Causative agents of lymphatic nematode parasites are transmitted by a vector, which invade the lymphatic system of humans creating pathological changes. The disease is endemic, where public support is not very promising in following the drug regimen required for the elimination of the disease. Filarial menace is further aggravated by the endosymbiont Wolbachia’s association with the filariid. This further necessitates the use of safe, non-toxic alternatives for the eradication of filarial menace. Since times immemorial plants have always been considered as safe bet as alternative sources. This review aims to bring forth the role of medicinal plants in combating filariasis and worldwide research findings in the usage of plants in the field of filariasis.

Keywords: Lymphatic filariasis, medicinal plants, toxic, Wolbachia, filariid

1. Introduction

Tropical countries are endowed with a number of parasitic infections such as trypanosomiasis, leishmaniasis, schistosomiasis, lymphatic filariasis and onchocerciasis [1]. All of these represent major health problems in the tropical countries like central Africa, Nile Delta, South and Central America and the tropical regions of Asia including southern China and Pacific. Amongst these Lymphatic filariasis is one of the major health concern. Causative agents of Lymphatic filariasis are three nematode parasites i.e. Wuchereria bancrofti, Brugia malayi and Brugia timori, which invade the lymphatic system of humans creating pathological changes leading to filarial manifestations. These three filarial nematode parasites are transmitted by a number of species of mosquitoes namely Culex, Anopheles, Aedes and Mansonia species [2]. Further to aggravate the filarial menace, there is one obligate intracellular bacterium Wolbachia pipientis associated with them [3]. About one-third of the global population at risk for this disease lives in India. This facilitated initiation of national programs in endemic countries, including India. The program in India was made a part of the National Vector Borne Disease Control Programme (NVBDCP) in 2003 under the National Health Policy of 2002, and it set a target for elimination of LF by 2015. In this, India adopted a two pillars strategy for the elimination of lymphatic filariasis by interrupting transmission through mass drug administration (MDA) with diethylcarbamazine (DEC) and providing care for those who are already infected [4]. Ramaiah, (2009) [5] reported that India’s filarial control programme was scaled up MDA over past several years and then albendazole (ABZ) was added for the treatment of 590 million Indians living at risk of infection. In India the coverage level of MDA programme varies from 55% to 90% and Odisha has reported the microfilaraemia (mf) rate of 0.43% in 2011 as compared to 2.54% in 2004 [6]. Although there is considerable improvement of reduction is micorfilarae rates still 100% coverage has not been reported from any of the affected countries.

Cure and control of Lymphatic filariasis is dependent on three factors which are as follows:

1. Vector control
2. Blocking of transmission (WHO Strategy)
3. Chemotherapy to reduce symptoms and killing of adult worms.

In the present review why there is still need for development of a safe nontoxic alternative of existing synthetic drugs has been discussed.

Results and Discussion

First of all we would discuss the standard drugs available for filariasis, their properties, usefulness and then their side effects if any.
Diethylcarbamazine (DEC): Diethylcarbamazine (DEC, N, N-diethyl-4-methyl-1-piperazine carboxamide) is a synthetic derivative of piperazine used as an anthelmintic drug for the treatment of filariasis in humans, dogs and cats. The antifilarial action of hetrazan was discovered by Hewitt [7] working with cotton rats infected with Litomosoides carinii, and later activity of DEC on human filariasis by W. bancrofti was also reported and it was found that DEC lowers the blood microfilaria levels significantly even in single annual doses of 6 mg/kg, and this effect was sustained even at the end of one year. Even though DEC kills the adult worms, this effect was seen in only 50% of patients [8]. DEC does not act directly on parasites and its action is mediated through the host immune system. DEC is an inhibitor of arachidonic acid metabolism in filarial microfilaria. This results in vasoconstriction and amplified endothelial adhesion leading to immobilization of microfilarial parasites, enhanced adherence and cytotoxic activity by host platelets and granulocytes. These effects represent activation of the innate, non-specific immune system, independent of the adaptive, antigen-specific, immune response. This makes the microfilariae more susceptible to innate immune attack, but does not kill the parasites outrightly [9]. The successful use of iodized salt to eliminate iodine-deficiency disorders is encouraging; similarly, fortified salt could be used as a vehicle to eliminate lymphatic filariasis. Despite the potential programmatic advantage of fortifying salt with DEC instead of undertaking mass administration of tablets, DEC- fortified salt remains an underutilized intervention [10].

Side effects associated with Diethylcarbamazine citrate (DEC)
Adverse reaction in some of the patients was observed by a single dose of DEC. It was reported that nine Nigerians with severe Onchocerciasis treated with DEC developed clinical changes, ranging in severity from mild itching to distress, cough and syncope [11]. Physiological changes such as, fever, tachypnoea, tachycardia or hypertension were seen in eight patients. Circulating eosinophils decreased profoundly in all cases just before or during the clinical and physiological changes. The reaction coincides with the death of microfilariae and the accompanying physiological changes may be so severe, even in generally healthy patients. Adverse effects of DEC i.e., the Mazzotti reaction, a complex, acute inflammatory response characterized by fever, tachycardia, hypotension, adenitis, and an ocular inflammatory response, usually results from the death of microfilarial load was also reported by other researchers [12]. However, it is sometimes difficult to determine whether these reactions are due to the death of microfilariae or by DEC itself.

Albendazole
Albendazole, methyl 5(propylthio)-2-benzimidazolcarbamate is the next preferred broad spectrum anthelmintic agentIt is useful for giardiasis, trichuriasis, filariasis, neurocysticercosis, hydatid disease, pinworm disease and ascariasis. As an antihelmintic, albendazole causes degenerative alterations in the intestinal cells of the worm by binding to the colchicine-sensitive site of tubulin, thus inhibiting its polymerization into microtubules. The loss of the cytoplasmic microtubules leads to impaired uptake of glucose by the larval and adult stages of the susceptible parasites and depletes their glycogen storage [13]. Degenerative changes in the endoplasmic reticulum, the mitochondria of the germinal layer and the subsequent release of the lysosomes result in decreased production of ATP. Due to diminished energy production, the parasite is immobilized and eventually dies. The efficacy of Albendazole in treating filarial nematode-based diseases is attributable to dual targeting of nematode microtubules and their Wolbachia endosymbiont [14].

Side effects associated with Albendazole
Albendazole causes abdominal pain, dizziness, headache, fever, nausea, vomiting, or temporary hair loss in sensitive patients. In rare cases, it causes persistent sore throat, severe headache, seizures, vision problems, yellowing eyes or skin, dark urine, stomach pain, easy bruising, mental/mood changes, very stiff neck, or changes in amount of urine. Elevation of liver enzymes during treatment is a common side effect, but in rare cases, acute liver failure has been reported. Allergic reactions are also possible. Rarely, albendazole has been reported to cause marrow suppression, agranulocytosis, or aplastic anaemia. The risk of developing this side effect seems to be increased in patients with liver disease, including echinococcal cysts [15].

Ivermectin
Ivermectin is a broad-spectrum antiparasitic agent, traditionally against parasitic worms. It is mainly used in humans in the treatment of onchocerciasis (river blindness), but is also effective against other worm infestations. Nobel Prize in Physiology or Medicine was awarded jointly to Campbell and Omura [16] for discovering avermectin, “the derivatives of which have radically lowered the incidence of river blindness and lymphatic filariasis, as well as showing efficacy against an expanding number of other parasitic diseases.
Ivermectin acts on parasites and kills by interfering with nervous system and muscle function, in particular by enhancing inhibitory neurotransmission. The drug binds to glutamate-gated chloride channels (GlutCls) in the membranes of invertebrate nerve and muscle cells, causing increased permeability to chloride ions, resulting in cellular hyperpolarization, followed by paralysis and death [17].

Side effects associated with the drug Ivermectin
Adverse effects which include fever, myalgia, headache, sore throat, and cough are usually more prevalent in individuals with higher microfilaremic levels. As the drug acts via nervous system neurotoxicity can also not be ruled out [18]. Kar et al. [19] evaluated the side reactions following ivermectin treatment in sixty males with high density bancroftian microfilaraemia (GM 1388/ml). Following a single oral dose of ivermectin of different strengths (20, 50, 100 or 200μg/kg). Microfilaria levels significantly lowered after ivermectin administration in all dosage groups and 98% of pre-treatment mf densities and were independent of the dose administered. These side reactions were transient, self
limiting and were not serious enough to warrant any treatment. These exaggerated unusual reactions were possibly due to allergic response of the susceptible host to rapid killing of large number of microfilariae. Moreover, these standard drugs used against the filarial parasitic round worms kill only the microfilariae when used in mass drug administration programme proposed by World Health Organization (WHO). These drugs do not have macrofilaricidal effect and possess side effects, which discourage the people in the endemic areas where disease compliance is more and this could be a possible reason for the unwillingness towards the MDA programme. So this is essential to investigate the alternate source of higher efficacy and lower toxic lead molecules which possibly would become a safer new drug and for this reason medicinal plants would be a valid alternative for searching new drugs.

The therapeutical potential of ethno-medicinal plants

Medicinal plants and its healing activities against various diseases has been a valuable ingredient in various therapeutic applications since centuries ago in Ayurvedic, Unani, Siddha and Chinese medicinal practices. According to WHO 80% of population in different countries relies on traditional medicinal herbs for curing diseases like fever, cough, joint pain, nausea, hypertension, insomnia, cancer, diabetes, Alzheimer’s disease etc.

The potency of medicinal plants in the treatment of parasitic diseases has gained increasing importance among researchers to formulate new drug leads. This could be a possible alternative towards the current drug regime, as the current synthetic drugs are effective but possess various side effects. In the context of lymphatic filariasis, the current drugs available for MDA implementation by national programmes such as Ivermectin, ALB and DEC, which have been the drugs of choice for filariasis control, are effective in reducing microfilariae counts but not effective in killing adult worms. It also has been reported to cause side effects such as fever, gastrointestinal disturbance, headache, malaise and skin rash that reduce patient compliance. So, there is an urgent need of a cheap, non-toxic and novel antifilarial drug with macrofilaricidal activity.

The present antifilarial drug diethylicarbamazine (DEC), ivermectin and albendazole have only microfilaricidal activity and possess less activity against adult worms. These drugs also show some side effects in patients, so there is a social stigma regarding the mass consumption of these drugs. This warrants the need for developing an effective and safe drug, which could kill or sterilize the adult worm.

A total of 25 family members so far were reported in filarial chemotherapy out of which Fabaceae, Asteraceae and Euphorbiaceae showed maximum number of genus reported for activity. As can be observed from the table, four models were used in the reports these were Brugia malayi, Brugia phangi, Setaria digitata and Setaria cervi. None of the study involved human Wuchereria bancrofti as it is very difficult to procure the same for experimental work. Some of the significant results are as follows:

- Cassia occidentalis Linn, Oldenlandia herbacea L.Roxb, Sida acuta Burm.f., Clitoria ternatea Linn and Euphorbia hirta Linn were selected for macrofilaricidal study against Setaria digitata. Methanolic extracts were used for the study. Worm motility assay was performed and all the plant extracts showed complete immobilization of worms at 10 mg/ml at the end of 4 hours incubation period. MTT formazan colorimetric assay for viability of worms were carried out. Cassia occidentalis, Oldenlandia herbacea and Sida acuta exhibited > 50% of formazan inhibition at 4 hours. Clitoria ternatea and Euphorbia hirta exhibited < 50% of inhibition at 4 hours. Oldenlandia herbacea exhibited 65.67, 78.6 and 85.66% of inhibition for the concentration of 1, 5 and 10 mg/ml respectively. This study identified Oldenlandia herbacea as a potential macrofilaricidal agent.

- Antifilarial activity of Methanol/Hexane-ethanol extracts of Butea monosperma L. (leaves) and Ciproxofloxacin was explored against adult Setaria cervi worm after incubation for 24 hrs with concentration range of 0.25 to 20 mg/ml. Inhibitory concentrations (IC50) for the plant extracts with significant antifilarial activity against Setaria cervi adult in vitro system for MTT assay have been derived to be 1.25, 3.6 and 7.5 mg/ml Methanol, Hexane-ethanol extracts and Ciproxofloxacin respectively. Methanol and Hexane-ethanol extracts of Butea monosperma L. plant leaves showed significant antifilarial activity as compared to Ciproxofloxacin.

- In vitro efficacy of ethyl acetate extract of Vitex negundo was studied against adult Setaria cervi worm. Extract concentration 0.03 to 1.00mg/ml was used for worm motility assay followed by MTT reduction assay. In motility assay complete inhibition of motility was observed and in MTT assay >50% inhibition was found for concentrations 0.2, 0.5 and 1.00mg/ml at dose dependent manner. IC50 was obtained to be 0.16mg/ml. Vitex negundo plant extract showed potency towards the discovery of a novel drug candidate for lymphatic filariasis.

Efficient plant source that can induce apoptosis of filarial parasites possibly can provide a new direction towards developing a new class of antifilarials. Mukherjee et al. evaluated the antifilarial efficacy of an optimized polyphenol rich ethanol extract of Azadiractha indica leaves. Motility reduction, MTT assay and dye exclusion test have confirmed the micro and macrofilaricidal potential of extract. They had found cellular disturbances in extract treated parasites characterized by chromatin condensation, in situ DNA fragmentation and nucleosomal DNA laddering. Depletion in worm GSH level and elevation in catalase, GPx and superoxide anion indicated the generation of ROS. They also reported that ethanolic extract causes decreased expression of anti-apoptotic genes and increased pro-apoptotic genes at the level of both transcription and translation.

Bioassay guided isolation of ferulic acid from ethyl acetate fraction of Hibiscus mutabilis was obtained. The crude and ferulic acid the active molecule showed significant macrofilaricidal as well as macrofilaricidal against the Setaria cervi by both the worm motility and MTT reduction assay. By the consequences of ferulic acid treatment extreme cellular disturbances was recorded by chromatin condensation, in situ DNA fragmentation and nucleosomal DNA laddering. Ferulic acid exerts its antifilarial effect through induction of apoptosis and by down regulating and altering the level of some key antioxidants (GST, GSH and SOD) of the filarial nematode. Further antifilarial effect of Ursolic acid (UA) isolated from ethyl acetate fraction of Nyctanthes arboristris was reported. Same compound was isolated from leaves of Eucalyptus tereticornis. The crude extract and Ursolic acid showed significant micro as well as macrofilaricidal activities against the filarial parasite Brugia malayi using in vitro and in vivo assays, and in silico docking search on glutathione-s-transferase (GST) parasitic enzyme were carried out. The UA was lethal to microfilariae (mf: LC100: 50; IC50: 8.84μM) and female adult worms (LC100: 100; IC50: 35.36μM) as observed oocyte, microfilaria and adult of Setaria cervi (S.
by dye exclusion test and MTT reduction assay. Antifilarial activity of UA against the human lymphatic by motility assay; it exerted 86% inhibition in MTT reduction potential of the adult parasites [23].

The effect of aqueous and alcoholic extract of the leaves and seeds of *P. corylifolia* on the spontaneous movement of the whole worm and the nerve muscle preparation of *Setaria cervi* and the survival of microfilariae in *in vitro* was investigated. Alcohol extracts of both leaves and seeds caused the inhibition of spontaneous movements of the whole worm and the nerve muscle preparation of *S. cervi* at doses 160, 30 and 150, 20µg/ml, respectively characterized by initial, short lasting small increase in tone of contraction followed by paralysis. LC50 and LC30 for the death of microfilariae was obtained to be 12 and 25ng/ml for alcoholic leaf extract and 12 & 18ng/ml for alcoholic extracts of seeds respectively [28]. Details of other medicinal plants have been given in Table 1, which have been explored for antifilarial activity and have shown mild activity. Plant kingdom is vast and further exploration is still warranted for a suitable and safe macrofilaricidal agent in order to alleviate the menace of filariasis.

**Table 1: Medicinal plants used for treating Filariasis**

<table>
<thead>
<tr>
<th>Family</th>
<th>Plant name</th>
<th>Parts used</th>
<th>Target parasite</th>
<th>Activity on filarial parasites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acanthaceae</td>
<td><em>Andrographis paniculata</em></td>
<td>Leaves</td>
<td><em>B. malayi</em></td>
<td>Anti-filarial activity of aqueous extracts on adult parasites at doses 5 and 10mg/ml in terms of reduction in relative motility of worms i.e. 0% after 24hrs of treatment [29].</td>
</tr>
<tr>
<td>Apiaceae</td>
<td><em>Trachyspernum anmi</em></td>
<td>Fruit</td>
<td><em>S. digitata, B. malayi</em></td>
<td>In vitro and in vivo antifilarial efficacy of crude as well as active fractions atdoses 0.01 to 0.5mg/ml on adult worms were reported in terms of motility inhibition and MTT reduction assays [30].</td>
</tr>
<tr>
<td>Asteraceae</td>
<td><em>Centraherum anthemliniticum</em></td>
<td>Seed</td>
<td><em>S. cervi</em></td>
<td>Ethylacetate, acetone and methanol extracts showed inhibition of spontaneous motility of the nerve-muscle preparation of <em>S. cervi</em> characterized by decreasedamplitude and frequency of contractions [31].</td>
</tr>
<tr>
<td>Asteraceae</td>
<td><em>Neurolaena lobata</em></td>
<td>Leaf</td>
<td><em>B. phangi</em></td>
<td>Ethanolic extract was reported to be effective on micro as well as macrofilariae of <em>B. phangi</em> [32].</td>
</tr>
<tr>
<td></td>
<td><em>Sphaeranthus indicus</em></td>
<td>Whole plant</td>
<td><em>S. digitata</em></td>
<td>Methanolic extract showed macrofilaricidal activity at dose below 4mg/ml after incubation of 100min [33].</td>
</tr>
<tr>
<td>Betulaceae</td>
<td><em>Atnus nepalensis</em></td>
<td>Leaves</td>
<td><em>B. malayi</em></td>
<td>The diarylethanoid compounds isolated from this plant showed both micro as well asmacrofilaricidal activity with IC50 value of 6.57-10.31µg/ml concentration [34].</td>
</tr>
<tr>
<td>Caesalpinaeae</td>
<td><em>Bauhinia racemosa</em></td>
<td>Leaves</td>
<td><em>B. malayi</em></td>
<td>Galactolipids isolated from ethanol extract showed better adulticidalactivity than ivermectin and DEC at doses 58.3 ± 8.33% [35].</td>
</tr>
<tr>
<td></td>
<td><em>Caesalpinia bondacella</em></td>
<td>Leaves and seeds</td>
<td><em>B. malayi</em></td>
<td>The leaves and seed kernel extract showed effective micro-filaricidalas well as macrofilaricidal activity using animal models [36].</td>
</tr>
<tr>
<td>Combretaceae</td>
<td><em>Terminalia chebula</em></td>
<td>Leaf and fruit</td>
<td><em>S. digitata</em></td>
<td>Methanolic extract showed potent macrofilaricidal activity at concentrations 8 to10mg/ml in terms of worm motility and MTT reduction assays [37].</td>
</tr>
<tr>
<td>Convolvulaceae</td>
<td><em>Argyreia speciosa</em></td>
<td>Whole plant</td>
<td><em>S. cervi</em></td>
<td>Aqueous and alcoholic extracts showed inhibitory activity on the whole worm and nerve muscle preparation at 150 and 75µg/ml concentration respectively [38].</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td><em>Ricinus communis</em></td>
<td>Seeds</td>
<td><em>S. digitata &amp; B. Malayi</em></td>
<td>Methanolic extract of seeds exhibited antifilarial activity on the adult worms at concentration 1mg/ml with 72.39% formazan inhibition [39].</td>
</tr>
<tr>
<td></td>
<td><em>Mallotus philippensis</em></td>
<td>Leaves</td>
<td><em>S. cervi</em></td>
<td>Aqueous and alcoholic extract of leaves showed potential antifilarial activity due to alteration of membrane permeability [40].</td>
</tr>
<tr>
<td></td>
<td><em>Excoecaria agallocha</em></td>
<td>Leaves</td>
<td><em>S. digitata</em></td>
<td>Methanolic extract showed promising antifilarial activity at very lower doseof 10µg/ml on the developmental stages of parasite [40].</td>
</tr>
<tr>
<td>Fabaceae</td>
<td><em>Acacia auriculiformis</em></td>
<td>Funicles</td>
<td><em>S. cervi</em></td>
<td>Triterpenoid saponins acaciaside A and acaciaside B isolated from funicles showed micro as well as macrofilaricidal effect of 97% and 100% inhibition Respectively within 100min [41]. Methanol and hexane-ethanol extract showed IC50 value of 1.25 and 3.6mg/ml respectively on adult worms. [22].</td>
</tr>
<tr>
<td></td>
<td><em>Butea monosperma</em></td>
<td>Leaves &amp; fruits</td>
<td><em>S. cervi and B. malayi</em></td>
<td>Aqueous and alcoholic extract at concentrations 250and 120µg/ml exhibited inhibition of spontaneous movement of <em>Setaria</em> worm [42].</td>
</tr>
<tr>
<td></td>
<td><em>Pongamia pinnata</em></td>
<td>Leaves &amp; seeds</td>
<td><em>S. cervi</em></td>
<td>The alcoholic extract of leaves and seeds at concentrations160 and 30µg/ml showed inhibitory effect on whole worm respectively [21].</td>
</tr>
<tr>
<td></td>
<td><em>Psoralea corylifolia</em></td>
<td></td>
<td><em>S. cervi</em></td>
<td>The column fractions obtained from methanolic and aqueous extracts showed antifilarial activity atconcentrations 0.01 to 1mg/ml in terms of worm motility inhibition of adult <em>Setaria</em></td>
</tr>
<tr>
<td>Lamiaceae</td>
<td><em>Leucas cephalotes</em></td>
<td>Flower &amp; stem</td>
<td><em>S. cervi</em></td>
<td>Alcoholic and aqueous extract of flower as well as stem showed inhibitory effects on spontaneous movement of <em>Setaria</em> worms [28].</td>
</tr>
<tr>
<td></td>
<td><em>Leucas aspera</em></td>
<td>Whole plant</td>
<td><em>S. digitata</em></td>
<td>The plant extract of <em>L. aspera</em> showed antiparasitic effect on <em>S. digitata</em> [43].</td>
</tr>
<tr>
<td>Liliaceae</td>
<td><em>Asparagus adscendens</em></td>
<td>Whole plant</td>
<td><em>S. cervi</em></td>
<td>The alcoholic and aqueous extract showed microfilaricidal activity with LC50 value of 8 and 3mg/ml respectively [44].</td>
</tr>
<tr>
<td>Lythraceae</td>
<td><em>Lawsonia inermis</em></td>
<td>Leaf</td>
<td><em>S. digitata</em></td>
<td>The column fractions obtained from methanolic and aqueous extracts showed antifilarial activity at concentrations 0.01 to 1mg/ml in terms of worm motility inhibition of adult <em>Setaria</em></td>
</tr>
</tbody>
</table>
### Menispermaceae
- **Tinospora crispa**
  - **Stem**
  - **B. malayi**
  - Dried stem extract of the plant showed strong antifilarial effect on adult worms of subperiodic **B. malayi** [28].

### Moraceae
- **Streblus asper**
  - **Bark**
  - **S. cervi & B. malayi**
  - The aqueous extract of stem bark also put strong macrofilaricidal effect on **B. malayi** in rodents [49].

### Pinaceae
- **Cedrus deodara**
  - **Plant wood**
  - **S. digitata**
  - Methanolic extract showed macrofilaricidal activity in terms of worm motility and MTT reduction potential at concentration 1mg/ml exhibited 86.5% inhibition [52].

### Piperaceae
- **Piper betle**
  - **Leaves**
  - **B. malayi**
  - The ethanolic extract of leaves from *P. betle* showed larvicidal activity at 7.8µg/ml and also reported about 63.6% inhibition of worm motility and MTT reduction potential at dose 4mg/ml concentration in 60 and 88mins respectively [48].

### Plumbaginaceae
- **Plumbago indica**
  - **Root**
  - **S. digitata**
  - The methanolic extract of the root showed 83.3% immobilization of worms after 6hrs and the isolated compound plumbagin exhibited >70% inhibition of formazan in MTT assay at 0.05mg/ml concentration [54].

### Rutaceae
- **Aegle marmelos**
  - **Leaves**
  - **B. malayi**
  - Methanolic extract of leaves showed microfilaricidal activity at concentration 100ng/ml exhibiting complete immobilization after 48hrs of incubation period [59].

### Sapindaceae
- **Cardiospermum halicacabum**
  - **Whole plant**
  - **B. pahangi**
  - The aqueous extract exhibited worm motility inhibition at concentration less than 500µg/ml after 24hrs of exposure where as the ethanolic extract showed little effect on worms detected by MTT assay [56].

### Saxifragaceae
- **Saxifraga stracheyion**
  - **Root**
  - **S. cervi**
  - Aqueous and alcoholic extract at doses 140 and 250µg/ml exhibited inhibitory effect on spontaneous movement of the worm [37].

### Solanaceae
- **Solanum khastanum**
  - **Fruit**
  - **S. cervi**
  - Solamargine, a steroidal alkaloid glycoside obtained from the fruit showed 100% inhibition of adult worms and microfilariae at 4mg/ml concentration in 60 and 88mins respectively [38].

### Verbenaceae
- **Vitex negundo**
  - **Leaves, Root**
  - **B. malayi & S. cervi**
  - The ethyl acetate extract of leaves from *V. negundo* showed significant worm motilityand MTT reduction activity of >50% at doses 0.2, 0.5 and 1mg/ml at 10, 6 and 2hrs incubation period respectively on **S. cervi** (Sahare and Singh, 2013). The root extract of *V. negundo* also exhibited in vitro microfilaricidal activity at 100ng/ml on **B. malayi** after 48hrs of incubation [37].

- **Lantana camara**
  - **Stem**
  - **B. malayi**
  - The crude extract prepared from stem of *L. camara* at 1 g/kg for five days by oral route killed 43.05% of the adult *Brugia malayi* parasites in the rodent model *Mastomys coucha* [36].

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