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Medicinal plants that used as repellent, insecticide and larvicide in Ethiopia

Abstract

Plants have been used since ancient times to repel/kill insects throughout the world including Ethiopia. The distribution of knowledge and services of medicinal plants in Ethiopia are hierarchically placed and there is very little ethno botanical documentation on most medicinal species of the country. In order to document the insecticidal/ repellent plants which can use as source for development of new plant based insecticides, repellant and larvicides, this review was initiated. Different ethno botanical publications by different researchers over the past couple of decades and the relevant ethno botanical MSc and PhD theses as well as other botanical sources were reviewed. The review revealed a total of 83 medicinal plants distributed across 49 families and different parts of these plants were used by preparing in different forms.

Keywords: insecticide, repellant, larvicide, medicinal plants, Ethiopia

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Introduction

Vector control and personal protection vector contacts are currently the most important measures to prevent vector born diseases.[1] The common approach for the control of vectors and reducing the transmission of human pathogens is based on the chemical based intervention measures. However, in the past, the frequent and repeated use of chemical insecticides, repellants and larvicides has resulted in the worldwide development of resistance, destabilization of the ecosystem and toxic effects on human beings and non-target organisms.[2] Thus, there is an urgent need to develop new plant based insecticides, repellants and larvicides for controlling insects which are more environmentally safe, biodegradable and target-specific against the insects.[3]

Plants have been used since ancient times against blood-sucking insects in the human history and even now, in many parts of the world people are using plant substances.[4] In recent years, much effort has, therefore, been focused on plant extracts or phytochemicals as potential sources of vector control.[5,6] Several extract and compounds from different plant families have been evaluated to show new and promising insecticides and larvicides. Further, repellency is known to play an important role in preventing the vector borne diseases by reducing man-vector contact.[7] Many researchers have reported the effectiveness of plant extracts or essential oils as efficient insecticides, larvicides and repellents without posing hazards of toxicity or few effects on non-target organisms and environment.[1,7]

Many plant species contain and produce substances that protect them by killing or repelling the insects that feed on them.[8] These substances fall into several categories, including repellents, feeding deterrents, toxins, and growth regulators.[9,10] Although the primary functions of these compounds are defense against phytophagous insects, many are also effective against mosquitoes and other biting Diptera, especially those volatile components released as a consequence of herbivores.[10,11] The fact that several of these compounds are repellent/killer to haematophagous insects could be an evolutionary relict from a plant-feeding ancestor, as many of these compounds evolved as repellents/killers to phytophagous insects.[10]

In Ethiopia the distribution of knowledge and services of medicinal plants are hierarchically placed and there is very little ethno botanical documentation on most medicinal species of the country.[12] The information has been passed down many generations chiefly through word of mouth which may result in distortion or loss of indigenous knowledge and usage custom of insecticidal/ repellent plants.[12,13] Therefore, right now documenting and safeguarding these practices and the recorded species of medicinal plants also needs special attention. In order to document the insecticidal, repellent and larvicidal plants which can used as source for development of new plant based insecticides ,repellant and larvicides , this review was initiated.

Materials and methods

The information on insecticidal, larvicidal and insect repellent plants was collected from published articles, theses and research reports. Different ethno botanical publications by different researchers over the past couple of decades and the relevant ethno botanical MSc and PhD theses as well as other botanical sources were reviewed. Google Scholar and Pub med were browsed using some important key words such as insecticide, repellant, larvicide and medicinal plants. Appropriate data collection format was prepared to tabulate scientific, family and local names of species, plant part used, method of application and the sources of references each species. The information was entered in Excel spread. The collected data were analyzed using descriptive statistics to evaluate the frequency of plant part used and method of application.

Result and discussion

The diversity of medicinal plants

The review revealed a total of 83 medicinal plants distributed across 49 families, of which eight and six species were within Lamiaceae and

Asteraceae family, respectively. Most of the families which were 34 in number contain a single medicinal plants (species) except the above two and Rutaceae(4), Solanaceae(4), Balsaminaceae(3), Fabaceae(3), Myrtaceae(3), Oleaceae(3), Verbenaceae(3), Cucurbitaceae(2), Leguminaseae(2), Poaceae(2) and Vitaceae(2) (Figure 1). All the 83 medicinal plant species which are claimed to be used for repelling/and killing insects and larvae are shown with their respective sources of references in Table 1.

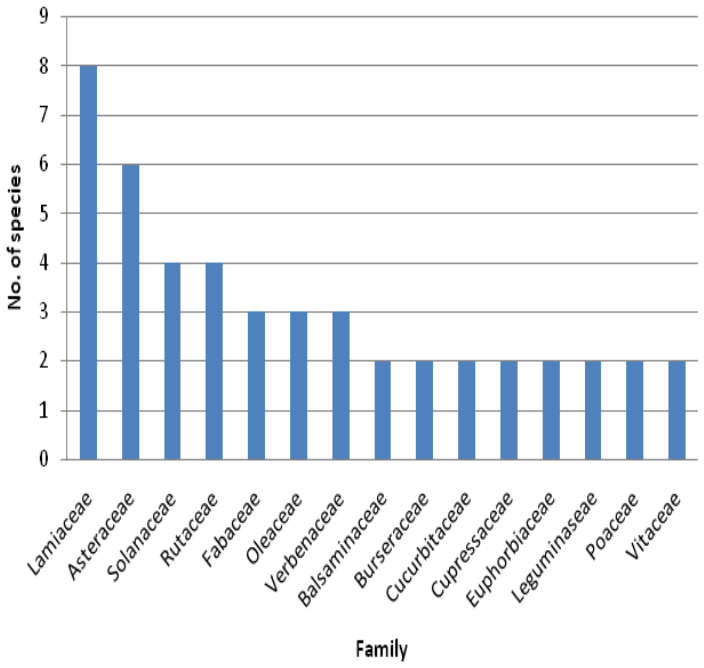

Figure 1 No. of species with in a family that contain at least 2 species.

Table 1 List of plants that used as repellent, insecticide and larvicide in Ethiopia

S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
1	Acokanthera schimperi (A. DC.) Schweinf	Appocynaceae	Kararo (O), Oboyo (S)	Stem and leaf	Smoking the area to stifle the insect	Mosquito repellent	14,15
2	Agave sisalana	Agavaceae	Qacaa /Qacha (O)	Leaves and stem	Leaves juice sprayed in the house	Kill insects	16,17
3	Ageratum conyzoides	Asteraceae	Tufo (O)	Whole plant juice	Whole plant juice sprayed in the house	Insecticide	16,17
4	Ajuga integrifolia	Lamiaceae	Tut astil (Amh.), Harmagusa(O)	Whole plant juice	Whole plant juice sprayed the sediment in the house	Insecticide	16,17
5	Albizia gummifera	Leguminaseae	Ambabesa, Sesa	seeds	Aqueous extract show effect as larvicidal	Larvicidal	18
6	Allium sativum Linn.	Alliaceae	Qullubii adii(O), nechishinkurt(A)	Bulb	Crushing and applying the juice on the skin	Mosquitoes killing and repellency effect	7,16,19,20, 21
7	Aloe pirottae Berger	Aloaceae	Hargeysa (O), Gebedherta, De'ar (S)	leaf	Smoking dried leaf the area to stifle the insect	Insect repellent	15
8	Aloe pulcherrima	Aloaceae	Hargessadhala (O)	leaves	Burning the dried leaves to generate smoke and crushing leaves to spray in and around houses.	Mosquitocide and insect repellent	16,17,19

Table Continued...

S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
9	Asparagus africanus	Asparagaceae	Sariitii (O), Geday (S)	leaves	Leaf is crushed, mixed with milk and taken one coffee cup every morning until the individual back to the malarious area. Leaf pounded and mixed with the leaf of Aloe species is drunk.	Mosquitocide	16
10	Azadirachta indica	Meliaceae	Limo/nim	Leaves	Not explained	Insecticides	22
11	Balanites aegyptica	Balanitaceae	Bedana(O)	fruits	Aqueous extract show effect as larvicidal	Larvicidal	18
12	Boswellia (Del.) Hochst	Burseraceae	Etan(A)	Resin	Smoke	Repellant of insects	13
13	Boswellia papayrifera	Burseraceae	Ixanaa/nadii(o)	Barks and Resin	Burning to barks and resin to generate smoke.	Mosquitoes and house fly repellant	19
14	Brassica nigra Linn. Koch	Brassicaceae	Sanaficaa(O)	Seeds	Seed crushed and its juice rubbed on the body	Insecticidal and repellency	16,17,19
15	Buddleja polystachya Fresen.	Buddlejaceae	Qomonyoo(O)	Dermis of roots	Burning the dried roots to generate smoke	Mosquitoes repellant	16,19
16	Calpurnia aurea Benth	Fabaceae	Liyita, Hitsawts(T), digita(amh),ceka(O)	Seed, leaves	The leaf is ground along with barks of Millettia ferruginea and sprayed on the area of problem (body, cloth. room,bed). Leaf is crushed, soaked in water and bathing the body days to kill body lice.of cattle/ chickenfor 2	Mosquito repellent, Insecticidal and tick repellant	5,16,17, 23, 24
17	Canna indica L. (DB.19)	Cannaceae	Cale(O)	Rhizome	juice sprayed in the house	Insecticide	17
18	Capparis tomentosa Lam.	Capparidaceae	Gumero (A)	Root, Leaves	Not explained	Mosquito repellent, Insecticide	23
19	Capsicum annuum	Solanaceae	Karia, keto, mitmita (A)	paper	Smoking the dried paper in the home	Insect repellant	16,25
20	Carica papaya Linn.	Caricaceae	Papayaa(O)	Leaves	Crushing the dried leaves and apply the juice on the exposed parts of the body.	Mosquitoes and ticks repellant	19
21	Chenopodium schraderianum	Chenopodiaceae	Sinign (A)	Above ground parts of the plant	Above ground parts are chopped and fumigated chickens' rooms	Insect repellant	16
22	Citrus aurantifolia (Christm.)	Rutaceae	Lommii(O)	Peels of fruits,fruit	Peels crushed and applying on exposed parts of the body. Fruit is squeezed with leaf of L. ocymifolia seed of L. sativum, Salvia schiperi, R. chalepensis and A. sativum, all of these are mixed together in water and drunk for Hen.	Insect repellant	16, 19
23	Citrus sinensis (L.) Osb.	Rutaceae	Qolaa burtukanaa	Peals	Dried peels burned to generate smoke	Mosquitoes and house fly repellant	19

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Table Continued...

S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
24	Clausena anisata	Rutaceae	Limich (A)	leaf	The leaf is crushed, squeezed with water and Injera, given to hens.	Insect repellant	16
25	Clematis simensis	Ranunuclaceae	Yeazohareg (A)	Leaf and steam	The leaf and steam chopped and mixed with water. The mixture stays 21 days to ferment and sprayed over on cereal crops.	Insect repellant	16
26	Colchicum autumnale Linn.	Colchicaceae	Bukbuka(O)	Barks/dermis	Burning the dried parts to generate smoke.	Not explained	19
27	Commicarpus grandiflorus	Nyctaginaceae	Engurbaba (A)	Above ground parts	Above ground parts to repel (lice, fleas and bugs) by placing it on the bed	repel lice, fleas and bugs by placing it on the bed	16
28	Croton macrostachyus Hochst. ex Del.	Euphorbiaceae	Misana(A), Bissana (A); Bissano (G); Makanisaa, Bakkanisa (O)	Leaf/bark/root	Bark of croton put on fire and the smoke used as to protect mosquito bite. Crushed fresh leaf with root of C. adenocaule and S. hermonthica is soaked in ale and decanted when cattle ate the leaf of Sorghum that contained poisoned Insects. Burning the dried leaves to generate smoke.	Insecticidal and insect repellant	13,16,19,26
29	Cupressus lusitanica Mill.	Cupressaceae	Tid(A), Gatirra Habasha(O)	Leaves, dermis, barks	Burning dried parts to generate smoke	Mosquitoes and house fly repellant	13,19
30	Cymbopogon citratus (DC. ex.Nees) Stapf	Poaceae	Tej sar(O)	Leaves	Smoke	Repellant of Culicidae, Siphonaptera and Phthraptera	11,13
31	Cymbopogon nardus (L.) Rendle	Poaceae	Tej sar(A)	Leaves	Smoke	Mosquitoes repellant	11
32	Cyphostema adenanthum (Fresen.) Descoings	Vitaceae	Etse-zewe (A)	Root,leaves	Not explained	Mosquito repellent ,Insecticide	23
33	Discopodium penninervium Hochst.	Solanaceae	Rajii (O)	Leaf,bark and roots	Fresh leaf is crushed and rubbed on the skin	Insect repellant	4,16
34	Dodonaea angustifolia L.	Sapindaceae	Tahsost(T) Kitkita (A); Itancha (Sid.); Itacha, Dhitecha (O); Ittechhae (G)	leaf and fruits/ seed	Leaves juice sprayed to the affected body of horse. Fresh leafs are crushed and pounded with water then painted on the infected body by lice, fleas and ticks	Insect repellantl and ecto parasite	5,16
35	Echinops kebericho Mesfin.	Asteraceae	Kebercho(A), Qabaaricho(O)	Root	Dried leaf and/or root burned to generate smoke	Mosquitoes repellant	7,10,13,19
36	Erythrina brucei Schweinf.	Fabaceae	Walleensu(O)	leaf	Squeeze and paint dermal	Prevent insect bite Insect bite	27

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S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
37	Eucalyptus globules/ citrodora	Myrtaceae	Nech bahir zaf(A) Barzafae (G.), Baarzaafii adii (O)	Whole plant and leaves	Burning whole plant and crushing leaves and applying on exposed body parts	Repel Mosquitoes ,coachroaches, ticks, house fly and other haematophagous insects	5, 7, 11, 13, 19, 16
38	Guizotia scabra	Asteraceae	Tuufoo(O)	Leaf	Topical	Ectoparasites, insecticide	28
39	Hedera helix	Araliaceae	Ivy(O)	leaves, fruits	Aqueous extract show effect as larvicidal	Larvicidal	18
40	Impatiens rothi	Balsaminaceae	Ensosila (A)	Root	Not explained	insecticidal	16
41	Impatiens tinctoria	Balsaminaceae	Gushirit (A)	Root	Not explained	insecticidal	16
42	Jasminum aby ssinicum Hochst	Oleaceae	Tenbele (A)	Not explained	Not explained	Mosquito repellent Insecticide	23
43	Juniperus procera	Cupressaceae	Tid(A)	leaf	Crude extract of dried leaf	Mosquitoe repellant and larvicidal	29,30
44	Justicia schimperiana T.	Acanthaceae	Simiza,/Sensel (A), Dhummuugaa/Kisha (O)	Leaves	Burning to generate smoke.	Mosquitoes and coachroaches repellant	16,19
45	Laggera tomentosa	Asteraceae	Alashume (A)	Above ground parts	Above ground parts, against mites attack in harvested crops	Insect repellant effect specially against mites attack in harvested crops	16
46	Lantana camara	Verbenaceae	Dat'hara/Tselim(T)	Whole part	Growing of plants as a living fence to repel insects like ticks	Repellent of pests	31
47	Lepidium sativum Linn	Brassicaceae	Feto (A), Feecoo/ Fexo,/Fetto/Shinafaa (O), Feaxxo (G)	Seeds	Crushing and applying on skin also drinking / Seed crushed and its juice sprayed in the house/ Smoked its seed with Echinops Kebericho and leaves of C. macrostachyus	Insecticidal and repellant of Mosquitoes, housefly, ticks and mites.	16,17,19,23
48	Lippia adoensis	Verbenaceae	Koseret (A)	Dried leaves	Essential oils were extracted by steam distillation show effect repellency	Repellant against Anopheles arabiensis and Aedes aegypti	32
49	Lippia javanica	Verbenaceae	Kusaye (O)	leaf and stem	Leaf and stem burned and smoke	The smoke keeps away the mosquitoes and any insects in the house.	16,17,33
50	Maesa lanceolata Forssk	Myrsinaceae	Kalawa (A), Abayi(O)	Fruit	Smoking/fruit juice sprayed in the house insecticide	Insecticide	16,17,28
51	Melia azedarach	Meliaceae	Kiniin (Sid.); Nim (A), Mim (O)	Leaves	Growing plant nearby houses and leaf suspension	Mosquito repellent, Insecticide	5,7,13,23

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S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
52	Milletia ferruginea	Leguminosae	Sotallo (O), Birbira (A), Hengedicho (Sid.);	Seeds, Leave and stem	Aqueous extract show effect as larvicidal Taking off the stem bark & putting the bare stick in camp of ants. Juice of leaves or stem is used as ear drop. Fresh leaf and stem bark is crushed and pounded with water and painting on the body	Larvicidal and Insect repellant effect	16,18
53	Momordica foetida	Cucurbitaceae	Marqura, areg riesa (A), haragoge, Laqana Qura (O)	Leaf, root, Seed, whole plant	smoke/ Whole plant juice sprayed in the house	Mosquito repellent, Insecticide	7,23,16,17
54	Nicotiana tabacum	Solanaceae	Tambo(O)	Leaf Smoking	Leaf smoking	Deter mosquitoes indoor	7
55	Ocimum basilicum	Lamiaceae	Besobila (A) Zahahene (O)	Not explained	No explained	insect repellent	34
56	Ocimum lamiifolium Hochst. ex Benth.	Lamiaceae	Damakessie/Qoricha Michi (O)	Leaves,whole plant	Burning dried parts to generate smoke, making juice and applying on skin essential oils were extracted by steam distillation show effect repellency Growing plant nearby houses	Mosquitoes repellant	16,17,19,32
57	Olea europaea L.	Oleaceae	Ejersaa (O), Awlie(T) Woira(A)	Stem,leaves and barks	Dried parts burned to generate smoke	Mosquitoes and house fly repellant	5,10,13,19
58	Olea welwitschii (Knobl.) Gilg and Schellenb	Oleaceae	Baya(O)	Stem	Smoke	Repellant of Culicidae and other Diptera	13
59	Opuntia ficusindica (L.) Mill.	Cactaceae	Nimi(A)	leaf	Leaf of O.Ficusindica is collected with small node and fumigated in the house	Kill malarial vectors	35
60	Oreosyce africana	Cucurbitaceae	Manabasi (O)	leaf	Leaf juice sprayed in the house	Insecticidal	16,17
61	Otostegia fruticosa	Lamiaceae	Sasa(T)		Not explained	Not explained	5
62	Otostegia integrifolia	Lamiaceae	Tinjut(A) Chiendog(T)	leaves	Smoking dried leaf	Anopheles arabiensis mosquitoes and insect repellant	5,10,16,36
63	Pavonia urens Cav.	Malvaceae	Hincinnii(O)	Leaves	Burning to generate smoke	Mosquitoes and house fly repellant	19
64	Phytolacca dodecandra	Phytolaccaceae	Andoode (O)	Seed	Seed infusion	kill mosquito larvae	7
65	Plectranthus barbatus	Lamiaceae	Keskeso (O)	leaf	Leaf is added on fire; fumigate the house to kill bugs, flies and poisonous insects that cause allergic, such as spiders.	Insecticidal and insect repellant effect	16

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Table Continued...

S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
66	Premna schimperi	Lamiaceae	Urgessa (O)	stem and leaf	The stem and leaf burned to fumigate the house, animal cage, so as to disinfect mosquito & flies.	Insecticidal and insect repellants effect	16.17,33,37
67	Rhoicissus revoilii	Vitaceae	Iddefitii (O)	leaves	Leave is added on fire, and fumigate the house in order to kill wheel.	Insecticidal and insect repellants	16
68	Ricinus communis	Euphorbiaceae	Qobo(gulo) (O)	seed	Seed crushed and its juice rubbed on the skin	Insecticidal	4,16,17
69	Ruta chalepensis	Rutaceae	Tenadam (A), Ciladama (O)	fruit	Fruit smoking in the house.	insect repellant	16,17
70	Salvia schimperi	Lamiaceae	Gimekitel, Yahya joro (A)	leaf	Leaf is squeezed by mixing with leaf of L. ocymifolia seed of L. sativum, juice of C. lemon, R. chalepensis and A. sativum, together in water and drunk or given with food for Hen. Against bug pests when placed the aerial parts under bed.	insect repellant	16
71	Schinus molle L.	Anacardiaceae	True-man-tree(A)	Fresh leaves	Essential oils were extracted by steam distillation show effect repellency, leavees are commonly placed on dining tables in hotels, restaurants and resident places to repel flies	Repellant against Anopheles arabiensis, Aedes aegypti and flies	32
72	Senna singueana	Fabaceae	Gufa (O)	leaf	Fresh leaves are put with crops in order to prevent from destroying by wheels.	insect repellant	16
73	Sesamum orientale	Pedaliaceae	Selit (A)	Seed	No explained	Insecticidal/insect repellant	16
74	Silene macroserene	Caryophyllaceae	Wogeret(A) ,Saerosaero(T)	roots	Smoking dried roots	Anopheles arabiensis mosquitoes repellant	4,10
75	Solanum macrocarpon	Solanaceae	Hidi Warabesa (O)	fruit	Fruit juice sprayed in the house	Insecticidal	16,17
76	Solanum nigrum	Solanaceae	Tikur Awut (A)	Leaf	Not explained	Insecticidal	16
77	Solenostemon latifolius	Lamiaceae	Dachet (O)	leaf	The fresh leaf is squeezed with the leaf of S. schimperi, L. ocymifolia and L. sativum; given to hen to treat Coccidiosis disease (by coccoides vector).	insect repellant	16
78	Stephania abyssinica	Menispermaceae	Yeayit-hareg (A)	Above ground parts	Placed on bed against bed pests	Insect repellant	16
79	Tagetis minuta L.	Asteraceae	Hada Barifidee (O)	Whole plant, leaf	Whole plant smoking Fresh leaves together with leaves of Eucalyptus globulus are used to keep away insects particularly trailing ants to attack beehive or living rooms.	Insect repellent	16,38

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Table Continued...

S .no	Scientific name	Family name	Vernacular name	Parts used	Method of application	Insect(s) controlled	Reference
80	Verbascum sinaiticum Benth	Scrophulariaceae	Gurra harree(O)	leaves	Fresh leaves powdered and mixed in water then apply topically	Avoid lice and fleas infestation	28
81	Vernonia amygdalina	Asteraceae	Eebicha(O)	Leaves and barks	Crushing the leaves and apply the juice on the exposed parts of the body	Tick, mites and mosquitoes repellant	19
82	Warburgia ugandensis	Cannaleaceae	Mukabiftu(O)	leaves	Aqueous extract show effect as larvicidal	Larvicidal effect	18
83	Ziziphus spinachristi	Rhamnaceae	Qurkura(A)	Leaf/root	Leaf/root is added on fire and fumigates to eradicate flies.	Insect repellant	16

Note: Vernacular name is expressed in different languages that speak in Ethiopia in different localities. A-Amharic, O-Oromifa, T-Tigrigna, G-Guragigna, S-Somaligna, and Sid-Sidamigna

Plant parts used

Different parts of the plant like leaf, root, stem, plant resin used in different forms of preparation. Whole parts,[17,31] some of the parts[14-16] and a single part of the plant[17-19] can be used. In other way there was also application by mixing one plant part with other plant/plants. For instance the leaves of *Calpurnia aurea* Benth grounded along with barks of *Millettia ferruginea* and sprayed on the area of problem (body, cloth. room, bed).[5,16] The local community most dominant part was leaves and roots take the second proportion. Figure 2 summarizes the plant parts used for the preparation of insecticides, repellants and larvicides.

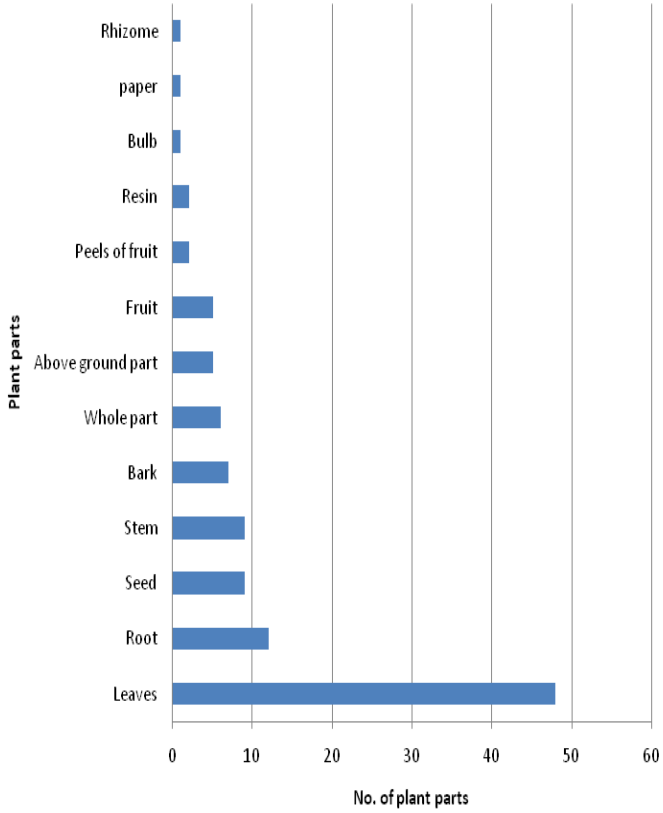

Figure 2 Frequency of plant parts used.

Application and effect of plant based vector control method

Burning plants to make smoke or hanging fresh plants to deter nuisance biting insects entering or resting in houses was identified in the review of different ethno-botanical studies.[14,15] It is chiefly done by smoldering various repellant plants on the traditional charcoal stove. There was also application to skin, clothing or other surfaces which discourages insects from landing or climbing on that surface and killing of hazardous insects.[7,16,19-21] By making a juice of different parts of the plant and spraying it in the house[16,17] and growing of plants as a living fence to repel or kill insects[5,7,13,23,31] were also another methods. Aqueous extract of different plants showed effect as larvicidal activity against different insect's larvae.[18] Generally, smoking was the most widely used method followed by application on skin (Figure 3).

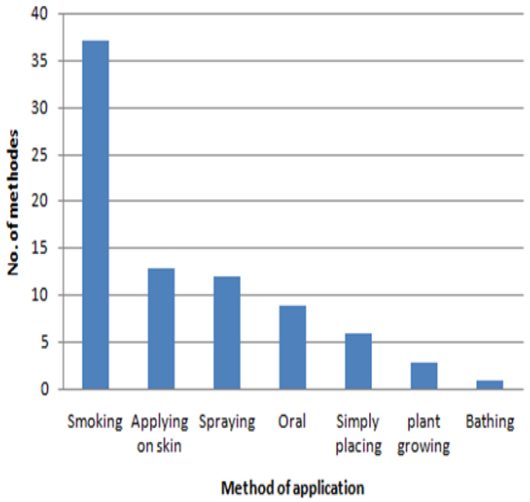

Figure 3 Method of application.

The review identified many medicinal plants in different preparations that used as a repellent, insecticidal[16] and larvicidal[18] to different type of insects and their larvae as observed in Figure 4. Some of these act as both insecticidal and repellent[23] others as both larvicidal and repellant.[29,30] This indicates as plants contain a range of bioactive chemicals that might offer an alternative source of insect control agents.

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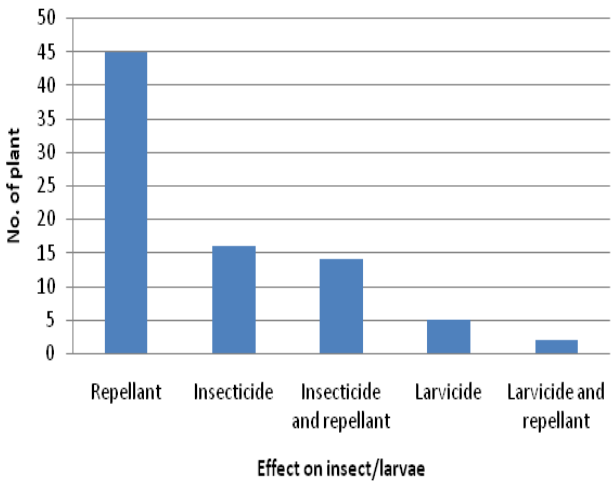

Figure 4 Effect of plants on insects/larvae.

Conclusion

This review clearly demonstrates the presence of many Ethiopian medicinal plants as insecticidal, repellant and larvicidal agents. Therefore, this information indicates the need of research to be carried out on the bioactive compounds present in the particular plants which have a potential against insects as a solution of the deleterious effects of synthetic insecticides, including lack of selectivity, impact on the environment and the emergence and spread of pest resistance. From these medicinal plants there will be a promising role in the development of future commercial insecticidal agents in terms of larvicidal, antifeedant, repellent, oviposition deterrent and growth regulatory used as a preventive medicine point of view.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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