone, pristimerin and β-sitosterol in the roots. Similarly, maytenoic acid was identified in the root bark of the plant (Sosa *et al*., 2007).

Pharmacological evaluation of the *M. senegalensis* proved that the plant possesses anti-inflammatory effects (Sosa *et al*., 2007; Da silva *et al.*, 2010), growth inhibitory effects on ß-lactamase producing bacteria (Mbatchou and Adoum, 2010) and antiplasmodial activity (El-Tahir *et al*., 1999).

***Moringa stenopetala* (Bak. f) Cuff.**

M. stenopetala is locally known as 'Kelanki' and 'Haleko'. It is commonly called Cabbage tree and belongs to the family Moringaceae. The plant is native to East Africa mainly Ethiopia, Kenya and Somalia (Jhan, 1999). The plant is used for the treatment of malaria, hypertension and abdominal colic by the Hamer people. In Ethiopia, the Kara and Kwego communities use the plant as a source of food (Teklehymanot and Giday, 2010b). In Turkana district of Kenya, the plant is widely used for the treatment of both human and veterinary diseases (Stave *et al*., 2007). Furthermore, the bark extract is used for HIV/AIDS related diseases in Katima Mulilo, Namibia (Chinsembu and Hedimbi, 2010) and to treat vomiting in Ethiopia (Mesfin *et al*., 2009).

Phytochemical investigation of *M. stenopetala* seed showed the presence of glycoside (rutin, 4-(4'-O-acetyl-L-rhamnosyloxy)-benzylisothiocyanate and 4-(4'-O-acetyl-L-rhamnosyloxy)-benzaldehyde (Asres, 1995) and glucosinolate 4-(α-l-rhamnopyranosyloxy)-benzylglucosinolate

in large amount. The leaves also contain 4-(α-l-rhamnopyranosyloxy)-benzylglucosinolate, three monoacetyl isomers of this glucosinolate, 3-O-rhamnoglucoside (rutin) and 5-caffeoylquinic acid (Asres 1995; Bennett *et al*., 2003). Bio-guided fractionation of seeds extracts *M. stenopetala* resulted in a myrosinase hydrolysis product, 5,5-dimethyloxazolidine-2-thione, which was formed from the glucosinolate glucoconringiin (Mekonnen and Drager, 2003)

Pharmacological evaluation of *M. stenopetala* demonstrated that the plant has hypoglycemic effect (Asres 1993; Makonnen *et al*., 1997), oxytocic activity (Mekonnen, 1999), cytotoxic effect (Mekonnen *et al*., 2005) and *in vitro* antitrypanosomal activity (Mekonnen *et al*., 1999). Besides, investigations on the seeds confirmed the traditional water purifying capacity of plant (Göttsch, 1992; Mataka *et al*., 2006; Sajidu *et al*., 2006; Mataka *et al*., 2010).

Figure 10 Photograph of leaves and fruits of *Moringa stenoptala* (Bak. f) Cuff.

***Salvadora persica* L.**

S. persica L. locally called Kerja and commonly called Miswak or Toothbrush is used for the treatment of gum bleeding by the Hamer people. It is one of the most popular medicinal plants in the Hamer woreda. It is a small tree or shrub which belongs to the family Salvadoraceae (Sher *et al*., 2010). The traditional medicinal uses of *S. persica* has been known since the Babylonians, 7000 years ago as antimicrobial toothbrush stick for oral hygiene and to treat inflammation of the gum (Al-Sabawi *et al*., 2007; Ismail *et al*., 2010). It is also commonly used in the treatment of abscess and wounds (Marawat *et al*., 2009).

Phytochemical investigations of various parts of the plant parts revealed the presence of alkaloids (salvadorine), cardiac glycosides, flavonoids (quercetin and kaempferol), terpenoids,

essential oils and sterols (Ma'ayergl *et al*., 1984; Abdillahi *et al*., 2010; Mariita *et al*., 2010). Four benzylamides, namely butanediamide, N^1, N^4-bis(phenylmethyl)-2(*S*)-hydroxy-butanediamide, *N*-benzyl-2-phenylacetamide, *N*-benzylbenzamide and benzyl urea have been repoted from the stem of *S. persica* (Khalil, 2006). In addition, the root has been reported to contain a urea derivative called salvadourea (Al-Quran, 2008).

Figure 11. Image of *Salvadora pressica* L.

Pharmacological evaluation of the plant revealed that it possesses antimicrobial (Abd El Rahman *et al*., 2002; Al-Ali and Al-Lafi, 2003; Al-Sabawi *et al*., 2007; Noumi *et al*., 2010), anti-hypercholesterolemic (Ardakani *et al*., 2009) and antitubercular (Mariita *et al*., 2010). It has been reported to have buffering capacity of the saliva (El-Bagieh, 1991).

***Solanum incanum* L.**

S. incanum locally called Gerante is used for the treatment of abdominal colic, wound healing and toothache by the Hamer community. It belongs to the family Solonaceae. It is used as antivenom in Kenya (Owuor and Kisangau, 2006), in the management of fungal infections in Tanzania (Moshi *et al.*, 2007) and as cough suppressant in Konta, Southern Ethiopia (Bekalo *et al.*, 2009).

Pharmacological investigation of the plant revealed that it has antibiotic (Beaman- Mbaya and Muhammed, 1976), antihyperglycemic (Okolie *et al.*, 2010), spasmolytic (Assefa *et al.*, 2006) and antifungal activities (Guiama *et al.*, 2010). The plant also possesses antinociceptive and antipyretic effects (Mwonjoria *et al.*, 2011).

Phytochemical investigation of the fresh ripe fruit of the plant led to the isolation of the biologically active glycosidal alkaloids solasonine and solamargine (Fukuhara and Iubo, 1991**)**, and incanumine (Lin *et al*, 1990). Also saponin and tannins, flavonoids and chlorgenic acid (Lin *et al*., 2000) were isolated from different parts of the plant.

Figure 12. Photo of fruit of *Solanum incanum* L.

Table 8. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informant	Part(s) used	Medicinal indication(s)	Method of preparation and use
H043	Sewute	*Acacia tortilis* (Forisk.) Hyne	Fabaceae	HHs	Leaf	Goat intestinal parasite	Fresh leaves are fed to goats
H003	Gebez Dhesha	*Adenium obesum* (Forssk.) Roem. & Schult [I]	Apocynaceae	Both	Root	Abdominal colic	Roots are chewed and swallowed.
						Evil eye	Roots are chopped, boiled in water, allow to cool and drunk.
H009	Dhita	*Albizia anthelmintica* (A.Rich.) Brogn.	Fabaceae	HHs	Bark	Intestinal parasite	Inside of the fresh bark cut, boiled with water, filtered, mixed with sorghum powder to make porridge and fed.
H002	Welqante	*Aloe otallensis* Baker [I]	Aloaceae	Both	Exudate	Malaria	Exudate from fresh leaves is collected, mixed with honey and milk, and drunk.
						Wound healing	Exudate from fresh leaves is applied on the broken skin/wound
H053	Zen dhesha	*Amaranthus hybridus* L.	Amaranthaceae	KI	Seed	Diarrhoea	Seeds are powdered, cooked in water and drunk with honey
H045	Ekumangenta	*Amaranthus spinosus* L.	Amaranthaceae	KI	Root	Toothache	Roots are crushed and kept in mouth for a while

[I] stands for indegeneous Ethiopian plant

Table 9. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H025	Dhumuko	*Balanites aegyptiaca* (L) Del. [I]	Balanitaceae	HHs	Bark	Hypertension	Inside of the bark is peeled off, infusion is made with water, filtered and drunk.
H022	Chaki Dhesha	*Barleria eranthemoides* R.Br.	Acanthaceae	HHs	Leaf	Evil eye	Leaves are chopped, boiled with water, filtered and drunk.
H044	Alela	*Boswellia neglecta* S. Moore [I]	Burseraceae	HHs	Exudate	Evil eye	The dried resin is burned and the smoke inhaled.
H024	Dhela	*Cadaba farinosa* Forssk. [I]	Capparidaceae	KI	Root	Hypertension	Roots are chopped, boiled with meat soup and drunk.
						Malaria	Roots are chopped, boiled with meat soup and drunk.
H030	Menzo	*Cadaba mirabilis* Gilg.	Capparidaceae	Both	Leaf	Cattle disease	Fresh leaves are crushed and juice applied into the affected eye.
H032	Medhel	*Canthium pseudosetiflorum* Bridson	Rubiaceae	HHs	Leaf	Malaria	Leaves are ground, macerated with water, filtered and drunk.
H016	Akemba	*Carissa spinarum* L	Apocynaceae	Both	Root	Malaria	Fresh roots are crushed, infusion prepared in water, filtered, and drunk

[I] stands for indegeneous Ethiopian plants

Table 10. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H041	Choq	*Chasmanthera dependens* Hoscht.	Menispermaceae	KI	Leaf	Tooth ache	Fresh leaves are chopped, smashed and placed on the affected tooth.
H023	Dhare/Fire	*Cissampelos pariera* L.	Menispermaceae	HHs	Leaf	Wound healing	Fresh leaves are ground, the juice squeezed on the wound.
H034	Zegurma	*Combretum aculeatum* Vent [I]	Combertaceae	HHs	Leaf	Abdominal colic	Fresh leaves are chewed, juice are sipped and swallowed.
H054	Wefenkur	*Commelina benghalensis* L	Commelainceae	HHs	Exudate	Skin problem	Fresh tuber is broken and the jelly juice from the tuber applied on the affected area.
H035	Bote	*Cucurbita pepo* L.	Curcurbitaceae	KI	Seed	Intestinal parasite	Dried seed are roasted, chewed and swallowed.
H004	Gebez dhesha	*Cyperus distans* L.f.	Cyperaceae	KI	Root/ Bark	Malaria	Roots or mixed with the inner bark or both are chopped, macerated in water, mixed with milk and drunk.
H055	Busente	*Cyperus alternifolius* L [I]	Cyperaceae	HHs	Root	Abdominal colic	The root is chopped, chewed, sipped and the extract swallowed

[I] stands for indegeneous Ethiopian plants

Table 11. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H007	Guni Dhesha	*Datura metel* L	Solonaceae	Both	Leaf	Snake bite	Fresh leaves are squashed and juice applied on the affected area.
H042	Meta dhesha	*Datura stramonium* L.	Solanaceae	HHs	Leaf	Tinea	Fresh leaves are chopped, squashed, and juice applied on scalp.
H027	Kera	*Euphorbia* sp.	Euphorbaceae	HHs	Bark	Hypertension	Fresh bark is chopped, infusion made, mixed with honey and drunk.
H033	Tuzi	*Euphorbia trucalli* L[I]	Eurhorbaceae	Both	Leaf/Stem	Wound healing	Fresh juice is applied on wounds.
H039	Gergesho	*Grewia villosa* Wild [I]	Tialiaceae	HHs	Fruit	Intestinal parasite	Fruit is chewed and swallowed.
H052	Busente	*Hypoestes forskaolii* (Vahl) R.Br	Acanthaceae	KI	Root	Evil eye	Fresh roots are ground, macerated in water, filtered and drunk.
					Root	Malaria	Fresh roots are ground, macerated in water, filtered, mixed with honey and drunk

Table 12. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H036	Chaqi dhesha	*Indigofera* sp.	Fabaceae	HHs	Root	Evil eye	Leaves are chewed, juice sipped and swallowed.
H060	Gusi	*Lagenaria siceraria* (Monila) Standl.	Curcurbitaceae	HHs	Fruit	Jaundice	Fruit is dissected and the patient face is covered with the inside part of the dissected fruit.
H046	Mordhe	*Launaea intybacea* (Jacq.) Beauv. [I]	Asteraceae	HHs	Root	Abscess	Root is ground, macerated with water, and the filtrate applied the on the skin.
H056	Feto	*Lepidium sativum* L.	Brassicaceae	Both	Seed	Allergic reaction on skin, ulcer in mouth and throat	Seed is ground, mixed with butter, applied on the skin, mouth and throat.
H047	Ara dhesha	*Maytenus senegalensis* (Lam.) Excell	Celasteraceae	Both	Leaf	Jaundice	Fresh leaves are chopped, boiled in water and the vapor is inhaled.
H051	Kelanqi	*Moringa stenopetala* (Bak. f) Cuf. [I]	Morigaceae	Both	Leaf	Hypertension/ Abdominal colic	Fresh leaves are boiled, allowed to cool, and the filtrate is drunk.
					Leaf/root	Malaria	Fresh leaves or roots or both are boiled, allowed to cool, filtered, mixed with honey and drunk.

[I] stands for indegeneous Ethiopian plants

Table 13. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H050	Bishi dhesha	*Ocimun lamiifolium* Hochst. ex Benth	Lamiaceae	HHs	Leaf	Skin diseases	Fresh leaves are crashed and rubbed on affected area.
H059	Beles	*Opuntia ficus-indica* (L) Mill	Cactaceae	HHs	Leaf	Hair loss	The leaf like structure is dissected, rubbed on the affected part of the scalp.
H031	Moshke	*Ormocarpum trichocapum* (Taub.) Engl.	Fabaceae	HHs	Leaf	Abscess	Leaves are chopped, macerated with water, applied on swollen skin.
H005	Salbana	*Ozoroa insignis* Del.	Anacardaceae	Both	Bark	Malaria	Inner side of the bark is peeled off, chopped, macerated in water, filtered and drunk.
H037	Gudembur kanane	*Plectaranthus* sp.	Lamiaceae	HHs	Root/Leaf	Abdominal colic	Leaves/ roots chopped, boiled with water and decoction drunk.
H058	Kelewa	*Rhamnus prinoides* L'Herit [N]	Rhamnaceae	HHs	Fruit	Skin diseases	Ripen fresh fruit were macerated with water and the swollen fruit rubbed on the affected skin.
H040	Kufuri	*Rhus natalensis* Krauss [I]	Anacardiaceae	HHs	Fruit	Various disease of stomach	Fruit are macerated in water, filtered, mixed with honey, and drunk.
					Stem	Malodor of mouth	Fresh stem is, gently chewed about an hour.

[I] stands for indegeneous Ethiopian plants

Table 14. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H028	Kerja	*Salvadora persica* L [I]	Salvadoraceae	HHs	Stem/ Root	Gum bleeding	Root or stem is chewed, and juice is kept in the mouth
H018	Alko/ Algi	*Sansevieria ehrenbergii* Schwiennfurth ex Baker [I]	Dracaenaceae	HHs	Root	Muscle pain	Fresh root is chopped, boiled in water, filtered and drunk
					Leaf	Wound healing	The fresh leaves are smashed, juice applied on the wound
H020	Atmin Dhesha	*Sansevieria forskaoliana* (Schult.f.) Hepper & Wood	Dracaenaceae	HHs	Leaf	Blister after burning	Fresh leaves are smashed, juice applied on the site of burning
H017	Armacha	*Senna italica* Mill. [I]	Fabaceae	HHs	Leaf	Allergy on skin	Fresh leaves are crushed, infusion is made in water and the filtrate is drunk
H048	Chursha	*Sida rhombifolia* L. [I]	Malvaceae	HHs	Arial part	Bone strength	Fresh aerial part is ground, macerated in water, and filtrate is drunk
H049	Gerante	*Solanum dasyphyllum* Schumach. [I]	Solonaceae	HHs	Root	Abdominal colic	The root is chopped, chewed, and swallowed
H001	Gerante	*Solanum incanum* L [I]	Solonaceae	Both	Root	Tooth ache	Fresh root are chewed and the extract is swallowed
					Fruit	Wound healing	Ripen fruit are squeezed on wounds

[I] stands for indegeneous Ethiopian plants

Table 15. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H038	Ara	*Terminalia brownii* Fresen. [I]	Combretaceae	HHs	Bark	Jaundice (Both Human and Animals	The inner bark is peeled, chopped, macerated with water, filtered and drunk.
H029	Kena	*Vepris glomerata* (F. Hoffm.) Engl. [I]	Rutaceae	HHs	Bark/ Leaf	Malaria, abdominal colic	Fresh leaves or mixed with bark are cut into pieces, infusion is made in water, filtered and drunk.
H021	Butambero	*Withania somnifera* (L) Dunal [I]	Solonaceae	HHs	Root	Common cold, tonsillitis	The fresh root were chewed, sip the extract and the juice could be swallowed.
H026	Gedeqa	*Zanthoxylum chalybeum* Engl. [I]	Rutaceae	HHs	Fruit	Abdominal discomfort	The dried fruits are roasted, chewed and swallowed.
H014	Dhenqesho	*Zehneria pallidinervia* (Harms) C. Jeffery	Cucurbitaceae	KI	Leaf	Cattle disease	Fresh leaves are crushed, and the Juice applied into the affected eye.
H013	Lalombe aka	*Leucaena leucocephala* (Lam.) De Wit	Fabaceae	KI	Stem	Hypertension, intestinal parsite, Irregular manustaration, loss of appetite	Different parts of the plants are mixed, crushed, macerated/infused in water, filtered, mix with honey and milk and drunk.
H011		*Maerua triphylla* A. Rich	Capparadaceae	KI	Leaf		
H013	Singla			KI	Bark		

Table 16. Medicinal plants reported by household (HH), key informants (KI) and both respondents of the Hamer ethnic group, South Omo Zone, Jan-Feb, 2010 GC.

Coll. no.	Vernacular name	Scientific name	Family	Informants	Part(s) used	Medicinal indication(s)	Method of preparation and use
H008	Buri			KI	Root	Abdominal colic	Roots are crushed infusion prepared, filtered and mixed with milk and drunk.
						Evil eye	Fresh root are burnt and the essence of the root are inhaled.
H015	Gurdo/ Ardo			Both	Leaf	Snake bite	Fresh leaves are chopped, squashed, juice is applied on the affected area.
H019	Adema			KI	Bark	Ara	Bark is chopped, infusion is made in water, and the vapor is inhaled.
H006	Butambero			KI	Root/Leaf	Shello/Bishi fechi	Leaves are chopped, macerated/boiled in water, filtered and drunk.
H057	Onoko			KI	Leaf	Koli berdate	Leaves are fed to goats

4.2 *In vivo* antimalarial activity studies on the leaf exudate of *Aloe otallensis* Baker

4.2.1 Characterization of the isolated compound

There were no previous reports on the isolation and characterization of the constituents of *A. otallensis.* Isolation of the pure compound (BAO1) was carried out by silica gel TLC. TLC has been widely used in botanical extract analysis and plays an important part in the fractionation; isolation and detection of active compounds present in crude plant extracts (Hahn-Deinstrop, 2007). TLC compared to other chromatographic methods, is simple and inexpensive method, requiring minimal sample cleanup and little equipment (Braithwaite and Smith, 1999). Crude plant material may contain a cocktail of constituents and usually are unknown. TLC is used for separation of the crude plant extracts into its constituent components. These chromatograms provide not only a fingerprint of the crude constituents but also a template for the analysis of sample properties (Braithwaite and Smith, 1999).

Analytical TLC of the exudate of *A. otallensis* revealed the presence of one major band, the purification was effected by preparative TLC over silica gel in a chloroform-methanol (7:3), which yielded a pure compound BAO1. Structure of BAO1 was characterized on the basis of UV, ESI-MS, ^{1}H and ^{13}C NMR and by two dimensional NMR spectral assignments.

The presence of a naphthalene-type chromophore in BAO1 was indicated by the absorption maxima and fine structure of its UV-Spectrum λ_{max}^{EtOH} (absorbance) 301 nm (1.868), 316 nm (1.358) and 330 nm (1.132). The ESI-MS positive mode spectrum of BAO1 showed strong peak at m/z 515, $[M+H]^+$ and m/z 537, $[M+Na]^+$ suggesting the molecular formula of the compound to be $C_{23}H_{30}O_{13}$. In addition, intense peaks at m/z 353, $[M+H]^+$ and m/z 191, $[M+H]^+$ correspond to an aglycone attached with one glycosyl unit and an aglycone moiety resulting from the loss of two glycosyl units, respectively.

The 400 MHz ^{1}H NMR and 100 MHz ^{13}C NMR data of BAO1 could be interpreted in terms of diglycosilated methylnaphthalene-triol. The ^{1}NMR specta of the individual aromatic protons, the

anomeric protons, methyl protons and other protons of the glycosyl moiety of BAO1 are shown in Table 9.

DEPT 90, DEPT 135, and HMBC experiments were used to assign the quaternary carbon atom signlas which helps to determine the structure of BAO1. DEPT 90 and DEPT 135 spectra indicated the presence of five quaternary carbons that resonate downfield from the carbon that resonate at δ_C 123 ppm, and another quaternary carbon that resonates at δ_C 115 ppm. In addition, HMBC experiment indicated that the methyl protons (H-11) correlate with C-4 and ^{13}C resonance at δ_C 134 ppm and δ_C 140 ppm. It has been also observed that H-4 correlates with C-2, C-5 and the signal at δ_C 115 ppm. Cross-peaks that were observed between H-6 and two quaternary carbon signlas at δ_C 154.5 ppm and δ_C 133 ppm might arise from C-8 and C-10, three bonds away from H-6. Further intense cross-peaks were observed between H-5 and ^{13}C resonance at δ_C 110 ppm, δ_C 115 ppm, δ_C 119 ppm (carbon atoms assigned to C-7, C-9 and C-4, respectively) three bonds away from H-5. Correlation was also observed between H-5 and ^{13}C resonance at δ_C 133 ppm (assigned to C-10), two bonds away from H-5, and between H-7 and ^{13}C signals δ_C 122 ppm and δ_C 115 ppm (assigned to C-5 and C-9, respectively) three bonds away from H-7. Additionally, cross-peaks were observed between C-7 and ^{13}C signals δ_C 154.5 ppm assigned as C-8, two bonds away from H-7. The signal at δ_C 145 ppm was assigned to the remaining quaternary carbon.

The positions of the two glycosides were revealed from HMBC experiment which showed intense correlation between H-1′ and ^{13}C signal at δ_C 140 ppm (assigned to C-2) and between H-1″ and ^{13}C signal at δ_C 154.5 ppm (assigned to C-8). Furthermore the ESI-MS showed that the aglycone contains three oxygen atoms, two of which forming the glycosidic linkages, the remaining one existing as a hydroxyl group attached to C-1. The proton carbon correlation obtained from HMBC is shown in Figure 16. Based on the data obtained the isolated compound was identified as 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene (Figure 17).

Though naphthalene derived glycosides are not new from aloe species (Wessels *et al*, 1996; Yang *et al*, 2010), 2,8-diglycosyl-1-hydroxy-3-methylnaphthalene known by its common name plicatoside has been isolated only once from the exudate of *A. plicatilis* (Wessels *et al*, 1996) and this is the first report on the isolation of compounds from *A. otallensis*.

Table 17. ^{1}H- and ^{13}C-NMR chemical shifts[a] assigned for 2,8 diglycosyl-1-hydroxy-3-methyl naphthalene isolated from the exudate of *A. otallensis* in comparison with those reported for picataloside.

	^{1}H		^{13}C	
	DGMTN[b]	Plicataloside[c]	DGMTN[b]	Plicataloside[c]
H/C				
1	-	-	145	144.14
2	-	-	140	139.63
3	-	-	134	133.44
4	7.1(*s*)	7.158 (*s*)	119	118.79
5	7.35(*dd*)	7.385(*dd*)	122	121.89
6	7.2 (*dd*)	7.254(*dd*)	123	125.21
7	7.15 (*dd*)	7.199 (*dd*)	110	109.74
8	-		154.5	154.02
9	-		115.5	114.85
10	-		133	132.76
11	2.35(*s*)	2.3919 (*s*)	18	17.73
1′	4.8(*d*)	4.818(*d*)	105	104.19
2′		3.309 (*dd*)	74	74.23
3′		3.258(*dd*)	76.5	76.35
4′		3.1599(*dd*)	70	69.91
5′		3.087 (*dddd*)	78.5	77.08
6′a		3.607 (*ddd*)	61	60.08
6′b		3.426 (*dt*)		
1″	4.95(*d*)	4.985 (*d*)	103	102.69
2″		3.388 (*dd*)	74.5	73.61
3″		3.330(*td*)	76.5	76.20
4″		3.206 (*td*)	70	69.85
5″		3.407(*dddd*)	77.5	77.60
6″a		3.514(*ddd)*	61	60.74
6″b		dt)		

[a] Spectra were run in $(CD_3)_2$ SO

[b] DGTMN = 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene

c NMR data were obtained from Wessels *et al* (1996)

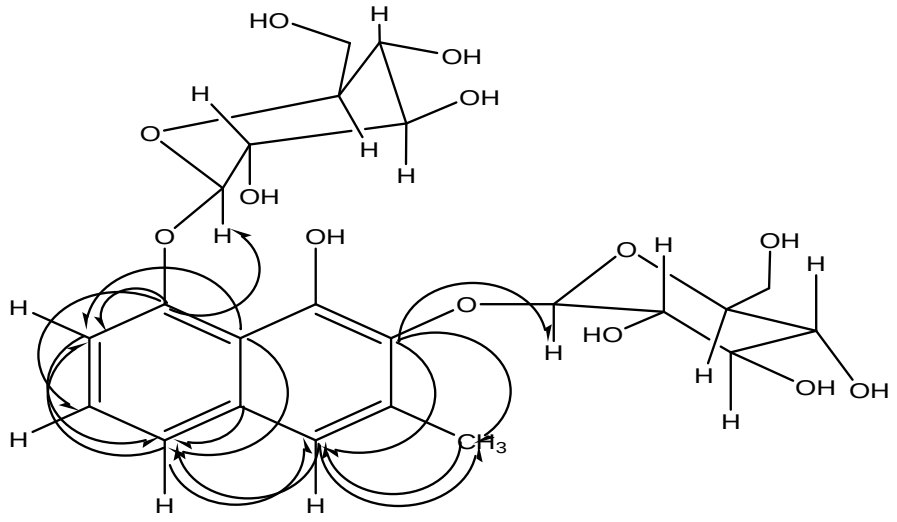

Figure 13. HMBC 2D Correlation of ^{13}C and ^{1}H for BAO1

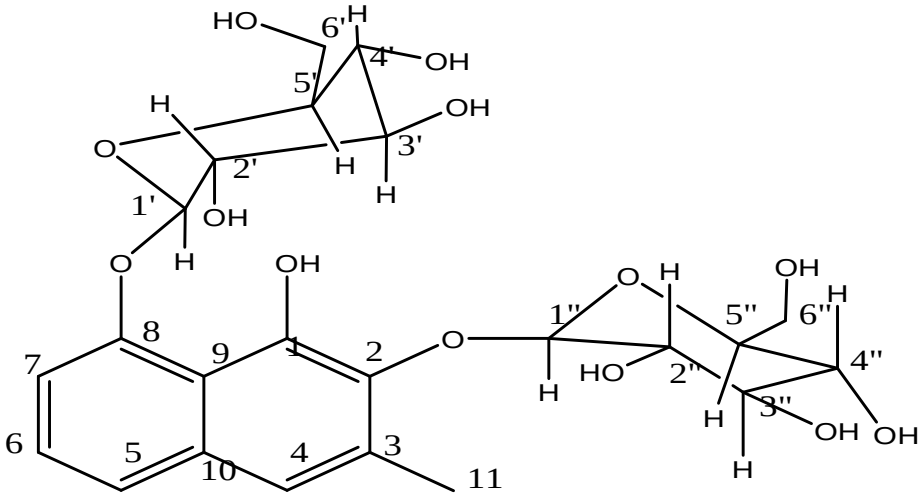

Figure 14 Chemical structure of 2,8-*O*,*O*-di (β-D-glucopyranosyl)- 1,2,8- trihydroxy -3-methylnaphthalene.

4.2.2 Acute toxicity testing

The oral acute toxicity of the leaf exudate of *A. otallensis* was carried out according to OECD guideline (OECD, 2006). The method helps in detecting adverse effects that may arise as a result of a single dose administration in a short time (within 24 h) and requires a few animals. Mortality and acute toxicity symptoms of orally administered aqueous solution of the exudate of *A.*

ottalensis were determined at a dose of 1500 mg/kg. All the treated mice were carefully observed for 24 h for any signs of toxicity (behavioural changes and mortality). Shivering, diarrhea and piloerection were the main signs of toxicity observed. However, these signs disappeared after 24 h. No mortality was observed following administration of the specified dose. The signs of toxicity observed in the present study have been reported in different findings following administration of crude plant extracts at higher doses (Riaz *et al*., 2010; Pillai *et al*., 2011). However, the above mentioned signs of toxicity were not observed following administration of higher doses of juices of *Aloe vera* and *A. debrana* (Shah *et al*., 1989; Deressa *et al*., 2010). The absence of mortality in mice at the administered dose might justify the relative safety of the plant and hence its use in folk medicine (Aarthi and Murugan, 2011; Pillai *et al*., 2011). Determination of efficacy and safety of herbal remedies in folk medicine is necessary because many people use these agents as self medication (Rodriguez-Fragoso *et al*., 2008).

4.2.3 *In vivo* four-day chemosuppressive antimalarial test

Early malaria infections/four day chemosuppressive activity test for the aqueous solution of exudate of *A.otallensis* produced a dose dependent chemosuppression as shown in Table 12. After four days of treatment with the different doses, the mean parasitaemia of the test groups ranged from 9.90 ± 0.20 to 14.3 ± 0.40%, while the corresponding value of the negative control group was 25.20 ± 0.32%. Maximum suppression (60.7%) of parasitaemia was observed at the dose of 300 mg/kg body weight. As shown in Table 10 percentage suppression of parasitaemia increased as the concentration of the exudate increased. Mice treated with chloroquine (25 mg/kg), positive control, were completely free from the parasites on day 4. The antimalarial activity produced by the exudate was statistically significant when compared to the control ($P < 0.05$).

The results of the *in vivo* four day chemosuppressive evaluation of 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene on early infection of *P. berghei* also showed a good chemosuppressive activity. After four days of treatment with the different doses, the mean parasitaemia of the test groups ranged from 14.39 ± 1.18 to 21.02 ± 0.52, while the corresponding value of the negative control group was 27.3 ± 0.41. The compound was marginally active at 25 mg/kg per day with 23.04% suppression of parasitaemia. However, at

doses of 50 mg/kg per day and 100 mg/kg per day, suppression of parasitaemia increased to 32.45% and 47.29%, respectively (Table 11).

Table 10. Effect of the aqueous solution of exudate of *A. otallensis* on the early stage of malaria.

No.	Treatment	Dose (mg/kg/day)	* % Average parasitaemia	% Chemosupression	*Mean survival time (in days)
1	Exudate	75	14.3 ± 0.40	43.1	9.60 ± 0.25
2	Exudate	150	11.4 ± 0.20	54.6	9.80 ± 0.20
3	Exudate	300	9.9 ± 0.20	60.7	11.20 ± 0.20
4	Chloroquine	25	0.0 ± 0.00	100.0	13.60 ± 0.25
5	Distilled water	1ml	25.2± 0.30	0.0	7.60 ± 0.25

*Values presented as Mean ± SEM, n = 5

The mice in the positive control group that received chloroquine 25 mg/kg per day showed complete chemosuppression. Percentage suppression was observed to increase as concentration of 2,8-O,O-di(β-Dglucopyranosyl)-1,2,8-trihydroxy-3-methtlnaphthalene increased. The chemosuppression produced by the compound was statistically significant ($P < 0.05$) when compared to the negative control. The difference in chemsuppresion between mice treated with 25 mg/kg/day and those treated with 50 mg/kg/day was found to be insignificant ($P > 0.05$). However, the percentage suppression produced by chloroquine was statistically significant ($P < 0.05$) when compared to the exudate and the isolated compound as well as the negative control.

Recently, there is a surge in interest on screening of plant derived extracts for their antimalarial activity with the aim of herbal drug development and also to obtain new lead compounds to combat the disease (Verma *et al*., 2011). The results of the present study indicated that both the exudate of *A. otallensis* and the compound isolated from it showed chemosuppression at varying degree. This early malaria suppression activity of the exudate was comparable to the antimalarial activity of other species of the genus *Aloe* (Madureira *et al*., 2002; Deressa *et al*., 2010), and other plant crude extracts (Aarthi and Murugan, 2011; Verma *et al*., 2011; Okokon *et al*, 2011). The finding also showed that both the exudate and isolated compound possess dose dependent response, which has been reported to exist in other plant extracts (Deressa *et al*., 2010; Aarthi and Murugan, 2011; Verma *et al*., 2011). At the tested doses, the activity of the exudate was

higher than that of the isolated compound. The reason for this activity difference may be attributed to the different doses used for the two samples. It is also possible that the exudate contains other minor compounds with superior activity or syneregestic effects may have existed between the minor constituents and the major compound isolated from the plant.

Table 18. Effect of the aqueous solution of 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene on early stage of malaria

No.	Treatment	Dose(mg/kg/day)	*% Average parstiemia	% Chemosuppresion	*Mean survival time (in days)
1	DGTMN	25	21.02 ± 0.52	23.04**	9.60 ± 0.40
2	DGTMN	50	18.45 ± 0.82	32.45**	10.60 ± 25.00
3	DGTMN	100	14.39 ± 1.18	47.29	12.40 ± 0.40
4	Chlorquine	25	0.0 ± 0.00	100.00	14.40 ± 0.25
5	Distilled water	1 ml	27.30 ± 0.41	0.00	7.80 ± 0.37

DGTMN = 2,8-O,O-di(β-Dglucopyranosyl)-1,2,8-trihydroxy-3-methtlnaphtalene
* Values presented as mean ± SEM, n = 5
** not significant when compare to each other

The time of deaths following infection and administration of the test substances in each group was recorded and the average survival time in each group was determined for both the exudate and isolated compound. As indicated in Table 10, the exudate given at different doses showed better survival time than the untreated mice (negative control). Maximum survival time was recorded for mice that received cholroqunie (25 mg/kg/day). Even though the mean survival time of mice that received different doses of the exudate was longer than the negative control, it is only those mice that received doses of 150 and 300 mg/kg/day showed significant different mean survival time compared to the negative control ($P < 0.05$).

As shown in Table 11, at all doses used, the isolated compound showed longer survival time compared to the negative control. Maximum mean survival time was recorded in positive control group that received 25 mg/kg/day chloroquine (14.40 ± 0.25) (Table 13). Similarly, all doses of the isolated compound with the exception of the lowest dose (25 mg/kg/day), the average survival time was found to be statistically significant ($P < 0.05$) when compared to the negative control. Mice treated with the exudate and isolated compound showed a longer survival time

compared to those in the negative control groups. The mice in both the negative control groups died between the 6th and 10th days. The longest time of survival was among the mice treated with chloroqiune (14 days). The mean survival time of mice treated with the isolated compound was slightly shorter than those mice treated with the exudate.

4.2.4 DPPH free radical scavenging activity

In the present study, both the exudate of *A. otallensis* and the isolated compound 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene showed free radical scavenging activity. The percent scavenging activity of the exudate ranged from 15.16% to 88.86% for serial doses between 6.25 µg/ml to 50 µg/ml, while the percent scavenging activity of the isolated compound ranged between 16.01% to 84.92% for serial doses of 6.25 µg/ml to 50 µg/ml (Figures 15 and 16). The IC_{50} values of the exudate and isolated compound calculated from the dose response curve were found to be 26.9 µg/ml and 26.2 µg/ml, respectively (Table 12).

Table 19. DPPH radical scavenging activity IC_{50} values of the exudate of *A. otallensis* and 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene compared with that of vitamin C

Test sample	IC_{50} value (µg/ml)
Exudate	26.9
DGTMN	26.2
Vitamin C	4.6

DGTMN = 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphtalene

DPPH is one of the free radicals widely used for testing preliminary radical scavenging activity of secondary metabolites and crude plant extracts (Gyingiri *et al*., 2011). The model system of scavenging DPPH free radicals is a simple and acceptable method to evaluate the antioxidative activity of antioxidants (Bhuiyan *et al*., 2009). It is accepted that the DPPH free radical scavenging by antioxidants is due to their hydrogen or electron donating ability (Chen and Ho, 1995). The DPPH test provides information on the reactivity of the test compounds with a stable free radical. DPPH gives a strong absorption band at 517 nm in visible region. When the odd electron becomes paired off in the presence of a free radical scavenger, the absorption reduces

and the DPPH solution is decolourized as the colour changes from deep violet to light yellow. The degree of reduction in absorbance measurement is indicative of the radical scavenging (antioxidant) power of the substances (Ayoola *et al*., 2008).

Both the exudate and 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphtalene showed good antioxidant activity. Nonetheless, their IC_{50} values were much higher than that of vitamin C. The activities of the exudate and the isolated compound were comparable with that of *A. vera* leaf juice (Joseph and Raj, 2010) but better than many plant crude extracts (Han *et al*., 2004). The antioxidant activity of the exudate might be associated with the presence of phenolic groups in the isolated compounds (Braca *et al*., 2002; Demiray *et al*., 2009).

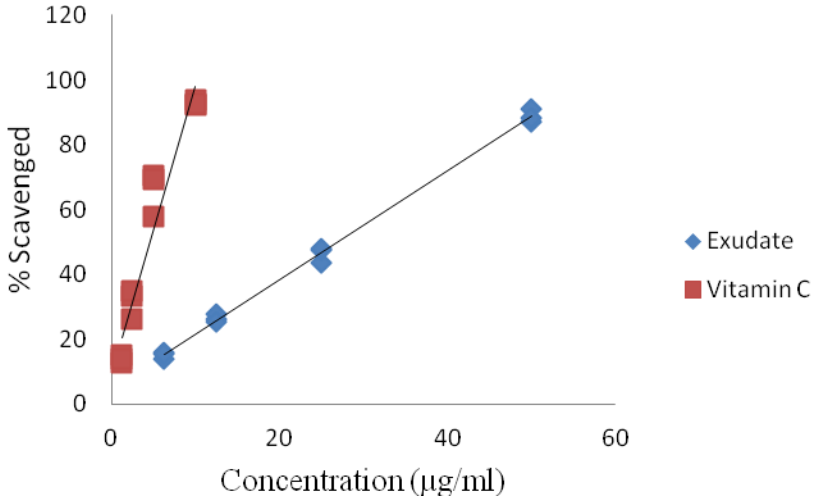

Figure 15. Concentration dependent DPPH free radical scavenging activity of the exudate of *A. otallensis* in comparison with vitamin C.

The antioxidant or free radical scavenging potential of the exudate and the isolated compound might help to reduce the oxidative stress on red blood cells. This further prevents the severity of malaria related complications because the *Plasmodium* infected erythrocyte is under constant oxidative stress. This is caused by exogenous reactive oxygen spesies (ROS) and reactine nitrogen species produced by the immune system of the host, and by endogenous production of ROS generated during the digestion of host cell haemoglobin and concomitant biochemical

reactions (Bozdech1 and Ginsburg, 2004). It can, therefore be said that the antioxidant activity of the isolated compound may contribute to the antimalarial activity of the plant by minimizing oxidative stress (Kukurani *et al*., 2003; Ayoola *et al*., 2008; Gyingiri *et al*., 2011).

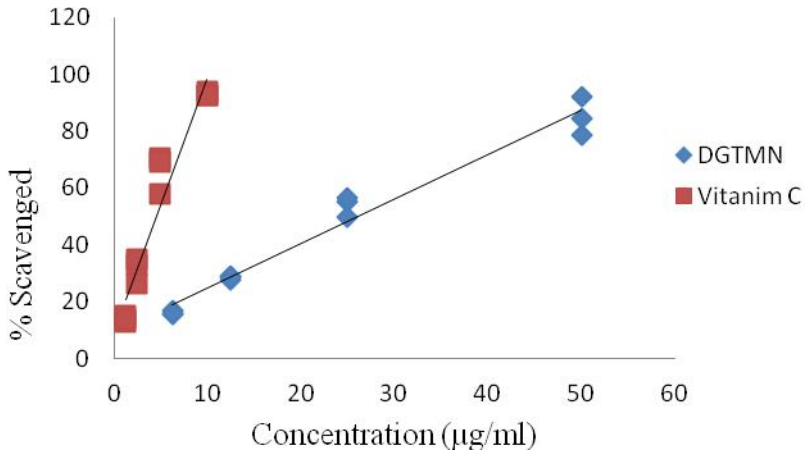

Figure 16. Concentration dependent DPPH free-radical scavenging activity of different 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene (DGTMN) in comparison with that of vitamin C.

Conclusions

The present study revealed that the health seeking behavior of the Hamer ethnic group is affected by different socioeconomic and cultural factors. There is also a strong indication for traditional medical practices and use of plant materials to treat various ailments and health problems among the study population. Selection of medicinal plants by the Hamer ethnic group appears to have sound basis as most community members claim to have benefited from the use of herbal drugs. The study also showed that the majority of medicinal plants are collected from the wild; with leaves and roots being the most widely used plant parts. Water was found to be the most widely used vehicle for the preparation of herbal remedies, and liquid dosage form was the most widely used preparation. By and large, doses of herbal remedies are measured approximately. It appears that the use of medicinal plants in particular and traditional medicine in general among the study population is facing danger of survival as the means of transferring knowledge from one generation to another is mainly by word of mouth and the younger generation appears to have lack of interest in acquiring such knowledge.

On the basis of ethnopharmacological information obtained from the Hamer community, the antimalarial activity of *A. otallensis* has been studied. It was found that the exudate of this plant possesses genuine antimalarial activity. Phtyochemical analysis of the exudate resulted in the isolation of a naphthalene derived glycoside identified as 2,8-O,O-di(β-D-glucopyranosyl)-1,2,8-trihydroxy-3-methylnaphthalene. In addition to the genuine antimalarial activity, both the exudate and isolated compound showed good *in vitro* radical scavenging activities suggesting their possible involvement in reducing oxidative stress on the red blood cells which commonly occurs in patients infected with malaria parasites. The results of the present study do seem to justify the traditional use of *A. otallensis* for the treatment of malaria.

Recommendations

- The government as well as the non-government bodies should work together with the community to improve the quality of the health services;
- Further survey on other ethinic groups of the woreda should be conducted in order to collect, identify and document medicinal plants and other traditional medical practices;
- Additional studies on *A. otallensis* as well as the isolated compound should be carried out to ascertain its pharmacological activities.

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Annexes

Annex I: Operational Definitions

Here in after in this paper, the following terms will have such interpretations.

Compound mixtures: herbal preparations prepared from two or more plants.

Elders: those members of the community with age greater than 30.

Herbal Drugs/Remedies: part of traditional medicines which only involves medicines obtained from plants.

Herbalists: individuals who treat people by using herbal drugs.

Health seeking behavior: individual's actions to promote optimal wellbeing, resurgence, and rehabilitation.

High income: more than ten cattle, goats and hives.

Illiterate: member of the community who can read and but not write and who cannot read and write.

Literate: member of the community who can read and write.

Local route of administration: routes where herbal drugs have been applied on affected site (e.g. Skin and eye)

Low income: less than five cattle, no goats and hives.

Middle income: five to ten cattle, goats and hives.

Simple recipes: herbal preparations prepared from single plant.

Traditional Medical Practices(TMPs)/ *Traditional Medicine (TM)*: practices which involves different kinds of conventional medical practices based on the social and cultural backgrounds as well as the prevailing knowledge, attitudes and beliefs regarding physical, mental and social well-being and the causation of disease and disability in the community including Herbalism, Witch-hunt, Bone setters etc.

Traditional Medical Practitioners: Someone who is recognized by the community in which he/she lives as competent to provide health care by using vegetable, animal and mineral substances and certain other methods based on the social and cultural backgrounds as well as the prevailing knowledge, attitudes and beliefs regarding physical, mental and social well-being and the causation of disease and disability in the community (i.e. herbalists, Bone-setters, witch-hunts etc..)

Wealth: Expressed in terms of possession of cattle, goat, sheep and honey combs. According to this, the monthly income of the community will be classified into low, medium and high.

Western medicine: refers to what is also called “conventional medicine”, “clinical medicine”.

Young: those member of the community with age less than or equal to 30.

Annex II Glossary of local names of illness and some traditional medical practices and their equivalent meaning in English.

Afi Burka: illness which is characterized by itching, redness and pain to the eye.

Ara: illness which appear as yellow color of scelera of the eye, nail, skin (Symptoms similar to jaundice).

Berdate: illness characterized by helments in faces, usually teania.

Bishi Ajim: illness of the skin usually infectious like fungal infections (E.g. dandruff)

Chaki: Evil eye

Ded medmat: Bleeding of jinjiva

Dunguri Qansa: superstitions which they predict the future by looking "shoes" dropping

Emburikadana: illness which is characterized by abdominal spasm/Colic

Ethadhana: illness characterized by swelling of skin

Fersi: Traditional alcoholic drink made of sorghum and corn

Gebeze: illness characterized by fever, chilling, loss of appetite tiredness shivering (Symptoms similar to malaria)

Gulfadhana: common cold

Guni: illness/Pain due to bite by snake and scorpion

Kolin Ashedha: looking at goat intestine for predicting future.

Korokor: Fungal infection of the scalp.

Logagna: illness which is characterized by constricting the back of the neck, tiredness (Symptoms similar to hypertension)

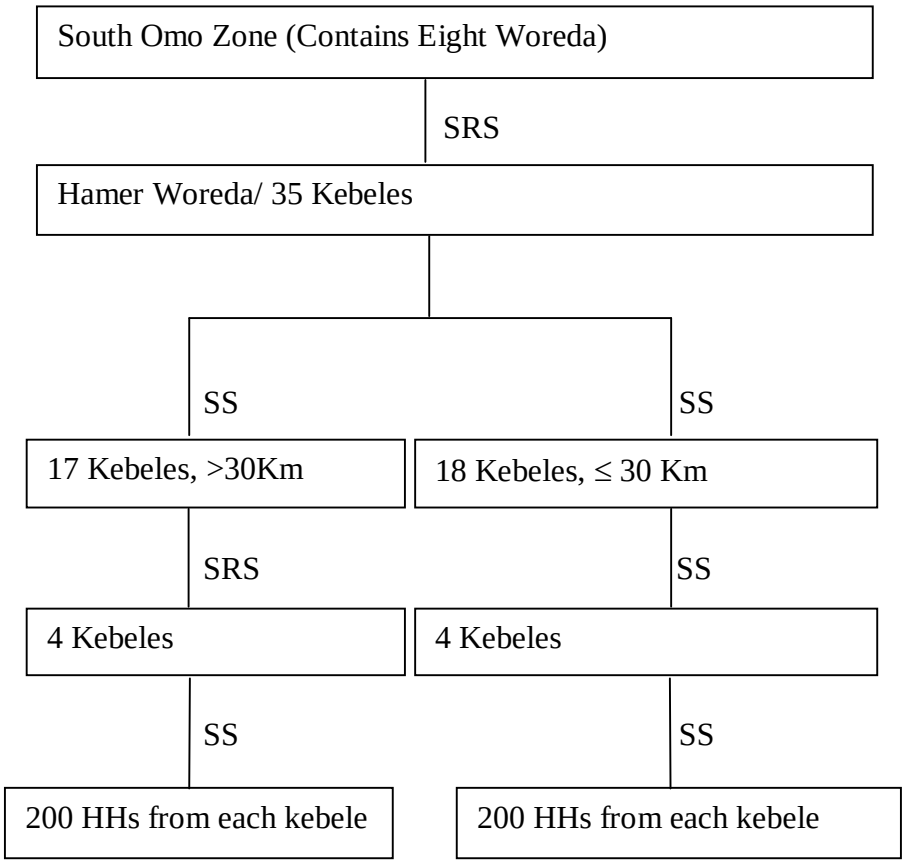
Merankal: Traditional practice which involve witch-hunt.

Shello Fecha: illness of the skin which appear as itching, redness (symptoms similar to inflammation).

Shoforo: Traditional coffee made from coffee peel

Zen: illness characterized by diarrhea.

Annex III Sampling methods used during ethnopharmacological survey among Hamer Ethinic Group, Hamer Woreda, and Jan, 2010.



SRS= Simple random sampling, SS= Stratified Sampling

Annex IV Questionnaire to be used to collect ethnopharmacological information at house hold level among Hamer ethnic group, Hamer Woreda, South Omo Zone, SNNPR.

Date of Interview_____ Time_____

Name of Interviewer _____

1. Address of Respondent

Kebele_____ Village_____

Instruction: Circle the Letter that Contain the Appropriate Choice

2. Demographic Information

2.1 Sex: 1. Male 2. Female

2.2 Age_____

3. Religion

1. Orthodox 2. Muslim 3. Protestant 4. Others, if any_____

4. Status of the family

1. Husband 2. Wife 3. Head of Household (Woman) 4. Others

5. Household size_____

6. Occupation_____

7. Education Status

1. Illiterate 2. Religious education 3. Basic education 4. Grade 1-4

5. Grade 5-8 6. Grade 9-10 7. Grade 11-12 8. Above 12, _____

8. Economic Status

8.1 Type of House: A. Permanent B. permanent

8.2 Average monthly income, if known_____

8.3 Number of Domestic animals:

Cattle_____ Goat/Sheep_____ Horse/Donkey

8.4 Source of information

1. Radio 2. Television 3. Other, Specify_____

9. Was there any family member who gets ill in the past two weeks?

1. Yes_____ 2. _____

(If your answer is yes to question is 9, fill the table below)

Sino	Sex	Age	Perceived illness (Symptoms)	What do you think the cause of illness	Taken action to alleviate the problem			
					Went to Health institution	Went to healer	Used homemade remedy	No action
1								
2								
3								
4								

10. What do you do when any member of the family get sick?

1. Go to health institutions
2. Go to traditional healers
3. Use homemade remedies
4. Others, Specify_____

11. What is your preference to choose the option in question 10?

1. It is cheap
2. It is more effective
3. No access to other alternative
4. Other, Specify_____

12. Do you know any plants used as medicines in your district? A. Yes B. No

(If your response to Q. 12 is yes, fill in the table below)

		Medicinal plants			
		1	2	3	4
12.1	Vernacular name				
12.2	Indications				
	1				
	2				

	3				
12.3	Part of plant used				
	1. Leaf				
	2. Flower				
	3. Bark				
	4. Seed				
	5. Root				
12.4	Mode of Use				
	1. Fresh				
	2. Dry				
	3. Both				
12.5	Time of Collection				
	1. Dawn				
	2. Mid day				
	3. Down				
	4. Any time				
	Why time of collection is necessary?				
12.6	Area of Growth				
	1. Domestic(Cultivated)				
	2. Wild				
	3. Both				
12.7	Precaution taken during Collection				
12.8	Preparation of the medication				
	1. Infusion				
	2. Decoction				
	3. Other, Specify				

12.9	Dosage regimen				
	1. Dose/ quantity				
	2. Measurement used				
	3. Frequency				
	4. Duration of treatment				
12.10	Route of Administration				
	1. Oral				
	2. Topical				
	3. Inhalation				
	4. Others, Specify_____				
12.11	Dietary items restricted through the course of therapy				
12.12	Precaution during treatment				
12.13	Adverse effects				
	1.				
	2.				
	3.				
12.14	Antidotes				
12.15	Contraindications				
	1. Children				
	2. Geriatrics				
	3. Pregnant				
	4. Lactating mother				
	5. Disease condition, Specify_____				
12.16	Shelf Life				

12.17	Storage				
	1. Container used				
	2. Place of Storage				

Annex V Questionnaire to be used to collect ethnopharmacological information for key informants among Hamer ethnic group, Hamer Woreda, South Omo Zone, SNNPR.

Date of Interview_____ Time_____

Name of Interviewer _____

1. Address of Respondent

Kebele_____ Village_____

Instruction: Circle the Number that Contain the Appropriate Choice

2. Demographic Information

2.1 Sex: 1. Male 2. Female

2.2 Age_____

3. Religion

1. Orthodox 2. Muslim 3. Protestant

4. Others, if any_____

4. Education Status

1. Illiterate 2. Religious education 3. Basic education 4. Grade 1-4

5. Grade 5-8 6. Grade 9-10 7. Grade 11-12 8. Above 12, _____

5. Economic Status

5.1 Type of House: A. Permanent B. permanent

5.2 Average monthly income, if known_____

5.3 Number of Domestic animals:

Cattle_____ Goat/Sheep_____ Horse/Donkey_____

6. Source of information

1. Radio 2. Television 3. Other, Specify_____

7. Years of Experience as healer_____

8. Source of Knowledge and skills as healer

1. Family members

2. Religious institutions

3. Friends

4. Gift of Nature

5. Others, Specify_____

8. Manner of Practice

1. Full time 2. Part time

9. Do you have assistant(s) while practicing Healing? 1. Yes 2. No

10. If your answer to Q10, do you let it to observe all your healing practices? 1. Yes 2. No

11. Average Number of patients treated per day_____

12. How much (on average) do you get monthly from your TM practice?

13. Do you have set treatment costs? 1. Yes 2. No

14. If yes for Q 13, how much is the average cost per medication? _____

15. If not for Q13, How do charge your clients? _____

16. Illness treated

Sino	Name of Illness	Symptom	Causes	Mode of transmission

17. What are your sources of medicines?

1. Plants

2. Animals

3. Minerals/Soil

4. Others, Specify_____

18. Would you mind telling plants which used as Medicine?

		Medicinal plants			
		1	2	3	4
18.1	Vernacular name				
18.2	Indications				
	1				

	2				
	3				
18.3	Part of plant used				
	1. Leaf				
	2. Flower				
	3. Bark				
	4. Seed				
	5. Root				
18.4	Mode of Use				
	1. Fresh				
	2. Dry				
	3. Both				
18.5	Time of Collection				
	1. Dawn				
	2. Mid day				
	3. Down				
	4. Any time				
	Why time of collection is necessary?				
18.6	Area of Growth				
	1. Domestic(Cultivated)				
	2. Wild				
	3. Both				
18.7	Precaution taken during Collection				
18.8	Preparation of the medication				
	1. Infusion				
	2. Decoction				

	3. Other, Specify				
18.9	Dosage regimen				
	1. Dose/ quantity				
	2. Measurement used				
	3. Frequency				
	4. Duration of treatment				
18.10	Route of Administration				
	1. Oral				
	2. Topical				
	3. Inhalation				
	4. Others, Specify_____				
18.11	Dietary items restricted through the course of therapy				
18.12	Precaution during treatment				
18.13	Adverse effects				
	1.				
	2.				
	3.				
18.14	Antidotes				
18.15	Contraindications				
	1. Children				
	2. Geriatrics				
	3. Pregnant				
	4. Lactating mother				
	5. Disease condition, Specify_____				

18.16	Shelf Life				
18.17	Storage				
	1. Container used				
	2. Place of Storage				

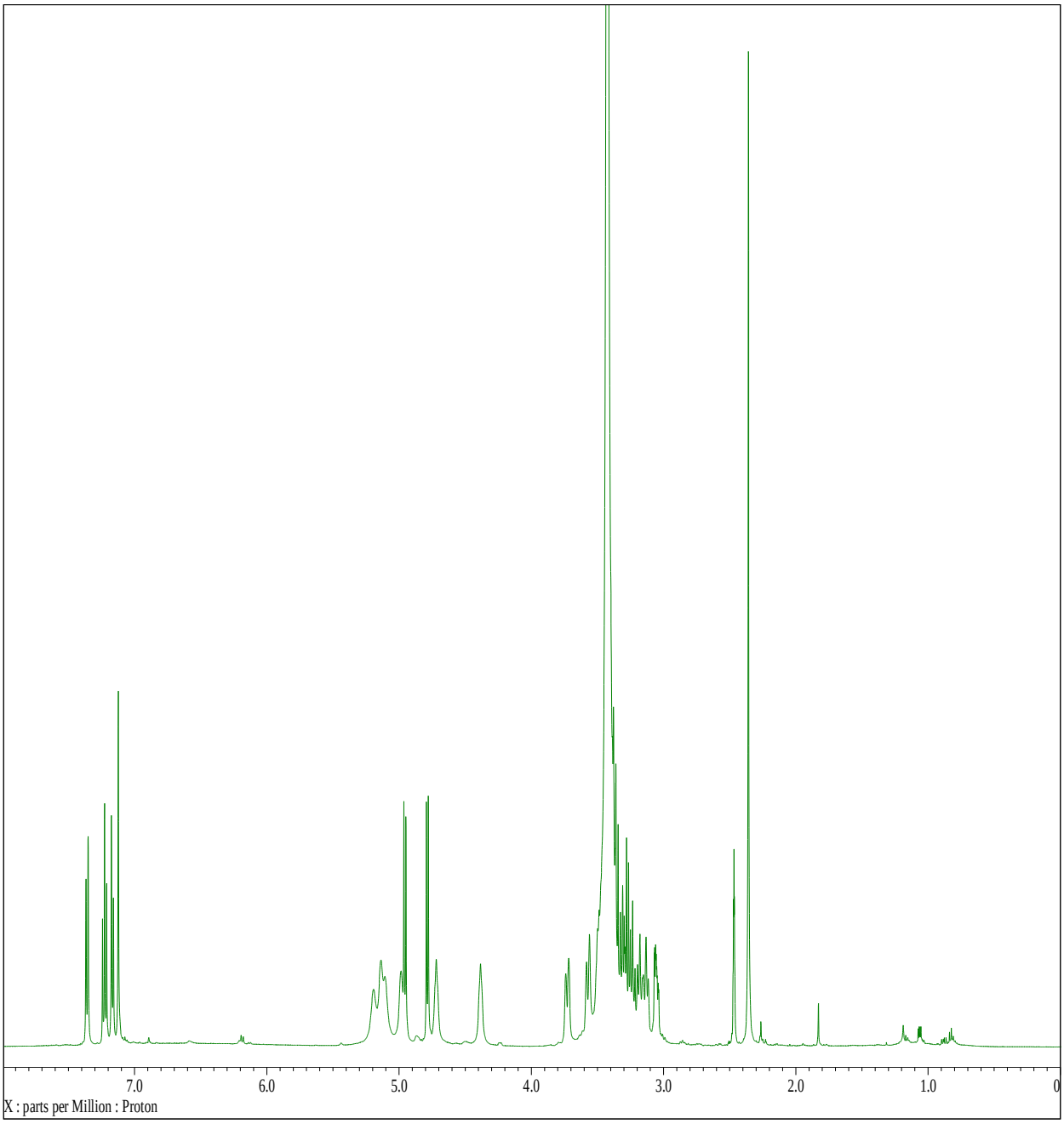
Annex VI Questions for Focused Group Discussions

I would like to thank in advance all of you for your participation in group discussion.

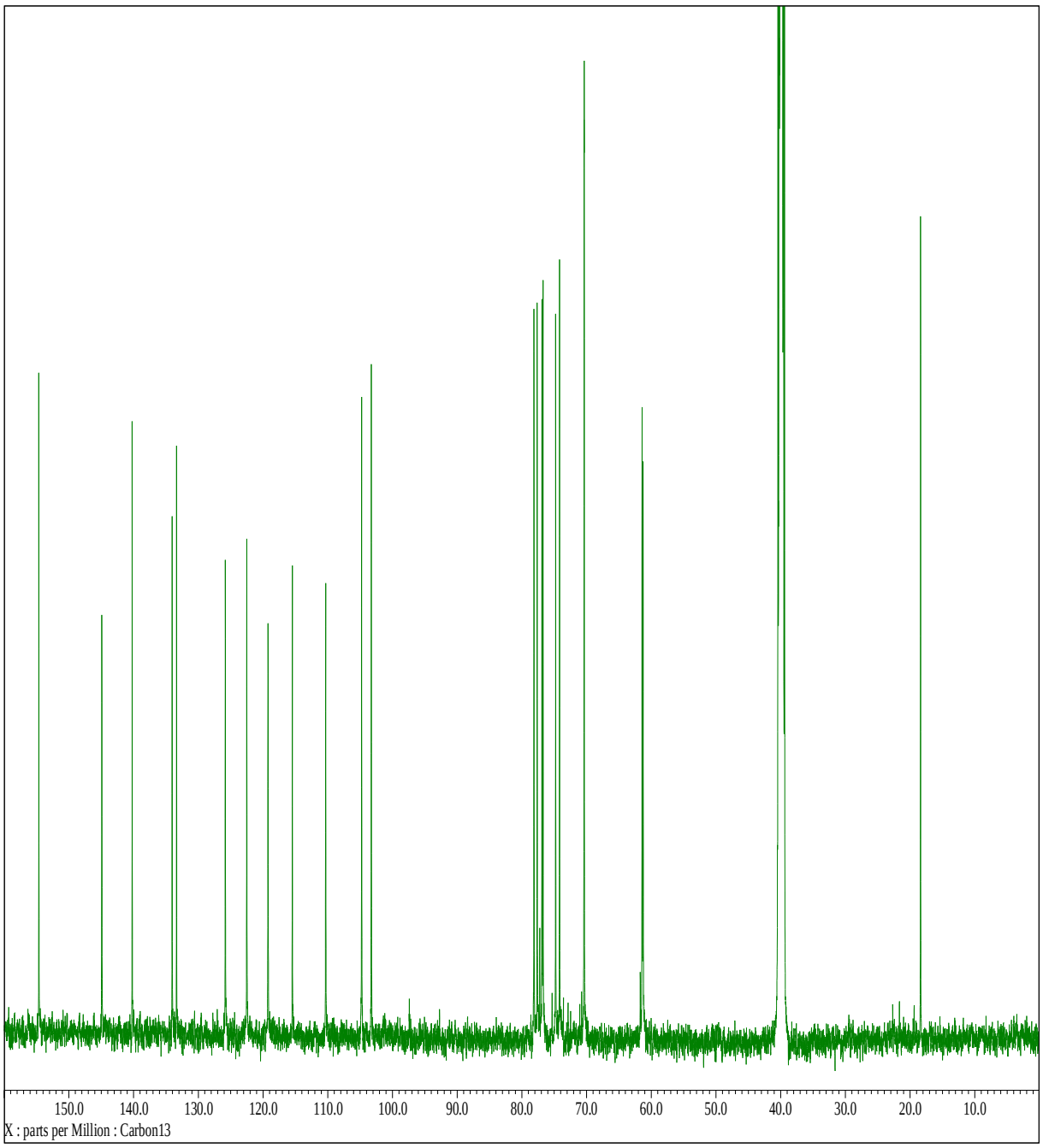
1. What are the commonest illnesses in your society?
2. What do you usually do during illnesses?
3. What are the reasons for your Choice?
4. What are the major Sources of TM in your Society?
5. Is there any special attention given to plants used as medicine or treated in the same way as non-medicinal plants?
6. What are the trend of TM use in terms of availability of plants and acceptance by younger generation?
7. How is Knowledge of healing transferred from generation to generation?
8. What do you recommend to satisfy the health care needs of your society?
9. What are the Benefits and Limitation of Traditional medical practices to your community?

Thank U!

Annex VII Different spectra of BAO1



BAO-1 H-NMR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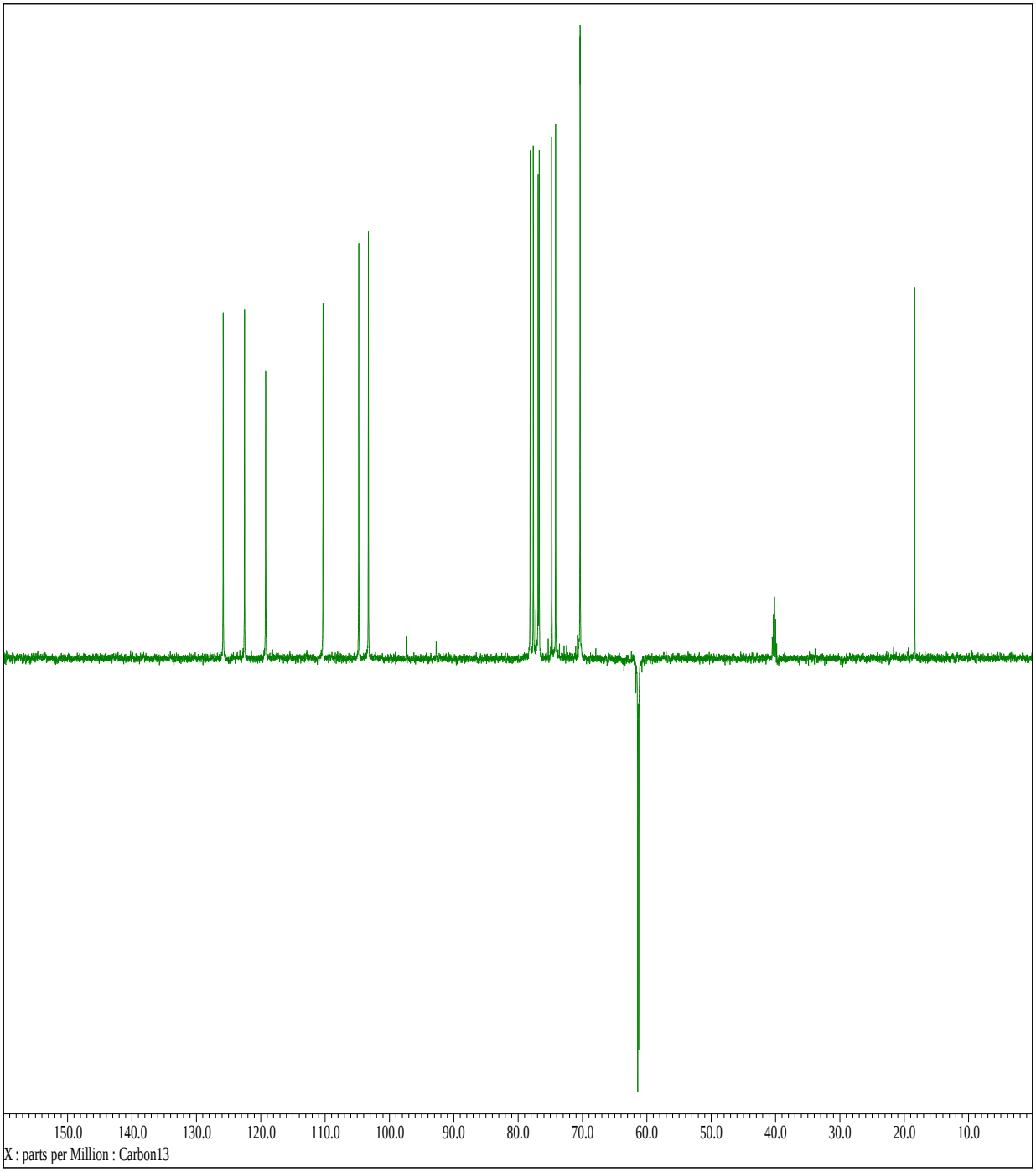
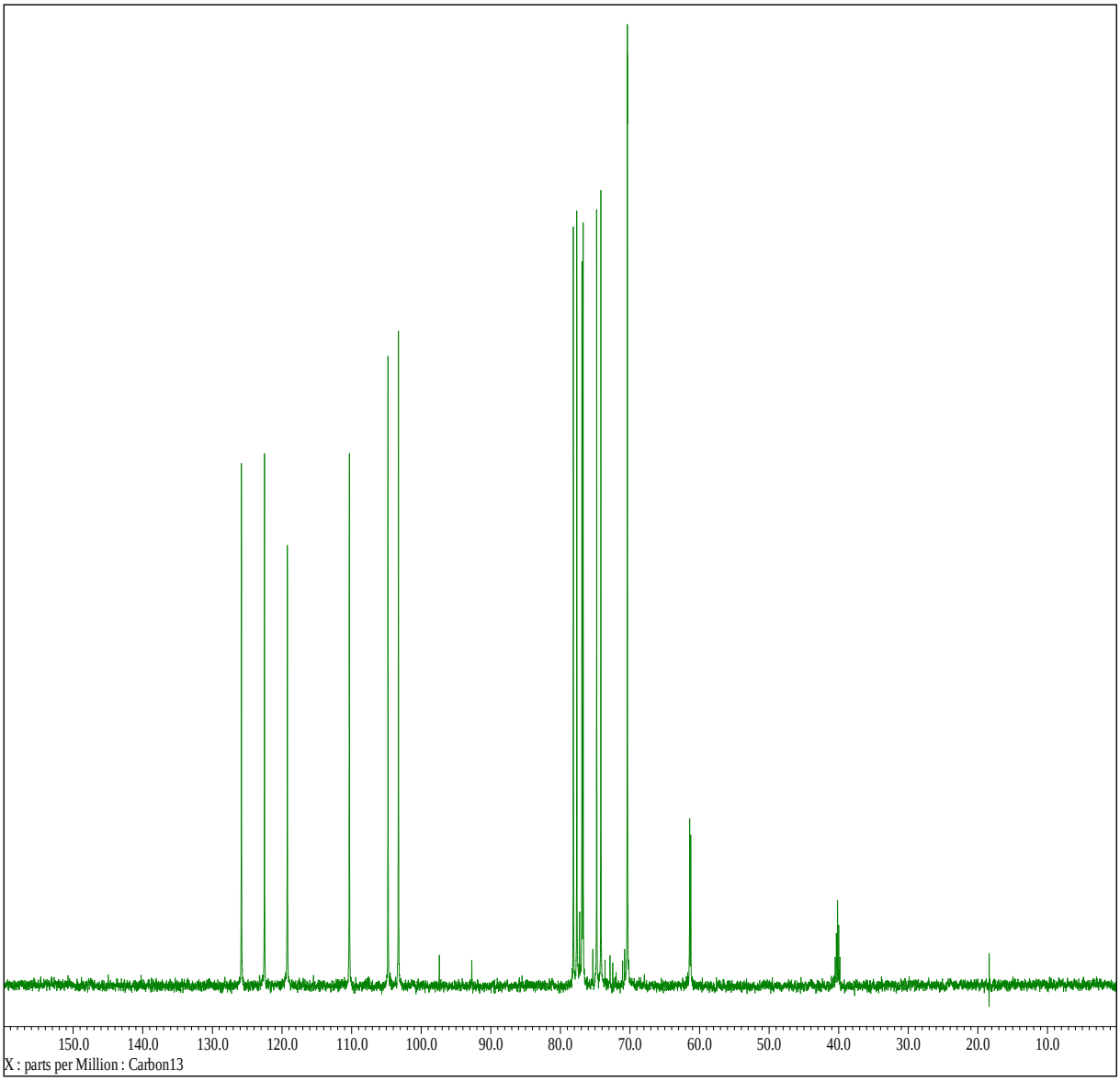
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
X : parts per Million : Carbon13

BAO-1 C-NMR



BAO-1 DEPT135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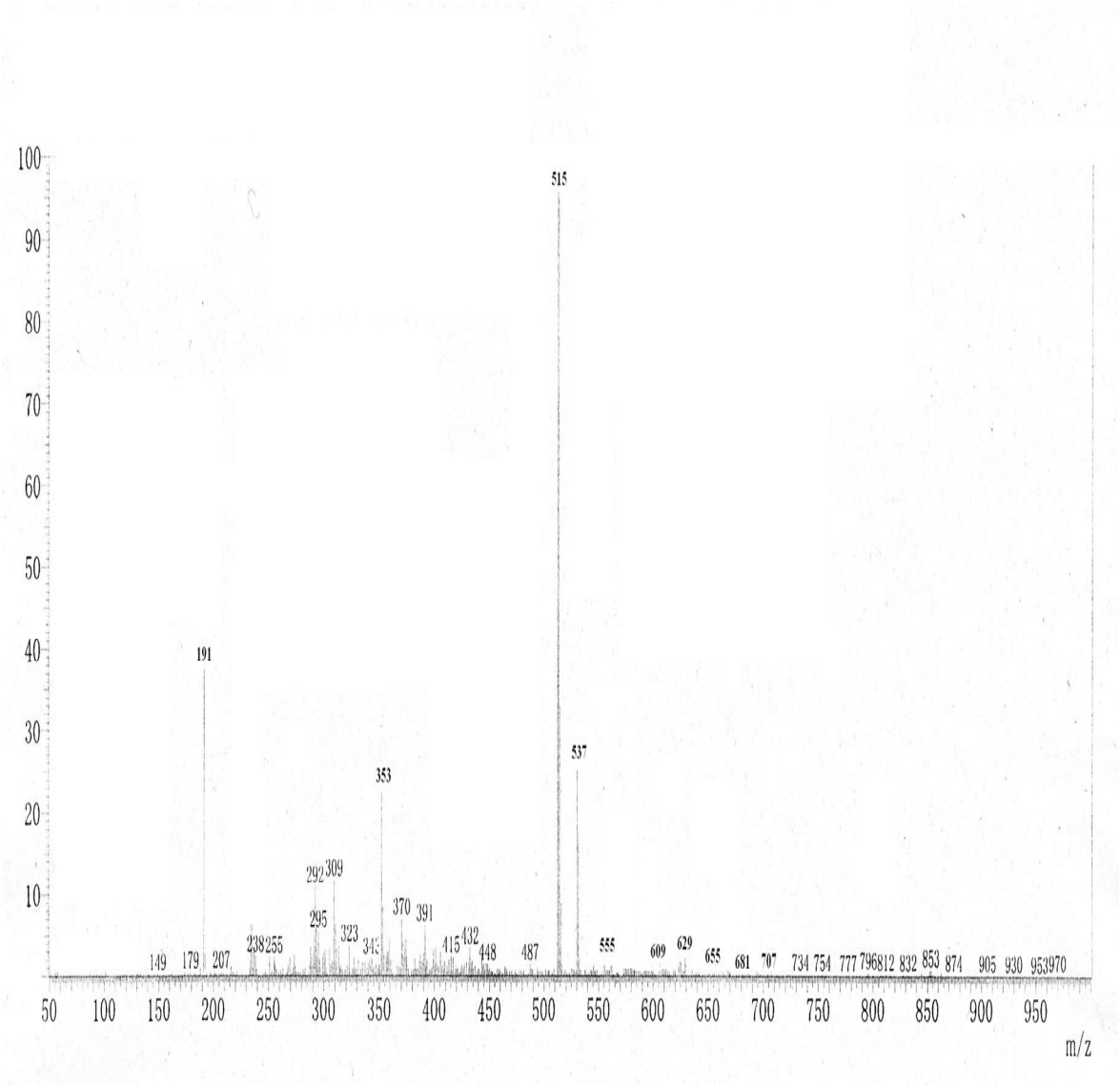
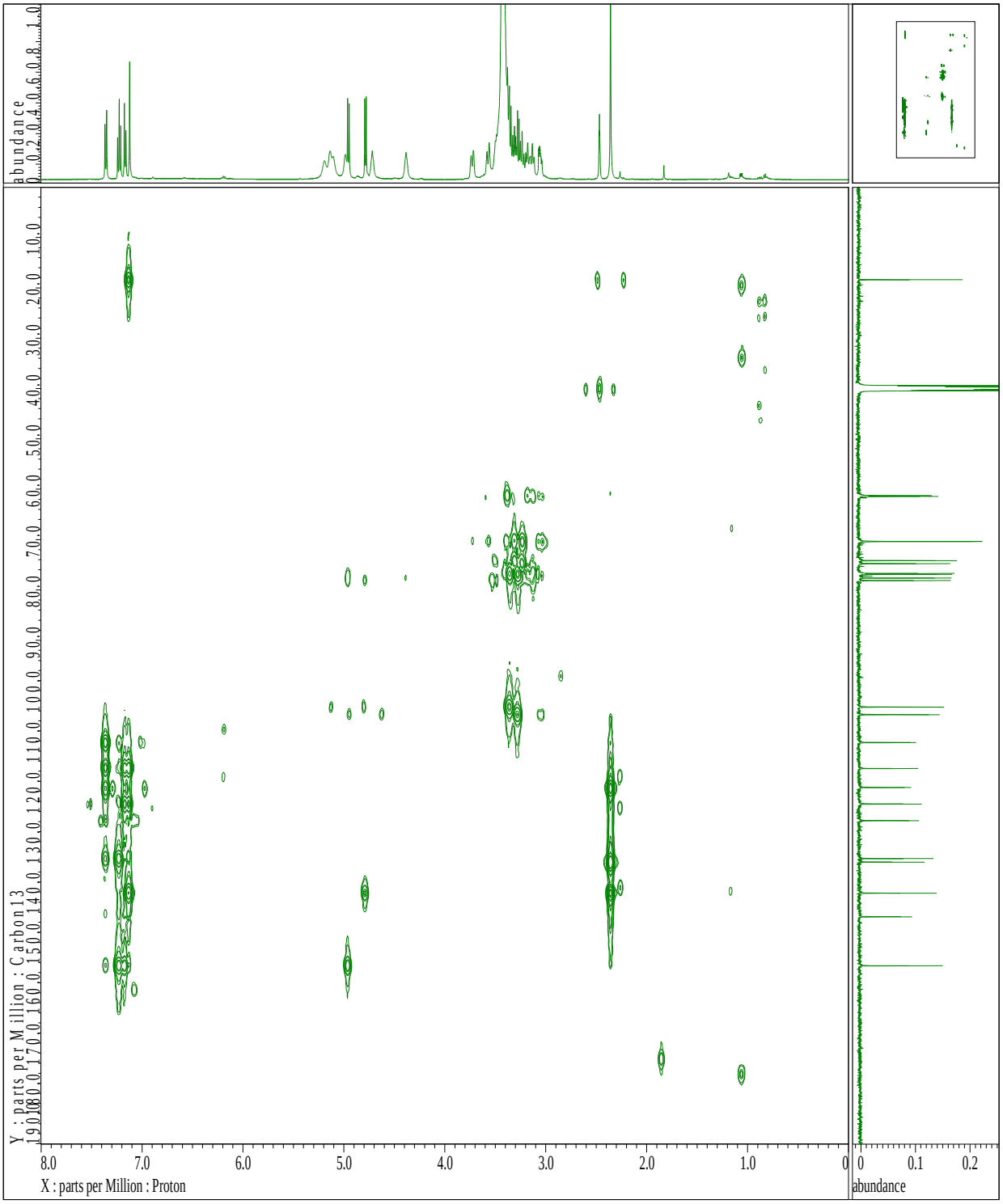
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
X : parts per Million : Carbon13

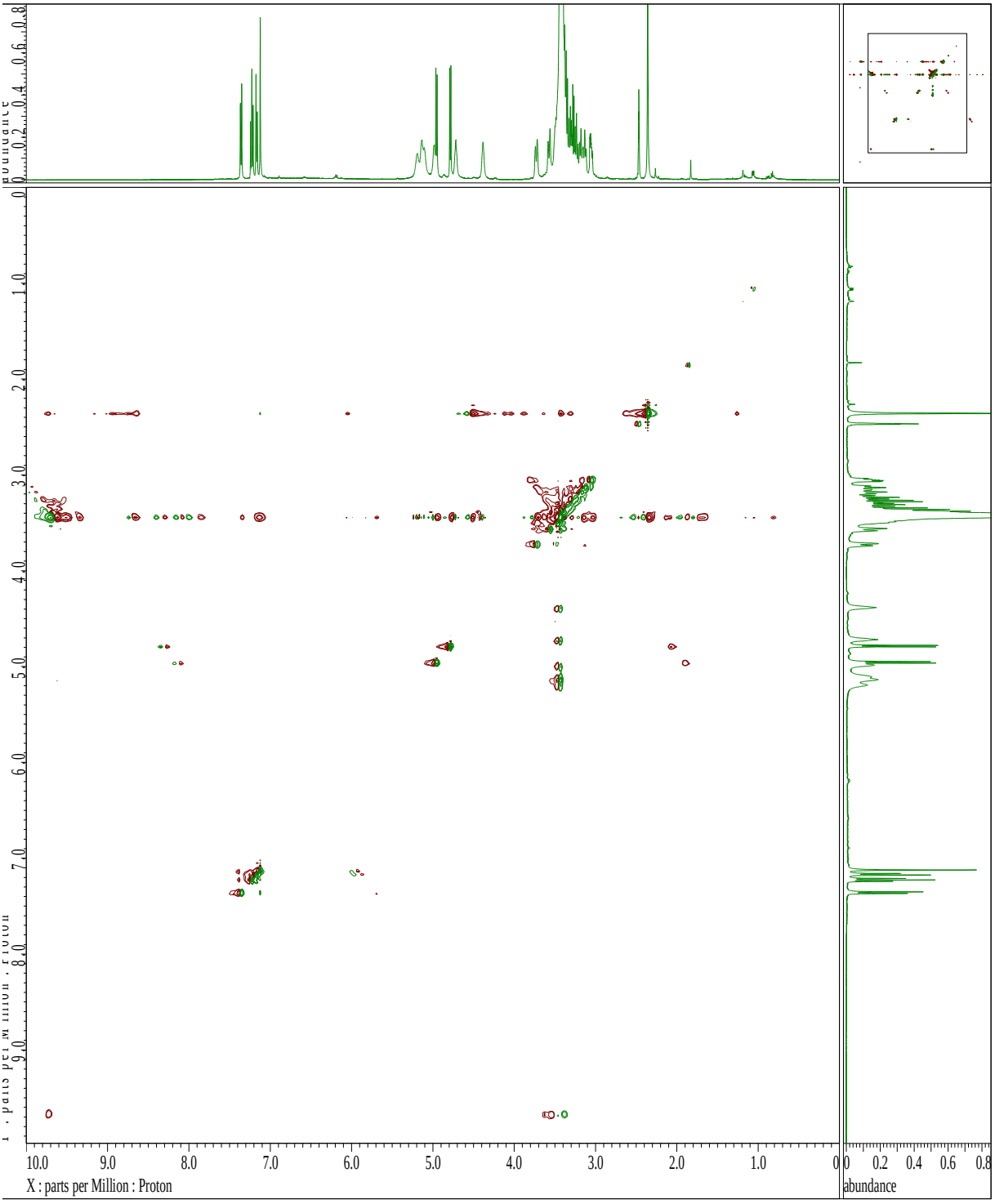
BAO-1 DEPT90



ESI-MS (Positive-mode) of BAO-1


abundance
Y : parts per Million : Carbon13
X : parts per Million : Proton
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
0.1
0.2
abundance

BAO-1 HMBC


10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
X : parts per Million : Proton
0 0.2 0.4 0.6 0.8
abundance

BAO-1 NOESY

Declaration

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university.

Name: Biniam Paulos

Sig _____

This Thesis has been submitted for examination with approval as a university advisor.

Name	Sig
Kaleab Asres (PhD)	_____
Teferi Gedif (PhD)	_____