ETHNOBOTANICAL DOCUMENTATION OF FUNCTIONAL FOOD PLANTS AROUND DEBERE MARKOS DISTRICT, EAST GOJJAM, ETHIOPIA

Hirut Belay

A Thesis Submitted to the Department of Biology

Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology, Addis Ababa University

Addis Ababa, Ethiopia

August, 2016

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Graduate Programs

This is to certify that the thesis prepared by Hirut Belay entitled: *Ethnobotanical Documentation of Functional Food Plants around Debre Markos District, East Gojjam, Ethiopia* and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Biology complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

Signed by the Examining Committee:

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Hirut Belay, MSc, 2016

ABSTRACT

An ethnobotanical study of Functional Food Plants was conducted to document indigenous knowledge of the people in Debre Markos District, East Gojjam, Ethiopia. Data collection was conducted from October, 2015 to July, 2016 using ethnobotanical methods. Among the 21 villages in the District, ten villages were randomly sampled to conduct the study. A total of 80 informants (61 males and 19 females) between ages of 20 and 79 were selected to participate in the study and provide information about Functional Food Plants grown and utilized in the District. Of these 80 informants, 20 were selected (as key informants) based on the recommendation obtained from elders and kebele administrators while the rest were selected through random sampling method. Ethnobotanical data were collected using semi-structured interviews and group discussion. A total of 29 species belonging to 27 genera and 19 families were recorded as functional food plants grown in the District. Poaceae and Fabaceae appeared to be the most diverse families comprising 5 and 4 species, respectively. The habits (growth form) of the species are herbs (23), shrubs (3), and trees (3). The most frequently used plant parts were grains (23.4%), followed by leaves (13.8%). The most widely used method of preparation was cooking/boiling of seeds (23.4%) followed by raw/unprocessed (12.9%). Informant consensus showed that *Lupinus albus* L. (Gibto) to be the most frequently reported species (90%) followed by *Eragrostis tef* L. (Dabbo teff) (78.8%). Preference ranking showed *Linum usitatissimum* L. (Telba) to be the most preferred species to prevent several diseases. Direct matrix analysis based on general use value of functional food plants revealed that *Eragrostis tef* L. (Dabbo teff) to be the most important species. Fidelity level index showed *Cinnamomum verum* L. (Kerefa) and *Lupinus albus* L. (Gibto) to have high functional value to prevent against Diabetes millets and Hypertension respectively. The main threat of few Functional Food Plants as *Lupinus albus* (Gibto) in the study area were reported to be lesson of agricultural lands due to construction of new buildings as the woreda is the central city of East Gojjam Zone. So, stalk holders must give attention to solve the problem.

Key words / phrase: - Debre Markos, Ethnobotany, Functional Food Plants, Indigenous Knowledge, Phytochemicals

ACKNOWLEDGEMENTS

Above all, I want to thank the Almighty God who strengthened me throughout my work and I wish to express my deepest appreciation to my advisor Dr. Tigist Wondimu for her consistent advice, suggestion, comments and follow up starting from the development of the thesis proposal to the safe completion of the thesis paper.

My appreciation goes to my informants for sharing their incredible knowledge. I also thank center 1, center 4, and center 6 Developmental Agencies and also the following offices: District Rural Agricultural Development Office, District Health Office, District Health and HIV/AIDS Prevention and control Office, and District Finance and Economic Development Office for their provision of data and information.

I would like to thank Debre Markos University Biology Department lecturers and Main Library workers and my friends and colleagues for their support while doing the research which was significant for its success.

Addis Ababa University, Collage of Natural Sciences and the Department of Zoology are also highly appreciated for offering me the opportunity of perusing my education to a Master level.

Finally my special gratitude also goes to my families for their moral and financial support to carry out my research. Also my heartfelt thanks to all who participated directly or indirectly in the successful completion of my thesis work.

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LIST OF ABREVATION AND ACRONYMS

DMDARDO – Debre Markos District Agricultural and Developmental Office

DMDFEDO - Debre Markos District Finance and Economy Development Office

DMDH HIV/AIDS PCO – Debre Markos District Health and HIV/AIDS Prevention and Control Office

DMDHO – Debre Markos District Health Office

FAO –Food and Agricultural Organization

FFP – Functional Food Plant

FL – Fidelity Level

ICF- Informant Consensus Factor

IK – Indigenous Knowledge

CHAPTER ONE

1. INTRODUCTION

1.1. Background and Justification

Ethiopia is a country characterized by a wide range of climatic and ecological conditions possessing enormous diversity of flora and fauna. Moreover, the high variability of the geography coupled with complex cultural diversity of the various ethnic groups made the country a home of high diversity of traditional knowledge and practice (Zemede Asfaw, 2001).One of the greatest challenges in researches concerned about food productivity and improvement lies in maintaining sustainable food production while providing high quality food products with added functionality to prevent life-style related diseases (Lizhe and Torsten, 2012).

Functional Foods provide health benefit over and above normal nutrition. Functional Foods are different from medicinal Foods and dietary supplements in that Functional Foods may be consumed freely as part of everyday life. Usually medicinal foods and drugs are used in specific cases to treat disease. In the other hand dietary supplements map over with those foods developed for special dietary uses and fortified foods (Ross, 2000).

With few exceptions, most Functional Foods which have been shown efficacy in reducing lipid and cholesterol levels, increase bone mineral density and antioxidant status as well as possessing anticancer properties obtained from plants (legumes, cereals, grains, fruits and vegetables) (Eskin and Tamir, 2006). However, of the hundreds of plant origin Functional Foods that have been identified, few had been incorporated in to common foods for habitual consumption (Lizhe and Torsten, 2012).

As described by Kebede Deribe *et al.* (2006) healing in Ethiopian traditional medicine is not only concerned with curing of diseases but also with the protection of human physical, spiritual, social, mental and material wellbeing. This implies that traditional knowledge about functionality of food plants in Ethiopia has a very long history. Traditionally the use of Functional Food Plants is still wide spread in Ethiopia, and its acceptability, availability and popularity is no doubt since most of the populations use it. Similar to elsewhere in Ethiopia, people living in Debre Markos District have traditional practices which have passed from generation to generation in order to prevent certain human diseases. However, according to FAO (1995) in many parts of the world including Ethiopia indigenous knowledge is being lost at an accelerated rate and disappears with changes in life style, occupational patterns of house hold members and death of knowledgeable persons.

As the information obtained from Botanical Department of Debre Markos University and to the opinion of the researcher, there has not been any ethnobotanical research carried out in Debre Markos District on "Functional Food Plants". Therefore, the intention of this study was to fill the gap and enrich the limited inventory of Functional Food Plant use of the country by studying and documenting traditionally used Functional Food Plants in Debre Markos District.

The study will generate valuable information on the status of Functional Food Plants and their use in the study area. This will provide a base line data for future researches.

1.2. Statement of the Problem, Research Questions, Hypotheses and Objectives

1.2.1. Statement of the problem

The study site, Debre Markos is found in East Gojjam Zone of Amhara National Regional State (ANRS). It is the central city of East Gojjam Zone, which is in turn located in North Western and North Central part of Ethiopia. The study is selected because there is no documented report on Ethnobotanical information of Functional Food Plants in the district. As a result, to prevent various diseases of humans and to preserve indigenous knowledge of Functional Food Plants, Ethnobotanical information is very important. Therefore, the present study will develop to contribute the documentation of traditional knowledge of the Amhara people as it applies to Debre Markos District Functional Food Plants.

1.2.2 Research question

- What are the important Functional Food Plants that are used by the local people to prevent various human ailments?
- Which parts of the plants are used for such purpose and how are they prepared?

1.2.3. Hypotheses

People living in and around Debre Markos District have deep knowledge on the use of Functional Food Plants that they cultivate.

1.2.4. Objectives of the study

General Objective

The general objective of this study is to investigate and document Functional Food Plants used by the community in Debre Markos District.

Specific Objectives

- To spot out and document the indigenous knowledge of the people on Functional Food Plants in the study site.
- To identify and document the most important Functional Food Plants used by people of Debre Markos District.
- To illustrate plant parts used as Functional Food and method of preparation by the local people of the study area.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. General Perspective of Functional Food Plants

During the first 50 years of the 20th century, scientific focus was on the identification of essential elements particularly vitamins and their role in the prevention of various deficiency diseases. This is not going further, the emphasis on under nutrition is dramatically changed during 1970s, when disease related to over nutrition became a major public health problem and consumers began to focus on wellness and the reduction of chronic diseases (Hasler, 2002). In the 1980s Japanese society, being aware of the aging process, has become more and more concerned with the prevention of the life style related disease, through daily dietary (Functional Foods) (Arai, 2001).

The term Functional Food was first introduced in Japan in the mid-1980s and refers to processed foods containing ingredients that aid specific bodily functions in addition to being nutritious (Roberfroid, 2003).

Many organizations have proposed definitions for this new emerging area of the food and nutrition science (Hasler, 2002):-

- The National Academy of Science, Food and Nutrition Board in 1994 defined Functional Foods as "Any modified food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains."

- The International Life Science Institute defined them as "Foods that, by virtue of the presence of physiologically-active components, provide a health benefit beyond basic nutrition."
- The Institute of Medicine and Nutrition Board (IOM/INB, 1999) define Functional Foods as" Any food and food ingredient that may provide a healthy benefit beyond the traditional nutrient it contains."
- The American Dietetic Association in 1999, position paper, defined Functional Foods as "foods that are whole, fortified, enriched or enhanced." But more importantly, states that such foods must be consumed as part of a varied diet on a regular basis, at effective levels for consumers to reap their potential health benefits.

Definition of Functional Foods varies among countries for reasons that are historical, cultural and regulatory. In most countries a Functional Food must take the form of food or beverage not a medication, and should be consumed the way a conventional food or beverage is consumed (Galland, 2005).

The use of Functional Foods for promoting health and relieving symptoms is as old as the practice of medicine. Specific dietary recommendations for treating or preventing various types of illness have been documented in Hippocratic and Vedic texts and the Canons of traditional Chinese medicine (Galland, 2005).Functional Foods are used, distributed and regulated differently from medical foods and drugs, in that Functional Foods may be consume freely as part of everyday life while medical foods and drugs are used in specific cases to treat or manage a condition under medical supervision (Ross, 2000). Another term often used interchangeably with Functional Foods is "nutraceuticals", a term coined in 1991 by Foundation for Innovation in Medicine to refer nearly any bioactive component that delivers a health benefit. Also the term

nutraceuticals defined as "food or part of food that provide medical or health benefits" (Felice, 1999 cited in Tigist Wondimu *et al.,* 2006).

In the last decade, preventive medicine under gone a great advance. Many researches have demonstrated that nutrition plays a crucial role in the prevention of chronic diseases (Lopez-Varela *et al.,* 2002), in particular those physiologically active components in food called Functional Foods. Clearly all foods are functional, as they provide taste, aroma or nutritive values but these foods provide an additional physiological benefit beyond that of meeting basic nutritional needs in that they provide health benefit and enhance performance above their nutritional values (Kwak and Jukes, 2001)

The concept of Functional Foods derives from the observation that certain foods and beverages exert beneficial effects on human health that are not explained by their nutritional content. Scientists also begun to identify physiologically active components in foods from both plants and animals known as phytochemical and zoochemical respectively, that potentially could reduce risk for a variety of chronic disease (Hasler, 2002). Phytochemicals are naturally occurring bioactive components of plants. Plant foods contain many bioactive compounds (phytochemicals) in addition to those traditionally considered as nutrients, such as vitamins and minerals (Rodriguez *et al.,* 2006). Phytochemicals other than traditional nutrients can reduce cancer risk (Steinmetz and Potter, 1991a). Latterly health professionals recognized the role of phytochemicals not only reduced risk of cancer but also their role in health enhancement (Howard and Kritcheveky, 1997).

Truswell (2002) revealed that Wheat, buck wheat, barley, brown rice, oats, soy, flax seed and products; tomatoes, garlic, other cruciferous vegetables; citrus compound wine and grapes are the most common plant based Functional Foods.

2.2. Functional Food Plants in Ethiopia

The various climatic and topographic conditions of the country contributed to a rich biological diversity. Ethiopia is believed to be home of about 6000 species of higher plants with approximately 10% endemism (Vivero *et al.,* 2006). Similarly as it was reported by IBC (2008) the flora of Ethiopia consists of an estimated number of 6000 species of higher plants with 10-12% endemism. Functional Food Plants also part of those many plant species of the country. Like all other parts of the world plants are used as a source of Functional Food in Ethiopia and also each tribe in Ethiopia has its own belief and attitudes related to foods. Some of these are related to food and disease prevention and treatment; others in qualities as cold or hot, light or heavy foods. Ethiopia has not only a long history on the use of traditional medicine to combat disease but also use plants to prevent disease. Mekonnen Bishaw (1991) described traditional medicine healing practice is not concerned with curing diseases but also with protection and promotion of human health status. So, the attitude of Ethiopians about Functional Food Plants is as old as their traditional medicine healing practice.

Ethiopia in Africa is center of origin for 38 species in crop. Of them flax seed (*Linum usitatissimum*), Garden cress (*Lepidium saivum*), barley (*Hordeum vulgare*), sesame (*Sesamum indicum*), coffee (*Coffee 8rabica*) and castor bean (*Ricinus communis)* are functional crops which recognized to have anticancer value (Zeng *et al.,* 2015). Additionally on the review, Cherry Creek nutrition.com of 10 top Functional foods in 2009, eight of them are from plant

origin as broccoli, green leafy vegetables, oranges, carrots, garlic, fiber, oats and tomato which are common plant species in Ethiopia.

Recently, considering the western consumers‟ trend on Functional Foods and health benefits, certain researches to increase functionality of Ethiopian traditional foods is carried out. For instance research carried by Geremew Bultosa *et al*. (2015) aimed at studying to improve nutrients and functional properties of "Beso", suggesting to include roasted faba bean and dried carrot flour to 50-60% of barley rather than to use only one grain (barley).

2.3. Indigenous Knowledge of Functional Food Plants in Ethiopia

Nyirenda (2011) described indigenous knowledge as the unique, traditional, local knowledge existing within and developed around the specific conditions of woman and men indigenous to a particular geographic area. As the life activities of human beings are more inter related to plants, traditional people around the world possess unique knowledge of plant resources on which they depend for wood, medicine and general utility including tremendous botanical expertise (Martin, 1995). In the same way mentioned by different authors (Fassil Kibebew, 2001; Berhanemeskel Weldegerima, 2009) people in Ethiopia have their own indigenous knowledge on plant resource utility. Such knowledge systems are cumulative, representing generations of experiences, careful observations and trial and error experiments (Behailu Etana, 2010). Beside these the indigenous knowledge of Ethiopians about Functional Food Plants is as old as their knowledge since utilized plants for medicinal purpose and well physical being (Mekonnen Bishaw, 1991).

2.4. The Importance of Functional Food Plants in Human Health Care System

Functional Foods can lessen the incidence of disease and provide a cost effective way to maintaining the body and organs in good health. Evidence from epidemiological, invivo, invitro and clinical trial data indicates that plant based diet can reduce the risk of chronic disease (Krinsky and Johnson, 2005).

In the other hand, Burkit (1969) studied the effect of diet rich in fiber on African people. This author observed that population consumed plants rich in fiber did not suffer with certain disease such as colon cancer, that are very common among more developed occidental societies, where fiber consumption was much lower. Also, Walker (1974) carried out a comparative study on the diet of black and white people in South Africa and found that the black population which consumed non-refined maize flour with high content of fiber has less risk of suffering disease such as atherosclerosis, hemorrhoids and colon cancer.

The change in dietary behavior such as increasing consumption of fruits, vegetables and grains is a practical strategy for significantly reducing the incidence of chronic disease. Meaning consumption of vegetables as well as grains has been strongly related with reduced risk of cardiovascular disease, cancer, diabetes, Alzheimer, cataracts and age related functional decline (Arshed, *et al.,* 2013). In addition Hasler (2002) mentioned that consumption of Functional Foods or their associated physiological active components may be linked to disease risk reduction; the great majority of these components derived from plants.

Generally, Functional Foods are not pills or capsules but are consumed as part of a normal every day diet; at the moment the most important and the most frequent used Functional Food components are plant antioxidant which are connected to reduction of cancer risk, improvement

of gastrointestinal health, stimulation of immune system, decrease of menopause symptoms, improvement of heart health, maintenance of urinary tract health, anti-inflammatory effects, reduction of blood pressure, maintenance of vision, antibacterial, antiviral and reduction of osteoporosis (Grajek, 2005).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. Geographical location of the study area

Debre Markos is one of the 18 Districts of East Gojjam Zone and one of 151 districts in Amhara National Regional State (DMDARDO, 2015). It is the major town of East Gojjam Zone, which is situated at about 295 km from Addis Ababa and 265 km from Bahir Dar, the central city of ANRS. It comprises 7 kebeles. Its altitude is about 2420m-2509m above sea level, and is located in geographical coordinates of 10^0 20¨ N. 37^0 43‟ E.\ 10^0 333¨ N. 37^0 717¨ E. (Fig.1). The district is bounded by Gozamin district in the east, in the north and in the west; and also by Aneded district in the south. The topography of the woreda is often 98% plane and 2% plateau (DMDFEDO, 2015).

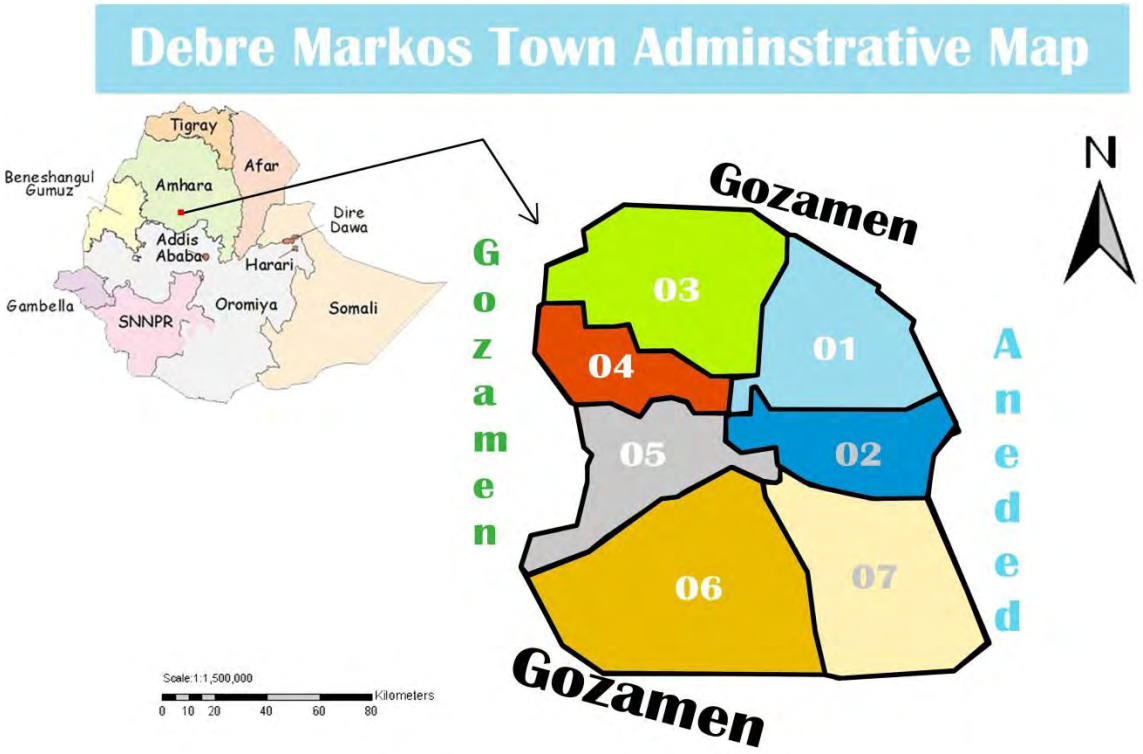

Figure 1:- Map of Debre Markos District (source: DMDFEDO, 2015)

3.1.2. Soil and drainage

In Debre Markos District, there are two dominant soil type, namely clay soil and black soil, each covering about 73% and 27% respectively. The topography, vegetation and rain fall pattern in the district encourages the existence of few perennial rivers as Wetrin, Weseta and Chemoga that have been provided irrigational function under traditional system (DMDARDO, 2015).

3.1.3. Climate and ecology

Traditionally, the agro-climatic zone of the District is recognized as „weina-dega" with average annual temperature ranging between 15^0 and 20^0 c. The district is characterized by having unimodal rain fall where the total annual rain fall is received in the end of April to October with average annual range between1200mm and1380mm (DMDARDO, 2015).

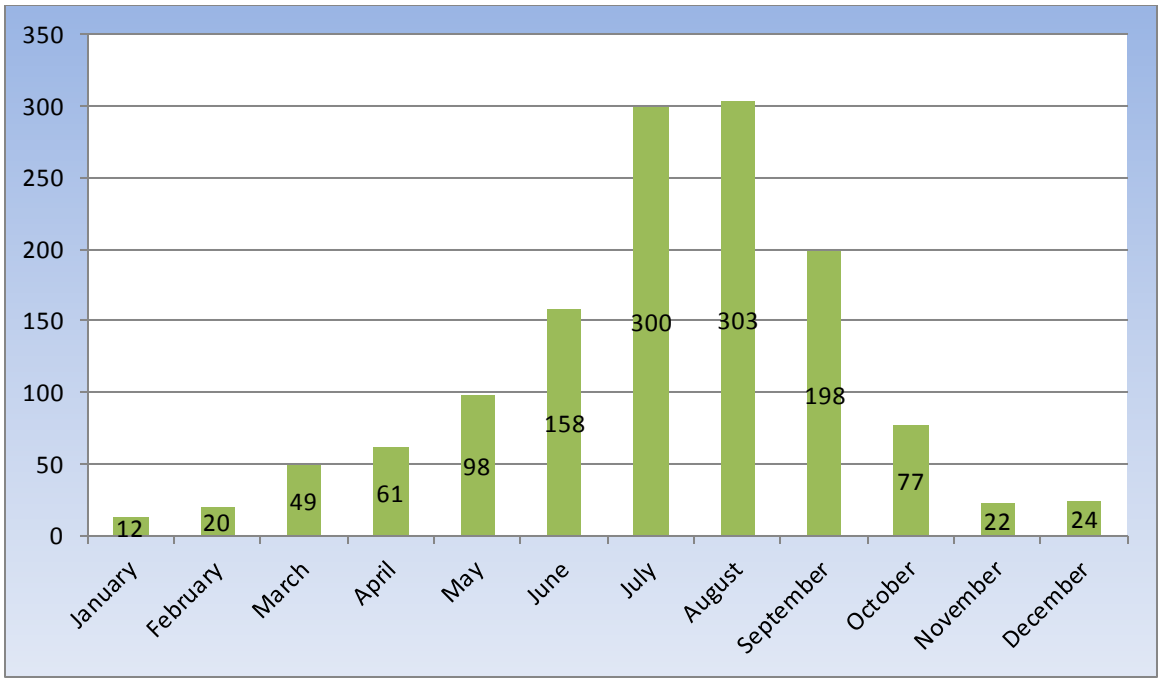

Fig.2:-Monthly precipitation of Debre Markos District, 2015 (Source of data:-Versat international LLC)

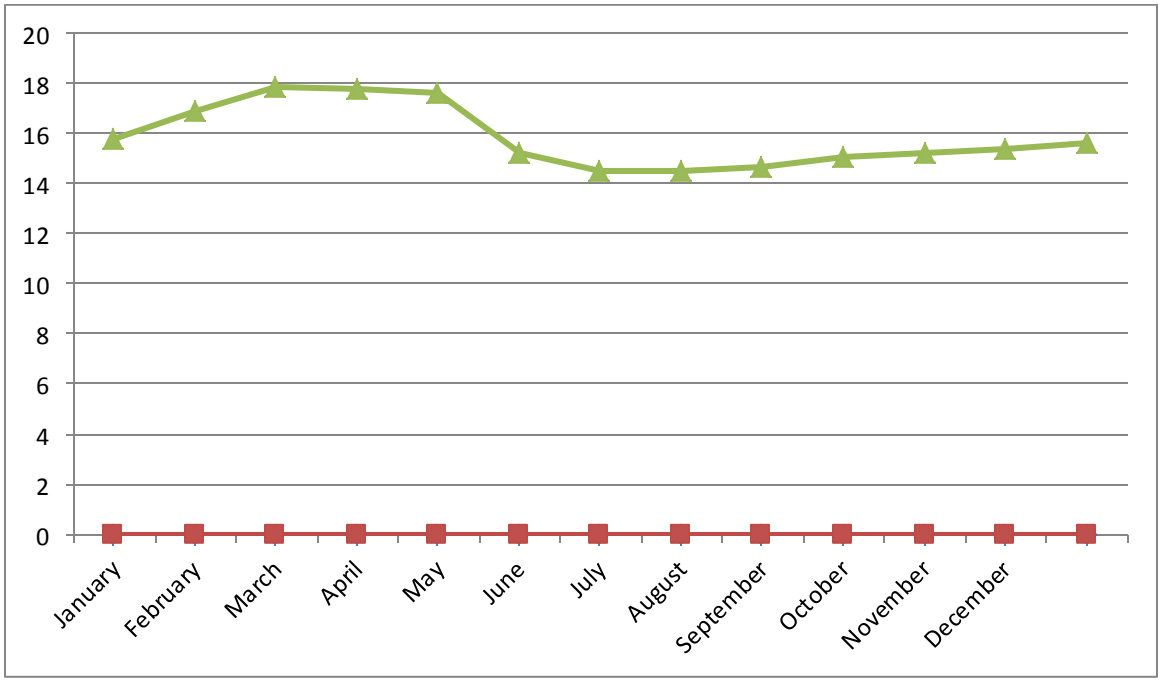

Fig.3:- Monthly temperature of Debre Markos District, 2015 (Source of data: - Versat international LLC)

Crop production is entirely rain fed and in small scale irrigation practices. There is only one rainy season (termed as „kiremt" in the local language), and it is important for the cultivation of both long and short cycle crops.

The agricultural system of the area is mixing farming system, Crop production under this farming system is multiple cropping with limited area is intensively employed. Traditionally, continuous cropping is exercised through crop rotation, where cereal production alternates with the production of legume crops as means of maintaining soil fertility.

The food crops growing in the district are cereals (wheat, teef, maize, barley, engedo, oat), pulses (chick peas, pea, bean, gibto), oil crops (nug, telba, gomenzer), fruits (papaya, abukado, apple, zeyituna, pom, cock, lomi, orange, mango, banana, tirengo), vegetables (garlic, cabbage, tomato, pumpkin, salad, kosta), root crops (sweet potato, potato, reddish, carrot) and some cash crops such as coffee and chat are grown (DMDARDO, 2015).

3.1.4. Land use and agricultural system

According to the information obtained from DMDARDO, (2015), the district covers a total area of 6160 hectars, of which the largest proportion, is agricultural land (2363 ha., 38.36%) followed by residence, road and water bodies land of 1995 ha.(32.4%). There are also other land features that share considerable areas as listed in table 1.

Table 1:- Land use patterns of Debre Markos District

Land use	Area (ha)	Percentage
Agricultural land	2363	38.36
Residence, road and water bodies	1995	32.40
Grazing land	815	13.23
Forest areas	624	10.12
Irrigation areas	363	5.89
Total	6160	100

Source: (DMDARDO, 2015)

3.1.5. Population structure and medical service

The total population of the district is 107433, of whom 50036 are males and 57397 are females. Of the total population a total of 1268 (1053 males and 215 females) are rural dwellers and 106165 (48983 males and 57182 females) are urban dwellers. The largest ethnic groups reported in the district are the Amhara (98%), Oromo (0.8%) and others (1.2%). 1Amharic is spoken as first language by 99.3% and the majority of population (96%) followed Orthodox Christianity, while the rest practice Protestant and Islam (DMDFEDO, 2015).

According to DMDHHIV/AIDSPCO, (2015), the first ten top human diseases in the area are acute upper respiratory infection 3431 (20.53%) people infected followed by Dyspepsia (gastritis) 1984 (11.87%) and the others are mentioned on Table 2.

Table 2:- Top ten human diseases in Debre Markos district

Type of disease	No of people affected	Percentage
Acute upper respiratory infection	3431	20.53
Dyspepsia (gastritis)	1984	11.87
Acute febrile illness	1891	11.31
Parasitic disease	1600	9.57
Disease of musculoskeletal system and connective tissue	1506	9.01
Urinary tract infection	1407	8.42
Diarrhea	1338	8.01
Un specified digestive system disease	1305	7.81
Eye disease	1159	6.93
Pneumonia	1093	6.54
Total	16714	100

Source: DMDHHIV/AIDSPCO, (2015)

However, according to DMDH HIV/AIDSPCO (2015) few numbers of the people of Debre Markos are affected by chronic diseases such as diabetes, hypertension, heart disease and cancer are 104, 432, 5 and 12 respectively.

3.2. Methods of the Study

3.2.1. Design of the research

The cross-sectional study was designed to investigate and document the Functional Food Plants in Debre Markos District. Collecting of journals and other literatures is employed from September 30, 2015- November 12, 2015. Reconnaissance survey was conducted from October 5

to November 5, 2015. Developing proposal and its submitting has relayed till November 27, 2015. Data gathering was carried out from December 22, 2015 to the first two weeks of March, 2016 and then developing of thesis is accomplished from the mid of April to the end of June, 2016.

3.2.2. Reconnaissance survey and selection of the study sites

Reconnaissance survey was conducted from October 5 to November 5, 2015, before the start of the actual study in order to obtain an impression about Functional Food Plants and to identify sampling sites. During the survey, 10 representative villages selected from 7 kebeles (Table 3). To determine number of representative villages the selection was made systematically in that by considering the population size with number of villages in each kebele, and random selection was employed to determine sample sites from each kebele. Thus, study site selection followed systematic simple random sampling method.

Table 3:- Study kebeles with their corresponding sampling site and no. of informants participated.

Study kebeles	Sample villages	Population size	Number of informants	Total
1	Endegem	12762	9	9
2	Engecha	13505	10	10
3	Shola amba Yebragie	27163	13 8	21
4	Yemeka	14000	10	10
5	Kebi achira Muakuat	18016	7 6	13
6	Yenora	10921	7	7
7	Abedeg Chemoga	11066	6 4	10
Total	10	107433	80	80

Source of population data: DMDFEDO, (2015)

3.2.3. Selection of informants

A total of 80 informants (male 61, female 19) were selected with age between 20 and 79 years and the number of informants from each kebele determined systematically based on the proportion of the population size. Beside this twenty informants who are elders and knowledgeable persons were identified as key informants following purposive sampling (Martin, 1995) and other informants selected randomly from the sampled villages. The key informants

were selected based on the recommendation and comments of elders, farmers, students, religious leaders and researcher's observation from the community group.

3.2.4. Age group, educational and marital status of informants

Eighty informants in the study area were represented in four age groups. They included the young (20-34), the middle age (35-49), the elder (50-64) and elderly (65-79). The highest number of informants was obtained from the middle age groups. Males were more in number (61) compared from females (19). Most of the informants (31) were able to read and write. About 68 of the total informants were married (Table:-4).

Table 4:- Demographics

	Age group (in yrs.)	Sex and no of informants		Total
		Male	Female	
Age group	20-30	13	5	18
	35-49	21	10	31
	50-64	20	3	23
	65-79	7	1	8
Education level	Illiterate	12	3	15
	Only read and write	22	9	31
	Modern education	20	7	27
	Church education	7	-	7
Marital status	Single	6	2	8
	Married	53	15	68
	Divorce	2	2	4

3.2.5. Ethnobotanical data collection

Ethnobotanical data collection was conducted from December 22, 2015-March 21, 2016. Ethnobotanical data such as different types of Functional Food Plants, diseases have been prevented, parts used and method of preparation; following the data collection tools recommended by Martin (1995).

Semi- structured interview-Ethnobotanical data collection through semi-structured interview was performed on the basis of check list item questions prepared in English (Appendix 2) and later translated to Amharic. The items include information on informants personal identity, local health problem, names of Functional Food Plants, part(s) used, methods of preparation and disease prevented. The entire interview with informants was done through direct communication between the researcher and informants (Fig. 4). The willingness of informants was first confirmed before starting data collection. This was done through awareness creation for informants by describing the future significance of the research for the study area and for the country.

Fig. 4:- Photographs showing group discussion to key informants during ethnobotanical data collection

Group discussion- Short and precise group discussions were made with informants regarding the Functional Food Plants in the study sites. Information on local names of the Functional Food Plants, their uses, methods of preparation, indigenous knowledge on them and related data were recorded.

3.2.6. Functional Food Plant specimen collection and identification

The voucher specimens were collected during guided field walk, numbered, pressed and dried for identification. Identification was done by using Flora of Ethiopia and Eritrea with the help of some staff members of Debre Markos University, Biology Department.

3.3. Data Analysis Procedures

3.3.1. Descriptive statistics

The collected ethnobotanical data were analyzed following survey and analytical tools for ethnobotanical methods, which are recommended by Martin (1995) and Alexiades (1996). Descriptive statistical methods were employed to analyze and summarize the data on Functional Food Plants and associated knowledge obtained from informants of the study area. The most useful information gathered on Functional Food Plants reported by local people including functional value and method of preparation were analyzed by using appropriate software and descriptive analysis method.

3.3.2. Informant consensus

In order to evaluate the reliability of information during the interview, informants were contacted consequently, if the idea of the informant deviates from the original information, it was rejected since it was considered as irrelevant information. Only the relevant ones were taken in to account and statistically analyzed; this method was adopted from Alexiades (1996). Similarly, informant consensus factor was quantitatively analyzed for six groups of plant uses reported by informants.

ICF=nur-nt /nur-1 Where, ICF= Informants Consensus Factor

nur = number of use citation in each category

nt = number of species used

3.3.3. Preference ranking

Preference (priority) ranking was performed using seven key informants for most Functional Food Plants used to prevent the most prevalent disease in the study area. Accordingly, five Functional Food Plants were chosen to be ranked preferentially by key informants on the bases of preventing Gastritis using a numerical scale (0 for no value, 1 for lowest value and 5 the highest value, and the rest with intermediate values). Values given by the key informants were added to identify the ranks of Functional Food Plants preference by the community in the study area. The highest score ranked as first while the lowest score ranked last, and the rest take different ranks according to the scores obtained from the analysis. A similar analysis was conducted on the on six Functional Food Plants on the degree of preventing of several diseases.

3.3.4. Direct matrix ranking

Direct matrix ranking is used in order to compare multiple purposes of plants commonly reported by informants Cotton, (1996). Thus based on the relative benefits obtained from each plant direct matrix ranking exercise was employed on eight Functional Food Plants reported for more than four number of plant uses (attributes) reported by informants during the general group discussion and semi-structured interview with key informants. Based on their perceived level of usefulness; use values to each attribute assigned as (5-best, 4-very good, 3-good, 2-less used, 1-least used and 0-no used); later the values assigned for each plant were added together to determine its rank.

3.3.5. Fidelity level index

Fidelity level index (FL) is used in order to claim the use of a certain plant species for the same major purpose (Alexiaden, 1996). Accordingly, fidelity level was calculated for Functional Food Plants used to prevent Diabetes and Hypertension. Fidelity level is calculated as:-

FL (%) = (NP/N) X 100 Where NP =Number of informants that claim a use of a Plant species to prevent a particular disease

N = Number of informants that use the plant as a Functional Food, as described by Alexiades (1996).

CHAPTER FOUR

4. RESULT AND DISCUSSION

4.1. Status of Indigenous Knowledge Related to Functional Food Plants in the Study Area

The local people of the study area use different Functional Food Plants to prevent /treat different diseases. In the area, several health problems except few (as TB, pneumonia, acute diarrhea) are believed to have plant or spiritual remedies. These people use different Functional Food Plants for the prevention of different diseases which assumes also immunity boosting function. Informants reported that knowledge on Functional Food Plants as health function obtained informally from friends or elders of neighbors‟ mostly through discussion and mainly during the outbreak of health associated problem accounted about 70% of the respondents. The second main source of knowledge acquisition was from family members by attaining the knowledge from their parents which accounted 20% of the response frequency.

Most of the indigenous knowledge acquisition from elders, parents, or friends transferred orally as it is done elsewhere (Abbasi *et al*., 2013). Therefore, the transferring system may be threat to the indigenous knowledge. In many parts of the world including Ethiopia, indigenous knowledge is being lost at an accelerated rate and disappears with changes in life style, changing occupational patterns of household members and death of village elders (FAO, 1995). Many of the informants involved in this research also agree that the knowledge system is being threatened due to modernization.

4.2. Functional Food Plants in the Study Area

4.2.1. Distribution of functional food plants among taxa

A total of 29 species belonging to 27 genera and 19 families were identified and documented during the study. Poaceae appeared to be the most diverse family that included six species under five genera, followed by Fabaceae including four species under four genera. This might be because these families are the most abundant, utilized and cultivated food plants in this area. Solanaceae having two species and two genera, Rutaceae with two species under a genus and the rest (15) included one species each (Table 5). This reveals the presence and utilization of high diversity of Functional Food Plants in the study area. In the other hand utilization of plant species for certain purpose and indigenous knowledge about them largely related to biodiversity.

Table:-5 Number of Functional Food Plant species in each family in the studying area

Family	*Scientific name*	*Vernacular name*	Habit	No. of genera	No. of species	Percentage of plant species	Abundance
Alliaceae	*Allium sativum*	Nech shinkurt	Herb	1	1	3.44	Common
Apiaceae	*Daucus carota*	Carrot	Herb	1	1	3.44	Common
Asteraceae	*Guizotia abyssinica*	Nug	Herb	1	1	3.44	Common
Brassicaceae	*Brassica carinata*	Yabeshagomen	Herb	1	1	3.44	Common
Caricaceae	*Carica papaya*	Papaya	Tree	1	1	3.44	Common
Chenopodiaceae	*Beta vulgaris*	Key sir	Herb	1	1	3.44	Common
Cucurbitaceae	*Cucurbita pepo*	Duba	Herb	1	1	3.44	Common
Fabaceae	*Cicer arietinum* *Lupinus albus* *Trigonella foenum graecum* *Vicia faba*	Shimbra Gibto Abish Bakela	Herb Herb Herb Herb	4	4	13.79	Common Common Common Common
Lamiaceae	*Thymus schimperi*	Tosign	Herb	1	1	3.44	Rare
Lauraceae	*Cinnamomum verum*	Kerefa	Tree	1	1	3.44	Rare
Lineaceae	*Linum usitatissimum*	Telba	Herb	1	1	3.44	Common
Pedaliaceae	*Sesamum orientale*	Selit	Herb	1	1	3.44	Rare
Poaceae	*Avena sativa* *Eragrostis tef* *Hordeum vulgare* *Sorghum bicolor* *Triticum dicoccon* *Triticum aestivum*	Engedo Dabbo teff Gebis Zengada Ajja Sendie	Herb Herb Herb Herb Herb Herb	5	6	20.68	Common Common Common Common Common Common
Ranunculaceae	*Nigella sativa*	Tikurazemud	Shrub	1	1	3.44	Rare
Rutaceae	*Citrus aurantifolia* *Citrus sinensis*	Lomi Birtukan	Shrub Shrub	1	2	6.89	Common
Solanaceae	*Lycopersicon esculentum* *Solanum tuberosum*	Timatim Dinich	Herb	2	2	6.89	Common Common
Thaeceae	*Camellia sinensis*	Shay kitel	Tree	1	1	3.44	Rare
Urticaceae	*Urtica simensis*	Sama	Herb	1	1	3.44	Common
Zingberaceae	*Zingiber officinale*	Zingible	Herb	1	1	3.44	Common

4.2.2. Diversity of habits (growth forms) of Functional Food Plants

Analysis of habits of Functional Food Plants in the study area reveals that herbs constitute the largest category with 23 species (79.3%) followed by shrubs and trees with 3 species each (10.34%) (Fig.5).

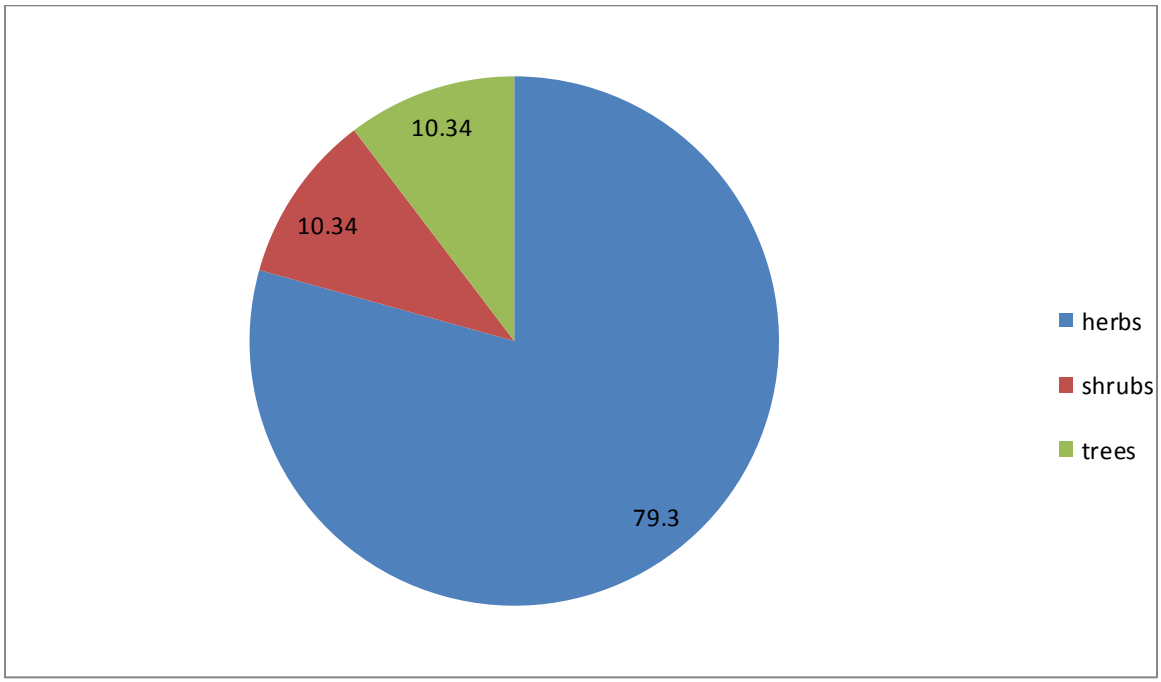

Fig.5:- Habits (growth forms) of Functional Food Plants in the study area

4.2.3. Human diseases and the corresponding number of Functional Food Plant species used in the study area

A total of 29 food plant species are reported to have disease prevention and immunity boosting value. Most of them are common species of the area and utilized commonly in the community of the study area. Beside these, most of them are conventional foods their preparation method is in similar way of preparing our daily diet (Table:-6).

Table 6:- List of Functional Food Plants; family; local name; habit (hb) H-herb, T-tree, Sh- shrub; habitat (H) Hg-home garden, Cu-cultivated; plant parts used (Pp); disease prevented and methods of preparation.

Scientific name of FFP	Family	Local name in Amharic	Hb	H	Pp	Disease type	Method of preparation
Allium sativum L.	Alliaceae	Nech shinkurt	H	Hg	Bulb	Cancer, hypertension. Microbial disease	The crushed bulb *of Allium sativum* with daily prepared food as in "watt." Crushed bulb with tea or honey.
Avena sativa L.	Poaceae	Engedo	H	CU	Grain	Diabetes, general weakness, osteoporosis.	The grain of *Avena sativa* is powdered & baked to form "injera" or the grain powder is mixed with *Hordeum vulgare & Triticum dicoccon* and boiled to make "atmit*"* (gruel).
Beta vulgaris L.	Chenopodiaceae	Keysir	H	Hg	tap root	Hypertension	The tap root of *Beta vulgaris* is roasted or cooked.
Brassica carinata A.Braun	Brassicaceae	Yabeshago men	H	Hg	Leaf	Constipation and Cancer	The leaf of the plant chopped and cooked with oil and *Allium cepa* for few minutes.
Camellia sinensis L.	Thaeceae	Shay kitel	T	Cu	Leaf	Heart disease & [illegible]	Boil the leaf of the *Camellia sinensis* with water.
Cicer arietinum L.	Fabaceae	Shimbra	H	Cu	Grain	Diabetes & general weakness	The grain of *Cicer arietinum* roasted as "Kolo" or cooked as Nifro or the roasted powder as "Shiro".
Carica papaya L	Caricaceae	Papaya	T	Hg	Fruit and Grain	Gastritis Helminthiasis	The fruit of *Carica papaya* is eaten without processing/raw The grain of *Carica papaya* dried crushed and drink with tea.
Cinnamomum verum L.	Lauraceae	Kerefa	T	Cu	bark	Diabetes	The bark of *Cinnamomum verum* boiled with water or with tea or the powder mixed with honey.
Citrus aurantifolia Christm.	Rutaceae	Lomi	Sh	Hg	Fruit	Microbial disease Cancer	Juice of the fruit *Citrus aurantifolia* poured on uncooked vegetables as salad or with tea. Eating the fruit as it is.
Citrus sinensis L.	Rutaceae	Birtukan	Sh	Hg	Fruit	Microbial disease	The fruit or juice of the plant.
Cucurbita pepo L.	Cucurbitaceae	Duba	H	Hg	Fruit	Gastritis Helminthiasis	Eating the fruit of *Cucurbita pepo* after boiled and then cooled. Roasting the dried seed of the plant.
Daucus carota L.	Apiaceae	Carrot	H	Hg	root	Cancer	Eat unprocessed fresh, roasted cooked, juice of *Daucus carota* root.
Eragrostis tef L.	Poaceae	Dabbo teff	H	Cu	Grain	Anemia	The grain powder of *Eragrostis tef* as "injera" or "atmit" gruel.

Scientific name of FFP	Family	Local name in Amharic	Hb	H	Pp	Disease type	Method of preparation
Guizotia abyssinica L.f.	Asteraceae	Nug	H	Cu	Grain	Bronchitis	The grain of *Guizotia abyssinica* is roasted, well ground and eaten with "Kolo" prepared from *Horedeum vulgare* and *Cicer arietinum* or boiled with water and drunk after filtering.
Hordeum vulgare L.	Poaceae	Gebis	H	Cu	Grain	Gastritis Osteoporosis or general weakness	The grain of *Hordeum vulgare* dehulled and roasted then ground and the powder mixed with water and honey or sugar as" beso" or the roasted hulled grain of the plant as" Kolo". Hull roasted and grinded seed of *Hordeum vulgare* cooked as porridge.
Linum usitatissimum L.	Lineaceae	Telba	H	Cu	Grain	Gastritis Constipation, Breast cancer, Attention deficit	The seed of *Linum usitatissimum* soaked with water and boiled then cooled and drunk. The seed of *Linum usitatissimum* at any form usually the roasted and grinded seed mixed with warm water.
Lupinus albus L.	Fabaceae	Gibto	H	Cu	Grain	Hypertension	The seed of *Lupinus albus* are eaten after soaking for 2-3 days to remove a bitter taste, roasted& boiled and then spiced with onion and pepper or processed in the way which local areki synthesized to prepare Gibto areki.
Lycopersicon esculentum Mill.	Solanaceae	Timatim	H	Hg	Fruit	Anemia, heart disease & cancer	The juice, fresh or canned *Lycopersicon esculentum;* the whole fresh or canned or crushed diced fruit or as tomato paste and soup.
Nigella sativa L.	Ranunculaceae	Tikur azmud	Sh	Hg	Grain	Constipation, liver disease & general weakness	The seed of *Nigella sativa* powdered and mixed with honey or in the dough used to bake bread or chewing the seed as it is.
Sesamum orientale L.	Pedaliaceae	Selit	H	Cu	Grain	Diarrhea	The seed oil of *Sesamum orientale* or the roasted seed on bread as spice.
Solanum tuberosum L.	Solanaceae	Dinich	H	Hg & Cu	Tuber	Gastritis	The tuber of *Solanum tuberosum* in the form of juice.
Sorghum bicolor L.	Poaceae	Zengada	H	Cu	Grain	Hypertension and diabetes	The grain powder of *Sorghum bicolor* as a form of "atmit" or "injera".
Triticum dicoccon schrank	Poaceae	Ajja	H	Cu	Grain	Diabetes, blood pressure, rheumatism and osteoporosis	The flour from the grain of *Triticum dicoccon* as bread or "atmit" or the crushed seed as "Kinchie" or soup.
Triticum aestivum L.	Poaceae	Sendie	H	Cu	Grain	Constipation	The whole grain flour of *Triticum aestivum as* "injera" or bread. Also the seed roasted as "Kolo".
Thymus schimperi R.	Lamiaceae	Tosign	H	Wd	leaf	Hypertension & microbial disease	The leaf of *Thymus schimperi boiled with* water.
Trigonella foenum graecum L.	Fabaceae	Abish	H	Cu	Grain	Gastritis hypertension and	Germinated and dried seed of *Trigonella foenum graecum* powered and soaked with water through a night, withdraw the filtrate to minimize its bitterness and mixed with water and drunk or boiled seeds and drink it with

Scientific name of FFP	Family	Local name in Amharic	Hb	H	Pp	Disease type	Method of preparation
							honey or sugar.
						Poliomyelitis	Powder of the grain mixed with water and put at the back of the child on sun and strikes it slowly.
Urtica simensis steudel.	Urticaceae	Sama	H	Wd	leaf	Gastritis	Sting the leaves of *Urtica simensis* with protected hand and the leaves are cut and spread out b/n two hides on the ground and rub it to avoid burning sensation of the leaves after that the leaves can be boiled and grind to be smooth salted and prepared.
Vicia faba L.	Fabaceae	Bakela	H	Cu	Grain	Bronchitis	Boil the grain of *Vicia faba* and drink its water.
						Gastritis	Roasted and powdered grains of Vicia faba soaked with water through a night and drink it.
Zingiber officinale Mill.	Zingberaceae	Zingible	H	Hg	rhizome	Microbial disease	Throw few *Zingiber officinale* pieced in hot water, strain and drink.
						Bad mouth odor	Chewing the rhizome as it is and rinses the mouth with water.

Accordingly, about 19 human ailments which are prevented or cured with 29 plant species are documented. Of these, 13 ailments are prevented using two or more Functional Food Plant species, while 6 of them are prevented using only one plant species in the study area (Table:-7).From the top ten diseases of the district reported by DMDHIV/AIDSPCO in 2015 the prevalence of chronic diseases was very rare, this shows that the life style of population in this area is more related to use of Functional Foods; in that Functional Foods have beneficial effect to improve the health, to prevent and reduce the risk factors of chronic diseases (Roberfroid, 2003).

Table:-7 List of human diseases in the study area with number of Functional Food Plants (NFFP) used to prevent them.

Disease prevented	Local name of the disease	NFFP	Percentage
Gastritis	Yechegoara beshita	8	27.5
Hypertension	Yedem gfit	7	24.1
Cancer	Cancer	5	17.2
Diabetes millets	Yeskuar beshita	5	17.2
Microbial disease	Worershign	5	17.2
Constipation	Yehod dirket	4	13.8
General weakness	Yeakim medakem	4	13.8
Osteoporosis	Yeatint melashek/Sibrat	3	10.3
Rheumatism	Kurtimat	2	6.9
Bronchitis	Yesal beshita	2	6.9
Heart disease	yelib himem	2	6.9
Anemia	Deme manes	2	6.9
Helminthiasis	Yehod telatil	2	6.9
Attention deficit	Yeamro zigemet	1	3.4
Bad mouth odor	Motifo yeaf teren	1	3.4
Breast cancer	Yetuit cancer	1	3.4
Diarrhea	Tekimat	1	3.4
Liver disease	Yegubet beshita	1	3.4
Poliomyelitis	Yelejinet lemisha	1	3.4

The documentation shows, Gastritis is prevented using large number of Functional Food Plants 8 species followed by Hypertension which used 7 species ; cancer 6 species; diabetes and microbial disease 5 species each and then Constipation and General weakness with 4 species each (Table:- 8). These indicated that a given disease can be prevented by different Functional Food Plant in the study area.

Table 8:- List of human diseases that are prevented by more than three Functional Food Plants in the study area

Family name	Scientific name of the plant	Vernacular name	Disease prevented	Local name of the disease	No. of plant	Percentage
Caricaceae	*Carica papaya*	Papaya	Gastritis	Yecheguara beshita	8	27.6
Cucurbitaceae	*Cucurbita pepo*	Duba				
Poaceae	*Horedeum vulgare*	Gebs				
Lineaceae	*Linum usitatissimum*	Telba				
Fabaceae	*Solanum tuberosum*	Dinich				
Solanaceae	*Trigonella foenum graecum*	Abish				
Fabaceae	*Urtica simensis*	Sama				
Urticaceae	*Vicia faba*	Bakela				
Alliaceae	*Allium Sativum*	Nech shinkurt	Hypertension	Yedem gfit	7	24.1
Chenopodiaceae	*Beta Vulgaris*	Key sir				
Fabaceae	*Lupinus Albus*	Gibto				
Poaceae	*Sorghum Bicolor*	Zengada				
Poaceae	*Triticum dicoccon*	Ajja				
Lamiaceae	*Thymus schimperi*	Tosign				
Fabaceae	*Trigonella foenum graecum*	Abish				

Alliaceae Brassicaceae Rutaceae Rutaceae Lineaceae Pedaliaceae	*Allium sativum* *Brassica carinata* *Citrus aurantifolia* *Citrus sinensis* *Linum usitatissimum* *Sesamum orientale*	Nech shinkurt Yabeshagomen Lomi Birtukan Telba Selit	Cancer	Nekersa	6	20.7
Alliaceae Rutaceae Rutaceae Lamiaceae Zingberaceae	*Allium sativum* *Citrus aurantifolia* *Citrus sinensis* *Thymus schimperi* *Zingiber officinale*	Nech shinkurt Lomi Birtukan Tosign Zinjibil	Microbial disease	Worershign	5	17.2
Poaceae Fabaceae Lauraceae Poaceae Poaceae	*Avena sativa* *Cicer arietinum* *Cinnamomum verum* *Sorghum bicolor* *Triticum dicoccon*	Engedo Shimbra Kerefa Zengada Ajja	Diabetes	Yeskuar beshita	5	17.2
Brassicaceae Ranunculaceae Lineaceae Poaceae	*Brassica carinata* *Nigella sativa* *Linum usitatissimum* *Triticum aestivum*	Yabeshagomen Tikur azmud Telba Sendie	Constipation	Yehod dirket	4	13.8
Poaceae Fabaceae Poaceae 	*Avena sativa* *Cicer arietinum* *Horedeum vulgare* *Nigella sativa*	Engedo Shimbra Gebs Tikur azmud	General weakness	Yeakim medakem	4	13,8

4.2.4. Plant parts used as Functional Food

In this study, different parts of the plant were reported to be used for functional purpose. According to interview results grains were the most commonly used plant parts, grains

accounting for (14, 48.3%), followed by leaves (4, 13.8%) tuber (3, 10.3%), fruits and grains (3, 10.3%), fruits (2, 6.9%) then roots, barks and bulb accounting (1, 3.4%) each (Fig.6). As Functional Food Plants are parts of a varied diet on a regular basis, at effective level. So most of daily edible part of the plant species which expected to have functional value in the study area is grain.

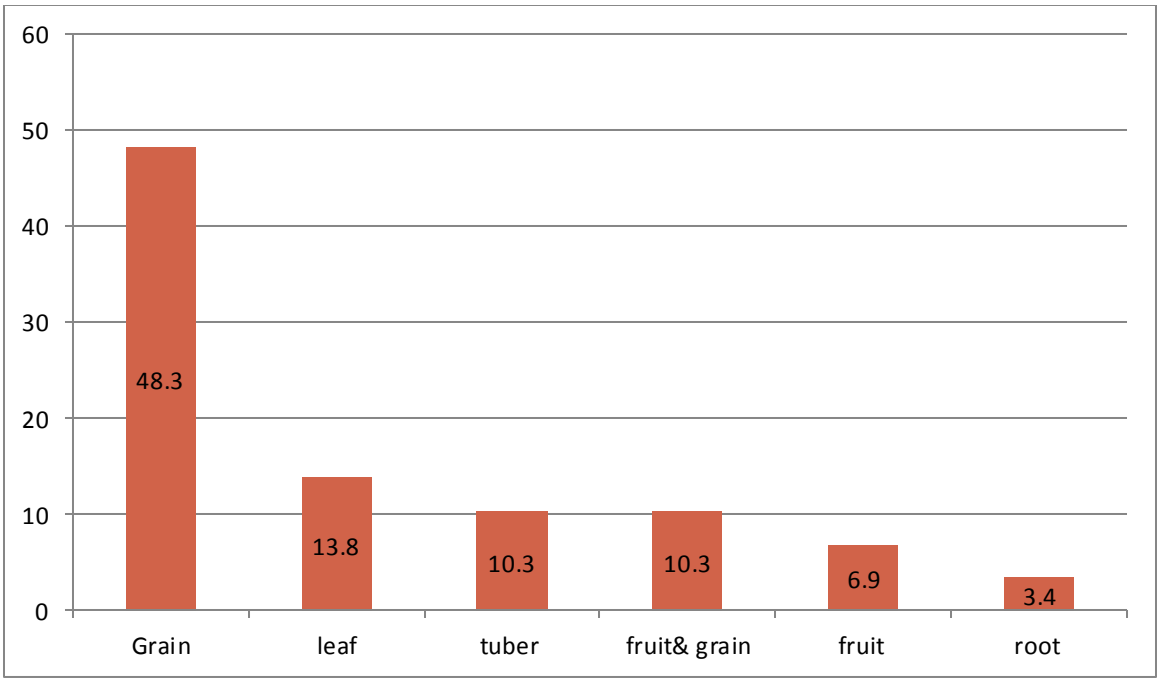

Fig 6:-Plant part used as functional food

4.2.5. Methods of preparation of Functional Food Plants

The local communities of Debre Markos district employ various methods of preparation of Functional Food Plants, most of them are processed by cooking/boiling (37.9 %) followed by raw (20.7 %), powdering & baking (17.2 %) and fluid/ juice account (17.2 %). Other forms of preparations are also shown (Table.9).

Table 9:- Methods of preparation of Functional Food Plants

Methods of preparation	No. of FFP species	Percentage
Cooking/boiling	11	37.9
Raw/unprocessed	6	20.7
Powdering &baking	5	17.2
Fluid juice	5	17.2
Powdering & boiling	4	13.8
Crushing	3	10.3
Roasting	3	10.3
Roasting & crushing	3	10.3
Crushing & cooking	2	6.8
Boiling & grinding	1	3.4
Roasting, powdering &soaking	1	3.4
Soaking &roasting	1	3.4
Dehulling & roasting	1	3.4
Powdering soaking	1	3.4

4.3. Major Plant Use Categories of Functional Food Plants used by the People in the Study Area

A total of 29 plants having great Functional Food values were documented from the study area. In addition to their functionalities the plants are used for various purposes by the community. Six use categories were reported by informants of the study area (Table:-10). As a result a total of 2257 use-reports (ur) which are reported by each informants on 29 Functional Foods Plants were recorded from 94 frequency of occurrences for total use category. Accordingly, plants used to construction take highest ICF value (0.98) followed by Functional Food Plants and forage use-category which account ICF value of (0.97) each. This analysis showed that homogeneity of ethnobotanical information and there is high consistency of plant use reports among informants on different use category of plants.

Table 10:- ICF by use categories of plants for the local people in the study area

Use-category	Species(#) (nt)	Percentage of species	Use reports (nur)	Percentage of use reports	ICF (nur-nt/nur-1)
Functional Food	29	100	809	35.8	0.97
Food/drink	21	72.4	557	24.7	0.96
Spice	10	34.5	171	7.6	0.95
Medicinal plants	22	75.9	317	14	0.93
Forage	9	31.0	306	13.6	0.97
Construction	3	10.3	97	4.3	0.98
Mean ICF					0.96

4.4. Informant consensus (FFP use report) of Popular Functional Food Plants

One way of confirming the efficacious of a given plant species is using consensus made by informants. In such cases, popular Functional Food Plants cited by the majority of local people of an area were registered and analyzed. As a result *Lupinus albus* (Gibto) cited by 72 (90%) informants whereas *Eragrostis tef* (Dabbo teff) was cited by 63 (79.8%) informants for their functionality as health care and others are shown in (Table: - 11). Popularity of these Functional Food Plants might be due to the efficacy of the plants or their availability for easy access.

Table 11:- List of Functional Food plant species reported by thirty and more number of informants

Scientific name	Vernacular name in Amharic	Number of informants	Percentage of informants
Lupinus albus	Gibto	72	90.0s
Eragrostis tef	Dabbo teff	63	78.8
Avena sativa	Engedo	54	67.5
Cucurbita pepo	Duba	51	63.8
Linum usitatissimums	Telba	49	61.3
Citrus aurantifolia	Lomi	49	61.3
Hordeum vulgare	Gebis	48	60.0
Allium sativum	Nech shinkurt	43	53.8
Triticum dicoccon	Ajja	39	48.8
Lycopersicon esculentum	Timatim	37	46.3
Trigonella foenum graecum	Abish	36	45.0

4.5. Preference Ranking of Functional Food Plants used to Prevent Gastritis

A single ailment can be prevented by several plant species. In such cases, the local people show preference to wards plant species on the basis of their preventing power against a given disease. In this study, analysis of preference ranking for five plants on the basis of preventing Gastritis (Table:-12) revealed that *cucurbita pepo* (Duba) is the most preferred species followed by Linum *usitatissimum* **(**Telba). The score was given by seven key informants, based on the preventing power of species against Gastritis. The largest value (5) was given for species having a greatest preventing potential and the least value (1) for species having low preventing potential as compared to the species listed.

Table12:- Preference ranking of Functional Food Plants used to prevent Gastritis by key informants (Respondents).

Functional food plant	R.4	R.5	R.16	R.20	R.39	R.42	R.53	Total	Rank
Cucurbita pepo	4	5	5	4	4	5	5	31	1
Hordeum vulgare	5	3	4	4	5	1	4	26	3
Linum usitatissimum	3	5	5	4	4	5	4	30	2
Trigonella foenum graecum	4	5	1	3	4	3	2	22	5
Urtica simensis	3	4	3	1	5	3	4	23	4

On the other hand, a given plant species is used in the treatment of different disease. Similarly, people show preference towards plant species having preventing potential of various diseases. Preference ranking performed by seven key informants (respondents) for six selected plant species (Table:-13) on the basis of preventing several disease showed that *Linum usitatissimum* L. (Telba) the mot preferred one followed by *Triticum dicoccon* schrank (Ajja).

Table-13:- Preference ranking of six selected Functional Food Plants on the degree of preventing several diseases by key informants (Respondent).

Functional Food plant	R.11	R.28	R.43	R.62	R.67	R.73	R.80	Total	Rank
Cicer arietinum	3	2	3	4	4	3	3	22	3
Linum usitatissimum	5	5	4	4	5	5	4	32	1
Lycopersicon esculentum	1	1	5	2	1	2	1	13	6
Nigella sativa	2	2	1	3	4	2	1	15	5
Trigonella foenum graecum	2	3	2	2	3	2	5	19	4
Triticum dicoccon	4	5	4	5	5	3	4	30	2

4.6. Direct Matrix Ranking for Multiple Use of Functional Food Plants.

Direct matrix ranking is used in order to compare multipurpose of plants commonly reported by informants. Accordingly the majority of the community in the study area relies on plants for various purposes such as functionality, foods/drinks, spice, medicinal, forage, construction etc. Based on the analysis *Eragrostis tef* **(**Dabbo teff) ranked first followed by *Hordeum vulgar* (Gebis) and *Avena sativa* (Engedo) which stood second and third respectively(Table:- 14). This shows that these plants are most preferred plant by local people for various use and they are the most available plant species as the informants reported and also the perspective of the researcher. The least ranked species in the direct data matrix is *Thymus schimperi* (Tosign). This is probably due to its least availability in the studying area. So this indicated that utility of resources depends on availability.

Table14:- Direct matrix analyses of selected Functional Food Plants

Species	Use category						Total	Rank
	Functionality	Food/drink	Spice	Medicinal plants	Forage	Construction		
Avena sativa	5	4	0	5	5	1	20	3
Cicer arietinum	3	5	0	2	4	0	14	7
Eragrostis tef	5	5	0	2	5	5	22	1
Guizotia abyssinica	4	4	2	4	5	0	19	4
Hordeum vulgare	4	5	0	4	4	4	21	2
Lycopersicon esculentum	3	4	4	4	0	0	15	6
Thymus schimper	3	0	5	3	2	0	13	8
Vicia faba	3	5	0	4	4	0	16	5

Key: - Use values given from 0 to 5; 5= Best, 4= very good, 3= good, 2= less, 1=least & 0= no value.

4.7. Fidelity Level Index of Functional Food Plants Used to Prevent Diabetes and Hypertension

Fidelity level (FL) is the percentage of informants claiming the use of certain plant species for the same major purpose or to confirm the efficacy of plant species determining its importance (Endalw Amenu, 2007). Similarly, Fidelity level index was calculated for Functional Food Plants used to prevent Diabetes and Hypertension, the result revealed that

Cinnamomum verum (Kerefa) and *Lupinus albus* (Gibto) have the highest Functional value to prevent diabetes and hypertension with (FL=0.78) and (FL=0.89), respectively (Table:-15).

Table:-15 Fidelity level indexes for plant species used to treat Diabetes millets and Hypertension in the study area

Disease	Percentage of informants	Species	NP	N	Fidelity level index (NP/N)
Diabetes millets	67.5	*Avena sativa*	35	54	0.65
	21.3	*Cicer arietinum*	10	17	0.58
	11.3	*Cinnamomum verum*	7	9	0.78
	78.8	*Eragrostis tef*	26	63	0.41
	10	*Sorghum bicolor*	6	8	O.75
	48.8	*Triticum dicoccon*	28	39	O.72
Hypertension	13.8	*Thymus schimperi*	5	11	0.45
	53.8	*Allium sativum*	38	43	0.88
	22.5	*Beta vulgaris*	10	18	0.56
	10	*Sorghum bicolor*	6	8	0.75
	90	*Lupinus albus*	64	72	0.89
	48.8	*Triticum dicoccon*	26	39	0.67

4.8. Description of Most Cited (Ten top) Functional Food Plants in the Study Area with their Functionality

All Functional Food Plants (10 species) that had cited by informants above 45% (Table 11) are described below.

1. *Lupinus albus* L. (Fabaceae) GIBTO (Amh.)

Lupinus albus L. is herbaceous plant with shortly hairy, bushy steam; obovate leaflets of lower leaves and obovate-cuneate upper leaves. Its corolla is white to blue. The pod is shortly villous and glabrescent with smooth seeds. The plant is cultivated particularly in Gojjam. The seed is employed to prevent largely hypertension in the study area. Zerihun Nigussie (2012) the local people in North-western Ethiopia used "Gibto Areki" as local made

antihypertensive medicine. Ragunathan and Solomon (2009) also indicate the same idea in that the fruit and seed of this plant are used to for the same functional purpose in Ethiopia.

2. *Eragrostis tef* L. (Poaceae) TEFF (Amh.)

Eragrostis tef L. is cultivated herb, an annual forming scanty tufts; culms up to 120cm high in selected cultivated plant. Leaf blades narrow, folded panicle narrow, with a depressed branches at the base; spike lets grey or golden, with up to ten florets and the seedlings are small and delicate. It is native to Ethiopia. In Ethiopia two types are grown, one white grain (Nech teff) and the other with brown grain (Dabbo teff). Locally the seeds of this plant especially Dabbo teff is used to prevent anemia and diabetes millets (lower blood glucose). As cited on SUDA.SR23 (2010) by different authors, teff has omega-3 fatty acids to lower risk of heart attacks and reduce prostate tumor growth; omega-6 fatty acids may also reduce cardio vascular disease and also docosahexaenoic acids in it were associated with a reduced risk of breast cancer.

3. *Avena sativa* L. (Poaceae) ENGEDO (Amh.)

Avena sativa L. is cultivated herb. It may occur occasionally as a contaminant of wheat or as an escape near cultivations. With simple, erect and40-180cm high culms. Spike lets 2-3 flowered with the upper most florets reduced1.7-3cm long non-shuttering; the florets lacking a basal bearded callus. Glumes are narrowly elliptic oblong and sharply acute. Lemmas are usually tough, 1.2-2.5cm long, glabrous hairy around the awn insertion. It is usually grown in Ethiopia at altitude of 2700-3000m, especially in areas of decreasing soil fertility in preference to barley. The crop residue is used for forage. Locally the seed of the plant used to

reduce the glucose level, to prevent against osteoporosis and strengthen general fitness. On other hand Lance and Garren (2002), reported that beta-glucan in the seed is available to reduce blood cholesterol to help in prevention of heart disease and also the seed of this plant regulate gastrointestinal function.

4. *Cucurbita pepo* L. (Cucurbitaceae) DUBA (Amh)

Cucurbita pepo L. is an annual herb with climbing, creeping or in some varieties bushy, 5-angled stems up to 15 meter long. The shallow root stem is branched, growing from a well-developed tap root. The stems are scabrous & setose, branching, often rooting at the noods. It has unisexual yellow flowers but the male & female are on the same plant. The local people used the fruit to prevent Gastritis by cooking simply with water & eat it when it cool and also the seeds roasted & ate to prevent from helminthiasis. In different reviews pumpkin (Duba) as other vegetable consider as functional food items of plant origin. For instance Braun and Cohen (2007), analyzed beta-carotene in pumpkin regulate immune and hormonal systems and also protective role from lung cancer.

5. *Linum usitatissimums* L. (Linaceae) TELBA (Amh)

The flax plant is a slender annual herb that grows to 0.3 to 0.9m in height. It branches at the top and has small, pale green alternating leaves. Each branch is tipped with one or two delicate blue flowers. The local people used the seed of this plant to prevent from Gastritis, Constipation, and breast cancer and additionally for improvement of attention deficit but some informants recommended that a child, who took “absho” for this objective should not take flax seed as its side effect. Different authors deal about the functional purpose of flax seed, of them Martinchik *et al.* (2012) showed that the alpha-linolenic acid, lignans & fiber in

flax seed have potential health benefits such as reduction of cancer, diabetes, osteoporosis, atherosclerosis, autoimmune,arthritis, cardio vascular disease, neurological disorder. Beside these it has a role to improve menopausal symptoms & attention deficit disorder. Additionally as mentioned by Roiten and OZ (2005) taking flax seeds on a regular basis is supposed to lower real age by 3.4 yrs. due to its mono- unsaturated fats.

6. *Citrus aurantifolia* L. (Rutaceae) LOMI (Amh)

It is an evergreen shrub, with much–branched tree to 5m with very many short sharp spines on the stems and beside leaves. Leaves are oval, small shiny green, Flowers white fruit, round or oval to 6cm diameter but usually smaller, peel very thin, green or yellow. Pulp is green and very acidic but juicy. The local people used these plant fruit to prevent from microbial-diseases and nekersa. As Tigist Wondimu *et al.,* (2006) the fruit of this plant had nutraceuticals value by the community of „Dheerra" town to treat flue, wounds, stomach ache and skin rush. In the other hand, Hasegawa & Miyalce (1996) showed that the phytochemical called limonoids in citrus fruits is responsible to anticancer activity.

7. *Horedeum vulgare* L. (Poaceae) GEBIS (Amh)

Horedeum vulgare L. is an annual grass stem erect, stout and tufted. Leaf 1-2 mm long and truncate. Leaf blades are 10-15 mm wide. Flower anthers 3, ovary pubescent on apex. Its Fruit is cacyopsis with adherent pericarp. The local community used the plant for prevention to Gastritis, as a form of "Beso" or undehulling "Kolo" & also believed to give extra strength during sickness & for mothers after child birth as a form of "Gonfo". As Escajeda *et al*. (2013) showed the bioactive compounds (Beta glucans, tocotrienols, and poly-phendlunasin) in barley have anticancer role.

8. *Allium sativum* L (Alliaceae) NECH SHINKURT (Amh)

It is cultivated herb, grows in home gardens and farm lands. Bulb ovoid covered in a white coat enclosing bulb leaf. The bulbs used to prevent hypertension, microbials and nekersa at the study area. There are many findings on it, to reveal some, the purported health benefit include cancer chemo preventive, antibiotic, anti-hypertensive and cholesterol properties (Srivastava *et al*., 1995). The community of „Dheerra" town studied by Tigist Wondimu *et al*., (2006) the bulb of this plant had a nutraceutical value to treat from flue and lung abscess. In the other side, Ernst (1997), showed alliums may confer a protective effect on cancer of gastro intestinal tract.

9. *Triticum dicoccon* Schrank (Poaceae) AJJA (Amh)

It is annual cultivated grass culms solid or thick-wailed. Spikes 3-10 cm long laterally compressed; rhachis glabrow or shortly ciliated at the nodes, fragile, disarticulating above the spikelet insertion, spikelet falling attached to the inter node below. Spikelet 3(4) flowered; glumes 7-10 mm long, coriaceous with a single prominent keel; lemma usually with an awn up to 15 cm long. The local people of the study area used this food plant to stabilize diabetes Miletus, hypertension, and cholesterol in blood and to provide general fitness & strength bones often as a form of "Atmit". As the review of cherry creek (2009), the phytochemical saponins & functional component B-glucan in oat help to reduce LDL cholesterol which may help to lower blood pressure & reducing heart disease risk.

10. *Lycopersicon esculentum* Mill. (Solanaceae) TIMATIM (Amh)

It is annual or perennial herbs leaves alternate, petiolete. Flowers are bisexual. Pedicels articulate above middle. The calyx is deeply 5-lobed with stellate, yellow corolla. It has 5

equal lengthen stamens with bilocuar or plurilocular ovary by false septaae. Fruit is a red or orange berry with elliptical seeds. The local people believed that fresh or tomato paste used to prevent from anemia and heart disease. On the other hand, Krinsky and Johnson (2005) indicated that the phytochemical lycopene in tomato has role in the reduction of prostate cancer. Rao and Rao (2007) also showed this phytochemical in tomato may inhibit growth of breast, lung, cervical, ovarian and pancreatic tumors.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The results of the study revealed that indigenous people of the study area have their own traditional knowledge and practices which they accumulated for generations on Functional Food Plants.

Most of the functional food plants in the area cultivated in home and in the field. A few of them which are rare in the area are bought from the market for consumptional purpose and only one species that is *Urtica simensis* steudel. is wild one. Herbs were found the dominant habits used as Functional Food Plant followed by shrubs and trees. Seeds were also found to be the most frequently used plant parts as Functional Food. Preparation of Functional Food Plant is determine as the favorite of the dwellers but most of them are prepared by cooking/boiling.

The status of almost all Functional Food Plants in the study area was common because they are common demands of their daily life activities but one of the Functional Food Plant mostly cultivated in Gojjam, *Lupinus albus* threats due to lesson of agricultural lands in the case of construction as the woreda is developed to administrative town, so strong effects should be made by responsible stake holders to encourage growing of this species even on the fragmented habitats determining on its functionality.

It is also reported that transferring of knowledge among the community about functionality of foods was presupposed at the time of suffering with the disease. Therefore, further to build up healthy citizen documentation of Functional Food Plant is important to transfer the knowledge to existing generation and to further generation since to increase our awareness in order to prevent from chronic diseases caused by the radical change of our life-style and environmental impact.

5.2. Recommendations

Based on the finding of the study the following recommendations are forwarded.

- Local community of the study area should be involved in conservation of their indigenous knowledge in their locality.
- Provide priority for the cultivation of rare functional food plant species in the area by encouraging crop rotation.
- Further documentations & exploration in to nutritional profile, phytochemical analysis, and antioxidant potential, essential and toxic components in functional food resources is suggested.

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APPENDICES

Appendix1. Check list of semi-structured interview questions for collecting Ethnobotanical data.

I. General information.

1. Information on respondents:

Date…….Area of residence……..Kebele……

Name of respondent……..

Sex: Male……Female…….Age……..

Marital status: Single……Married……Divorced……..Widowed……..

Religion: Orthodox……..Protestant……Muslim……..Others……..

Source of income: Farming……..Trading local items……..Others…….

Level of education: Received normal education……..Read and write……

Read only……Can"t read and write……..Others……

Ethnicity……

For how long have you lived in the area? Since birth……..For the last 20 years……

For 15 years……..Less than 15 years……

II. Ethnobotanical data.

1. Mention types of plants that are used as a source of food in your daily life.

……
……..

2. Does each plant have any use other than use as food? If yes, state your opinion.

……..

3. What are the most common diseases in area?

……

4. From the disease you have mentioned above, is there any plant use to treat certain disease? If yes, mention them.

……

5. Which part of each Functional Food Plant listed is used? Leaves, roots, steams, flowers, seeds or whole plant

……

6. Is that the plant abundant or rare in the area?

……..

7. What is the method of preparation of the Functional Food Plants?

……

8. Are these Functional Food Plants are marketable as a treatment of ailments?

……

9. Any other information……

ተጨማሪ መጠይቅ

የዚህ ቃለ መጠይቅ ዋና አላማ በደ/ማርቆስ ወረዳ አካባቢዎች በምግብነት የምንጠቀማቸው እጽዋቶች በሰው ልጆች ላይ የሚያስቱ በሽታዎችን ከማከላከል አኳያ ያላቸውን ፋይዳ መዘግቦ ማቆየት ነው፡፡ ስለሆነም የጥናቱ ተአማኒነትና ጠቀሜታ የሚወሰነው እርስዋ ከሚጠሉት ቀና ትብብር በመሆኑ አስቀድሜ ስለትብብርዎት አመሰግናለሁ፡፡

1፡ -አጠቃላይ ሚጃ

ቀን፡ _____መኖሪያ ቦታ _____

ቀበሌ፡ _____ ሥም_____ እድሜ_____

ፆታ : ወ..... ሴ.....

የጋብቻ ሁኔታ፡ - ያላገባ .....ያገባ..... አግብቶ የፈታ..... ባሉ ወይም ሚስቱ የሞተበት.....

ሀይማኖት፡ - አርቶዶክስ..... ፕሮቴስታንት..... ሙስሊም..... ሌላ .....

መተዳደሪያ ገቢ፡ - ግብርና..... ንግድ..... ሌላ .....

የትምህርት ደረጃ፡ - መደበኛ ትምህርት ያጠናቀቀ

ማንበብና መጻፍ የሚችል

ማንበብ ብቻ የሚችል

ማንበብና መጻፍ የሚችል

ዜግነት፡ _____

በቦታው የቆዩበት ዘመን፡ - ከተወለዱ ጀምሮ ..... ለአለፉት 20 አመታት.....

ለ15 ዓመታት..... ከ15 ዓመታት በኋላ .....

2. በአካባቢው ያሉ ሰዎችና በዕጽዋቶች መካከል ያለውተዛምዶ ጭብጥ

በአካባቢያችሁ አዘወትራችሁ ለምግብነት የምትጠቀሟት የዕጽዋት አይነቶችን ጥቀሱ፡፡

_____

በምግብነት የምትጠቀሟቸው እነዚህ ዕጽዋቶች ለምግብነት ከመዋላቸው በተጨማሪ ሌላ ጥቅም አላቸው? መልሳችሁ አዎ ከሆነ ጥቅማቸውን ጥቀሱ.....

3. በአካባቢያችሁ በአብዛኛወን ጊዜ የሚታዩ የሰውልጅ በሽታች ምን ምን ናቸወ?

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4. ከላይ ከጠቀሳችኋቸው የተለያዩ በሽታዎችን ሊፈወሱ ወይም ቀድመው ሊከላከሉ የሚችሉ እጽዋቶች አሉ? ካሉ ጥቀሷቸው፡ ፡

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5. የእፅዋቱ የትኛው ክፍል ነው ከላይ ለጠቀሳችኋቸው በሽታዎችን ለሚፈወስም ሆነ ለመ ከላከል የሚወሉት ? ቅጠሉ .....ግንዱ..... ስሩ..... አበባው:.....

ዘሩ..... ወይስ ሁሉም የዕጽዋት ክፍል.....

6. እነዚህ አጽዋቶች በአካባቢው በስፋት ነው ወይስ በጥቂቱ የሚገኙት?

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7. እነዚህ እጽዋቶች በሽታን ለሚፈወስም ሆነ ለመከላከል እንዴት ነው የሚዘጋጁት?

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8. እነዚህ አጽዋቶች እንደ በሽታ መፈወሻም ሆነ መከላከያ አገልግሎት ገበያ ላይ ይወላሉ?

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9. ሌላ ተጨማሪ ሀሳብ ካላችሁ፡ ፡

Appendix 2. List of informants involved in the ethnobotanical study selected from 10 villages

No	Name of informants	sex	Age	Marital status	Educational status	Residence	Occupation
1	Andargachew Zewdu	M	46	Married	4	Endegem	Farming
2	Ayenew Asrat	M	28	Single	4	Endegem	Farming
3	Dessie Zeleke	M	30	Married	Read & write	Endegem	Farming
4	Enawgaw Manaye*	M	46	Married	Read & write	Endegem	Farming
5	Gedefaw Mosyie*	M	63	Married	Read & write	Endegem	Farming
6	Keralem Ayele	M	66	Married	Read & write	Endegem	Farming
7	Yalew Getnet	M	38	Married	Read & write	Endegem	Farming
8	Yerom Angaw	F	26	Married	Read & write	Endegem	House wife
9	Zegiju Lela	F	30	Married	Illiterate	Endegem	House wife
10	Abatneh Adamu	M	55	Married	Read & write	Engecha	Farming
11	Aweke Adamu*	M	69	Married	Read & write	Engecha	Farming
12	Embiale Biadgie	M	29	Married	Church edu.	Engecha	Priest
13	Manaye Abebe	M	32	Married	4	Engecha	Farming
14	Meselu Teshale	M	42	Married	6	Engecha	Farming
15	Mesert Kumie	M	38	Married	Read & write	Engecha	Farming
16	Sera Alemseged *	F	52	Married	12	Engecha	House wife
17	Temsgen Tesfaye	M	62	Married	Read &write	Engecha	Farming
18	Zena Yalew	M	46	Married	12	Engecha	Public servant
19	Zwdu Negriew	M	64	Married	Church edu	Engecha	Priest
20	Abebe Dires*	M	69	Married	Read & write	Shola amba	Farming
21	Anchenalu Haile	F	40	Married	12+1	Shola amba	Teacher
22	Endawoke Abate	M	30	Married	8	Shola amba	Public servant
23	Fetene Delele	M	50	Married	Read &write	Shola amba	Farming
24	Fikrie Sewnet	F	52	Married	Read &write	Shola amba	House wife
25	Geta Mola	M	38	Married	Read & write	Shola amba	Farming
26	Linger Yetayew	M	59	Married	Read &write	Shola amba	Teacher
27	Mesganaw Abay	M	48	Married	8	Shola amba	Public servant
28	Minyebel Jegnaw*	M	38	Married	10	Shola amba	Merchant
29	Nurie Lemnh	M	32	Married	10	Shola amba	Farming
30	Tigist Andualem	F	30	Married	Read & write	Shola amba	House wife
31	Wondie Andualem	M	40	Married	Read & write	Shola amba	Farming
32	Zuriashework Abera	F	41	Married	Read &write	Shola amba	House wife
33	Amahu Ayele	M	62	Married	Church edu.	Yebragie	Merigeta
34	Ayalew Tamer	M	58	Married	5	Yebragie	Merchant
35	Bizuayehu Tayew	M	70	Married	Read & write	Yebragie	Farming
36	Elkena Lashetew	M	52	Married	Read & write	Yebragie	Farming
37	Tilahun Ayenew	M	48	Married	Read & write	Yebragie	Farming
38	Tinur Delele	F	58	Divorced	Illiterate	Yebragie	Small trade
39	Tizazu Bitew*	M	70	Married	12+2	Yebragie	Pensioner
40	Wbetu Tessema*	M	62	Married	12	Yebragie	Pensioner

41	Addis Kebede	F	40	Married	Read & write	Yemeka	House wife
42	Asmare Hunegnaw*	M	43	Married	Read & write	Yemeka	Farming
43	Belayneshe Gedilu*	F	33	Married	12+1	Yemeka	Accountant
44	Liyew Desalegn	M	25	Single	6	Yemeka	Farming
45	Yohanies Afework	M	48	Divorced	Church edu	Yemeka	Merchant
46	Nurie Demeke	M	45	Married	Illiterate	Yemeka	Farming
47	Solomon Zeleke	M	36	Married	10	Yemeka	Driver
48	Wale Beyene	M	65	Married	Illiterate	Yemeka	Farming
49	Wdie Tefferi	F	39	Married	Read & write	Yemeka	House wife
50	Zwdu Dessalegn	M	40	Married	3	Yemeka	Farming
51	Abebe Belachew	M	26	Married	Church edu	Kebiachira	Student
52	Berzelegn Semachew	M	54	Married	illiterate	Kebiachira	Farming
53	Desta Asres *	F	47	Married	Read & write	Kebiachira	House wife
54	Habtamu yeshu	M	60	Married	illiterate	Kebiachira	Farming
55	Haimro Tegegn	M	32	Married	Read &write	Kebiachira	Farming
56	Menwyie Ayaliew	M	55	Married	Illiterate	Kebiachira	Farming
57	Mola Admass*	M	62	Married	Illiterate	Kebiachira	Farming
58	Alemwasie Yehunie*	M	55	Married	6	Muakuat	Farming
59	Esubalew Tizazu	M	65	Married	Illiterate	Muakuat	Farming
60	Menuye Endalamaw	M	60	Married	Read & write	Muakuat	Small trade
61	Tessfa Ayalew	M	27	Single	10	Muakuat	Public servant
62	Wubeliker Abewa*	M	45	Married	Read & write	Muakuat	Farming
63	Yalew Wondemneh	M	43	Married	Illiterate	Muakuat	Farming
64	Abate Andualem *	M	76	Married	Illiterate	Yenora	Farming
65	Adane Mekuiaw	M	28	Single	12+2	Yenora	Nurse
66	Demise Belachew	M	22	Single	Church edu	Yenora	Student
67	Wunegnw lake*	M	45	Married	Church edu	Yenora	Merigeta
68	Negrie lemenh	m	35	Single	5	Yenora	Farming
69	Selenat Bayle	F	66	Married	Illiterate	Yenora	House wife
70	Seraneshe Alemu	F	35	Married	Read & write	Yenora	House wife
71	Ayalew Demesie	M	42	Married	Read & write	Abedeg	Farming
72	Birtucan Tadege	F	36	Married	12+2	Abedeg	Pharmacist
73	Gojjam Asabie*	F	45	Married	Read & write	Abedeg	House wife
74	Menalu Meku	M	50	Divorced	Illiterate	Abedeg	Farming
75	Mengestu Walle	M	32	Married	3	Abedeg	Farming
76	Wudu Basaznew *	M	53	Married	Illiterate	Abedeg	Farming
77	Azmeraw Biadglegn	M	26	Single	10+2	Chemoga	Public servant
78	Keralem Zeru	M	60	Married	Illiterate	Chemoga	Farming
79	Yemiserach Zewdu*	F	41	Married	12	Chemoga	Merchant
80	Yeshe Alemayehu *	F	35	Divorced	5	Chemoga	Small trade

Key to abbreviations : 1, 2, 3…… education level (grade), church –traditional education and *-key informants