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Research Article

Review and Analysis of Ethnobotanical Studies on Plants Used in The Traditional Treatment of Human Gastrointestinal Problems in Ethiopia

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Abstract

Relevance of the review: Despite vast number of ethnobotanical studies carried out in Ethiopia during the past decades, most of the studies are too general and information available in these literatures is too fragmented. Such fragmented piece information may pose burden in the screening, scientifically verifying and approval of potentially significant plant species of interest for specific health problem in question to improve healthcare services and drug development.

Aim of the review: The main objective of this summary paper is to compile a review and synthesis on ethnobotanical survey of plants used in the traditional treatment of gastrointestinal problems in Ethiopia with emphasis on gastrointestinal parasites. The review produced a full-fledged piece of information from fragments of research results present in various literature sources and research thesis.

Materials and Methods: Fragment of information on plants used in the traditional treatment of human gastrointestinal problems emphasizing protozoan and helminthes infection was assessed. The information was available in student thesis of different study years. Assessment considered studies conducted in different geographical regions of Ethiopia and the distribution was compared.

Results: A total of 173 plant species distributed across 147 genera and 69 families were identified. The plants are used to treat about 10 major traditionally recognized types of gastrointestinal problems. A given medicinal plant species could be used multiple times to treat gastrointestinal diseases. A single health problem could also be treated

by one or more medicinal plants. The Sorensen's coefficient of similarity index (SI) is used to compare the composition of medicinal plants within the general floras. Highest similarities were observed between Southern Gonder, Libo Kemkem (21%), Eastern Gojjam, Gozamn (19%), Eastern Oromiya, Arsi-Seru (17%) and Northern Gondar, Dabark (17%) parts of Ethiopia.

Conclusions: The similarity indices values revealed that the medicinal plants are unevenly distributed across the general floral regions of Ethiopia. Biological, physical as well as chemical factors determining the frequencies, species composition and distributions of the medicinal plants within their respective habitats and floristic regions need to be studied.

Keywords: *Ethnobotany; Ethnomedicine; Flora; Gastrointestinal Parasites; Diarrhea; Traditional Treatment*

Introduction

According to Robbins and Cotran [1], pathology is a bridging discipline involving both basic science and clinical practice that are devoted to the study of the structural and functional changes in cells, tissues and organs thereby underlying diseases. It is known that infectious organisms which can enter the human host and known as endo-parasites belong to a wide range of classes with varying sizes. Protozoan and helminthes are among the classes of human endo-parasites. Thus, depending on the parasitic species, humans may harbor either adult worms or; immature stages or asexual larval forms. Most gastrointestinal pathogens are transmitted by foods or drinks contaminated by fecal material.

Traditional medicine is a kind of therapeutic method that had been handed down by the tradition of a community or ethnic a given group [2]. It includes all kinds of folk medicine, unconventional medicine or health practices, approaches, knowledge and believes incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques as well as exercises applied singularly or in combination to treat, diagnose and prevent illness or maintain wellbeing [3,4].

Humans have learned to use plants to treat parasitic diseases and in the last century modern medicine has developed pure compounds from plants into pharmaceutical drugs. It was stated that use of traditional medicine continues, for social, cultural, medical and financial reasons. On that note, traditional medicines are still used and are valuable especially for those who do not have access to modern drugs [5,6].

It was noted that [7] prioritized research of plant species with proven folklore in treating intestinal parasitic pain and diarrhea through intensive screening to identify and test bioactive compounds to verify their effectiveness, mechanism of action and safety and translational research are needed to facilitate these advances and the integration of traditional botanical preparations for treating pain and gastrointestinal disorders into western medicine. The main objective of this summary paper is to compile a review and synthesis on ethnobotanical survey of plants used in the traditional treatment of gastrointestinal problems in Ethiopia with emphasis on gastrointestinal parasites and in the meantime produces a full-fledged piece of information from fragments of research results present in various literature sources and research thesis.

Human Gastrointestinal Parasites

Human intestinal parasites (HIP) are parasites populating the gastrointestinal tract in humans Haque [8]. They can live throughout the body, but most prefer the intestinal wall. Protozoa and helminthes are among the classes of

human endo-parasites. Parasitic protozoa such as *Entamoeba histolytica* and *Giardia lambilia* are single celled organisms endowed with motility, pliable plasma membrane, and complex cytoplasmic organelles. They are spread by the fecal-oral route. Helminthes are parasitic worms that are highly differentiated multi-cellular organisms where their lifecycles are complex; most alternate between sexual and asexual reproduction in the definitive host and asexual reproduction in the intermediary host or vector [1]. It was further noted that parasitic worms are of three classes namely: round worms or nematodes which are characterized by a collagenous tegument and a non-segmented structure. These include ascaris, hookworms and strongyloides among the intestinal worms. Flatworms or cestodes comprise gutless worms whose head, the scolex, sprouts a ribbon of flat segments known as the proglottids covered by an absorptive tegument. This class includes pork tapeworm, beef tapeworm, fish tapeworm and the cystic tapeworm larvae also known as cyst cerci and hydatid cysts. Flukes or the trematodes are the third classes of parasitic worms associated with lung, liver and blood parasites.

Human parasitic diseases can be classified as those caused by protozoan (single-celled organisms) and those caused by helminthes (worms). Parasitic worms of the intestine include round worms, and flat worms [6]. Parasitic infections caused by intestinal helminthes and protozoan parasites are among the most prevalent infections in humans in developing countries affecting more than one billion people and are the cause of 1, 55, 000 deaths annually worldwide [9]. It was noted that these diseases are in general widespread in tropical regions and their high frequency represents more than 40% of tropical health problems excluding malaria. Hence, it was reported to be the causes of high mortality and reduced productivity particularly in developing countries where hygiene and sanitary conditions are poor in both humans and animals [9,10].

Herbal Remedies Used to Treat Human Gastrointestinal Parasites

According to WHO [11], traditional systems of medicine have become a topic of global importance. Estimates suggested that in many developing countries, a large proportion of the population depend highly on traditional practitioners and medicinal plants to meet primary healthcare needs. They also noted that although modern medicine may be available in these countries, herbal medicines have often maintained popularity for historical and cultural reasons. Over the past two decades there has been a tremendous increase in the use of herbal medicine [12]; however, there is still significant lack of research data in the field. Hence, since 1999, WHO is aimed at producing monographs on selected medicinal plants based on their worldwide use and published in four volumes available at (http://www.who.int) but unable to continue to produce more monographs on commonly used medicinal plants due to the diversity of medicinal plants and herbal medicines. Hence, one of the objectives of WHO monographs is to provide a model that will support countries in developing their own national or regional monographs on medicinal plants or national formularies on herbal medicines [12]. Traditional medicine in Ethiopia has become an integral part of the culture of the people [13]. This traditional knowledge has been mainly transferred orally from generation to generation through herbalists and other knowledgeable people. Hence, it is not unusual for people living in the countryside to treat some common ailments using plants available around them. *Hagenia abyssinica* (Rosaceae), for instance, is used to expel tapeworm and *Brucea antidysentrica* (Simaroubaceae) is used as a remedy against dysentery. Metazoal and protozoal parasitic infections are one of the most important health problems worldwide and the prevalence rate of these infections globally exceeds 50% and it is still on the rise [14].

Plants used for treating gastrointestinal parasites in Ethiopia: It is worth considering the status of Neglected Tropical Diseases (NTD) in the African region [15]. Soil-transmitted helminthiasis, for instance, is continuously placing an unacceptable burden on the health of the poorest population [16]. Similarly, most protozoan infections can cause acute or chronic diarrhea in healthy individuals and may result in intractable, life threatening illness in patients in immune-responsive status [17]. It was stated that in the indigenous health delivery system of Ethiopia, numerous plant species are used to treat diseases of infectious origins [18]. Limited access to modern healthcare facilities could be considered the main factors for the contribution of traditional practices [19]. It was further noted that medicinal plants such as *Glinus lotoides* are among the ones with the most preferred, and popular against tapeworm infections. Moreover, it was noted that the majority of Ethiopians depend on traditional medicine as their primary form of healthcare, yet they are in danger of losing their knowledge and the plants they have used as medicines for millennia [20]. It was emphasized that ethnobotanical studies are imperative and concomitant sustainable programs that support the sustainability of herbal medicine traditions may be considered a way to collect and disseminate information thereby supporting communities in their efforts to maintain their heritage [20]. Despite vast number of ethnobotanical studies carried out in Ethiopia during the past few years, most of the studies are too general and information available in these literatures is too fragmented. Such fragmented piece information may pose burden in the screening, scientifically verifying and approval of potentially significant plant species of interest for specific health problem in question to improve healthcare services and drug development.

Summary and synthesis of plants used in treating gastrointestinal parasites: About 173 (Additional Files 1-4) plant species belonging to 147 genera across 69 families were identified for treating gastrointestinal diseases. These include tapeworm, dysentery, amoebiasis, taeniasis, ascariasis, hookworm, giardiasis, abdominal helminthes, intestinal parasites, stomachache, abdominal parasites, diarrhea and constipation. These health problems are associated with both protozoan and helminthes infections (Additional file 5). Ten major gastrointestinal aliments were also indentified under two major causative agents namely protozoans and helminthes (Table 1).

Table 1: Groups of gastrointestinal parasites and diseases.

SN	Parasitic disease	Number of use reports	Percentage
	Total reports	318*	100.00
1	Intestinal and stomach problems	110	34.59
2	Taeniasis/Tapeworm	74	23.27
3	Ascariasis	49	15.41
4	Abdominal problems and diarrhea	37	11.64
5	Amoebiasis	16	5.03
6	Dysentery	9	2.83
7	Hookworm	5	1.57
8	Abdominal helminthes	4	1.26
9	Giardiasis	4	1.26
10	Others	4	1.26

*= Number of use reports (318) is greater than the total number of species reviewed (173) implying that a single plant species is reported more than once for multiple uses as medicine for Gastro Intestinal Parasites.

It is indicated that the total number of plant species represented in Table 2 is 245 but only 173 species reviewed. The lesser number of species identified in the review as compared to the total number of species reported per aliments add up together implying that a single plant species can be used to treat more than one types of aliments. Similarly, a single health problem is seen to be treated by a number of plant species.

Table 2: Number of plant species reported to treat single diseases.

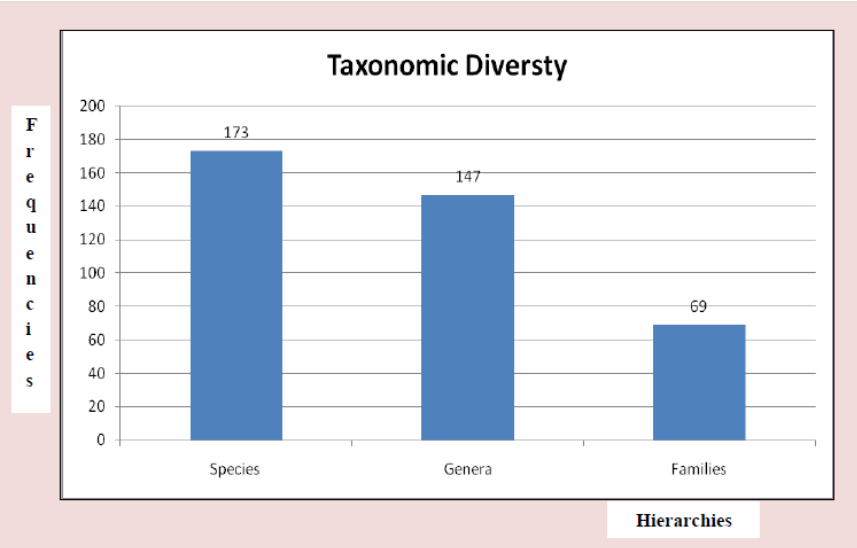
SN	Parasitic disease	Number plant species	Percentage
	Total use reports	245	100.00
1	Intestinal and stomach problems	85	48.86
2	Taeniasis/Tapeworm	57	32.76
3	Ascariasis	37	21.26
4	Abdominal problems and diarrhea	31	17.82
5	Amoebiasis	13	7.47
6	Dysentery	10	5.75
7	Hookworm	5	2.87
8	Abdominal helminthes	4	2.3
9	Giardiasis	3	1.72

When there is difficulty in differentiating which particular infecting agents are responsible for a given health problem, the literature sources indicated too general reports. For instance, abdominal helminthes, intestinal parasites, stomachache, abdominal parasites, diarrhea, constipation are simply reported as general illness that traditionally treated by trial and error by traditional healers. However, which particular parasite or infecting agent is responsible for causing such illnesses is not well stated and it needs further scientific proof. Therefore, the review is expected to provide some firsthand clues on the detailed study of both the traditionally used herbs and associated health problems in a more simplified manner.

Taxonomic diversity of medicinal plants for treating GIP: From analytical tables for species, genera and families, the frequency distributions for the taxonomic diversities in the respective hierarchies are 173, 147 and 69 respectively (Figure 1).

These higher values for the three hierarchies indicate that there are potential herbal remedies in the flora regions where the ethnobotanical studies were conducted by respective authors. Such information can provide clues on the target families to screen out the target species that is most frequently used by the society to treat particular gastrointestinal diseases. Hence, it could be good source of information for researchers who are interested in phytochemical screening of plant species in question for particular diseases and drug discovery.

Figure 1: Taxonomic diversity of medicinal plants for treating gastrointestinal parasites.



Similarity Indices: Similarity indices are used to compare the general floras of larger areas by measuring the degree to which the species composition of the general floras or sample maches alike (Table 3).

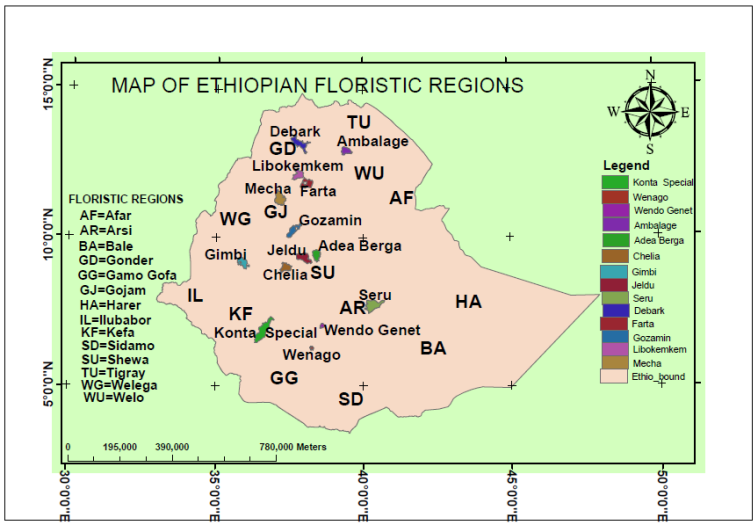
Table 3: Index of similarity in medicinal plant composition with respect to floristic regions.

Author	Year	Geographic/flora region			*SI	
			b(c)	**a**	**S_s**	**%S_s**
		Total species reviewed	**173**	-	-	-
Haimanot Reta	2010	Eastern Gojjam, Gozamn	34	8	0.19	**19**
Getinet Chekol	2011	Southern Gonder, Libo kemkem	33	8	0.21	**21**
Mengistu G/Hiwot	2010	Eastern Oromiya, Arsi, Seru	29	6	0.17	**17**
Nigussie Amsalu	2010	Southern Gonder, Fata	29	2	0.07	7
Sintayehu Tamene	2011	SNNPR, Wendo Genet	25	2	0.08	8
Eskedar Abebe	2011	Northern Gonder, Dabark	19	4	0.17	**17**
Getaneh Gebeyehu	2011	Western Gojjam, Mecha	19	1	0.06	6
Tesfaye Godifey	2010	Southern Tigray, Emba Alaje	11	0	0	0
Alemayehu Kefyalew	2010	East Shewa, Ada'a Berga	10	0	0	0
Balcha Abera	2014	Western Ethiopia, Ghimbi	9	1	0.1	10
Etana Tolosa	2007	Western Wellega, Ghimbi	9	0	0	0
Endalew Amenu	2007	Western Shewa, Cheliya	8	1	0.12	12
Fiseha Mesfin	2009	SNNPR, Wonago	7	0	0	0
Tesfaye H/Mariam	2009	Southern Ethiopia, Konta	7	0	0	0
Zewdie Kassa	2009	Western, Shewa, Jeldu	6	-	-	-

The Sorensen's coefficient of similarity calculated as: Ss = 2a/(2a + b + c) where, Ss is the sorensen's coefficient of similarity, a is the number of species common to both sites, 1 and 2; b is the number of species in site 1and c is the number of species in site 2 [21]. About 14 general floras (Ada'a Berga, Emba Alaje, Cheliya, Dabark, Fata, Ghimbi, Gozamn, Jeldu, Konta, Libo Kemkem, Mecha, Seru, Wendo Genet, Wonago) were identified [22-28]. The respective number of species were sorted descending. Similarity indices were calculated for adjacent values accordingly for comparison. The result indicates that Libo Kemkem, Gozamn, Seru and Dabark were found to be with 21, 19, 17 and 17 percent similarity respectively with repect to medicinal plant composition (Table 3). The higher the values of similarity indices the more similar the general floral areas are and vice versa.

Geographical distribution of medicinal plants for treating GIP: The available information from literature sources indicated that there is uneven distribution of medicinal plants for treating stomach and intestinal related problems.

Figure 2: Distribution of medicinal plants for treating GIP across Ethiopian floristic regions.

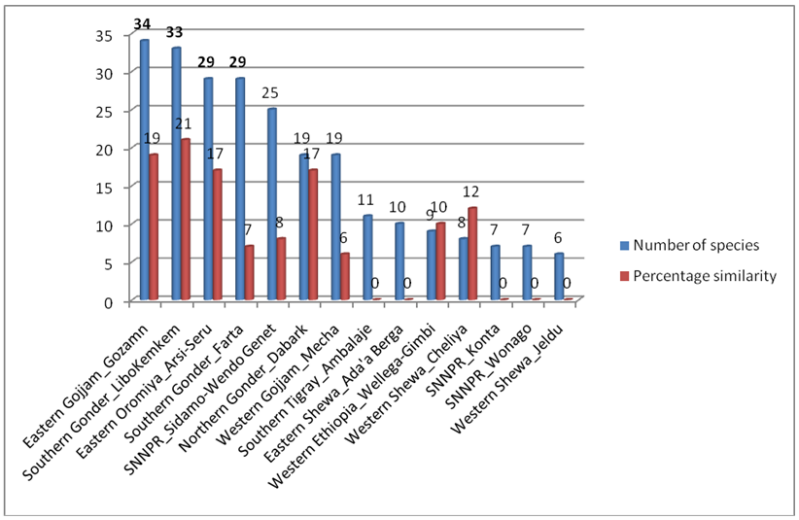


The majority of the species were reported from the Northern and the Western floritic regions while there is limited amount of available information in the rest of the country. Figure 2 represents the distribution of medicinal plants for treating GIP across Ethio-floristic regions (AF= Afar, AR= Arsi, BA= Bale, GD= Gonder, GG= Gamo Gofa, GJ= Gojam, HA= Harerge, IL= Ilubabor, KF= Kefa, SD= Sidamo, SU= Shewa, TU= Tigray, WG= Welega and WU= Welo). The highest number of species reported were from Eastern Gojjam, Gozamn (34 species) and the least number of species reported were from Western Shewa, Jeldu (6 species). This wide range of difference in species composition could be explained by a number of factors (Figure 3).

In areas with limited ethnobotanical information available on medicinal plants used to treat gastrointestinal problems, it does not mean that the plants are not available there rather since such information is highly influenced by sociocultural, environmental and modernity factors, it needs through study to indicate exactly what variations are available between floristic regions in their medicinal plant composition. Such studies better aided by analysis of both

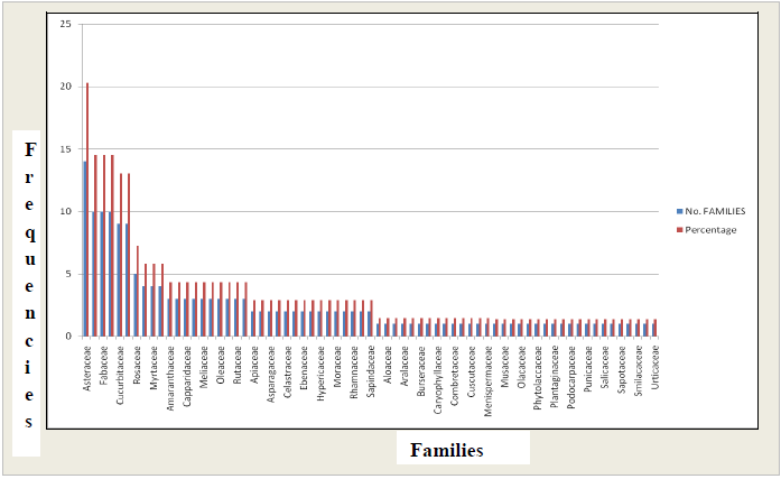
ecological and phytochemical parameters rather than depending solely on ethnobotanical information retrieved from local herbalists. Therefore, it is when the local indigenous knowledge is an integral part of what science has already thought that effective discovery and drug development becomes a meaningful scientific finding.

Figure 3: Species composition and percentage similarities between floral regions.



Families of medicinal plants used to treat GIP: Top six plant families identified as treating gastrointestinal parasites are: Asteraceae (20.29%), Euphorbiaceae, Fabaceae and Lamiaceae (14.49% each), Cucurbitacea and Solanaceae (13.04% each). The higher percentages of these families as compared to the remaining 63 families indicate that they are potenitial familes to undertake further phytochemical analysis to come across the most effective antiparasitic drugs (Figure 4).

Figure 4: Families of medicinal plants for treating gastrointestinal parasites.



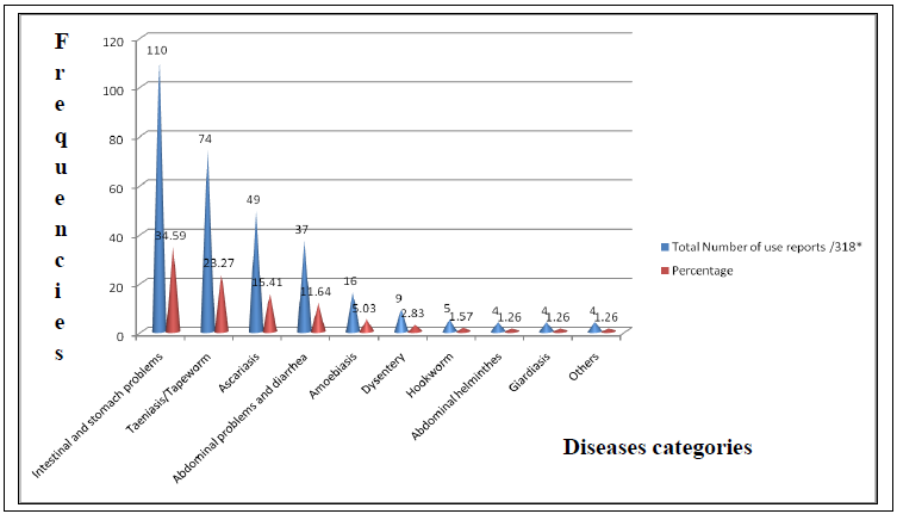
Knowing the ecology and distribution of these families may also help to look for biological, physical and chemical features responsible for their phytochemical activity thereby testing whether there is relationship between the

ecology and environment in which the plants occur and the phytochemically active molecules they contain. Such through tests may answer the question why certain plant species very common as medicines in some floristic regions may not be known as medicines at all in the other floristic regions and vice versa.

Types of gastrointestinal problems treated by traditional herbal remedies

Gastrointestinal problems have a wide range of causes [1]. It can be protozoan (giardiasis, amoebiasis); parasitic worms which could be helminthes (tapeworms) or nematodes (ascaris) and/or bacterial, viral as well as fungal origins or a combination of these. Based on the information collected during the review, ten types of gastrointestinal problems were identified by traditional classification of diseases. These are intestinal and stomach problems, taeniasis, ascariasis, abdominal problems and diarrhea, amoebiasis, dysentery, hookworm diseases, abdominal helminthes, giardiasis and those which could be viral, bacterial or fungal origins (Figure5). Top four frequently reported gastrointestinal problems are intestinal and stomach problems (34.59%), taeniasis (23.27%), ascariasis (15.41%) and abdominal problems and diarrhea (11.64%) (Refer to Tables1-2; Additional file5).

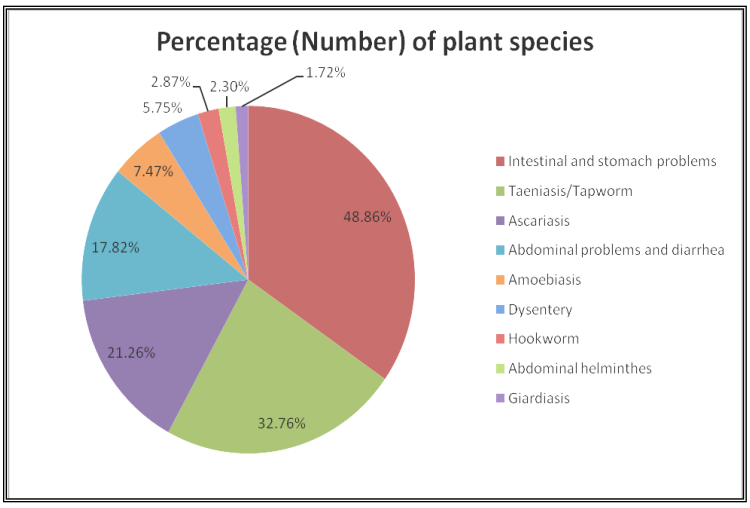
Figure 5: Traditional classifications of diseases treated versus number of medicinal plant (MP) use reports.



The classifications here are not distinct from one another. The first one is so broad a category so that it may as well be able to include some records from the others. The basis of classification is not on a uniform criterion and it is based on sources from secondary data from informants as stated in the students' thesis. The implication is that traditional way of classifying health problems does not show clear cut distinctions between diseases and its one of the shortcomings. The total number of plant species use reports is 245 but only 173 species are identified in the review implying that a single plant species can be used to treat more than one type of aliments.

The highest percentages of medicinal plant species per a given gastrointestinal problem is seen for intestinal and stomach problems (48.86%), taeniasis/tapeworm (32.76%), ascariasis (21.26%) and abdominal problems and diarrhea (17.82%) (Figure6).

Figure 7: Percentage (number) of plant species per GIP aliment.



Conclusions

Gastrointestinal problems are caused by either parasites or non-parasitic origins. Those caused by parasites can be protozoan or parasitic worms. Traditionally, people classify gastrointestinal problems based on the signs and symptoms they may observe on the patient thereby using herbal remedies as a cure for the diseases by trial and error. A number of ethnobotanical studies on medicinal plants were carried out in different regions of Ethiopia over the past few years to document the vast array of knowledge hosted in the local communities along with the potential medicinal plant species used by traditional healers. However, such studies are too general and fragmented. Information is not easily available to professional researchers who are eager in screening, verifying and approval of potentially significant plant species of interest to treat specific health problems. The scenario calls for the need for reviewing and compiling the fragmented pieces of information making easily available to the readers as well as professional researchers.

List of abbreviations

AF= Afar Floristic Region; AR= Arsi Floristic Region; BA= Bale Floristic Region; GD= Gonder Floristic Region; GG= Gamo Gofa Floristic Region; GJ= Gojam Floristic Region; HA= Harer Floristic Region; IL= Ilubabor Floristic Region; KF= Kefa Floristic Region; SD= Sidamo Floristic Region; SU= Shewa Floristic Region; TU= Tigray Floristic Region; WG= Wellega Floristic Region; WU= Welo Floristic Region; GIP= Gastrointestinal Parasites; HIP= Human Gastrointestinal Parasites; NTD= Neglected Tropical Diseases ; SI= Similarity Index; WHO= World Health Organization.

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Author' contributions: Zewdie Kassa have made substantive intellectual contributions to this review in secondary data collection, organization of the data, analysis, interpretation of results, preparation of the manuscript and proof reading.

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