INDO AMERICAN JOURNAL OF PHARMACEUTICAL RESEARCH

A COMPREHENSIVE REVIEW ON ANTHELMINTIC ACTIVITY OF SOME MEDICINAL PLANTS

Dnyaneshwari Bade*, Vishal Rasve

SAJVPM'S, College of Pharmaceutical Sciences and Research Center, Kada Ashti, Beed MH-414202.

ARTICLE INFO

Article history
Received 27/02/2023
Available online
10/03/2023

Keywords
Medicinal Plants,
Phytochemical,
Anthelminthics,
Ethanopractices,
Parasites.

ABSTRACT

Indian medicinal herbs have long been recognized for their healing properties. The oldest medical system, Ayurveda, advises using treatments based mostly on medicinal herbs to address a wide range of human and animal ailments. The average person can afford and get herbal therapies. The powerful source of many pharmacological activities was medicinal plants. Due to the ability of the plants and its chemical to treat a disease that results in significant financial loss and decreased animal production for livestock owners, one of the plants with anthelmintic action has attracted a lot of interest. Although less effective at curing diseases, crude drugs are generally side effect free. Various in vitro and in vivo techniques have been used to examine medicinal plants for this activity. The crude compounds made from plants are less effective in treating parasite disorders but they are generally free from adverse effects. In undeveloped nations, helminthiasis is historically treated with a wide variety of medicinal plants. In order to treat parasitic infections, plant-derived medications are receiving a lot of attention.This review present the herbal medicines or medicinal plants which are have number of benefits and used as anthelmintic. Ethnobotanical survey, in India the belief that their evaluation will accelerate the discovery of new effective therapeutic agents as anthelmintic.

Corresponding author
Dnyaneshwari Bade
SAJVPM'S, College of Pharmaceutical Sciences and Research Center,
Kada, Ashti, Beed MH-414202, India.
+918767557738
badednyaneshwari972@gmail.com

*Please cite this article in press as **Dnyaneshwari Bade** et al. A Comprehensive Review on Anthelmintic Activity of Some Medicinal Plants. Indo American Journal of Pharmaceutical Research.2023:13(03).*

INTRODUCTION

Many various types of medications, including antispasmodics, emetics, anti-cancer, antimicrobials, and antihelminthics, are derived from plants. Numerous plants are said to have antibacterial qualities in the conventional system and are widely used by indigenous people around the world. Nowadays, it is thought that nature has provided a form of treatment for every ailment. In Ayurveda, plants have been used to treat a variety of illnesses. Due to a number of drawbacks, the use of chemical anthelmintics medications to manage animal parasites is fast declining in popularity. Animal health is in danger due to the emergence of anthelmintic resistance in parasites and the ineffectiveness of chemical anti-parasitic substances.[1]

Ayurvedic, Unani, and Siddha are some of the indigenous medical systems that are still used today by a sizable portion of the world's population, including India. Several researchers have reported that several plants, including *Piper longum, Allium sativum, Zingiber officinale, Carica Papaya, Nicotiana tabacum, Momordica charantia, Berberis lyceum, Melia azedarach, and Allium fistulosum.*New or alternative medicine were required for treatment of helminthes Due to recurrence of helminthes infection is more frequently. [2]

Pharmacology of anthelmintics

The prevalence of morbidity and mortality from parasitic helmintic infections is rising daily all over the world. This includes the cestodes, trematodes, and intestinal nematodes (roundworms) (tapeworms). Because it is the primary source of environmental contamination and transmission, the disease is unevenly distributed in low income nations, where it is most severely impacted and carries the largest risk of morbidity. Due to the ongoing rise of resistance, albendazole, mebendazole, and praziquantel are the three most often used anthelmintics with broad spectrum activity and high cure rates.

Types of worm parasites:-

1. Roundworms (Nemathelminthes)

The seven species of roundworms that make up the majority of the population will be briefly reviewed in the section that follows in relation to the disease they cause in humans:

a) Hookworms:-these are two type, namely, necatoramericanus (American variety) andancylostomaduodename (European variety)
b) Roundworm
c) Whipworm
d) Pinworm
e) Strongyloidsstercorails
f) Trichinellaspirails
g) Wuchereriabancrofit

2. Flatworms (Platyhelminthes)

The flatworms are normally of two kinds, namely segmented (cestodes) and non-segmented (trematodes)

a) Cestode
1) Beef tapeworm (Taeniasaginata)
2) Pork tapeworm (Taeniasolium)
3) Fishtapeworm (Diphyllobothriumlatum)
4) Dwarf tapeworm (Hymenolepis nana).

b) Trematodes[3]

Mechanism of actions of Anthelmintics

The most commonly used and frequently prescribed medication for treating parasite infections is piperazine. The main ingredient of piperazine, an over-the-counter medicine used to treat thread worm infections in children, was first used as an anthelmintic in the 1950s.Ion channel proteins in the nematode are the main targets of most of these medications. In *Ascaris suum*, piperazine mimics weak GABA (4-aminobutyric acid) and induces a flaccid, reversible paralysis of body wall muscles. It is a partial agonist at GABA-gated chloride channels, according to single-channel measurements, with limited potency.

Thiabendazole is a class of broad-spectrum anthelmintics that was first discovered in 1961.Many benzimidazoles, including albendazole, have been developed for use as anthelmintics. The parasite's -tubulin is specifically bound by benzoimidazoles with a high affinity, which prevents microtubule polymerization, causing the cytoskeleton to be disrupted and the worm to die.

Tetramisole's pure L-isomer is known as levamisole. It stimulates the nicotinic acetylcholine receptors (nAChRs), resulting in the worms' spastic paralysis and muscle spasms. Levamisole also encourages Caenorhabditis elegans of the wild type to produce eggs.

Both pyrantel and morantel target the L-subtype nAChR in Ascaris suum. Morantel is a methyl ester analogue of pyrantel. The ACR-26/ACR-27 subunits from Haemonchus contortus or *Parascaris equorum*, produced in Xenopus laevis oocytes, were recently demonstrated to act as an agonist of the nAChR subtype.[10]

In the 1980s, Merck introduced ivermectin, a semi-synthetic derivative of avermectin that comprises large macrocyclic lactone fermented product of the microorganism Streptomyces avermitilis, as an anthelmintic.[26,27] It is an effective medication, and its discovery sparked the creation of ivermectin analogues such moxidectin, milbemycin oxime, doramectin, selamectin, abamectin, and eprinomectin.[28,29]Pharyngeal and body wall muscles are paralysed by ivermectin. Numerous ligand-gated ion channels with which it has been demonstrated to interact. [3]

Advantage of Plant based anthelmintics over chemicals anthelmintics

1. Plant-based anthelmintics are less expensive than synthetic anthelmintics.
2. Compared to plant-based anthelmintics, synthetic anthelmintics have an issue with drug residues.
3. The risk of developing drug resistance increases with continued use of synthetic anthelmintics, whereas the risk is lower with plant-based anthelmintics.
4. Synthetic medicines are not readily available in rural locations, despite being widely available elsewhere.
5. Plant-based anthelmintics are environmentally friendly and support biodiversity whereas synthetic medications pollute the environment. [1]

Common phytochemicals found in plant containing potent anthelmintic activity are as follows,

a. Alkaloids e.g. Palasonin
b. Isoflavones e.g. Genistein
c. Triterpenoids e.g. Ursolic acid
d. Polyphenols (Tannins and flavonoids), simple phenols (Phenolic acids)
e. Saponins f. Organosulfides- Allicin, Isothiocyanates
f. Thymoquinone
g. Cysteine proteinases[1]

ANTHELMINTIC PLANTS:

Melia azedarach

It is commonly obtained by steam, leaf, pollen and seed of *Melia azedarach Linn* belongs to the Family*Meliaceae.*Common name of the plant is Bakain, Vilayati neem, Ghoda neemwhich content Active principle of Mliacaprin, Scopoletin, Meliartenin. Leaves and seeds plant parts are used for the pharmacological activities.

It was discovered that piperazine phosphate's anthelmintic activity was inferior to that of the ethanolic extract of *Melia azedarach Linn. (Meliaceae)* against *T. solium*. Extracts from *Melia azedarach* are larvicidal and ovicidal to the worm *Haemonchus contortus*. *M. azedarach* extracts successfully reduced the viability of *Trichmonas vaginalis*. *M. azedarach* extracts were effective in controlling the tick *Boophilus micoplus*, the mosquito that spreads dengue, Aedes aegypti, the mosquito that spreads malaria, *Anopheles stephensi*, and the human lice, *Pediculus humanus capitis.* [1]

Nigella sativa Linn

The plant commonly known as *Kala Jira* (*Ranunculaceae)*is a reputed plant in Indian system of medicine for its usefulness in a variety of ailments and possesses carminative, digestive, astringent and diuretic properties. The essential oil of *Nigella sativa Linn* has anthelmintic properties. *N. sativa*was tested against hookworms, nodular worms, tapeworms, and earthworms; it performed reasonably well against both of them. Similar to that of hexyl resorcinol, the activity against hookworm and nodular worm. Thymoquinone, dithymoquinone-cymene, and alpha-pinene are *N. sativa's* major active ingredients.[1]

Azadirachta indica (Neem)

The plant is commonally obtained from leaves,flowers of *Azadirachta indica*belongs to the Family*Meliaceae*. Alcoholic extract effective against *Fasciola gigantica*. Aqueous and alcoholic extracts of flowers show anthelmintic activity against Setaria cervi. Aqueous and Methanolic extract of leaves is effective against *Haemonchus contortus, Azadirachta indica* (neem) possesses larvicidal activity against *C. felis* and *Xenopsylla brasiliensis*.[2,30]

Ocimum Sanctum

Biological source of the plant is obtained from leaves of *Ocimum sanctum*belongs to the Family *Lamiaceae*. A number of extracted essential oils and eugenol from the *Lamiaceae* family plant *Ocimum sanctum Linn*. Have exhibited impressive anthelmintic activity against *C. elegans*. It is also commonly knonw as Basil (tulsi) whichcontains volatile oil of which the chief constituents are eugenol (about 51%) B-caryophyllene (37 %) and number of sesquiterpenes and monoterpenes.Eugenol shows anthelmintic activity in *ocimum sanctum.*[4]

Piper Longum Linn.

Common name of the plant arelong pepper,black pepper,king of spices.Piperine is the alkaloid responsible for the pungency of black pepper, *Piper nigrum. Piper longum L.*,belonging to the family *piperaceae*.The essential oil from the fruits *of P.longum Linn*.Was screened for the anthelmintic activity against *Asaris Lumbricoids.*The experiments revealed that its oil has a definite paralytic action on the nerve-muscular preparation of *Ascaris Lumbricoids*.The activity of oil was found to be greater than the piperazine citrate used as standard in the study.[4]

Carica Papaya

Common name of the plant is papita pawpaw.The biological source of the papaya is the plant species *Carica papaya*, one of the 21 accepted species in the genus Carica belong to the Family*Caricaceae*. Papaya has antihelmintic activity against natural infection of A. suum in pigs and found 100% efficacy at the dose rate of 8g/kg b.w.[31] The plant extract of papaya possess a dose dependent significant effect on egg, infective larvae and adult worm of *T. colubriformis*.[32] The cold macerated aquous extract of matured papaya seed shown anti amoebic activity against *E.* histolytica.[33] Aqueous extract of the seeds of *Carica papaya* showed over 90 % efficacy against *Oesophagostomum, Trichuris and trichostrongylus*.[4]

Evolvulus alsinoides Linn.

Biological source of the plant is obtained from flowering plant of *Evolvulus alsinoides Linn.* Belongs to the Family*Convolvulaceae*. The Common name of plant are dwarf morning glory and slender draw morning glory.

It is frequently used in Ayurveda as a potent aphrodisiac, anthelmintic, and brain stimulant. Using the adult Indian earthworm *Pheretima posthuma* as a model animal, ethanol extract of the entire plant material was tested to confirm its anthelmintic action.[4]

Areca catechu

Biological source of plant is the areca nut is the fruit of the *areca palm* (*Areca catechu*), which grows in much of the tropical Pacific (Melanesia and Micronesia), belongs to Family *Arecaceae.* The activeChemical Constituents are Carbohydrates, Glycosides, Saponins, Tannins, Alkaloids, Phenolic compounds and Flavonoids.For the anthelmintic effect, various fixations (25, 50, and 100 mg/mL) of plant extract from Areca catechu were dissolved with 3% Tween 80 in ordinary saline. Normal saline was used as the control and albendazole was used as a form of standard. The results were reported regarding the minutes needed to report the worm's paralysis and death.[5, 14]

Cassia tora

The plant commonly known as Sickelpod, sickle senna. Biological source of the plant is commonly obtained from leave, seed, and root of *Cassia Tora* belonging to the Family*Leguminosae.*Chemical Constituents of the plant are flavonoids and tannins as well as Anthraquinones. The Indian adult earthworm (*Pheretima posthuma*) was used as a model to evaluate the anthelmintic properties of methanolic concentrate and its ethyl acetic acid division of *Cassia tora L. leaves*. The ethyl acetic acid division was strong among the earthworms. The results were compared to an established drug called albendazole. According to the results of the phytochemical analysis of the two concentrates, the active components may include phenolic such flavonoids, tannins, and anthraquinones.[34] The current investigation supports the ethno-medical account of the plant's efficacy as an anthelmintic drug.[5]

Cucurbita maxima Duch

Biological source of plant is commonally obtained from seed,puip and fruit staik *Cucurbita Maxima Duch* belongiong to the Family*Cucurbitaceae. The common name of the plant are Winter Squash,Buttercup Squash*.

The plant's seeds have a reputation in the Ayurvedic medical system as an anthelmintic, particularly against tape worms. Trematodes, cestodes, and nematodes were evaluated in vivo and in vitro using aqueous, alcoholic, and ethereal extracts of the seeds. Aqueous, alcoholic, and ether extracts in the in vitro trials were in decreasing order of extract potency. According to the kymographic investigations, the seed extracts function by causing a decrease in motility, which results in temporary paralysis.[4]

Acacia nilotica

Biological source of the plant is commonly obtained from leaves and bark of *Acacia nilotica*belongs to the Family*Fabaceae***.**Bark crude aqueous methanol extract (CAME) demonstrated larger inhibitory effects on egg incubation than leaves (LC50= 769.2485 g/ml), which had a lower concentration. The CAME of bark showed the largest reduction (72.01%) in fecal egg count in vivo, followed by the CAME of leaves (63.44%) at day 12 post-treatment. The results suggest that the dynamic standards with anthelmintic activity in the bark and leaves of A. nilotica have a lipophilic nature.[8]

Gymnema sylvestre

The active chemical constituents of the plant are Saponin, gymnemic Acid which belonging to the Family*Apocynaceae.*

In the current study, experiments were conducted in vitro on adult Indian earthworms (*Pheretima posthuma*) to ascertain any potential anthelmintic properties of raw methanol concentrates of *Gymnema sylvestre*. The two plants' methanol concentrates at different fixations (25, 50, 100, and 200mg/ml) revealed dose-dependent vermicidal activities, and the results were conveyed in terms of the best time for worm death and the best time for worm paralysis. At a centralization of 10 mg/ml, piperazine citrate was used as a form of perspective standard. In comparison to Piperazine, the two plants show strong anthelmintic properties, according to the current studies.[9]

Allium fistulosum

The plant belongs to the Family*Amaryllidaceae*having active chemical constituents are Alkaloids, Saponins, Flavonoids, Steroids and Triterpenoids. The active part of plant ie leaves.

Ascaris lumbricoides was used as the test worm in this experiment to assess the anthelmintic activity of ethanolic and aqueous concentrates of *Allium fistulosum leaves*. At room temperature for seven hours, three concentrations of the ethanolic and aqueous concentrates of *A. fistulosum leaves* (50, 100, and 200 mg/ml) were independently tested against *A. lumbricoides*.The outcomes were discussed in terms of the most advantageous time for worm paralysis and time for worm death. Roundworm *A. lumbricoides* is resistant to the anthelmintic effects of ethanolic and aqueous concentrates of *A. fistulosum* leaves.[11]

Ascaridia galli

Biological source of the plant is a parasitic roundworm belonging to the family *Ascaridiidae*phylum Nematoda. Nematodes of the genus Ascaridia. Using the *Ascaridia galli* species as a good model for testing anthelmintic medications *Pheritima posthuma*, an Indian earthworm, was employed for the early in vitro testing of anthelmintic chemicals because it resembles human intestinal roundworm parasites anatomically and physiologically.[12]

Berberis lycium

The *Berberidaceae* family of plants includes the *berberis lyceum*, which is used by people as food or medicine and whose numerous parts include the root, bark, stem, leaves, and fruits. The *Pheretima posthuma* model was employed for the anthelmintic activity because it closely resembles the human intestinal parasite, round worms, in terms of its morphology and physiology and because it is readily available.[16, 18]

Nicotiana tabacum Linn

Nicotiana tabacum L. is a perennial herbaceous plant belongs to family *solanaceae.* Common name are *Tabacco,Tambaku.* It is found in cultivation where it is the most commonly grown of all plants in the *nicotiana* genus and its leaves are commercially grown in many countries to be processed into tobacco.In vitro and in vivo anthelmintic activity of *N. tabacum* Linn. Leaves were studied to rationalize its traditional use. Live *Haemonchus contortus* were used to assess the in vitro anthelmintic effect of a crude aqueous extract and methanol extract. For the in vivo studies both the extracts were administered in increasing doses to sheep naturally infected with mixed species of gastrointestinal nematodes. The results of the study showed that both the extracts possess dose-dependent anthelmintic activity, justifying the use of plant in traditional system of medicine.[21]

Allium sativum

Common name of *Alliumsativum* are Lahsun, lasum, lassan which contain active principle an oxygenated sulphur compound allicin.Bulb part of plant is used for different activity. Protozoan parasites such *Giardia lamblia, Leishmania major, Leptomonas colosoma*, and *Crithidia fasciculate* were all effectively suppressed by allicin (30 g/mL). Additionally, it has been claimed that the oil from *A. sativum* possesses anthelmintic properties and eliminates all harmful intestinal parasites. In vitro testing on *A. sativum eggs* and *H. gallinae*, A. galli, and *H. contortus* revealed that the plant contains anthelmintic properties. It is also efficient in vivo against donkey *strongyloids.*[22]

Momordica charantia

Momordica charantia plant belongs to theFamily *Cucurbitaceae* having active chemical principle Alkaloids and Steroidal Triterpenoids. This study examined the effectiveness of methanolic and water extracts as anthelmintics against the earthworm *Eisenia foetida*. Additionally, the progressive extraction isolates from pet ether, chloroform, ethyl acetate, methanol, and alcohol were examined at fixation concentrations of 5 mg/mL and 10 mg/mL. According to 10 mg/mL portions of the methanolic and aqueous extracts, the respective death times are 139 min and 152 min. [5, 35]

Limitation of plant based anthelminthics [1]

- The cyclical nature of some plants' availability.
- Certain plants must be found in particular habitats.
- The time-consuming process of collecting, preparing, and administering the ingredients.
- Western paradigms of scientific confirmation of efficacy are not applicable to ethanomedicine.

CONCLUSION

The traditional use of wide variety of common medicinal plant holds by great prominence source easily available and effective anthelmintic activity in different animal. The specific components responsible for the anthelmintic activity of these plant extracts and the corresponding molecular pathways are expected to be determined by extensive in vivo investigation. Various traditional plants that can be used as anthelmintic plants are described in ancient texts. Future research must focus heavily on phytochemicals, clinical activity, and mechanism of action. Additionally, the use of common drugs has to be mandated. To reduce the cost of pharmaceuticals, it is also necessary to develop or research new medicinal plants.

In this review present the herbal medicines or medicinal plants which are have number of benefits and used as anthelmintic. In future, this review may help in personnel research or further investigation of bioactive constituents of medicinal plants to fight against helminthsEthnobotanical survey, in India confirms the belief that their evaluation will accelerate the discovery of new effective therapeutic agents as anthelmintic.

AKNOWLEDGEMENT

None

FUNDING SOURCE

None

CONFLICT OF INTEREST

None

REFERENCES

1. Ramesh Kumar Nirala, Preety Raj, Kumari Anjana, Archana and KG Mandal; Medicinal plants and its activity against helminth: Journal of Pharmacognosy and Phytochemistry 2019; 8(5): 2348-2355.
2. Kumari Sunita , Pradeep Kumar, Mohammad Aasif Khan, Sadaf , Syed Akhtar Husain1, D. K. Singh; Anthelminthic/larvicidal activity of some common medicinal plants; of Biological Research Review Article European Journal of Biological Research 2017; 7 (4): 324-336.
3. Piyush yadav, rupali singh; anthelmintic drugs and their future scope; international Journal of Pharmacy and Pharmaceutical Sciences 3, 2011; 0975-1491.
4. Ravindra G Mali And Anita A Mehta; A Review On Anthelmentics Plants;Natural Product Radiance,7(5),2008,466-475.
5. Rukaiya Mulani, Zuber Choudhari, Ashutosh Pujari, Aafrin Jamadar, Parvati Gugwade, Aasiya Dadle; Anthelmintic Plants A Review; International Research Journal of Modernization in Engineering Technology and Science ;07/July-2020 ;- 5.354; 2582-5208.
6. Garg SC, Kasera HL. In vitro anthelmintic activity of the essential of Anacardium occidentale. Indian Perfumer. 1982; 26: 239-240.
7. Vinnakota V, Kumar VM, Aleemuddin M A, Gowtham T. Anthelmintic herbs: An update knowledge. J of Phar Res. 2012, 5(2): 1171-1175.
8. Badar N, Iqbal Z, Khan N and Akhtar S. In Vitro and In Vivo Anthelmintic Activity of Acacia nilotica (L.) Willd. Ex Delile Bark and Leaves. Pak Vet J. 2011; 31(3): 185-191.
9. Raj L, Gadamsetty G, Sarada N. Comparative studies on in vitro anthelmintic activity of gymnema sylvestre and acalypha fruticosa forssk. Int J Pharm Pharm Sci. 2012; 4(1): 107-109.
10. Wangchuk P, Pearson M, Giacomin P, Becker L, Sotillo J, Pickering D, Smout M, Loukas A. Compounds Derived from the Bhutanese Daisy, Ajania nubigena, Demonstrate Dual Anthelmintic Activity against Schistosoma mansoni and Trichuris muris. s. PLoS Negl Trop Dis. 2016; 10(8): 1-18.
11. Husori DI , Bancin DY, Muhaimin , Bahri S , Patilaya P. Anthelmintic Activity of Ethanolic and Aqueous Extracts of Allium fistulosum L. Leaves on Ascaris lumbricoides. Inte J of Pharm and Cli Res.2016; 8(9): 1310-1313.
12. K.R. Subash, N. Jagan Rao, Binoy Varghese Cheriyan, G.Muthulakshmi Bhaarati, K. Sandeep Kumar. The Anthelmintic Activity of Eupatorium triplinerve and Alpinia galanga in Pheritima posthuma and Ascardia galli: A Comparative Study. Journal of Clinical and Diagnostic Research. 2012 , Vol-6(6): 947-
13. Jaya Raju N, Ganga Rao B. Anthelmintic Activities of Antigonon Leptopus Hook And Mussaenda Erythrophylla Lam. Int J Pharm Pharm Sci,. 2011; 3(1): 68-69.
14. Goswami S, Mishra K, Mishra A, Singh A, Singh P , Singh P. Comparative Assesment of InvitroAnthelmintic studies of Some Plants From Indian Origin. J of Phar Res. 2016; 10(7): 514-518.
15. Tariq KA, Chishti MZ, Ahmad F, Shawl AS. Anthelmintic activity of extracts of Artemisia absinthium against ovine nematodes. Vet Para. 2009; 160: 83–88
16. Shah A, Sherwani S, Mohammad Sualeh, Kanwal S, Khan H, Kazmi S. In vitro anthelmintic and antiurolithic assessment of Berberis lycium root bark. J of Pharm and Phyto. 2014; 3 (2): 205-210.
17. Kokate CK, Purohit AK, Gokhale SB. History, definition and scope of Pharmacognosy. Pharmacognosy 2005. 114.
18. Mohammed MS, Mohammed M, Yusuf OA, Joseph OA. Anthelmintic activity of the crude methanol extracts of Xylopia aethiopica against Nippostrongylus brasiliensis in rats. Veterinarski Arhiv 2005; 75: 487-495.
19. Barar FSK, Essential of Pharmacotherapeutics.2000. p. 347- 453.

20. Ibrahim MA, Nwude N, Ogunsusi RA, Allu YO. A paper presented at the 5th International Symposium on Medicinal plants, University of lfe, llelfe, Nigeria; 1983. P.13-15.
21. W. Hu, S. B. Tian, Q. Di, S. H. Duan & K. Dai :Effects of exogenous calcium on mesophyll cell ultrastructure, gas exchange, and photosystem II in tobacco (*Nicotiana tabacum* Linn.) under drought stress:Photosynthetica volume 56, pages1204–1211 (2018).
22. Leyla Bayan, Peir Hossain Koulivand, and Ali Gorji ; Garlic: a review of potential therapeutic effects:Avicenna J Phytomed. 2014 Jan-Feb; 4(1): 1–14.
23. Willson J, Amliwala K, Harder A, Holden D L, Walker RJ. The effect of the anthelmintic emodepside at the neuromuscular junction of the parasitic nematode Ascaris suum. Parasitol 2003; 126:79–86.
24. Saeger B, SchmittWrede HP, Dehnhardt M, Benten WP, Krucken J, Harder A, et al. Latrophilin like receptor from the parasitic nematode Haemonchus contortus as target for the anthelmintic depsipeptide PF1022A. FASEB J 2001; 15:1332–1334.
25. Robertson AP, Clark C.L, Burns TA, Thompson DP, Geary TG, Trailovic SM, Martin RJ.Paraherquamide and 2deoxyparaherquamide distinguish cholinergic receptor subtypes in Ascaris muscle. J Pharmacol Exp Ther 2002; 302; 853–860.
26. Haber CL, Heckaman C L, Li GP, Thompson DP, Whaley HA, Wiley VH. Development of a mechanism of action-based screen for anthelmintic microbial metabolites with avermectin-like activity and isolation of milbemycin-producing *Streptomyces* strains. Antimicrobial Agents. Chemother 1991; 35: 1811–1817.
27. Brownlee DJ, Holden-D L, Walker RJ. (1997). Action of the anthelmintic ivermectin on the pharyngeal muscle of the parasitic nematode, *Ascaris suum*. Parasitology.1997; 115; 553– 561.
28. Pemberton DJ, Franks CJ, Walker RJ, Holden DL. Characterization of glutamate-gated chloride channels in the pharynx of wild-type and mutant *Caenorhabditis elegans* delineates the role of the subunit GluCl-alpha2 in the function of the native receptor. Mol Pharmacol 2001; 59:1037–1043.
29. Krause RM, Buisson B, Bertrand S, Corringer PJ, Galzi JL, Changeux JP, et al. Ivermectin: a positive allosteric effector of the alpha7 neuronal nicotinic acetylcholine receptor. Mol Pharmacol 1998; 53: 283–294.
30. Kushwaha DS, Kumar D, Tripathi HC, Tandan SK. Effect of some indigenous medicinal plants on *Fasciola gigantica in vitro*. Indian J Ani Sci. 2004; 74:143-146.
31. Satrija F, Nansen P, Bjorn H, Murtini S, He S. Effect of papaya latex agains Ascaris suum in naturally infected pigs. J Helminth. 1994; 68:343-346.
32. Tona L, Kambu K, Ngimbi N, Cimanga K, Vlietinck AJ. Antiamoebic and phytochemical screening of some Congolese medicinal plants. J Ethnopharmacol. 1998; 61:57-65.
33. Fajimi AK, Taiwo AA, Ayodeji IO, Adebowale EA, Ogundola FI. Therapeutic trials on gastrointestinal helminth parasite of goats using pawpaw seeds as a drench, In: Proceedings of the international conference on sustainable crop livestock production for improved livelihoods and natural resource Management West Africa held at the International Livestock Research Institute in partnership with International Institute of Tropical Agriculture, 2001, 9-23.
34. John J, Mehta A, Shukla S, Mehta P. A report on anthelmintic activity of Cassia tora leaves. Songklanakarin J. Sci. Technol. 2009; 31(3): 269-271.
35. Gandhi V, Vadalia J , Behzad M. Phytochemical And In Vitro Anthelmintic Activity Of Momordica Charantia Linn Fruit Extracts. Int. J. Res. Ayurveda Pharm. 2016; 7(1): 123-127.