

Medicinal Plants Used for the Management of Rabies in Ethiopia – A Review

Asfaw Meresa*, Sileshi Degu, Ashenif Tadele, Bekesho Geleta, Hiwot Moges, Firehiwot Teka and Netsanet Fekadu

Directorate of Traditional and Modern Medicine Research, Ethiopian Public Health Institute, PO Box 1242, Addis Ababa, Ethiopia

Abstract

Background: Rabies is a deadly zoonotic viral disease. It is a major public-health problem which presents huge economic and health burdens in most parts of the developing world. The disease is difficult to treat once the clinical manifestations start to develop; the vaccines produced in mammalian neural tissues have the disadvantage of causing severe adverse reactions. This leads to the practice of traditional medicine for the control of rabies in most parts of Ethiopia for many years.

Objective: The aim of this review is to give an insight into some of the most commonly used folkloric plants and their method of preparation for the management of rabies.

Methods: Data for this review were generated from the published research findings on Ethiopian traditional medicinal plants on indifferent peer reviewed journals and proceedings using search words, Rabies in Ethiopia, medicinal plants, Ethno botanical studies and anti-rabies activity. Descriptive analysis was conducted using excel spreadsheets and the numbers of plants species and families were reported in frequency tables and figures.

Results: Results showed that a total of 199 plant species belonging to 47 families were used for the management of rabies. The most commonly used families were ephorbiaceae stood first, followed by phytolaceae, cucurbitaceae, acanthraceae, fabaceae and solianaceae. *Phytolacadodecandra*, *Justicaschimperiana*, *Recinuscommunis*, *Brucea antidysenterica*, *Croton macrostachyus* and *Cucumis ficifolius* were the most cited medicinal plant species utilized for the management of rabies. The most widely used plant part for the preparations of remedy were roots followed by leaves, used in solution form by using water as a most cited solvent.

Conclusions: This review indicated that there are many plants utilized for the management of rabies. Hence further research is recommended for ascertaining the efficacy, safety and quality of the claimed medicinal plants. There is also recommended to strengthen the documentation of the indigenous knowledge which contributes for the drug development used for the management of rabies.

Keywords: Rabies; Prevalence; Anti-rabies; Medicinal plants; Ethno-botany

Introduction

Rabies is a deadly zoonotic viral disease which causes encephalitis in all warm-blooded animals and humans [1]. The disease, which is a worldwide occurrence and endemic in most developing countries of African and Asian countries, is transmitted to humans mainly through physical contact (bites and scratches) with both domestic and wild infected animals [2]. Dogs which are the principal sources of the rabies virus significantly contribute to the widespread and transmission of the virus to humans as well as livestock [1,3,4]. Nearly 98% of human rabies occurs in countries with high populations of owned and strayed dogs [5]. Rabies is one of the viral diseases which could not be cured and reversed with existing rabies vaccines once clinical manifestations of the disease begin to surface [6].

Rabies is a major public-health problem which presents huge economic and health burdens in most parts of the developing world [7]. The disease is known to cause large number of deaths in humans and animals each year [3]. Several scientific reports indicate that rabies has accounted for an estimated death of nearly 55,000 people every year globally, with the majority of rabies fatalities estimated to occur in Asia and Africa [5]. People who are at risk of dying due to rabies in these continents are those living in the rural areas. An estimated 10 million people worldwide receive post-exposure treatment after being exposed to animals suspected of rabies [2]. Deaths due to rabies occur despite the availability of effective vaccines which can prevent the development of fatal rabies cases [3]. Besides its health burden, Rabies has greatly contributed to the economic loss of many rabies endemic developing

countries of Asia and Africa as result of the high costs of human vaccine and rabies immunoglobulin (RIG) products, huge patient costs related to travel and income loss for post exposure prophylaxis (PEP) as well as costs due to cattle loss. Secondly, the disease affects the open market of different countries, particularly those of rabies free countries by hampering the movement of animals between them [5]. An estimated of US \$583.5 million (most of which is due to the cost of post exposure prophylaxis was annually spent in Africa and Asia due to rabies and the annual cost of livestock losses due to rabies is estimated to be US \$ 12.3 million in these continents. An estimated 10 million people worldwide receive post-exposure treatment after being exposed to animals suspected of rabies [2-4].

Deribe et al. [8] reported that about 996-14,694 cases of human rabies are estimated to occur in Ethiopia, mostly acquired through dog bites and the number of recorded human rabies cases has shown no apparent reduction for over twenty years in the country [8]. The

***Corresponding author:** Asfaw Meresa, Directorate of Traditional and Modern Medicine Research, Ethiopian Public Health Institute, PO Box 1242, Addis Ababa, Ethiopia, Tel: 0112133499; E-mail: asfawmeresa03@gmail.com

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high population density of dogs with poor management and limited vaccination, particularly in urban centers, greatly contributes to the high prevalence of the disease. Nearly 10, 000 people were estimated to die of rabies each year in Ethiopia. This makes it become one of the worst affected countries in the world [1,4,9]. Although it is difficult to estimate the prevalence and incidence of rabies at national level due to the absence of laboratory diagnosis and recorded data at different health facilities of the Country, a study by Ali et al. [7] uncovered that there was high occurrence of rabies in and around Addis Ababa due to the poor management of owned dogs and the presence of high population of unvaccinated stray dogs [7].

Ethiopia has remained behind in rabies control effort due to various socioeconomic factors and low understanding of the actual trend of the disease despite its effectiveness in rabies prevention than reliance on post exposure human treatments [7]. Rabies vaccines produced in mammalian neural tissues have the disadvantage of causing severe adverse reactions, at a rate estimated as 0.3–0.8 per thousand treated patients [10]. Similarly, the cell culture rabies vaccines are expensive and not readily available to individuals living in developing countries where rabies is endemic in dogs [11]. The high costs of tissue culture vaccine and inertia have been the main barrier to the replacement of Fermi type vaccine [10]. The practice of traditional medicine for the control of rabies in most parts of Ethiopia is based on the use of plant medicines for many years. Several traditional herbs have been formulated by traditional healers to treat human and animal rabies [12].

Materials and Methods

The ethno-botanical information was collected from different ethno botanical publications by graduate students over the past couple of decades, the relevant ethno botanical MSC theses as well as publications; research reports other botanical sources as well as databases were also reviewed. Various on-line sources including Google Scholar were browsed using some important key terms such as Rabies in Ethiopia, medicinal plants, Ethno-botanical studies. The scientific names were checked and confirmed with volumes of the Flora of Ethiopia and Eritrea. Appropriate data collection format was prepared to tabulate scientific, family and local names of species along with plant parts used, diseases treated and preparation of each species. The information was entered in Excel spread. The collected data were

analyzed using descriptive statistics to evaluate the percentage and frequency of different aspects such as, diversity of plants, applications, method of preparation and plant parts used. The results were presented with figures and tables.

Results

Diversity plant resources in the study area

A total of 199 species belonging to 47 families were included in this review. This finding is a good indicator for the presence of considerable diversity of plant species for the management of rabies in Ethiopia. In terms of family distribution, Euphorbiaceae stood first, followed by *Phytolaceae*, *cucurbitaceae*, *acanthraceae*, *Fabaceae* and *solanaceae* (Figure 1).

Plant species most frequently reported

Phytolacacodocandra, *Justicaschimperiana*, *Recinuscommunis*, *Brucea antidysenterica*, *Croton macrostachyus*, *Cucumis ficifolius*, *Salix subserrata*, *Calpurnia aurea* and *Euphorbia abyssinica* were mentioned at 21, 14, 10, 7, 7, 7, 6, 5 and 5 sites, respectively for the treatment of rabies (Table 1).

Conditions of preparation, solvents and additives of herbal remedies

As evident on Figure 2, herbal remedies are prepared using fresh material, dried form and some cases either fresh or dried form of the plant parts are utilized. Some of the remedies are taken with different additives and solvents; the most common solvent used is water is water followed by milk and local alcohol. Commonly used additives to prepare the medicinal plant material include butter, honey, milk, and Citrus juice.

Plant parts, method of preparation and applications

Regarding the preparation of medicinal plants for rabies treatment, various methods of preparation were utilized. The plant remedy preparations consisted mostly of solutions, mixture of powders, infusions, powdering, chopping, decoction, and burning. The prepared traditional medicines were applied in a number of methods; orally drinking or taking with food, directly apply on the affected area (either through the fresh leaf, latex, powder or oil); rubbing (with fresh leaf,

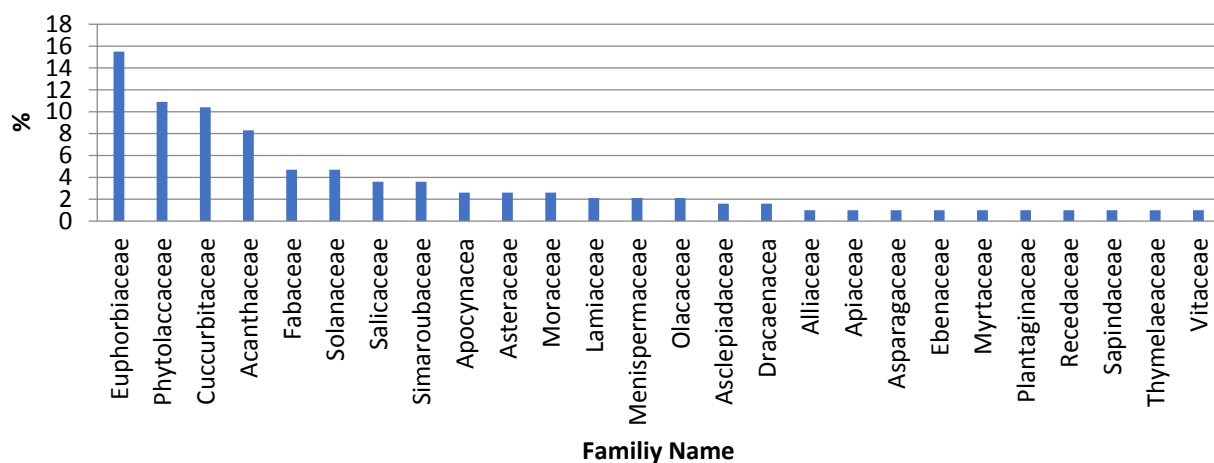


Figure 1: Diversity of Plant species for the management of rabies.

powder, latex or ash of the burned part), squeezing on the affected area, or painting applied on the affected area from the herbal preparations (Table 2). The most widely used plant part for the preparations of remedy were root followed by leaves, which accounted for 41.51 and 29.25% (Figure 3).

Generally, there are many medicinal plants that are claimed to be used for the management of rabies. As shown in different sources of references (Table 2), however, the same plant species have been utilized in most areas of the country although there are slight variations in their ethno botanical application.

Medicinal plant name	Number of reports	Percent
<i>Phytolacca dodecandra</i>	21	10.6
<i>Justica schimperiana</i>	14	7.0
<i>Ricinus communis</i>	10	5.0
<i>Brucea antidysenterica</i>	7	3.5
<i>Croton macrostachyus</i>	7	3.5
<i>Cucumis ficifolius</i>	7	3.5
<i>Salix subserrata</i>	6	3.0
<i>Calpurnia aurea</i>	5	2.5
<i>Euphorbia abyssinica</i>	5	2.5
<i>Artemisia abyssinica</i>	3	1.5
<i>Clusia lanceolata</i>	3	1.5
<i>Daturastramonium</i>	3	1.5
<i>Dorstenia barnimiana</i>	3	1.5
<i>Dracaena steudneri</i>	3	1.5
<i>Lagenaria siceraria</i>	3	1.5
<i>Momordica foetida</i>	3	1.5
<i>Solanum gigantum</i>	3	1.5
<i>Stephania abyssinica</i>	3	1.5
Total	199	100.0

Table 1: Plant species reported for the management of rabies in Ethiopia.

Discussion

Ethno botanical investigations have been found to offer important clues in the identification and development of traditionally used medicinal plants in to modern drugs. *Phytolaccadodecandra* L, *Justicaschimperia*, *Ricinuscommunis*, *Croton macrostachyus* Hochst. Ex, *Cucumisficifolius*, *Brucea antidysenterica*, *Euphorbia abyssinica* J. F. Gmel, *Salix subserrata* are the top five medicinal plants being utilized for the management of rabies by the Ethiopian traditional health care system.

This folk medicinal claim is also further supported with against anti-rabies activity; among the listed medicinal plants, the anti-rabies activity of only three medicinal plants had been scientifically evaluated in Ethiopia. These plants include *Phytolaccadodecandra*L, *Salix substrata* and *Silene macrosele*n. A study conducted on mice to evaluate the anti-rabies activity of the hydroethanolic extract of roots and leaves of *Phytolacca dodecandra* revealed that 80% ethanol macerated extract of both plant parts at the doses of 300, 600 mg/kg failed to display an increase in survival period of mice challenged with the rabies virus (CVS-11) compared with negative control. However, the leaf extract at 1000 mg/kg significantly ($P>0.05$) increased the survival period of mice compared to negative controls.

Deressa et al. [12] also conducted a study on the evaluation of the efficacy of the crude extracts of *Salix subserrata* and *Silene macrosele*n for the treatment of rabies in Ethiopia. The result demonstrated that the chloroform and methanol 80% extracts of the leaf of *Salix subserrata* and the chloroform and aqueous extract of the root of the same plant were found to increase the survival time of mice significantly [10]. These efficacy studies support the traditional use of the medicinal plants. However, deeper scientific investigations on the active ingredients, efficacy as well as safety profiles are necessary not only on these plants but also on the other medicinal plants which are not studied scientifically. These are the phytochemistry, efficacy and toxicity studies of commonly used Ethiopian medicinal plants for treatment of rabies virus.

Salix subserrata

Family: Salicaceae

Local name: Aleltu (Amharic) Wonzadmik/akaya

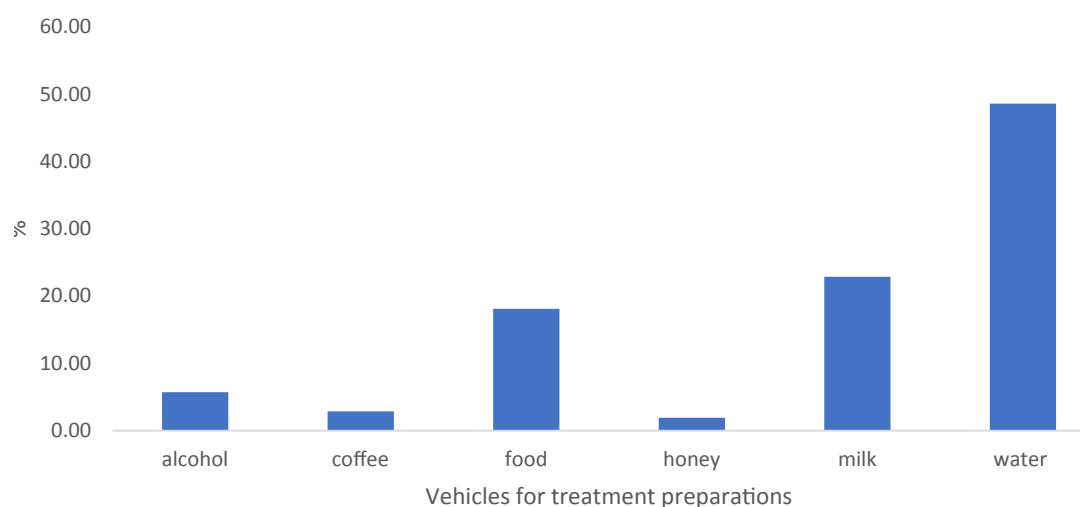


Figure 2: Common solvents and additives used for the administration of medicinal plant parts for the management of rabies in Ethiopia.

S No	Scientific name	Family name	Local name	Part (s) used	Method of preparation	Route of administration	Treatment for:	References
1.	<i>Daturastramonium L.</i>	Solanaceae	Machareqqa [ka] Banjii [O]	Leaf	Crushed and homogenized leaves drunk with water	Oral	Human	[1,13,14]
2.	<i>Justitia schimperana (Hochst. ex Nees) T. anders</i>	Acanthaceae	Gulbanna [ka] Dhumuga (O) Smiza [A]	Buds Root Leaf	Roots and leaves are pounded together and mixed with water and <i>Salix mucronata</i> leaf and given orally for human and animals in the morning before food	Oral	Both	[1,13-27]
3.	<i>Cucumisficifolius</i>		Yemidrembuay	roots	Powder of roots eaten with 'Teffkita/ Crushed fresh root with water fermented for 3 days is taken with honey early morning before breakfast orally until cure	Oral	Both	[1,18,27-30,58]
4.	<i>Dorsteniabarnimiana</i>		Work Bemeda [A]	Root	Powder of roots taken with skimmed milk or noug orally in the morning for seven days	Oral	Human	[1,30,31]
5.	<i>Gnidiaglauca</i>		Beto [A]	Root	Powder of roots mixed with skimmed milk and taken orally for seven days		Human	[1,30]
6.	<i>Phytolaccadodecandra</i>	Phytolaceae	Endod, Shibt, Haranje, Handode	Root Leaf	Powder of roots or leaves mixed with water or domestic alcohol and given orally to humans and animals	Oral	Both	[1,16,18,21-24,26-28,30,32,41]
7.	<i>Salix subserrata</i>		Aleltu [O]	leaf	Leaves from the tree given orally Leaves are pounded and dried, and then mixed with milk		Human	[1,19,34,42-44]
8.	<i>Croton macrostachyus Del.</i>	Euphorbiaceae	Makkanisa [O]	Root Bark Leaf	Pound the fresh root, add water and filter then administered orally for 3 days (dog) and 7 days (other animals) and apply topically ; The Bark of <i>Croton macrostachyus</i> is dried , powdered and mixed with water one coffee cup is given for human and 1 bottle is given to castles and 6 bottles is given to camel once a day for 3	Oral	Both	[15,16,28,40,41,46]
9.	<i>Silenemacroselen</i>		Wegert [O]	Root	Root from herbs given orally	Oral	Human	[1,12]
10.	<i>Bruceaantidysentrica</i>	Simaroubaceae	Qomonyoo [O]	Fruit Leaf Root	Squeezed and baked with teff flour and given for 3 days [together with <i>Croton macrostachyus</i> and <i>Rumexnervosus</i>].	Oral	Live stock Both	[16,18,20,22,27,38]
11.	<i>Euphorbia abyssinica J. F. Gmel</i>	Euphorbiaceae	Qulqwal [A]	Root Latex Leaf	One spoon root powder mixed with a cup of fresh milk. Give for dog or Powder of roots or leaves mixed with water and taken orally	Oral	both	[1,17,24,30,32,47]
12.	<i>Ricinus- communis</i>	Euphorbiaceae	Qoobboo [O]	Leaf root	Fresh leaves crushed and mixed with water and taken one cup of tea for 3 consecutive days		Human	[15,18-20,22,27,36,42,46]
13.	<i>Calpurnia aurea (Ait.) Benth.,</i>	Fabaceae, (AE)	Digita [A]	Leaf Fruit Seed Root	Fresh or dried leaf, fruit and seeds crushed, mixed with food and given to dogs	Oral [L]	Livestock	[15,17,29,40,48]
14.	<i>Artemisiaabyssinica Sch., Bip. ex A.Rich.</i>	Asteraceae	Qoddo [O] Chikugn [A]	Leaf	Leaf is ground in small water and given to the victim every morning for 3 days in small 'areqe' glass (Kenneeraa)	oral	both	[25,28]
15.	<i>Momordicafoetida</i>	Cucurbitaceae	Saaroobofaa [O]	Root Leaf stem	Pounding the roots, making Solution & drinking one coffee cup at once.	Oral, nasal	Human	[15,36]
16.	<i>Zehneriascabra</i>	Cuccurbitaceae	Korisinbira [O] Hiddareeffaa [o]	Root Leaf	Pounded roots taken orally	Oral	human	[1,18]

17.	<i>Stephaniaabyssinica</i> (Dillon&A.Rich	Menispermaceae	HiddaHantutaa[O] Yet areg [A]	Root Leaf	Dry root of Stephaniaabyssinica will be powdered and backed with teff flour and given to cattle. A crushed of leaf and root are soaked in honey for one day, decanted and one cup of juices is taken orally.	Oral [L]	Both	[16,24,32,38]
18.	<i>Lagenariasiceraria</i> (Molina) Standl	Cucurbitaceae	Qel [A]	Fruit	The fruit of Lagenariasiceraria and Calpurnaaurea are ground together and backed with powder of Teff given to the cattle as a breakfast for 3 days (given to dogs.	Oral	L iverstock	[28,49]
19.	<i>Clucia lanceolata</i>	Euphorbiaceae	Uleefoonii[o]	root	Fresh leaves hold in teeth	oral	Both	[18,22,27]
20.	<i>Olea eureapa</i>	Oleaceae	Ejersa [o]	Leaf	Root crushed and taken with coffee (Rabies)	Inhalation	human	[18,22]
21.	<i>Solanumgigantum</i> Jacq.	Solanceae	Hiddii saree [o]	Root	Root crushed and taken with coffee	Oral	Human	[22,46]
22.	<i>Allium sativum</i> L	Alliaceae	Nechshinkurt [A]	Bulb	Eat the part or Whole bulb directly	Oral	Human	[23,50]
23.	<i>Acokantheraschimperi</i> (DC) Benth	Apocynaceae	Merenze[A]	Root	The root of Acokantheraschimperiwith the root of Cucumisficifolius pounded together mixed with water and 1 litter is given to cattle once a day for 3 days.	Oral	Live stock	[28,49]
24.	<i>Dregeaschimperi</i> (Decne.) Bullock	Asclepiadaceae	Shanqq [T]	Leaf Fruit	Crush and drink the fluid Crushed And to be drunk	Oral	Both	[50,51]
25.	<i>Dracaena steudneri</i> Engl.	Dracaenacea	Atsu [O]	Bark Leaf	Leaves taken orally		Both	[1,15,27,32]
26.	<i>Euphorbia tirucalli</i> L.,	Euphorbiaceae	Kinchib[A] Tsedo (M)	Latex Root	Latex mixed with bean powder and given to eat after food	Oral []	Both	[16,52]
27.	<i>Euphorbia ampliphylla</i>	Euphorbiaceae	Qulquale [A]	Sap/latex	The drop of latex is collected, mixed with "teff" powdered and backed and then eaten 1/3 of it	Oral	Human	[35,40]
28.	<i>Eucleanatalensis</i> L	Ebenaceae	Kuliaw [T]		Not stated		Both	[53,54]
29.	<i>Rumexnervosus</i> Vahl.:	Polygonacea	Dhangaggo o [o]	Root	The root of Rumexnervosus together with that of Phytolaccadodecandra, Bruceaantidysenterica, Croton macrostachyus will be pounded together 1 teaspoon will be drunk with coffee	Oral	Human	[16]
30.	<i>Scandoxusmultiflorus</i> (Martyn) Raf.:	Amaryllidace ae	QulubiWarabesa [o]	Bulb	Bulb of Scandoxusmultiflorus will be pounded with bark of Croton macrostachyus and put in cold water for 1- night then by filtering one cup given to human	oral	Human	[16]
31.	<i>Capparisartilaginea</i> Decne.:	Capparidaceae	Goraa [o]	Root	Root of Capparisartilaginea together with that of Phytolaccadodecandra, Bruceaantidysenterica and Croton macrostachyus will be pounded and given to cattle	Oral	Livestock	[16]
32.	<i>Hypericumrevolutum</i> Vahl :	Guttifera	Hinedhe [o]	Root Leaf	The root and leaf of Hypericumrevolutum together with roots of Rumexnervosus and Phytolaccadodecandra, Bruceaantidysenterica, leaf and bark of Croton macrostachyus will be pounded together mixed with water and given to cattle.	Oral [L]	Livestock	[16]
33.	<i>Mikaniacapensis</i> DC.:	Asteraceae	HiddaReeffa [o]	Root	The root of Mikaniacapensis and Cucumisficifolius will be powdered together mixed with water given to cattle.	Oral	Livestock	[16]

34.	<i>Maytenus senegalensis</i> (Lam.) Exell,	Celastraceae,	GeramAtat [A]	Leaf	Fresh young leaf is crushed and applied topically	Topical	Human	[17]
35.	<i>Rhynchosia elegans</i> A. Rich.	Fabaceae,	TeroAreg [A]	Leaf	Fresh or dried leaf paste or powder mixed with little water is given orally to human and livestock	Oral	Both	[17]
36.	<i>Salix mucronata</i> Thunb.,	Salicaceae,	Achaya [A]	Leaf	Fresh leaf mixed with <i>Justicia schimperiana</i> leaf and squeezed juice is given orally before food to human and livestock	Oral [B]	Both	[17]
37.	<i>Carissa edulis</i> Vahl.	Apocynaceae	Agamsa (O)	Root	The root is powdered and mixed with food.	oral	Human	[19]
38.	<i>Carissa spinarum</i> L.	Apocynaceae	Agamsa [O]	Root, bark			Human	[29]
39.	<i>Lagenaria abyssinica</i> (hook.f.) C. Jeffrey	Cucurbitaceae	Buqesetena (O)	Root	Powdered root is mixed with food.	Oral	Human	[19]
40.	<i>Antiaristoxycaria</i> Lesch.	Moraceae	Dimbicho [O]	Bark	Dry/fresh stem bark is pounded and powdered then mixed with milk and given orally		Human	[39]
41.	<i>Combretum collinum</i>	Combretaceae	Abalo [A]	Seeds	The seed of <i>Combretum collinum</i> with seed of <i>Solanum dasycarpum</i> are crushed together powdered, mixed with "tella" and drunk for 3 days	Oral	Human	[35]
42.	<i>Otostegia integrifolia</i>	Lamiaceae	Tungut [A]	Leaf	The leaf of <i>Otostegia integrifolia</i> is pounded mixed with milk and drunk	Oral	Human	[35]
43.	<i>Ficus</i> sp.	Moraceae	Warka [A]	Stem bark, latex	+ <i>Phytolacca dodecandra</i>	Oral	Human	[40]
44.	<i>Jatropha curcas</i> L	Euphorbiaceae	Yesudan-gulo [A]	Seed	Not specified	Oral	Human	[40]
45.	<i>Cissampelos mucronata</i> A. Rich.	Menispermaceae	Balari (M)	Root	Not specified	Oral	Livestock	[52]
46.	<i>Clausena anisata</i> (Wild.) Benth	Rutaceae	Ulmaayii [O]	Bark	Bark of <i>Clausena anisata</i> , leaves of <i>Sida rhombifolia</i> , root of <i>Cucumis ficifolius</i> , bark root of <i>Brucea antidysenterica</i> powdered together and mixed in milk then drunk a cup of tea for three days in order to get cured from Rabies disease	Oral	Human	[46]
47.	<i>Crotalaria spinosa</i> Hochst. ex. Benth.	Fabaceae	Shumburaagugee [O]	Root	Root crushed, mixed with water and drunk	Oral		[46]
48.	<i>Argemone mexicana</i> L.	Papaveraceae	Yahyaeshoh [A]	Root	Crush then give with water	Not stated	Both	[24]
49.	<i>Diplophium africanum</i> Turcz	Apiaceae	Zegerawta [A]	Root	Pound and give with water	Not stated	Both	[24]
50.	<i>Dipsacus spinatifidus</i> Steud. ex A. Rich.	Dipsacaceae	Ferezeng/kelem [A]	Leaf	Pound and give with water [b]	Not stated	Both	[24]
51.	<i>Milletia ferruginea</i>			Young stem	Heat the right side of cattle with stick of <i>Milletia ferruginea</i> and <i>Brucea antidysenterica</i> for about seven days	Dermal	Live stock	[24]
52.	<i>Cyphostemma adenocaula</i> (A. Rich.) (Vitaceae)	Vitaceae	Asserkush [A]	Root	Root boiled with milk, filtered and filtrate taken in empty stomach Full of a coffee cup daily for 3 consecutive days	oral	Human	[55]
53.	<i>Jasminum abyssinicum</i> Hochst	Oleaceae	Tembelel [A]	Seed Leaf	Not specified	Not stated	Human	[48]
54.	<i>Ximenia americana</i> L.	Oleaceae	Enkuay [A]	Bark	Soaking bark in water and the water is taken orally	Oral	Human	[31]

55.	<i>Rhoicissus tridentate</i>	Vitaceae Lalo	Lalo[A]	Root Leaf	The root and leaf of this plant is ground together, mixed with water then 1-2 water glasses is drunk for human and 1litter is given to cattle for 3day	Oral	Both	[28]
56.	<i>Ajuga alba (Gurke) Robyni</i>	Lamiaceae	Anamuro [O]	Leaf Fresh or dried	Pounded, mixed with water	Oral	Human	[44]
57.	<i>Flueggeavirosa(Roxb. ex Willd.) Royle</i>	[Euphorbiaceae]	Harmazo	Root	Not specified	Not specified	Human	[41]
58.	<i>Anthemistigreensis.J. Gay ex A.Rich.</i>	Asteraceae	Sifay	Root Fresh	Concocted, crushed, mixed with water Or Boil and drink the decoction when cool	Oral	Human	[44,58]
59.	<i>Asparagus setassus (Kunth) Jessap</i>	Asparagaceae	Zeriti	Root Fresh	Concocted, crushed, mixed with water	Oral	Human	[44]
60.	<i>Convolvulus killimandschari Engl.</i>	Convolvulaceae	AserkushTebetbkush [A]	Root Fresh	Concocted, pounded, mixed with water, shaken, filtered	Oral	Human	[44]
61.	<i>Zingiberofficinale</i>	Zingiberaceae	Jinjibila [O]	Root	Root concoction is drunk (Rabies)	Oral	Human	[22]
62.	<i>Asparagus leptocladodiusChiov.</i>	Asparagaceae	Seriti[O]	Root	Not specified		human	[29]
63.	<i>Cucumisdipsaceus Ehrenb. ex Spach</i>	Cucurbitaceae	Kurera [O]	Fruit	Not specified		human	[29]
64.	<i>Garcinia livingstonei T. Anders</i>	Clusiaceae	Abuqurto [O]	Root	Not specified		human	[29]
65.	<i>Senna petersiana(Bolle) Lock</i>	Fabaceae	Sanaa maki [O]	Leaf	Squeezed and given with food to cattle Squeezed and 1/2 coffee cup is given for 2-3 days	Oral	Human	[20]
66.	<i>Solanumdasyphyllum Schumach.</i>	Solanaceae	Hidi waraabasaa[O]	Leaf Seed	Squeezed and 1/2 coffee cup is given to the animal	Oral	Human	[20]
67.	<i>PennisetumthunbergiiKunth</i>	Poaceae	Marga abaaboo[O]	Leaf Seed	Crushed, dried, powdered, mixed with milk ('Aguat') 2 spoon is given	Oral	Human	[20]
68.	<i>MaesalancelataForssk</i>	=Myrsinaceae	Abayi[O]		Crushed, squeezed and taken	Oral	Human	[20]
69.	<i>Ozoroa insignis Del</i>	Anacardiaceae	Gerri [O]	Bark Root [L]	Dried bark and root of the plant is pounded then 2 teaspoonful powder added to 1cup of water, administered orally for 20 days, 2 days interval	Oral	Human	[45]

70.	<i>Rhustenuinervis</i>			Root	The bark of the root is crushed and mixed with water and the decoction of the root is drunk after one hour.	Oral	human	[56]
71.	<i>Afrocarpusalcalatus</i> (Thunb.) C. N.				Not stated		Rabies	[42]
72.	<i>Rumex nervosus</i> <i>vani Senna</i> <i>oteryRicinuscmmunis</i>			Leaves	Fresh leaves are pounded and juice is prepared and taken	Oral	both	[21]
73.	<i>Cucumis dipsaleus</i> [livestock]	Cucurbitaceae	Haragoge	Fruit	The fresh fruit sare crushed and mixed with the leaf of <i>cucumis dipsaleus</i> then creamed on the bitten body and drenching	Dermal and Orally	Livestock	[57]
74.	<i>Ekebergiacapensis</i> sparm	Meliaceae	Mukaraso [AM]	Root	The fresh root are decoction and mixed with sheep/goat milk then rubbed on bitten body	Oral and dermal	Livestock	[57]
75.	<i>Apodytes dimidiata</i> E. Mey. ex Arn	Icacinaceae	Yetemenjalnchet/Donga	Stem bark	Not specified	Oral	Livestock	[59]
76.	<i>Plantagolanceolata</i> L.	Plantaginaceae	Wushamilastinshu	Root	Not specified	Oral	live stock	[59]
77.	<i>Plantagopalmata</i> Hook.f.	Plantaginaceae	Wushamilastiliku	Root	Not specified	Oral	live stock	[59]
78.	<i>Plectranthus lactiflorus</i> (Vatke) Agnew	Lamiaceae	Ayderkush [AM]	Leaf	Fresh or dried leaves of <i>Plectranthus lactiflorus</i> , drink the decoction.	Oral	human	[58,59]
79.	<i>Solanum marginatum</i> L.f.	Solanaceae	Imbuay [AM]	Root	Crush, heat/ burn or boil the part and inhale its smoke or steam	Oral	Human	[58]
80.	<i>Caylusea abyssinica</i> (fresen.) Fisch. & Mey	Recedaceae	Giesilla [M]		Root chopped and mixed with cold water and Drenched. (effective even when clinical signs are present	Oral	Both	[60]

Table 2: List of anti-rabies medicinal plants.

[M]=Maale; AM=Amharic; [T]=Tigrigna; Km=kambatgna; [O]=Oromigna

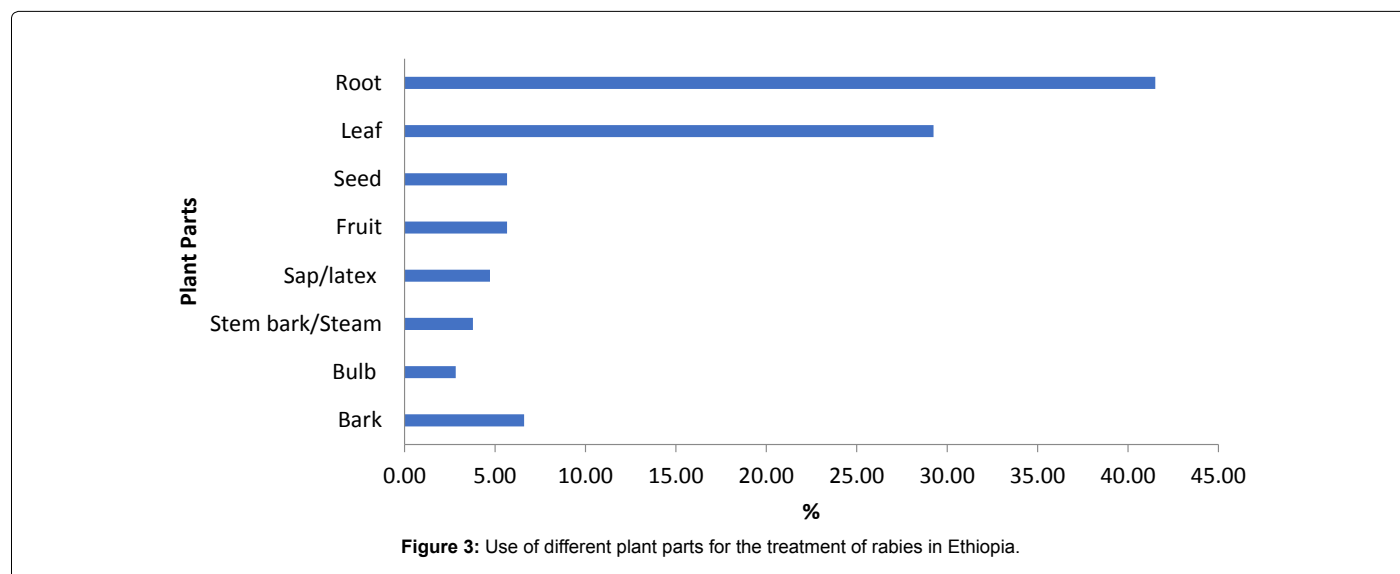


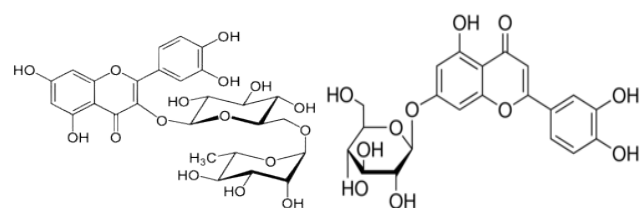
Figure 3: Use of different plant parts for the treatment of rabies in Ethiopia.

Traditional uses: Traditional tooth brush, live fence [62]. Roots are used in medicines that help cure stomach pains, fever, and headaches [64].

Anti-rabies activity or efficacy data: The chloroform, methanol 80% and aqueous leaf extracts of *Salix Subserata* were prepared using

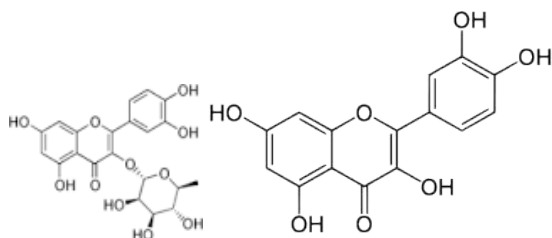
maceration technique. *Salix subserata* Chloroform crude extract on 1 day and 3 days treatment groups with the chloroform extract are significantly associated with the survival time [12].

Phytochemistry: Flavonoids such as rutin, luteolin-7-glucoside, quercetrin, and quercetin have been isolated from *S. subserata* [65].



Rutin

Luteolin-7-glucoside



Quercetrin

Quercetin

The bio-guided study of the chemical constituents of the bark and leaves of *Salix subserrata* (Salicaceae) has resulted in the isolation and characterization of eight compounds. These six compounds were identified as (+) catechin (1), 1,2-benzenedicarboxylic acid, bis (2-ethylhexyl) ester (2), saligenin (3), methyl 1-hydroxy-6-oxocyclohex-2-enecarboxylate (4), catechol (5), propyl acetate (6), β -sitosterol (7), and β -sitosterol glucopyranoside (8), were isolated for the first time from *Salix subserrata*. The above compounds were individually identified by spectroscopic analyses and comparisons with reported data [63] (Figure 4).

Silene macroselen

Family: Caryophyllaceae

Local name: Wogert

Traditional uses: Besides used for rabies management, in Ethiopia, the aqueous infusion of the stem and bark of this medicinal plant is used to treat hypertension, common cold, measles, abdominal pain, and chancroid as well as evil spirits as smoke [66]. Root decoction is also given orally three times a day to treat common cold, headache and fever. Smoke inside the house to drive back snake [67].

Anti-rabies activity [efficacy data]: Another study by Deressa et al. [12] also revealed chloroform and 80% methanolic root extracts of *Silene macroselen* were found to increase the survival time of mice significantly [12].

Phytochemistry: No phytochemical screening studies had ever been carried out on the various parts of this medicinal plant.

Safety data: There were no scientific reported data regarding the safety study of this medicinal plant.

Phytolaca decandra

Family: Phytolaccaceae

Local name: Endod(Amharic)

Traditional uses: Common medicinal uses of berries of this plant include treatment of skin itching (ringworm), malaria, sore throat, rheumatic pain abortion, jaundice gonorrhoea, leeches, intestinal worms, anthrax and rabies and for preparation of soaps and detergents [68,69].

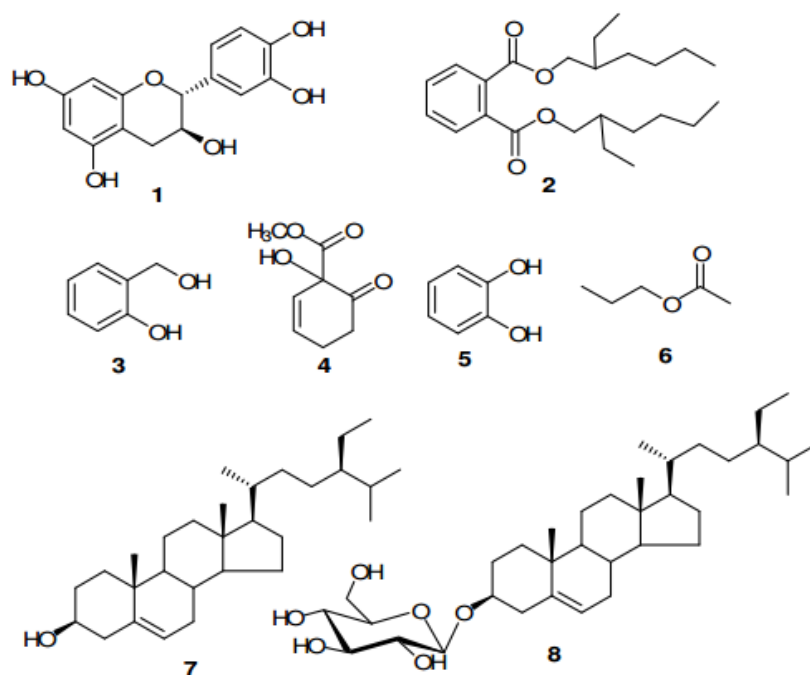
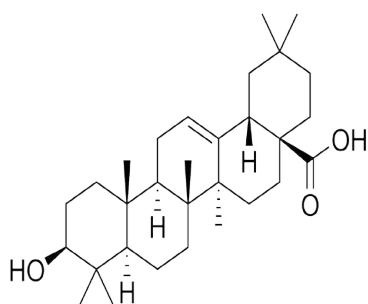


Figure 4: Compounds isolated from *S. subserrata*.

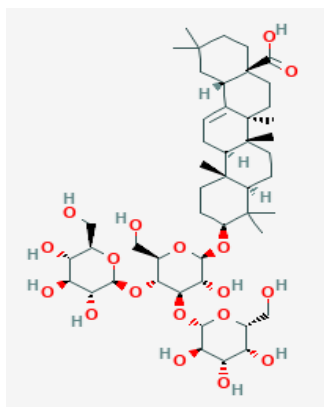
Anti-rabies activity [efficacy data]: A study conducted on mice to evaluate the anti-rabies activity of hydro-ethanolic extract of roots and leaves of *Phytolacca dodecandra* revealed that 80% ethanol macerated extract both plant parts at the doses of 300, 600 mg/kg failed to display an increase in survival period of mice challenged with the rabies virus (CVS-11) compared with negative control. However, the leaf extract at 1000 mg/kg significantly ($P > 0.05$) increased the survival period of mice compared to negative controls [61].

Phytochemistry: The Phytochemical screening test carried out on the aqueous indicated the presence of alkaloids, tannins, phenols, steroids, triterpenoids, free amino acids and reducing sugars [61]. Oleanolic acid (OA) is one of bioactive compounds isolated from from ethanolic extract of *Phytolacca dodecandra* and has been reported to have anticancer effects [71].



Oleanolic acid (OA)

Lemma toxin is one of the molluscicidal saponin components isolated from the fruit of *Phytolacca dodecandra* (endod), a derivative of oleanolic acid substituted in the 3 position with a branched trisaccharide containing two glucose units and one galactose unit [72].



Lemma toxin

Safety data: A toxicity evaluation study of *Phytolacca dodecandra* extract for its toxicity effectiveness against aquatic macroinvertebrates clearly indicated that the LC_{50} and LC_{90} values for berries crude extract of *Phytolacca dodecandra* against Baetidae were 181.94 and 525.78 mg/l and lethal doses (LC_{50} and LC_{90}) required for Hydropsychidae were 1060.69 and 4120.4 mg/l respectively. This laboratory evaluation demonstrated that Baetidae was more susceptible than Hydropsychidae, even at shorter exposure period of 2 h [70].

An acute toxicity study revealed that female rats that received the aqueous leaf extract of *P. dodecandra* at the dose of 2048 mg/kg

displayed a reduced appetite, sleepiness and excessive urination and shivering [61].

Conclusion

In this review study, some of the ethno-botanical claims were confirmed through the *in vivo* anti-rabies activity studies. This indicates the necessity of documenting ethno botanical indigenous knowledge which contributes for the drug development such as identification of the biologically active compounds, further bioactivity tests, for standardization and formulation development and commercialization and conservation following the indigenous knowledge. Therefore, further research is needed for the evaluation of the safety, efficacy and quality of those medicinal plants utilized for the treatments of rabies in Ethiopia.

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