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Medicinal Plants Biodiversity and Local Healthcare Management System in Chencha District; Gamo Gofa, Ethiopia

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Since the time of immemorial, plants were used for multiple socio-cultural and economic uses. Medicinal use is one of the services that plants provide for human welfare. The practice of traditional medicine is common in Ethiopia although it is not utterly studies and documented. So, the aim of this study is to conduct an ethnobotanical survey of medicinal plants used for treatment of human and livestock health problems in Chencha district. For that reason, a cross sectional study and systematic sampling technique was employed to select possible sampling sites and medicinal practitioners. A total of 9 sampling sites were selected, and a total of 17 informants were selected and interviewed. Ethnobotanical data was gathered using semi-structured interview, group discussion and field observation, and analyzed using descriptive statistics, Pearson correlation coefficient, informants' consensus and fidelity level index. A total of 89 medicinal plant species, used to treat human and livestock health problems, are discovered. Of these, nearly 42 species (47%) are harvested from only *ex-situ* while 19 species (21%) are harvested from *in-situ*, and the rest 28 species (32%) are gathered from both *in-situ* and *ex-situ*. On the other hand, about 64 species (72%) are found to be herbs, 16 species (18%) shrubs, 8 species (9%) trees and 1 succulent species. With regards to plant parts, leaves share the largest proportion with 44% followed by roots with 16%. Amongst several remedies, concoction forms account for 30% followed by infusion (21%). The majority of plant remedies (67%) are found to be administered via oral, followed by dermal (25%) and nasal (8%). On the other hand, the average informants' consensus factor calculated (µICF=0.64) shows the presence of high intra-cultural uniformity amongst practitioners in using plants for multiple purposes. However, Pearson correlation coefficient analysis (r= -950, p=0.05) depicts the existence of significant and inverse correlation between age range and medicinal plant knowledge amongst informants.

Keyword: Biodiversity, Medicinal Plants, Indigenous Knowledge, Ethnobotany, Ethnomedicine, Ailments, Traditional Medicinal Practitioners, Use-Categories.

1. Introduction

1.1 Background Information

People, since the beginning of civilization, have used plants for multiple purposes. Historical accounts of traditionally used medicinal plants depict that different medicinal plants were in use as early as 5000 to 4000 BC in China, and 1600 BC by Syrians, Babylonians, Hebrews and Egyptians (Dery *et al*., 1999). This time, the chemical and genetic constituents of plants are being increasingly exploited for human benefit (Gerique, 2006). In this regard, studies indicate that 25% of the modern drugs are derived from the extracts of medicinal plants (Robert and John, 1983).

Traditional medicine is any ancient and culturally based healthcare practice different from scientific medicine and commonly regarded as indigenous, alternative or folk medicine mainly orally transmitted knowledge owned by communities of different cultures (Martin, 1995). The high cost of drugs and the inability of many developing countries to purchase modern drugs have forced local communities to look for products in the form of medicinal plants that are proved to be effective, safe, inexpensive and culturally acceptable (Mohammed Adefa and Berhanu Abraha, 2011). For that reason, more than 70% of world populations use plant remedies for their primary healthcare system (Nair and Nathan, 1998). Similarly, more than 80% of Ethiopians rely on indigenous remedies for a numerous socio-cultural and economic reasons (Mesfin Tadesse *et al*., 2005). Despite of this, however, the alarming population growth with increasing demand and consumption is distracting medicinal plants resources from their natural habitat. Most importantly, deforestation and agricultural encroachment aggravate the loss of medicinal plants from their habitat and the consequent loss of globally significant plant species (Tesfaye Seifu *et al*., 2006). Furthermore, documentation of medicinal plants knowledge is incomplete as the result of limited inventory of medicinal plants traditionally used by local people (Kebu Balemie *et al*., 2004). Similarly, to the knowledge of the researchers, there has not been any ethnobotanical research carried out in Chencha district although the local communities widely use medicinal plants for upholding their primary healthcare system. Therefore, the aim of this study is to fill the gap and enrich the limited inventory of medicinal plants thereby documenting and preserving traditional medicinal plants and the associated knowledge used for treatment of human and livestock ailments in Chencha district which has varied forms of flora, socio-cultural diversity and different traditional medicinal systems from other parts of the country.

2. Research Material and Methods

2.1 Background of the study area

Chencha is one of 13 districts in Gamo Gofa zone, SNNP regional state, and is located between 37^0 29' 57" to 37^0 39' 36" to the east and $6^0$8' 55" to 6^0 25'30" to the north (see Figure 1). The district is categorized mainly into two agro-climatic zones; *Dega* (high altitude) covers about 44% of the area with an altitude of more than 2300 meter above sea level and *Woinadega* (mid altitude) ranging from 1900-2300 masl and covers about 56% of the area. According to the meteorological report obtained from the Agricultural and Rural Development Office of the District (ARDOD), the mean annual temperature and rainfall are 22.5^0C and 1201-1600 mm, respectively.

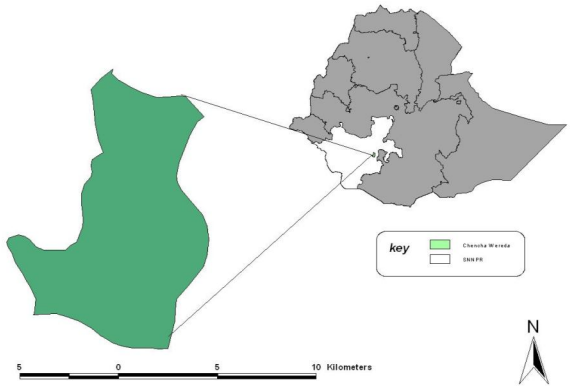

Fig 1: Map of the study area (Source: Ethiogis)

According to the ARDOD, the total area of the district is estimated to be 373.6 km^2 (37,360 hectare) of which 55.26% is cultivated land, 8.51% is grazing land, 15.47% is covered with forest and shrubs and 20.76% is used for settlement and other purpose. Barley, Enset, wheat, bean; and root and tuber crops such as potato, sweet potato and other are dominant crops grown in the area.

2.2 Study Sites and Informants Selection

A cross sectional survey along with systematic (or purposive) sampling was employed for selection of study sites and informants. A preliminary survey was conducted on some villages to sketch out the overall status of medicinal plant distribution and indigenous knowledge in the study area. Accordingly, the

study sites within the district were systematically selected in accordance with their status of forest coverage and population settlement. In this regard, about 9 sampling sites from 6 viable villages were surveyed (see Table 1).

Table 1: Location of sampling and medicinal plants collection sites (NB: masl=meters above sea Level, N= north, E= east).

No	Name of sampling site	Location		Elevation (masl)
		Latitude (N)	Longitude (E)	
1	02 Chencha	06°13′13″	037°34′01″	2559
2	03 Chencha	06°13′58″	037°34′41″	2555
3	Dorze Holo (1)	06°13′11″	037°34′04″	2564
4	Dorze Holo (2)	06°13′47″	037°34′23″	2597
5	Tegecha	06°07′02″	037°34′30″	1264
6	Dorze Ayra	06°12′34″	037°34′44″	2534
7	Azo Gule	06°21′06″	037°35′43″	2841
8	Tsida	06°16′30″	037°33′47″	2864
9	Amarana Boda	06°10′40″	037°34′35″	2317

Similarly potential informants (medicinal practitioners) were selected systematically with the help of local elders and administrative leaders. As the result, a total of 17 informants (11 males and 6 females) between the age of 19 and 80 were systematically selected.

3. Interview and Discussion

Ethnobotanical data was collected using semi-structured interviews and group discussion where two field visits were made to each sites based on procedures recommended by Martin (1995) and Alexiades (1996). The survey was made in between August 2011 and August 2012. Data collection was made on the basis of checklist (questionnaire) items prepared. The items include information on informant's personal background, local names of medicinal plants used, methods of preparation, diseases treated, dosage, routes of administration, side effect of remedies, sources and management of medicinal plants. Moreover, direct filed observation was also made when necessary.

3.1 Medicinal Plants Collection and Identification

Medicinal plants used by the local community on the study area were collected in adjacent to field walk interview and direct field observation with informants. Representative specimens Possessing both reproductive and vegetative parts were collected to make the identification process Easier (see Figure 2). Medicinal plants collection was made by using basic botanical collecting tools. Sample specimens were labeled by the name of institution owning the project, name of collectors, local and botanical name of the species; locality, habit and habitat of the species; collecting date, collecting number and indigenous use of the species.

Identification of specimens was carried out on the field while collecting and processing plant specimens. However, unidentified medicinal plants was brought to Arba Minch University botanical lab and then transported to Addis Ababa University herbarium for identification.

3.2 Data Analysis Procedures

3.3 Statistical Analysis

A descriptive statistic procedure like percentage and frequency distribution were employed for analyzing plant habit, plant parts used & methods of preparation, dosages and route of administration. Moreover, simple linear (Pearson correlation) coefficient test is calculated to determine the correlation between medicinal plant knowledge and age ranges amongst informant medicinal practitioners.

3.4 Informant Consensus

The level of homogeneity between information provided by different informants was calculated using informant's consensus factor (and the number of informants citing a given medicinal plant species) as given by Leonti *et al*. (2001). Seven use-categories were used for that purpose. An ICF value close to 1 is taken as an indication of high intra-cultural consensus, that is, more healers use the same plant species, whereas a value close to zero as a low probability of similarity in use of plants by different informants

Fig 2: Researchers during field survey and collection of plant specimens

3.5 Fidelity Level Index

The fidelity level (FL) is the percentage of informants claiming the uses of a certain plant species for the same major purposes or ailment to treat as described by Alexiades (1996). So, FL was calculated as FL (%) = (Np/N) X 100, where Np is the number of informants that claim the use of a plant species to treat a particular disease and N is the number of informants that use the plants as a medicine to treat any disease. So, in this study, seven medicinal plant species are systematically selected, and their FL index is analyzed for their preference by the informant to treat tonsillitis, stomachache and malaria.

4. Result and Discussion

4.1 Ethnomedicinal and Ethnoveterinary Plant Species in the Study Area

Plants are the major sources of livelihood for the community study area. Plants are in fact used as source of medicine, food, construction, forage and other financial incomes. This study came to document nearly 89 species of plants used to treat both human's and livestock's health problems in Chencha district. The majority of species are collected and preserved in Arba Minch University temporary herbarium. The discovery of utilization of such a large number of medicinal plants by the people of the study area shows the everlasting dependency of local people on traditional medicinal plant for treatment of both human and livestock health problems. In this study, the majority of medicinal plants are found to be harvested from farmland and home-gardens (see Table 2). In this regard, nearly 42 species (47%) are solely cultivated ones, and 19 species (21%) are collected from wild habitats. This indicates the presence of proper management of medicinal plants in the study area that has to be encouraged and promoted by stakeholders.

Table 2: Frequency distribution of sources of medicinal plants in the study area

Source	**Medicinal plants (#)**	**%age**
Wild (*In-situ*)	19	21
Cultivated (*Ex-situ*)	42	47
Both	28	32
Total	**89**	**100**

On the contrary, Mirutse Giday (1999) and Mohammed Adefa and Berhanu Abraha (2011) have separately reported that the majority of medicinal plants in their studies are often rather harvested from natural (wild) habitats.

On the other hand, analysis of habits (see Table 3) of plants documented shows that herbs share the largest proportion with 64 species (72%), followed by shrubs with 16 species (18%). In this regard, similar findings were reported by Mohammed Adefa and Berhanu Abraha (2011) in their research at Tehuledere district. However, Haile Yineger and Delenasaw Yewhalaw (2007) and Ermial Lulekal *et al.* (2008) have found shrubs to make up the highest proportion of medicinal use followed by herbs in their ethnobotanical research of Sekoru and Mana Angetu districts, respectively.

Table 3: Percentage distribution of growth forms of medicinal plants recorded

Growth Form	Medicinal plants (#)	%age
Herbs	64	72
Shrubs	16	18
Trees	8	9
Succulent	1	1
Total	**89**	**100**

4.2 Distribution of Medicinal Plants into Taxonomic Groups

Analysis of taxonomic group of plants revealed that a total of 89 species belonging to 80 genera and 39 families are documented. On the other hand, the study showed that the species belonged to diversifies genera. In this regard, the genus *Artemisia* is found to have 4 species, *Rumex* with 3 species, and *Euphorbia*, *Lemon*, *Ocimum* and *Plantago* consisted of 2 species each, and the remaining genera with one species each. With respect to families, Asteraceae shared the largest proportion, i.e. consisted of 19 species, followed by Lamiaceae with 10 species, Solanaceae and Euphorbiaceae having 5 and 4 species, respectively, and Apiaceae, Cucurbitaceae, Labiatae and Polygonaceae 3 species each, and Boraginaceae, Cruciferae, Fabaceae, Myrsinaceae, Plantaginaceae, Ranunculaceae, Rubiaceae and Verbenaceae 2 species each, and the remaining families with 1 species each. Likewise, Mohammed Adefa and Berhanu Abraha (2011) have discovered similar finding that Asteraceae usually takes the greater proportion their ethnobotanical study in Tehuledere district, south Wollo, Ethiopia.

4.3 Plant Parts Used and Preparation of Plant Remedies

Analysis for plants parts revealed that different parts of plants were used for preparation of remedies on the basis of types of disease to treat. Most importantly, leaves are found to frequently used plant part accounting for 44%, followed by roots making about 16% (see Table 4). Previous researches in other parts of the country indicated that leaves and roots are preferably used for treatment of various health problems (Haile Yineger and Delenasaw Yewhalaw, 2007; Mohammed Adefa and Berhanu Abraha, 2011). On the contrary, Ermias Lulekal *et al.* (2008) reported that roots take the highest proportion in the preparation of remedies in Mana Angetu district. In fact, the frequent use of roots for medicinal preparations aggravates the loss of medicinal plants from their natural habitat. However, the use of leaves for preparation of most plant remedies possibly will reduce the possibility of the loss of medicinal plants from the source. The loss of plants usually occurs when roots, stem and bark are highly used for preparation that the mother plant is also harvested together. In this regards, Dawit Abebe and Ahadu Ayehu (1993) have reported that plant harvest involving roots, rhizomes, bulb, bark and stem have a serious effects on the survival of the mother plant in its habitat.

Table 4: Frequency distribution of plant parts used to prepare remedies

No	Plant part	Frequency of occurrence	%age
1	Leaves	59	44
2	Roots	21	16
3	Seeds	16	12
4	Arial parts	16	12
5	Flowers	6	4
6	Whole plant parts	6	4
7	Fruits	4	3
8	Stems	4	3
9	Barks	2	1
10	Tuber	1	1
Total		**135**	**100**

On the other hand, analysis of method of preparation indicated that plant parts are often rendered into different forms of remedies in accordance with the type ailment to be treated and the medical history of the subject patient. In this regard, from a total of 131 preparations (see Table 5), concoction takes the highest share which account for about 30%, followed by infusion having a share of 21%. Despite the existence of variations of knowledge on preparation of remedies amongst different cultures, local peoples often tend to make remedies that are to some extent look alike. In this regard, other researches including Ermias Lulekal *et al.* (2008), and Mohammed Adefa and Berhanu Abraha (2011) have discovered that rather concoction forms of remedies are found to share the largest proportion in their respective studies at Mana Angetu and Tehuledere districts, respectively. This is due to the fact that Indigenous knowledge related to use of plant for healthcare maintenance is the reflection of the types and density of flora and fauna found in a given locality and the cultural background of the society in that area.

Table 5: Major forms of preparation of plant remedies in the study area

No	Forms of preparation	Frequency of occurrence	%age
1	Concoction	39	30
2	Infusions	28	21
3	Decoctions	25	19
4	Ointments	23	18
5	Macerations	9	7
6	Roasted/ Powder forms	5	4
7	Fumigations/smokes	2	1
Total		**131**	**100**

Additive substances like local ale, coffee, honey, and butter are often supplemented while preparing some plant remedies. Uses of such additives were also reported in other surveys elsewhere in Ethiopia (Endalew Amenu, 2007; Mohammed Adefa and Berhanu Abraha, 2011). These additives are often improving the flavor and reduce the adverse effects of remedies including possibility of vomiting and abdominal discomfort due to some heavier remedies.

4.4 Major Routes of Administration and Dosage of Plant Remedies

Analysis of routes of application of plant remedies depicted that drugs often administered to the patient through several ways. Most

importantly, Oral route of administration is predominantly used that accounts for about 67% followed by Dermal with 25% of remedies (see Figure 3). In this regard, similar findings were reported by Debela Hunde *et al.* (2004), Kebu Balemie *et al.* (2004), and Mohammed Adefa and Berhanu Abraha (2011).

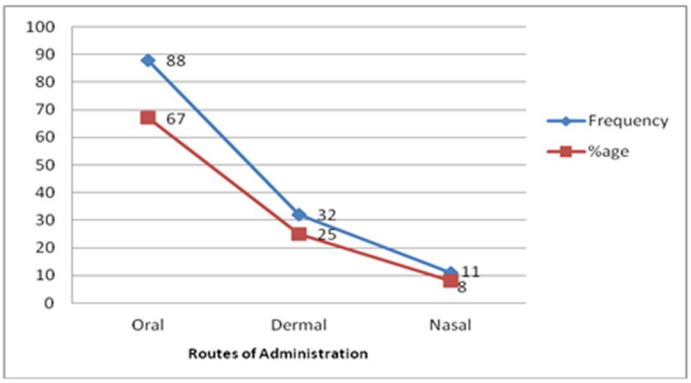

Fig 3: Frequency distribution of major routes of administration of plant remedies

In connection to this, reports showed that Oral and Dermal route of administration of remedies found to enhance the physiological reactions of remedies with the pathogens that in turn increase the healing power of the medication.

Despite the fact that most traditional remedies lack standard dosage and appropriate quantities, this study, however, shows that local people in the study area tends to determine the dosage and quantities of considerable number of plant remedies. In this regard, nearly 49% of preparation are subjected to have their standard dosage and quantity (see Table 6), and in fact the remaining 51% of remedies with no known fixed quantities. Similarly, Ermias Lulekal *et al.* (2008) and Mohammed Adefa and Berhanu Abraha (2011) have reported the presence of such dosage determination in their respective studies of Mana Angetu and Tehuledere districts.

Table 6: Distribution of dosage of remedies administered for patients

Category		**Frequency**	**%age**
Known (determined)	A cup of tea	47	37
	Spoonful	7	5
	A can/jog	5	4
	A handful	2	2
	A drop	1	1
Unknown (undetermined)		64	51
Total	**126**		**100**

4.5 Medicinal Knowledge Variation Amongst Levels of Ages

Several studies revealed that traditional medicinal knowledge normally increases with age. However, in this study, analyses of simple correlation (Pearson) coefficient test (r=-0.950) calculated using SPSS shows that age and medicinal plant knowledge has inverse correlation, that is the increase the age of informants the decrease the number of medicinal plants reported (see Figure 4).

The decrease in knowledge as age increases may be due to the relucctantness and unwillingness of some elderly respondent to share their knoweldege as compared to younger informants. In fact, we have realized that yougesters were more free to share their knowledge than older informants during our survey.

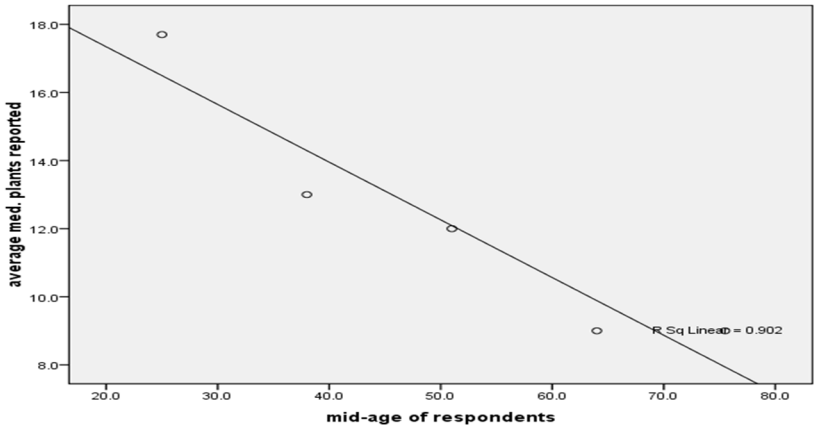

Fig 4: Scatter plot distribution and R^2 line of medicinal plants knowledge with age

On the contrary, Mohammed Adefa and Berhanu Abraha (2011) have reported that medicinal plant knowledge showed increment with age showing a significant correlation. Yet, in other report, Haile Yineger and Delenasaw Yewhalaw (2007) have reported the absence of such a correlation between age of traditional healers and medicinal plants knowledge in Sekoru district, Jimma zone.

4.6 Major Plant Use-Categories and Informants' Consensus

As it was stated above, a total of 89 plants with medicinal importance are documented from the study area. These plants also found to have multiple use-categories) apart from their medicinal valued in the community. Therefore, based on the information gathered, seven (7) use-categories (see Table 7) were set in which a total of 416 use-reports (Ur) were recorded from 89 species of medicinal plants. Analysis of ICF showed that there exists a high consistency (uniformity) of plant consumption among local people in the study sites. As it can be depicted from table below, all ICF values (and also the mean ICF which is 0.64) are close to 1 showing the presence of homogeneity in use of plants for multiple purposes. Accordingly, Furniture use-category takes the uppermost ICF value (0.76) followed by Forage use-category with ICF value of 0.70. Such similarities of use-categories are also reported by other researches in other parts of the country (Mohammed Adefa and Berhanu Abraha, 2011).

Table 7: Informants' consensus factor (ICF) computed for seven use-categories

Use category	Species (#) (nt)	%age of species	Use-reports (Ur)	%age of use reports	ICF (n_{ur}-n_t / n_{ur}-1)
Medicinal	89	100	227	55	0.62
Food	10	10	24	6	0.61
Forage	7	8	21	5	0.70
Fence	19	20	38	9	0.51
Fire Wood	23	26	63	15	0.65
Construction	10	10	25	6	0.62
Furniture	5	5	18	4	0.76
Mean ICF					**0.64**

4.7 Fidelity Level Index

Analysis of percentage of informants claiming the uses of a certain plant species for the same major purposes could not be taken as the only criteria to attest the efficacious of plant species. For that reason, sometimes, fidelity level index shall be

computed to see the medicinal use values and relative preference of species by the local community in a given area. In this study, 7 medicinal plants were systematically selected and analyzed for their fidelity level index that they give value in treating 3 diseases (see Table 8). For instance, despite *Ranunculus oreophytus Del* is reported by few numbers of informants (18%), than *Acmella caulirhiza Del* that is cited by relatively larger number of informants (41%), however, it seems that *Ranunculus oreophytus Del* (FL= 1.00) is more preferable than *Acmella caulirhiza Del* (FL=0.86) in treating tonsillitis.

Table 8: Fidelity level index for plant species used to treat tonsillitis, stomachache and malaria in the study area

Ailments	% of informants	Species	Np	N	Fidelity index (Np/N)
Tonsillitis	41	*Acmella caulirhiza Del*	6	7	0.86
	18	*Ranunculus oreophytus Del.*	3	3	1.00
Stomachache	41	*Artemisia afra Jacq. Ex Willdv.*	5	7	0.71
	12	*Rumex nervosus Vahl.*	1	2	0.50
	65	*Foenuculum vulgare*	4	11	0.36
Malaria	12	*Artemisia annua*	2	2	1.00
	18	*Veronia amygdalina*	2	3	0.67

5. Conclusion and Recommendation

The result of ethnobotanical survey of medicinal plants in Chencha district revealed the existence of medicinal plants and use knowledge in the district. The local people predominantly use medicinal plants and some animals derived remedies for maintaining their primary healthcare. The majority of the local people used to acquire medicinal knowledge from their parents and partners in their locality. In this regard, a total of 89 medicinal plants used for treating human and livestock disease are documented though all villages of the district are not surveyed. The majority of specimens are collected and preserved in Arba Minch University, department of Biology. The discovery of utilization of such large diversity of plant species for medicinal purpose attributes to the continued dependency of local people on traditional medicine for their central healthcare system.

The majority of species are found to have herbal growth forms followed by shrubs and trees. Leaves followed by roots are the dominant plant parts used for preparation of most remedies. On the other hand, the great numbers of preparations are found to be concoction, followed by infusion. The larger proportions of remedies are administered for internal ailments through oral route, while some external infections are treated commonly using dermal (topical) route.

The study discovered that deforestation, agricultural encroachment, drought and overgrazing are the major threat to medicinal plants and its associated knowledge in the district. In addition, the death of some knowledgeable people before passing their great knowledge to the new generation is the other existed threat.

So, the study recommends that the local government should organize traditional medicinal practitioners into associations, which has social and economic importance that their knowledge can be integrally used with modern medicine. Furthermore, *In-situ* and *ex-situ* conservation of medicinal plants should be practiced in the district by training model medicinal practitioners (farmers) to ensure the continuity of threatened medicinal plants. Moreover, further pharmaceutical investigation should be conducted on medicinal plant species so as to develop new drugs of organic kind.

6. Acknowledgement

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