We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Plant Extracts: A Potential Tool for Controlling Animal Parasitic Nematodes

Pedro Mendoza de Gives*, María Eugenia López Arellano,
Enrique Liébano Hernández and Liliana Aguilar Marcelino
*Centro Nacional de Investigación Disciplinaria en Parasitología Veterinaria, INIFAP
México*

1. Introduction

Many plants play a crucial role in maintaining animal and human life in a natural balance with a tendency to establish an environmental armory among the different biosphere inhabitants. During evolution of living organisms in the biosphere biological interactions with other organisms are established and they affect each other in many ways. Different types of relationships are involved among organisms including parasitism. Heritable strategies of biological adaptation are developed by living organisms to overcome adverse environmental conditions. Plants have developed biochemical mechanisms to defend themselves from biological antagonists that act as their natural enemies (Ryan and Jagendorf, 1995). This principle has led scientists to search for bio-active compounds produced by plants against pathogens (Sheludko, 2010). Since long a number of plants and their metabolites are evaluated against diseases of importance not only in public health (Shah et al., 1987); but also in animal and agricultural production (Githiori et al., 2006). In the present chapter, the importance of using plant extracts as an alternative method of control of animal parasitic nematodes is reviewed from a broad perspective.

2. Use of plants as a source of phyto-medicines

Ancestral cultures worldwide developed, over many centuries, several cures and remedies from plants and plant extracts against many diseases affecting human populations and a traditional medicinal system based on empiric knowledge was established and was improved through time (Hillier and Jewel, 1983). Some devastating infectious diseases *ie.*, malaria, responsible for deaths of thousands of people can be overcome with traditional herbal anti-malarian drugs obtained from South America, Africa and Asia *ie.*, Cinchona (*Cinchona sp.*), Qing hao (*Artemisa annua*), Changshan (*Dichroa febrifuga*), Neem (*Azadirachta indica*), *Cryptolepsis sanguinolenta*) and other plants (Willcox et al., 2005). Researchers around the world have scientifically explored the real effect of many plants used as medicines

* Corresponding Author

whose uses are not validated by rigorous scientific experimentation. Many plants are being screened for anti-parasitic effects on animals; since animal behaviour reveals self-medication when animals select and ingest some specific plants (Cousing and Huffman, 2002; Huffman, 2003). In Hawaii, Rodriguez et al (1985) reported an interesting work based on a peculiar behavior of primates in the Hawaiian jungle. Researchers noticed that troops of chimpanzees ate some plants that they had previously selected and which they fed their progeny. Researchers suspected that such plants could contain alkaloids with hallucinogenic effects and probably could act as stimulants as alkaloid drugs do. After in-depth studies of those plants researchers found a group of bio-active compounds which can treat bacterial, fungal and nematodal infections. Hence, the researchers concluded that primate behavior responded to a mechanism of self/cure using selected plants as phyto-medicines (Sumer and Plutkin, 2000). During the last decades the study of medical principles from plants has gained considerable interest and a number of natural bio-active compounds from plant extracts are currently commercially available to cure many diseases.

3. Parasites of veterinary importance

Livestock industry worldwide is severely affected by a number of infectious diseases caused by different kinds of parasites. The present chapter focuses on the use of plant extracts against the group of internal parasites and particularly to helminths known as Gastrointestinal Parasitic Nematodes (GIN); considered to be one of the most economically important group of parasites affecting the animal productivity around the world (Poglaven and Battelli, 2006; Abdel-Ghaffar et al., 2011). The most frequent GIN of ruminants in many countries around the world are: *Haemonchus contortus*, *Mecistocirrus digitatus*, *Trichostrongylus colubriformis*, *T. axei*, *Bunostomum trigonocephalum*, *Cooperia curticei*, *Teladorsagia circumcincta*, *Nematodirus spp*, *Trichuris ovis*, *T. globulosa*, *Strongyloides papillosus*, *Gaigeria pachyscelis*, *Chabertia ovina* and *Oesophagostomum columbianum* (Torres Acosta et al., 2005; Valcárcel Sancho et al., 2009). In this group of parasites the nematodes have a remarkable status as the main pathogens causing severe damage to their hosts. *Haemonchus contortus* and other genera/species of nematodes belonging to the group of trichostrongylids are of major concern because its blood-sucking feeding habits cause anemia that can be so severe resulting in the death of the animals (Macedo Barragán et al., 2009). This group of parasites is widespread in almost all tropical and sub-tropical countries and is considered responsible for deteriorating animal health and productivity.

4. Chemotherapy as the unique method of control

The most common method used to control ruminant helminthiasis is the use of chemical compounds commercially available as anti-helminthic drugs that are regularly administered to animals for deworming; the method is considered simple, safe and cheap (Jackson, 2009). There are several disadvantages in the use of such products such as their adverse effect against beneficial microorganisms in soil once they are eliminated with the feces (Martínez and Cruz, 2009). On the other hand, some anthelmintic compounds can remain as contaminants in animal products destined for human consumption *ie.*, meat, milk, etc. (FAO, 2002). One of the main concerns in the use of anthelmintic drugs for controlling

ruminant parasites is the development of anthelmintic resistance in the parasites that decreases the efficacy of the drugs (Sutherland and Leathwick, 2011; Torres-Acosta et al., 2011) and threatens economical sustainability of sheep production (Sargison, 2011). The anthelmintic resistance can reach enormous proportions when parasites develop mutations in their genome against different groups of anthelmintic drugs. Such phenomenon is known as “Multiple anthelmintic resistance” and it is a real threat to the inefficacy of commercially available anthelmintics (Taylor et al., 2009; Saeed et al., 2010). Such situation has motivated workers around the world to look for alternatives to control these parasites. Searching for plant bio-active compounds with medical properties against parasites has gained great interest in order to at least partially replace the use of chemical drugs.

5. Exploring the anti-parasitic properties of plants

A wide range of plants and their products around the world are being explored to look for their possible anthelmintic effects on cestodes and trematodes (Abdel-Ghaffar et al., 2011), and against nematodes (Datsu Kalip et al., 2011). Due to the important economic impact of gastrointestinal parasitic nematodes in the livestock industry around the world, most of the research on plant extracts are being focused on searching bioactive compounds from plants against this important group of parasites. Traditionally, some plants around the world are well known as anti-parasitic plants because they contain substances with anthelmintic effects against parasitic nematodes affecting agricultural crops (Krueger et al., 2009) or animal parasitic nematodes (Galicia Aguilar et al., 2008; López Aroche et al., 2008; De Jesús Gabino et al., 2010). Perhaps, the most known cases of plants with nematocidal properties around the world are garlic (*Allium sativum*) (Iqbal et al., 2001; Qadir et al., 2010) Marigold (*Tagetes erecta*) Krueger et al., 2009; Bhardwaj et al., (2010) and the goosefoot or Epazote (*Chenopodium abrosioides*) (Yadav et al., 2007; Eguale and Mirutse, 2009). Another example is the South African plant *Curtisia dentata* commonly used for ages by rural communities as a remedy to cure a number of diseases caused by bacteria and fungi in either human being or animals (Shai et al., 2008; Dold and Cocks, 2001) and against animal parasitic nematodes (Shai et al., 2009). Nevertheless, every year, the list of new plants with nematocidal *in vitro* and *in vivo* properties against animal parasites is growing as new natural alternatives for replacing (at least partially) the use of chemical drugs (Tables 1 and 2).

Some forage have been evaluated searching for potential bio-active compounds against sheep and goat parasitic nematodes with variable results. However studies must be intensified; since some individual limitations in application have been noticed; *ie.*, toxicity, metabolic disorders and inappropriate applications can cause severe damage and even the death of treated animals (Rahmann and Seip, 2008). Other plants are being investigated as bio-active forages in the control of *Haemonchus contortus* in lambs with good/moderate results. For instance Wormwood (*Artemisia absinthium*) which was offered to lambs for voluntary intake, parasitic burden was reduced almost in 50%. Additionally, faecal egg excretion expressed on a dry matter basis was also reduced by 73% in animals fed with the selected plant (Valderrábano et al., 2010). On the other hand, other plant/plant extracts *ie.*, *Melia azedarach* (Chinaberry tree, Indian Lilac) have shown promising results in trials that confirmed not only a very good anthelmintic efficiency, but also no side-effects (Akhtar and Riffat, 1984). Some plant extract have shown an extraordinary bio-activity against sheep

Table 1. In vitro nematocidal effect of different plant extracts against nematodes of livestock importance

Plant	Extract	Target nematode	Anti-nematode Efficiency
<i>Adhatoda vasica</i>	aqueous and ethanolic extracts	<i>H. contortus</i> , <i>O. circumcincta</i> , <i>Trichostrongylus spp</i> ,	84-89% in vitro hatch inhibition
<i>Adhatoda vasica</i>	aqueous and ethanolic extracts	<i>S. papillosus</i> , <i>Oe.columbianum</i>	81-85% larval development inhibition
<i>Tagetes erecta</i>	Acetonic extract	<i>Haemonchus contortus</i> (L4)	99.7% lethal activity
<i>Castela tortuosa</i>	Hexanic extract	<i>Haemonchus contortus</i> (L4)	95.8% lethal activity
<i>Prosopis laevigata</i>	Hexanic extract	<i>Haemonchus contortus</i> (L3)	81% maximum mortality
<i>Bursera copalifera</i>	Acetonic extract	<i>Haemonchus contortus</i> (L3)	66% máximo mortality
<i>Acacia pennatula</i> , <i>Lysiloma latisiliquum</i> , <i>Piscidia piscipula</i> y <i>Leucaena leucocephala</i>	Acetone/ water extracts	<i>H. contortus</i>	Variable range of larval migration inhibition on different <i>H. contortus</i>
<i>Salvadora persica</i>	Aqueous extract	Strongyline nematodes	99.9% anthelmintic activity
<i>Terminalia avicenoides</i>	Aqueous extract	Strongyline nematodes	100 %anthelmintic activity

Plant	Extract	Target nematode	Animal specie	% efficacy
<i>Artemisia absinthium</i>	Crude Ethanolic extract	<i>Haemonchus contortus</i>	sheep	Faecal egg count reduction (FECR) of 90.46%
<i>Artemisia absinthium</i>	Crude aqueous extract	<i>Haemonchus contortus</i>	sheep	Faecal egg count reduction (FECR) of 80.49%
<i>Prosopis laevigata</i>	n-hexanic extract	<i>Haemonchus contortus</i>	Jirds	Parasitic burden was reduced in 42.5%
<i>Parkia biglobosa</i>	Aqueous extract	<i>Haemonchus</i> , <i>Trichostrongylus</i> , <i>Oesophagostomum</i> and <i>Bunostomum</i> species	Bovine	Produced a high hatch inhibition
<i>Piper tuberculatum</i>	Oil extract	<i>Strongyloides venezuelensis</i>	<i>Rattus norvegicus</i>	No in vivo anthelmintic activity

Table 2. In vivo nematocidal effect of different plant extracts against nematodes of livestock importance

parasitic nematodes; *ie.*, supplementing sheep with a *Fumaria parviflora* ethanol extract eliminated fecal eggs and caused 72 and 88% mortality of adult *Haemonchus contortus* and *Trichostrongylus colubriformis*, respectively (Hördegen et al., 2003). These are only a few examples of candidate plant extracts to be used in the control of parasites in sheep and goat farming. Rochfort et al (2008) from Australia published a very complete and extraordinary review about bioactive plants and their impact on animal health and productivity. On the other hand, Diehl et al (2004) published the results of a very interesting research project evaluating eighty six plant extracts from Ivory Coast flora and finding that fifty percent of the evaluated plants had nematocidal activity against *Haemonchus contortus* larvae. Such results showed evidence about the important nematocidal activity of plants from Ivory Coast as potential ethnobotanical tools of control against ruminant parasitic nematodes (Diehl et al., 2004). Some recent reports of nematocidal activity of plant extracts against ruminant parasites in different countries are described as follows: In Pakistan, *Adhatoda vasica* both aqueous and ethanolic extracts exhibit an *in vitro* ovicidal and larvicidal activity ranging between 81-89% against diverse genera/specie of gastrointestinal parasitic nematodes of sheep (Al-Shaibani et al., 2008). In Burkina, Faso, two medicinal plants *Anogeissus leiocarpus* and *Daniellia oliveri* were analyzed to identify their anthelmintic effect against nematodes of sheep abomasum. *A. leiocarpus* and *D. oliveri* showed a maximum lethal activity, between 80 and 100%, respectively, against adult *Haemonchus contortus* (Aldama et al., 2009; Kaboure et al., 2009). Many countries have developed important screening of plant extracts with anthelmintic properties from their native flora with an enormous potential for the control of animal parasitic nematodes with encouraging results. Some countries *i.e.* Brazil, India, South Africa, China and others possesses an extraordinary richness in their medicinal flora and they have currently developed an important industry from plant extracts ably supported by science. Some researchers stand out for their important contributions in this regard: Githiori et al (2006) at the International Livestock Research Institute in Nairobi, Kenya; Iqbal et al (2001) and his group or researchers from the Department of Veterinary Parasitology, University of Agriculture, Faisalabad, Pakistan have developed a solid package of information about a big list of native plants with encouraging results in the control of sheep parasites (Iqbal et al., 2001; 2004; Bachaya et al., 2009).

6. Condensed tannin-rich plants

A number of research works have focused on the anthelmintic effect of tannin rich plants against GIN. This group of bio-active compounds present in selected plant material are being obtained from all over the world, from temperate areas (Athanasiadou et al., 2004; Hoste et al., 2006) as well as from tropical tannin rich fodders (Alonso-Díaz et al., 2010). Interdisciplinary groups of researchers (Hoste et al., 2006; Alonso Díaz et al., 2008; Calderón-Quintal et al., 2010; Martínez-Ortíz-de-Montellano et al., 2010) have developed important research studies on tannin-rich plants in the control of *H. contortus* and other important gastrointestinal nematodes. Most scientific works focused on identifying the bio-active compounds produced by nematocidal plants have reported the presence of different molecules including catechins, condensed tannins, flavonoids and steroids (Oliveira et al., 2009) and polyphenolics (Lorimer et al., 1996); as well as bio-active enzymes such as cysteine protease and secondary metabolites such as alkaloids, glycosides and tannins

(Athanasiadou and Kvriazakis, 2004). Further in-depth studies need to be undertaken since even though anti-parasitic properties are being demonstrated, negative effects such as reduction in food intake by animals have been identified and this should be considered before establishing their use as an alternative method of control (Githiori et al., 2006).

In recent studies, researchers are reaching beyond the general knowledge about lethal *in vitro* activity of plants and bio-active compounds derived from selected plants against the most important nematode parasites of ruminants. New efforts are being carried out to find practical applications of plants or plant products in the control of ruminant parasitic nematodes; including ways and means of overcoming limitations in applications to animals (Rahmann and Seipa, 2007). Recently in Laos, reduction in appearance of nematode eggs on goat feces with the Cassava foliage supplement has been demonstrated (Phengvichith and Preston, 2011).

7. Conclusions

The use of chemical anthelmintic drugs for controlling animal parasitic nematodes is rapidly losing popularity due to a number of disadvantages. Anthelmintic resistance in the parasites is spreading and the inefficacy of chemical anti-parasitic compounds is threatening animal health. New plants with medicinal properties against parasites of ruminants are being investigated around the world with promising results. In the near future natural products obtained from plants extracts seems that likely will become a viable alternative of control of parasites of veterinary importance. When plant/plant extracts are being selected for use as anti-parasitic drugs in sheep particular attention should be given to the fact that the bio-active compound could be found in stems, roots, leaves, flowers, fruits or even in the entire plant. This means that obtaining plant extracts is a laborious and complex process. Also, the mode of extraction and the solvent used can determine the success in isolating the expected bioactive compounds; since a wide variety of compounds can be hidden into the structural parts of the plants and the only way they could be isolated is through exploring the use of a range of organic solvents. On the other hand, a rigorous effort to identify possible side effects due to the administration of plant extracts should be established before carrying *in vivo* assays. It is remarkably important to consider that using plant/plant extracts as a unique method of control is insufficient to control itself the parasitosis in the animals. So, an alternated or combined method with other methods of control should be considered as an integrated method which would lead to reduce the use of chemical anthelmintic drugs.

8. Acknowledgments

Authors wish to express their gratitude to Dr. Felipe Torres Acosta (Autonomous University of Yucatan, Mexico) for his valuable comments on this chapter.

9. References

- [1] Abdel-Ghaffar, F., Semmler, M., Khaled, A., Al-Rasheid, S., Strassen, B., Fischer, K., Aksu, G., Klimpel, S., Mehlhorn, H. (2011) The effects of different plant extracts on intestinal cestodes and on trematodes. *Parasitology Research* (2011) 108:979-984.

- [2] Akhtar, M.S. and Riffat, S. 1984. Efficacy of *Melia azedarach* Linn. fruit (Bahain) and Morantel against naturally acquired gastrointestinal nematodes in goats. Pakistan Veterinary Journal, 4: 176-9.
- [3] Aldama, K., Belem A. M. Gaston, M., Hamidou, H., Amadou, T., and Sawadogo Laya, S. (2009) *In vitro* anthelmintic effect of two medicinal plants (*Anogeissus leiocarpus* and *Daniellia oliveri*) on *Haemonchus contortus*, an abosomal nematode of sheep in Burkina Faso. African Journal of Biotechnology 8 (18)4690-4695.
- [4] Alonso-Díaz, M.A., Torres-Acosta, J.F.J., Sandoval-Castro, C.A., Capetillo-Leal, C., Brunet, S., Hoste, H. (2008) Effects of four tropical tanniniferous plant extracts on the inhibition of larval migration and the exsheathment process of *Trichostrongylus colubriformis* infective stage. Veterinary Parasitology 153:187-192.
- [5] Alonso-Díaz, M.A., Torres-Acosta, J.F.J., Sandoval-Castro, C.A., Hoste, H. (2010) Tannin in tropical tree fodders fed to small ruminants: A friendly foe? Small Ruminant Research 89:164-173.
- [6] Al-Shaibani, I.R.M., Phulan, M.S., Arijoand, A., Qureshi, A. (2008) Ovicidal and larvicidal properties of *Adhatoda vasica* (L.) extracts against gastrointestinal nematodes of sheep *in vitro*. Pakistan Veterinary Journal. 28(2): 79-83.
- [7] Athanasiadou, S., Kvriazakis. I. (2004) Plant secondary metabolites: antiparasitic effects and their role in ruminant production systems. Proceedings of the Nutrition Society. 63(4):631-639.
- [8] Bachaya, H.A., Z. Iqbal, M.N. Khan, A. Jabbar, A.H. Gilani and I.U. Din, 2009. *In vitro* and *In vivo* anthelmintic activity of *Terminalia arjuna* bark. International Journal of Agricultural Biology, 11: 273-278.
- [9] Bhardwaj, P, Varshneya, C. and Mittra, S. (2010) Anthelmintic efficacy of *Bauhinia variegata* and *Tagetes patula* against *Haemonchus contortus*. The Indian Veterinary Journal 87(12): 1204-1206.
- [10] Calderón-Quintal, J.A., Torres-Acosta, J.F.J., Sandoval-Castro, C.A., Alonso-Díaz, M.A., Hoste, H., Aguilar-Caballero, A. (2010) Adaptation of *Haemonchus contortus* to condensed tannins: can it be possible? Archives of Medical Veterinary 42, 165-171.
- [11] Carvalho, O.C., C. Chagas, C.A., Cotinguiba, F., Furlan, M., G. Brito, G.L., Chaves, C.M.F., Stephan, P.M., Bizzo, R.H., Alessandro, F. T., Amarante, F.T.A (2011) The anthelmintic effect of plant extracts on *Haemonchus contortus* and *Strongyloides venezuelensis* Veterinary Parasitology (August 2011) (In Press).
- [12] Cousins, D. and Huffman, A.M. (2002) Medicinal properties in the diet of Gorillas: An ethno-pharmacological evaluation. African Study Monographs, 23(2): 65-89.
- [13] Datsu Kalip, R., Slyranda Baltini, A., Wycliff, A., Abdulrahman, F.I. (2011) Preliminary phytochemical screening and *in vitro* anthelmintic effects of aqueous extracts of *Salvadora persica* and *Terminalia avicennoides* against strongyline nematodes of small ruminants in Nigeria. Journal of Animal and Veterinary Advances. 10(4):437-442.
- [14] De Jesús Gabino, A.F., Mendoza de Gives, P., Salinas Sánchez, D.O., López Arellano, Ma. E., Liébano Hernández, E., Hernández Velázquez, V.M. and Valladares Cisneros, G. (2010) Anthelmintic effects of *Prosopis laevigata* n-hexanic extract against *Haemonchus contortus* in artificially infected gerbils (*Meriones unguiculatus*) Journal of Helminthology 84:71-75.

- [15] Diehl, M.S., Kamanzi Atindehou, K., Téré, H., Betschart, B. (2004) Prospect for anthelmintic plants in the Ivory Coast using ethnobotanical criteria. *Journal of Ethnopharmacology* 95(2-3):277-284.
- [16] Dold, A.R. & Cocks, M.L. (2001). Traditional veterinary medicine in the Alice district of the Eastern Cape Province, South Africa. *South African Journal of Science*, 97:375-379.
- [17] Egualé, T. and Mirutse, G. (2009) *In vitro* anthelmintic activity of three medicinal plants against *Haemonchus contortus*. *International Journal of Green Pharmacy* 3(1): 29-34.
- [18] FAO (2002) Evaluation of Certain Veterinary Drugs Residues in Food. WHO Technical Report No 911. Fifty-eighth report of the Joint FAO / WHO Expert Committee on Food Additives. Geneva 2002. 62p.
- [19] Galicia-Aguilar, H.H., Mendoza de Gives, P., Salinas-Sánchez, D., López-Arellano, Ma. E., Liébano-Hernández, E. (2008) *In vitro* nematocidal activity of plant extracts of the Mexican flora against *Haemonchus contortus* fourth larval stage. *Annals of the New York Academy of Science*, 1149:158-160.
- [20] Githiori, B.J., Athanasiadou, S. and Thamsborg, M.S. (2006) Use of plants in novel approaches for control of gastrointestinal helminths in livestock with emphasis on small ruminants. *Veterinary Parasitology* 139(4):308-20.
- [21] Hördegen, P., H. Hertzberg, J. Heilmann, W. Langhans and V. Maurer, (2003). The anthelmintic efficacy of five plant products against gastrointestinal trichostrongylids in artificially infected lambs. *Veterinary Parasitology*, 117: 51-60.
- [22] Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg, M.S. and O. Hoskin, O.S. (2006) The effects of tannin-rich plants on parasitic nematodes in ruminants. *Trends in Parasitology*, 22(6):253-261.
- [23] Hillier, S.M. and Jewel, J.A. (1983) Chinese traditional Medicine and Modern Western Medicine: Integration and separation in China. In: *Health Care and Traditional Medicine in China 1800-1982*. Boston: Routledge & Kegan Paul, 1983. 221-241.
- [24] Huffman, F. A. (2003) Animal self-medication and ethno-medicine: exploration and exploitation of the medicinal properties of plants. *Proceedings of the Nutrition Society* 62(2):371-381.
- [25] Iqbal, Z., Khalid Nadeem, Q., Khan, M.N., Akhtar, M.S. and Nouman Waraich, F. (2001) *In vitro* Anthelmintic Activity of *Allium sativum*, *Zingiber officinale*, *Curcubita mexicana* and *Ficus religiosa* *International Journal of Agricultural Biology*, 3(4):454-457.
- [26] Iqbal, Z., Lateef, M., Ashraf, M., Jabbar, A. (2004) Anthelmintic activity of *Artemisia brevifolia* in sheep. *Journal of Ethnopharmacology*, 93(2-3):265-8.
- [27] Jackson, F. (2009) Worm control in sheep in the future. *Small Ruminant Research*. 86:40-45.
- [28] Kaboure, A., Belem A. M. G., Gaston, M., Tamboura H. H., Traore, A. and Sawadogo, L. (2009) *In vitro* anthelmintic effect of two medicinal plants (*Anogeissus leiocarpus* and *Daniellia oliveri*) on *Haemonchus contortus*, an abomasal nematode of sheep in Burkina Faso. *African Journal of Biotechnology* 8 (18): 4690-4695.

- [29] Krueger, R., Dover, E.K., McSorley, R., Wang, K-H. (2009) Marigold (*Tagetes* spp) for nematode management. University of Florida IFAS Extension, Publication ENY-056.
- [30] López Aroche, U., Salinas Sánchez, D.O., Mendoza de Gives, P., López Arellano, Ma. E., Liébano Hernández, E., Valladares Cisneros, G., Arias Ataide, D.M. and Hernández Velázquez, V. (2008) *In vitro* nematicidal effect of medicinal plants from the Sierra de Huautla Biosphere Reserve, Morelos, Mexico against *Haemonchus contortus* infective larvae. *Journal of Helminthology* 82 (1): 25-31.
- [31] Lorimer, D.S., Perry, B.N., Foster, M.L. and Burgess, E. (1996) A Nematode Larval Motility Inhibition Assay for Screening Plant Extracts and Natural Products. *Journal of Agriculture Food Chemistry*, 1996, 44 (9), pp 2842-2845
- [32] Macedo Barragán, R., Arredondo Ruiz, V., Ramírez Rodríguez, J., García Márquez, L.J. (2009) Grazing sheep poisoned by milkweed *Asclepias curassavica* or gastrointestinal nematosis? A case report findings *Veterinaria México*, 40 (3):275-281.
- [33] Martínez, M. I. and Cruz, R.M. (2009) The use of agricultural and livestock chemical products in the cattle-ranching area of Xico, central Veracruz, Mexico, and their possible environmental impact. *Acta Zoológica Mexicana* 25(3):637-681.
- [34] Martínez-Ortiz-de-Montellano, C., Vargas-Magaña, J.J., Canul-Ku, H.L., Miranda-Soberanis, R., Capetillo-Leal, C., Sandoval-Castro, C.A., Hoste, H. and Torres-Acosta, J.F.J. (2010) Effect of a tropical tannin-rich plant *Lysiloma latisiliquum* on adult populations of *Haemonchus contortus* in sheep. *Veterinary Parasitology* 172(3-4):283-90.
- [35] Oliveira, L.M.B., Bevilaqua, C.M.L., Costa, C.T.C., Macedo, I.T.F., Barros, R.S., Rodrigues, A.C.M., Camurca-Vasconcelos, A.L.F., Moraes, S.M., Lima, Y.C., Vieira, L.S., Navarro, A.M.C. (2009) Anthelmintic activity of *Cocos nucifera* L. against sheep gastrointestinal nematodes. *Veterinary Parasitology* 159, 55-59.
- [36] Phengvichith, V. and Preston, R.T. (2011) Effect of feeding processed cassava foliage on growth performance and nematode parasite infestation of local goats in Laos. *Livestock Research for Rural Development* 23(1).
- [37] Poglaven, G. and Battelli, G. (2006) An insight into the epidemiology and economic impact of gastro-intestinal nematodes in small ruminants. *Parasitologia* 48(3):409-413.
- [38] Qadir, S., Dixit, K.A., Dixit, P. (2010) Use of medicinal plants to control *Haemonchus contortus* infection in small ruminants. *Veterinary World*, 3(11)515-518.
- [39] Rahmann, G. and Seip, H. (2008) Bioactive forage and phytotherapy to cure and control endo-parasite diseases in sheep and goat farming systems – a review of current scientific knowledge. In: *Landbauforschung Völkenrode*. Bundesforschungsanstalt für Landwirtschaft, pp. 285-295.
- [40] Rodriguez, E., Aregullin, A.M., Nishida, T., Wrangham, R., Abramkowski, Z., Finlayson, Towers, H.N.G. (1985) Thiarubrine A, a bioactive constituent of *Aspilina* (Asteraceae) consumed by wild chimpanzees. *Experientia* 41: 419.
- [41] Ryan, A.C. and Jagendorft, A. (1995) Self defense by plants. *Proceedings of the Natural Academy of Sciences. USA* 92:4075 Colloquium Paper.
- [42] Rochfort, S., Parker, J.A., Dunshea, R.F. (2008) Plant bioactives for ruminant health and productivity. *Phytochemistry* 69 (2008) 299-322.

- [43] Saeed, M., Iqbal, Z., Jabbar, A., Masood, S., Babar, W., Saddiqi, H.A., Yaseen, M., Sarwar, M., Arshad, M. (2010) Multiple anthelmintic resistance and the possible contributory factors in Beetal goats in an irrigated area (Pakistan). *Research in Veterinary Science*. 88(2):267-72.
- [44] Sargison, N.D. (2011) Pharmaceutical control of endoparasitic helminths infections in sheep. *Veterinary Clinical North American Food Animal Practice*. 27:139-156.
- [45] Shah, V., Sunder, R., De Sousa, N.J. (1987) Chonemorphine and Rapanone Antiparasitic Agents from Plant Resources. *Journal of Natural Products*. 50(4)730-731.
- [46] Shai, L.J., Bizimenyera, E.S., Bagla, V., McGaw, L.J., Eloff, J.N. (2009) *Curtisia dentata* (Cornaceae) leaf extracts and isolated compounds inhibit motility of parasitic and free-living nematodes. *Onderstepoort Journal of Veterinary Research*, 76(2):249-56.
- [47] Shai, L.J., McGaw, L.J., Aderogba, M.A., Mdee, L.K., Eloff, J.N. (2008) Four pentacyclic triterpenoids with antifungal and antibacterial activity from *Curtisia dentata* (Burm.f) C.A. Sm. Leaves. *Journal of Ethnopharmacology*. 26,119(2):238-44.
- [48] Soetan, K.O., Lasisi, O.T. and Agboluaje, A.K. (2011) Comparative assessment of *in-vitro* anthelmintic effects of the aqueous extracts of the seeds and leaves of the African locust bean (*Parkia biglobosa*) on bovine nematode eggs. *Journal of Cell and Animal Biology* Vol. 5 (6), pp. 109-112.
- [49] Sheludko, Y.V. (2010) Recent Advances in Plant Biotechnology and Genetic Engineering for Production of Secondary Metabolites. *Cytology and Genetics*, 44(1): 52-60.
- [50] Sumer, J. and Plutkin, M (2000) Chimpazees and self-medication. In: *The Natural History of Medicinal Plants* Timber Press Inc. Portland, Oregon, USA.
- [51] Sutherland, A.I. and Leathwick, M.D. (2011) Anthelmintic resistance in nematode parasites of cattle: a global issue? *Trends in Parasitology*, 27: 176-181.
- [52] Tariq, K.A., Chishti, M.Z., Shawl, A.S. (2008) Anthelmintic activity of extracts of *Artemisia absinthium* against ovine nematodes. *Veterinary Parasitology* 160(1-2):83-88.
- [53] Taylor, M.A., Learmount, J., Lunn, E., Morgan, C. Craig, B.H. (2009) Multiple resistance to anthelmintics in sheep nematodes and comparison of methods used for their detection. *Small Ruminant Research* 86: 67-70.
- [54] Torres-Acosta, J.F.J., Mendoza-de-Gives, P., Aguilar-Caballero, A.J., Cuéllar-Ordaz, J.A. (2011) Anthelmintic resistance in sheep farms: update of the situation in the American continent. *Veterinary Parasitology* (Accepted for publication).
- [55] Torres-Acosta, J.F.J. and Aguilar-Caballero, A.J. (2005). Epidemiología, prevención y control de nematodos gastrointestinales en rumiantes. En: Rodríguez, V.I. (Editor). *Enfermedades de Importancia Económica en Producción Animal*. Editorial McGraw-Hill Interamericana / UADY. Pp.143-173.
- [56] Valcárcel-Sancho, F., Rojo-Vázquez, F.A., Olmeda-García, A.S., Arribas-Novillo, B., Márquez-Sopeña, L., Fernando-Pat, N. (2009). *Atlas de Parasitología Ovina*. Editorial Servet. Zaragoza, España, 137p.
- [57] Valderrábano, J., Calvete, C. Uriarte, C. (2010) Effect of feeding bioactive forages on infection and subsequent development of *Haemonchus contortus* in lamb faeces. *Veterinary Parasitology*, 172 (1-2):89-94.

- [58] Willcox, M., Bodeker, G., Rasoanaivo, P. (2005) Traditional Medicinal Plants and Malaria: Volume 4 of the Traditional Herbal Medicine for Modern Times Series. The Journal of Alternative and Complementary Medicine. 11(2): 381-382.
- [59] Yadav, N., Vasudeva, N., Sing, S., Sharma, K.S. (2007) Medicinal properties of genus *Chenopodium* Linn. Natural Product Radiance 6(2): 131-134.

IntechOpen

IntechOpen

The Biosphere

Edited by Dr. Natarajan Ishwaran

ISBN 978-953-51-0292-2

Hard cover, 302 pages

Publisher InTech

Published online 14, March, 2012

Published in print edition March, 2012

In this book entitled "The Biosphere", researchers from all regions of the world report on their findings to explore the origins, evolution, ecosystems and resource utilization patterns of the biosphere. Some describe the complexities and challenges that humanity faces in its efforts to experiment and establish a new partnership with nature in places designated as biosphere reserves by UNESCO under its Man and the Biosphere (MAB) Programme. At the dawn of the 21st century humanity is ever more aware and conscious of the adverse consequences that it has brought upon global climate change and biodiversity loss. We are at a critical moment of reflection and action to work out a new compact with the biosphere that sustains our own wellbeing and that of our planetary companions. This book is a modest attempt to enrich and enable that special moment and its march ahead in human history.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Pedro Mendoza de Gives, María Eugenia López Arellano, Enrique Liébano Hernández and Liliana Aguilar Marcelino (2012). Plant Extracts: A Potential Tool for Controlling Animal Parasitic Nematodes, The Biosphere, Dr. Natarajan Ishwaran (Ed.), ISBN: 978-953-51-0292-2, InTech, Available from:
<http://www.intechopen.com/books/the-biosphere/plant-extracts-a-potential-tool-for-controlling-animal-parasitic-nematodes>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](https://creativecommons.org/licenses/by/3.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

IntechOpen

IntechOpen