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Alternative to Synthetic Anthelminthic to Prevent and Control Gastro Intestinal Parasite in Sheep and Goat

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Abstract: Infestation with gastro-intestinal nematodes in small ruminants can cause server economic losses and endanger animal welfare. To control the infestation with gastro-intestinal nematodes in small ruminants, the developments of anthelmintic resistant strains of parasites have enforced the search for sustainable alternatives treatments. In addition to anthelmintic resistance, inadequate availability and high cost of commercial anthelmintic are the other important constraints of helminthes control in developing countries. Therefore, this review provided information about alternative control strategies of gastrointestinal nematodes infecting small ruminants. The investigation of alternative anthelmintic treatments reviewed biological control, botanical dewormers, nutritional improvement, genetic improvement, pasture management, antiparasitic vaccine and other particles like copper-oxide. Of all the above mentioned alternative anthelmintic treatments botanical dewormers found to hold future potential, indicating a strong need for scientific verification of the potential of many plants. In conclusion, this paper shows possibilities and limitations in the area of alternative anthelmintic treatments as well as in non-chemical control options and outlines future research fields.

Key words: Anthelminthic · Nematodes · Medicinal Plant

INTRODUCTION

Parasitic infections remain a major constraint to sheep and goat production globally [1]. From parasitic; helminthes infections remain a major constraint to sheep and goat productivity across all agro-ecological zones and production systems in Africa, particularly in areas where extensive grazing is practiced [2]. In large scale sheep and goat farming systems endoparasites have been become a major threat, which is reflected in the sales figures of many countries [3]. Infections with gastro-intestinal nematodes can have a detrimental effect on animal health [4] that may result in financial loss and overall decreased productivity [5].

Various strategies are in practice to control parasitism which includes pasture management, biological control, dietary management, vaccination and use of anthelmintic drugs [6]. Widely and most common practice being followed these days is the use of chemical anthelmintic [7]. The intensive use has posed a variety of problems including emergence of anthelmintic resistance, e.g. multi resistant *Haemonchus contortus* had been already isolated. In addition, commercially available anthelmintic are relatively expensive and smallholder farmers are unable to spend major income for purchase of drugs to continue regular treatment [8].

Since the publication of the World Association for the Advancement of Veterinary Parasitology methods for the detection of anthelmintic resistance in the importance of resistance to the three groups of broad spectrum anthelmintic (The benzimidazoles (BZ), imidazothiazoles (levamisole, LEV) and hydropyrimidines (pyrantel/morantel) and the macrocyclic lactones (avermectins and milbemycins, ML) has increased dramatically in nematodes of sheep and goats in many parts of the world [9]. Work in South Africa [10] and UK [11] stress that resistance is present to all three broad-spectrum anthelmintic groups and therefore, sheep production is threatened.

In Ethiopia, various anthelmintic have been used in different parts of the country for the treatment of sheep and goats helminthesparasites [12, 13]. Some researcher reported existence [14] and some others absence of anthelmintic resistance in region [12, 15]. Albendazole was

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suspected for development of resistance, while Ivermectin and Tetramisole were found to be effective [16]. Three anthelmintic (Albendazole, Tetramisole and Ivermectin) were effective against the gastrointestinal nematodes of sheep kept under extensive management by small holder farmers [17].

The threats of anthelmintic resistance, risk of residue, availability and high cost, especially to farmers of low income in developing countries, have led to the notion that sustainable helminthes control cannot be achieved with commercial anthelmintic alone. Despite notable ongoing activities to identify and evolve new anthelmintic classes by a shrinking list of institutions, there is doubt that we will see the release of a product with a new mode of action in the livestock area in the near future [18].

Other alternative options like biological control, vaccine and traditional medicinal plants are being examined in different corners of the world [19]. Among the alternative methods, there is considerable and expanding interest in traditional herbal dewormers in both industrialized and developing countries [1]. Evaluation of the activities of medicinal plants claimed for anthelmintic property is getting attention these days [20].

However anthelmintic resistance can cause major problem in our country like economic losses and stress on animal. So that to improve this anthelmintic resistance alternative anthelmintic control strategies is essential.

Therefore, the objectives of this review are;

- To provide current scientific knowledge of alternative to synthetic anthelminthic to prevent and control gastro intestinal parasite in sheep and goat.

MEDICINAL PLANT AS ALTERNATIVES

Historical Backgrounds of Using Medicinal Plants: Traditional knowledge has been described as a cumulative body of knowledge, practice and belief, evolving through adaptive processes and handed over through generations by cultural transmission. Traditional medicine is used throughout the world as it is heavily dependent on locally available plant species and plant-based products and capitalizes on traditional wisdom-repository of knowledge [21].

The wide spread use of traditional medicine could be attributed to cultural acceptability, economic affordability and efficacy against certain type of diseases as compared to modern medicines. Thus, different local communities in countries across the world have indigenous experience in various medicinal plants where they use their perceptions and experience to categorize plants and plant parts to be used when dealing with different ailments [22].

Plants have been used from ancient times to cure diseases of man and animals [23]. Human societies have been in close contact with their environments since the beginning of their formation and used the ingredients of the environment to obtain food and medicine. Awareness and application of plants to prepare food and medicine have been realized through trial and error and gradually human became able to meet his needs from his surroundings [24].

Medicinal plants are used as a medical resource in almost all cultures [24]. During the past three decades, there has been increased worldwide interest regarding the use of herbal medicines/supplements and consistent with this, the use of traditional herbal therapy in Ethiopia has been on the rise. This increase in the use of herbal therapy has produced a greater desire among researchers to conduct studies on traditional Ethiopian medicinal plants [25].

Botanical Dewormers: Botanical anthelmintic being traditionally used in various parts of the world. "Traditional" refers to the sum total of all non-mainstream medical practices, usually excluding so-called "western" medicine. According to the [26], about 80% of the world's people depend on traditional medicine for their primary health care. The medicinal species that reside in natural areas have received increasing scientific and commercial attention in recent years. In glob between 50, 000-80, 000 flowering plants are used medicinally [27].

Different local communities in countries across the world have indigenous experience in various medicinal plants where they use their perceptions and experience to categorize plants and plant parts to be used when dealing with different ailments [22], which is transferred orally from one generation to the next through professional healers, knowledgeable elders and/or ordinary people [28]. Plants have played a central part in combating many ailments in human and livestock in many indigenous communities, including Africa [29]

There are many plants which have been reported in the literature for their anthelmintic importance. Among the most common medicinal plants which have anthelmintic effect are *Allium sativum, Nigella sativa, Artemisia* spp., *Balanites aegyptiaca*, *Acacia* spp., cucurbile (pumpkin seeds), *Commiphoramolmol* (Myrrh), *Calendula micranthaofficinalis, Peganum harmala* and Tumeric (curcumina) [30].

The vast majority of studies investigating the effects of Condensed Tanins (CT) on GIT nematode parasites, either in experimental or in grazing conditions, have been conducted using sheep [31]. Studies have also shown that CTs had an effect on GI parasite infections in goats. Tanniferous plants increase the supply and absorption of digestible protein by animals. This is achieved by tannins forming non-biodegradable complexes with protein in the rumen, which dissociate at low pH in the abomasum to release more protein for metabolism in the small intestine of ruminants; in other words, " natures protected protein". This indirectly improves host resistance and resilience to nematode parasite infections. These plants can be a promising future for the control of worms which had previously shown resistance to synthetic drugs [32].

Anthelminthic Activities of Secondary Metabolites of Plant: Most of the plants have major secondary metabolites like alkaloids, flavonoids, phytosteroides and withanoids. Preliminary qualitative screenings for major secondary metabolites of the medicinal plants were conducted. Plant materials were screened for the presence of polyphenols, cyanogenic glycosides, saponins, phytosteroides and withanoids, phenolic glycosides, flavonoids, tannins, alkaloids and antraqunone glycosides. These classes of plant secondary metabolites are considered the sources of chemicals responsible for wide therapeutic activities of several medicinal plants [33].

Herbal Medicine in Ethiopia: Studies showed that resistance was detected in different parts of Ethiopia against albendazole, levamisole, tetramisole and ivermectin [34]. These factors paved the way for herbal remedies as alternative anthelmintic [29]. Ethno veterinary medicine studies in Ethiopia documented several medicinal plants used for deworming livestock and human [35]. In spite of these valuable documentations, very few. Most of a few works in these regard is concentrated on medicinal plants against cestodes and little is done on nematodes [36]. Efforts have been made to scientifically evaluate these plants for their claimed activities). In Ethiopia, the fruit and decoction of the roots are used for treatment of venereal diseases, seeds for induction of abortion and leaves for treatment of constipation.

Even though most of the reports did not provide detailed information on the part of the plants used and method of preparation, traditionally in Ethiopia, the leaves, root fruits and bark of some plants are used against GIT parasites and ring worm [37]. For example, the leaves and fruits of *Phytolacca dodecandra* are used against endo-parasites [38] and the leaves as antiseptic [39]. The root, bark and inner bark of *Acacia tortilis* are used to treat diarrhea and the bark is used topically to treat ring worm [37]. The roots, leaves and bark of *Azadrichta indica* used against endo- and ecto parasites [40].

Biological Control: Biological control (BC) may be defined as the use of one living organism to achieve control over the targeted organism like parasite and thus reducing the population of pathogen below a threshold level where it cannot cause clinical problems and/or economic losses in the animals [6]. The philosophy behind biological control(BC) is that by using one of the natural enemies of nematodes, it will be possible to reduce the infection level on pasture to a level at which the grazing animals avoid both clinical and subclinical effects due to parasitic [41]. Of all possible antagonistic organisms' only nematophagous fungi, earthworms and dung beetles have realistic potential as biological control agents, although there are several species that little or nothing is known about and therefore their potential use for biological control cannot be assessed [42]. For example, biological control of parasitic nematodes in sheep seems to hold promise for the future, but to be able to assist producers, the optimal delivery system needs to be refined and further developed [43].

Earth Worms: Earthworms are soil inhabitants that live on organic matter deposited on the soil surface. Organic matter gets pulled down below the surface either for food or to plug the earthworms burrows. Therefore, the major contribution of earthworms towards the biological control of nematodes is seen in the destruction of eggs and larvae by digesting them and transferring them to deeper levels of the soil where chances that they can reach the surface as infective larvae are very low [42]. A New Zealand study examined the ability of mixed earthworm populations, alone or in combination with other biological control organisms to reduce pasture infectivity in two experiments (spring and autumn) [44].

Dung Beetles: The term 'dung beetle' refers to those beetles that live partly or exclusively on the dung of herbivorous; most species belong to the family *Scarabaeidae*. Adult beetles use the liquid contents of manure for their nourishment and some species form dung balls which they bury and lay their eggs in, others just live in the manure pats [45].

The activity of dung beetles is being discussed controversially: by breaking up the pats and partially burying the manure, they enhance the drying up of the dung which deteriorates growing conditions for larvae, but by the same activities in bad weather conditions they might help the larvae to survive by airing out the pats and thereby providing oxygen to the larvae [42].

The influence of dung burial in respect to larval development with the result of significantly more larval recoveries than when dung was not buried, although dung was manually buried in order to mimic the natural activities of the dung beetle [44].Also mention that results of studies with dung beetles have been variable, some species reduce and others increase larval numbers [46].

Nematophagous Fungi: It is one of biological control in which use of the naturally occurring nematophagous or nematode destroying fungi to control parasitic nematodes in ruminants. Nematophagous fungi are soil inhabitants and can be found in most soil types throughout the world. Research has shown they are found more frequently in organic production systems than any other [47].

The fungi of the nematode trapping group all have in common that they form a vegetative hyphal system that produces trapping organs such assticky nets, knobs or rings.When for example a nematode get strapped, the fungi penetrate the nematode cuticle with their hyphae that then grow out and fill the body of the nematode to finally digest it.The idea of using nematophagous fungi to control parasitic nematodes is based on the reduction of the larval level in the faces before larvae reach the vegetation, which requires a high density of spores in the faces [48].

There are two possible ways to reach that high spore density, the first is to artificially inoculate the faeces and the second way is to administer the evidence found for predaceous fungi working against parasitic nematodes [41]. Research with nematode-trapping fungi has documented the potential as a biological control agent against the free-living stages under experimental and natural conditions [1].

Among predaceous fungi, *Nematophagous microfungi*, such as *Duddingtonia flagrans*, could be given in an oral formulation. After passage through the bovine gastrointestinal tract, they reduce pasture contamination by preying on the pasture larvae [49]. This technology has been applied successfully under field conditions in all livestock species and is an environmentally safe biological approach for control of worms under sustainable, forage-based feeding systems [50]. Furthermore, *Duddingtoniaflagrans* shown promising results of reducing the number of infective larvae that migrate onto the pasture and it also showed that there was no effect on larval migration of prior and post deposited faeces [51].

Pasture Management: The scientific management of pasture is an effective way to control internal parasites in grazing livestock. Understanding the influence of pasture management on the internal parasite control possibly starts with detailed epidemiological knowledge of the development of the parasites in and outside their hosts. Ideally, the animals are allowed to graze clean or new pasture to fetch maximum productivity from them. The clean or new pastures are those pastures which have not been grazed since 6-12 months; pasture fields in which a hay or silage crop has been removed; pasture fields which have been rotated with field crops; and pastures that have been recently renovated by tillage. Regular burning of old or grazed pasture should always be practiced to obtain parasites free pasture land [52].

In Northern European conditions a pasture can be considered safe if it meets the Criteria; Pastures that have not been grazed by small ruminants in the last grazing season and that have not been grazed by small ruminants since midsummer of the previous year are safe all nematode species except for Nematodirus species in spring, Pastures last grazed in autumn of the previous year that have not been grazed in spring the following year and that have not been grazed for 3 months during summer are safe except forNematodirusspecies in summer [53].

Overstocking of animals in a small piece of land increases the concentration of parasites. So, allow optimum number of animals to graze in a given piece of land. It is estimated that parasite infections increases with the square of the animal load, per surface unit. Therefore, for a given piece of land, parasitic infestations become quadruples when animal density is doubled [54].

Improvement of Nutrition: The strongest link between nutrition and parasitism has been illustrated between protein intake and resistance to gastrointestinal nematode infection. The most dramatic has been abolishment of the per parturient egg increase in lambing ewes by providing protein at 130% of requirements. Immunity is closely related to protein repletion. Gastrointestinal nematodes increase the demand for amino acids by the sheep.

Compared with uninfected lambs, those infected with gastrointestinal nematodes will voluntarily select a higher protein diet. There is conflicting documentation that sheep will decrease feed intake when initially infected with gastrointestinal nematodes [55].

Supplementation with phosphorus has been shown to prevent worm establishment. Cobalt deficiency also has been associated with reduced immunity to gastrointestinal nematodes. Surprisingly, the addition of molybdenum at a concentration of 6-10 mg/d decreased worm burdens in lambs [56].

Antiparasitic Vaccines: As a consequence of drug resistance, efforts have increased in recent years to develop functional vaccines. This has been made possible by newer technologies in gene discovery and antigen identification, characterization and production. The increasing drug resistance of gastrointestinal nematodes has renewed intense interest in developing vaccines for these important veterinary pathogens. The most promising vaccine for small ruminant worms is based on a ‘‘hidden gut’’ antigen and specifically targets *Heamonchus contortus*. This antigen is derived from the gut of the worm and, when administered to the animal, antibodies are produced. When the worm ingests blood during feeding, it also ingests these antibodies [57].

The antibodies then attack the target gut cells of the worm and disrupt the worm's ability to process the nutrients necessary to maintain proper growth and maintenance, thus killing the worms. This vaccine has been tested successfully only in sheep under experimental conditions and has had limited success under field conditions. Reasons for this lack of success are unclear. The drawback to this vaccine is that the antigen is normally ‘‘hidden’’ from the host and a number of vaccinations may be required to maintain sufficiently high antibody titer to combat infection. This process may be quite expensive. In addition, massive numbers of whole worms are necessary to extract limited amounts of antigen; therefore, this will only be practical when the antigen can be mass produced artificially via recombinant technology to lower costs [58].

Vaccines for other worms that do not feed on blood have focused on using antigens found in worm secretary and excretory products. These antigens have contact with the host and should stimulate continuous antibody production. However, protection has been quite variable and marketing of such products has not been pursued. Additionally, immunologic control of worm infections through vaccination could be the answer to anthelmintic resistance. However, despite the identification of several candidate protective antigens, no vaccines against gastrointestinal nematode parasites are currently available [59].

Genetic Improvement: Several breeds of sheep around the globe are known to be relatively resistant to infection. Using such breeds exclusively or in crossbreeding programs would certainly lead to improved resistance to worm infection, but some level of production might be sacrificed [60]. Although such a strategy may be acceptable to some, selection for resistant animals within a breed also is a viable option. Within a breed, animals become more resistant to infection with age as their immune system becomes more competent to combat infection. Some animals within such a population do not respond well and remain susceptible to disease; therefore, the majority of the worm population resides in a minority of the animal population. It would make sense to encourage culling practices where these minority ‘‘parasitized’’ animals were eliminated, thus retaining more-resistant stock. This approach has been used successfully in some areas of New Zealand and Australia, but it may take a long time (up to 8–10 years) to achieve satisfactory results [61].

Copper-Oxide Wire Particle: Copper- oxide wire particle are available commercially to alleviate copper deficiency in ruminant livestock. Copper is important for immune function. The basic principal of this treatment is that the availability of macro-minerals and trace elements influences the host-parasite relationship [62]. When copper-oxide wire particles (COWP) are administered they remain in the rumen and release free copper into the abomasum which creates an environment that affects *Heamonchus contortus* ability to remain established [63]. Administration of copper-oxide wire particles led to a good reduction of parasite burden of *Heamonchus contortus* but the impact on other species was very average [64]. Further research proved the efficiency of COWP on *Heamonchus contortus* in goats but also showed that it does not influence greatly on other species [62].

CONCLUSION

Gastrointestinal nematodes remain a major threat to the health and welfare of small ruminants all over the world having severe consequences on the animal as well as the livestock leading to economic loss and restricted productivity. Anthelmintic has been used as the major option to control this pathogenic nematode which has resulted in parasitic drug resistance and affect environment. To improve this problem knowing about the alternative treatment control strategies of nematode control in small ruminant is very necessary. Such alternative controlstrategies like; biological control, nutrition improvement, genetic improvement, anti-parasitic vaccine, botanical dewormer and pasture managements a great option and should be adopted. Depending upon the above conclusion the following recommendation is forwarded;

- Awareness creation should be given to small ruminant owners about alternative control methods of GIT parasites.
- Improving animal nutrition and genetics to create host resilience and host resistant.
- Further investigation should be focused on plants with strong anthelmintic properties.
- Plant having antihelmantic activity should be conserved.

REFERENCES

1. Waller , P., M. Faedo and K. Ellis, 2001.The potential of nematophagous fungi to control the free-living stages of nematode parasites of sheep: Towards the development of a fungal controlled release device. Veterinary Parasitology, 102: 299-308
2. Eguale, T., G. Tilahun, M. Gidey and Y. Mekonnen, 2006. *In vitro* anthelmintic activities of four Ethiopian medicinal plants against *Haemonchus contortus*, Addis Ababa, Ethiopia, Ethiop Vet. J., 3: 153-165.
3. Coles, G.C., 2005. Anthelmintic resistance - looking to the future: a UK perspective. Research in Veterinary Science, 78: 99-108.
4. Luscher, A., D.A. Haring, F. Heckendorn, A. Scharenberg, F. Dohme, V. Maurer and H. Hertzberg, 2005. Use of tanniferous plants against gastro-intestinal nematodes in ruminants. Paper presented at Researching Sustainable Systems - International Scientific Conference on Organic Agriculture, Adelaide, Australia and September, 21-23.
5. Rahmann, G., R. Koopmann and H. Hertzberg, 2002. Alternative strategies to prevent and control endo parasite diseases in organic sheep and goat farming. Forschungs Report, pp: 4-7.
6. FAO, 2002. Biological control in a global perspective, a view on emphasis on Duddingtonia ? agrans. Final Proceeding of FAO, Technical Co-operation Project in Malaysia, pp: 19-37.
7. Muhammad, A., H. Ahmed, M.N. Iqbal and M. Qayyum, 2015. Detection of multiple anthelmintic resistance of *Haemonchus contortus* and Teladorsagiacircumcincta in sheep and goats of Northern Pun- jab, Pakistan. Kafkas. Univ. Vet. Fak. Derg, 21: 389-395.
8. Chandrawathani, P., O. Jamnah, P.J. Waller, M. Larsen, A. Gillespie and W.M. Zahari, 2003. Biological control of nematode parasites of small ruminants in Malaysia using the nematophagous fungus Duddingtoniaflagrans. Veterinary Parasitology, 117: 173-183.
9. Wolstenholme, A., I. Fair-weather, R. Prichard, G. Von Samson-Himmelstjerna and N. Sangster, 2004. Drug resistance in veterinary helminth. Trends Parasitology, 20: 469-476.
10. Van Wyk, J.A., M.O. Stenson, J.S. Van Der Merwe, R.J. Vorster and P.G. Viljoen, 1999. Anthelmintic resistance in South Africa: surveys indicate an extremely serious situation in sheep and goat farming. The Onderstepoort Journal Veterinary Research, 66: 273-284.
11. Sangster, N.C. and R.J. Dobson, 2002. Anthelmintic resistance. In: Lee D. (editor). The Biology of Nematodes. Taylor and Francis, London and New York, pp: 531-567.
12. Asmare, K., E. Gelaye and G. Ayelet, 2005. Anthelmintic resistance test in gastrointestinal of small ruminants in southern Ethiopia. Bulletin of Animal Health Production, 53: 89-95.
13. Biffa, D., Y. Jobre and H. Chaka, 2006. Ovine helminthosis, a major health constraint to productivity of sheep in Ethiopia. Animal. Health Research, 7: 10-118.
14. Kumsa, B. and G. Abebe, 2008. Multiple anthelmintic resistance on a goat farm in Hawassa. Tropical. Animal Health Production, 6: 100-112.
15. Sheferaw, D. and A. Asha, 2010. Efficacy of selected anthelmintic against gastrointestinal nematodes of sheep owned by smallholder farmers in Wolaita, Southern Ethiopia. Ethiopia. Veterinary Journal, 14: 31-38.
16. Sheferaw, D., D. Getachew, B. Jemere and D. Yifat, 2013. Assessment of anthelmintic resistance in gastrointestinal nematodes of small ruminants, Dale district, Southern Ethiopia. Journal of. Vetetinary Animal. Health, 5: 257-261.

17. Getachew, T., F. Urgessa and H. Yacob, 2013. Field investigation of anthelmintic efficacy and riskfactors for anthelmintic drug resistance in sheep at Bedelle District of Oromia Region, Ethiopia. Ethiopia Veterinary Journal, 17: 37-49.
18. Kaplan, R.M. and A.N. Vidyashankar, 2012. An inconvenient truth: Global warming and anthelmintic resistance. Veterinary Parasitology, 186: 70-8.
19. Githiori, J.B., 2004. Evaluation of anthelmintic properties of ethno veterinary plant preparations used as livestock dewormers by pastoralists and smallholder farmers in Kenya. Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala, Sweden.
20. Gathuma, M.J., M. Baria, James, Wanyama Jacob, H.F.A. Kaburia, L. Mpoke and Mwangi Jim, 2004. Efficacy of Myrsineafricana, Albiziaan the lmintica and Hilderbrantiasepalosa herbal remedies against mixed natural sheep helminthosis in Samburu district, Kenya. Journal of Ethno Pharmacology, 91: 7-12.
21. Berkes, J. Scolding and C. Fowlkes, 2003. Navigating social-ecological systems. Building resilience for complexity and change. Cambridge, UK, Cambridge University Press.
22. Omoruyi, B., G. Bradley and A. Afolayan, 2012. Ethno medicinal survey of medicinal plants used for the management of HIV/AIDS infection among local communities of Nkonkobe Municipality, Eastern Cape, South Africa. Journal of Medicinal Plants Research, 6: 3603-3608.
23. Akhtara, M.S., M.N. Zafar Iqbalb, M. Khanb and B. Lateef, 2000. Anthelmintic activity of medicinal plants with particular reference to their use in animals in the Indo Pakistan subcontinent, University of Agriculture, Faisalabad 38040, Pakistan. Small Ruminant Research, 38: 99-107.
24. Fatemeh, J.K., L. Zahra, A.K. Hossein and Medicinal, 2017. Plants: Past history and future perspective, Shahrekord University of Medical Sciences, Shahrekord, Iran, Journal of Herbmed Pharmacology, 7(1): 1-7.
25. Gidey, M. and G. Amini, 2003. An ethinobothanical survey on plants of veterinary importance in two woredas of southern Tigray, northern Ethiopia. SINET Ethiop J. Sci., 26: 123-136.
26. WHO, 2002. World Health Organization. Traditional Medicine Strategy.
27. IUCN, 2001. Species Survival Commission Medicinal Plant Specialist Group.
28. Giday, M., T. Teklehymanot, A. Abebe and M. Yalemtsehay, 2007. Medicinal plants of the Shinasha, Agew-awe and Amhara peoples in Northwest Ethiopia. Journal of Ethno pharmacology, 110: 516-525.
29. Fajmi, A.K. and A.A. Taiwo, 2005. Herbal remedies in animal parasitic diseases in Nigeria: A review. Afr. J. Biotec, 4: 303-7.
30. Shalaby, H.A., A.H. Namaky, F.A. Khalil and O.M. Kandil, 2012. Efficacy of methanolic extract of *Balanites aegyptiaca* fruit on Toxocaravitulorum. Veterinary Parasitology, 183: 386-392.
31. Waghorn, T.S., A.L. Molan, M. Deighton, R.A. Alexander, D.M. Leathwick, W.C. McNabb and L.P. Meagher, 2006. *In vivo* anthelmintic activity of Dorycnium rectum and grape seed extract against Ostertagia (Teladorsagia) circumcincta and Trichostrongyluscolubriformis in sheep. New Zealand Veterinary Journal, 54: 21-27.
32. Paolini, V., J. Bergeaud, C. Grisez, F. Prevot, P.H. Dorchies and H. Hoste, 2003b. Effects of tannins on goats experimentally infected with *Haemonchus contortus*. Veterinary Parasitology, 113: 253-261.
33. Debella, A., 2002. Manual for phytochemical screening of medicinal plants, Ethiopian health and Nutrition Research Institute; Addis Ababa, Ethiopia. Nutrition Research Institute, 28: 176-188.
34. Wakayo, B.U. and T.F .Dewo, 2015. Anthelmintic resistance of gastrointestinal parasites in small ruminants: a review of the case of Ethiopia, Journal of Veterinary Scientific Technology, 9: 21-27.
35. Deressa, A., S. Mekonnen and A. Tollosa, 2003. Ethno veterinary use of plants in North Shoa zone, Ethiopia. Ethiop Vet. J., 7: 11-17.
36. Endale, A., M. Kassa and T. Gebre-Mariam, 1998. *In vivo* anthelmintic activity of the extract of the seeds of Glinuslotoidus in Albino mice infested with Hymenolepis nana worms. J. Ethnopharmacol., 16: 34-41
37. Hayatu, A., 2003. A study on Ethinoveternary Knowledge and Practice in Low Lands of Borena Pastoral System, DVM thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia, pp: 6-7.
38. Belay, K., 2004. A Study on Ethno veterinary Medical Practices in East Showa Zone, Ethiopia and the Anthelminthic Effect of withaniasomnifea against H. contortus, DVM thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia, pp: 4-7.

39. Haylessielassie, M., 2004. Survey and Preliminary Screening of Selected Medicinal Plants for Treatment of Bovine Mastitis and Skin Diseases in Tigray, Northern Ethiopia.DVM thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit, Ethiopia, pp: 2-3.
40. Beyecha, K., 2004. A Study on Ethinoveterinary Knowledge and Practices in Moyale Wereda of Liben Zone, Somali, DVM thesis. Addis Ababa University, Faculty of Veterinary Medicine, Debrezeit.
41. Rahmann, G. and H. Seip, 2006. Alternative strategies to prevent and control endoparasite diseases in organic sheep and goat farming. A Review of Current Scientific Knowledge, 32: 54-57.
42. Gronvold, J., S.A. Henriksen, M. Larsen, P. Nansen and J. Wolstrup, 1996. Aspects of biological control with special reference to arthropods, protozoans and helminthes of domesticated animals. Veterinary Parasitology, 64: 47-64.
43. Larsen, M., 2006. Biological control of nematodes in sheep. Journal of Animal Science, 84: 133-139.
44. Waghorn, T.S., D.M. Leathwick, L.Y. Chen, R.A.J. Gray and R.A. Skipp, 2002. Influence of nematophagous fungi, earthworms and dung burial on development of the free-living stages of Ostertagia (Teladorsagia) circumcinctain New Zealand. Veterinary Parasitology, 104: 119-129.
45. Thomas, M.L., 2001. Dung Beetle Benefits in the Pasture Ecosystem, http://attra.ncat.org/attrapub/PDF/dungbeetle.pdf.
46. Vlassoff, A., D.M. Leathwick and A.C.G. Heath, 2001. The epidemiology of nematode infections of sheep. New Zealand Veterinary Journal, 49: 213-221.
47. Jansson, H.B. and L.V. Lopez-Llorca, 2004. Control of nematodes by fungi in: Arora, D.K. (Ed. Fungal Biotechnology in Agricultural, Food & Environmental Applications, Marcel Dekker, New York, 12: 205-215.
48. Hertzberg, H., M. Larsenand V. Maurer, 2002. Biological control of helminths in grazing animals using nematophagous fungi. Tierarztliche Wochenschrift, 115: 278-285.
49. Assis, R.C., F.D. Luns, J.V. Araujo and F.R. Braga, 2012. Biological control of trichostrongyles in beef cattle by the nematophagous fungus Duddingtoniaflagrans in tropical Southeastern Brazil. Experimental Parasitology, 132: 373-377.
50. Larsen, M., 2000. Prospects for controlling animal parasitic nematodes by predacious micro fungi. Journal of Parasitology, 120: 121-131.
51. Faedo, M., M. Larsen and S. Thamsborg, 2000. Effect of different times of administration of the nematophagous fungus Duddingtoniaflagrans on the transmission of ovine parasitic nematodes on pasture - a plot study. Veterinary Parasitology, 94: 55-65.
52. Stuedemann, J.A., R.M. Kaplan, H. Ciordia, A.J. Franzluebbers, T.B. Stewart and D.H. Seman, 2004. Bermuda grass management in the Southern Piedmont USA V: gastrointestinal parasite control in cattle. Veterinary Parasitology, 126: 375-385
53. Thamsborg, S.M., M. Larsen and M. Busch, 2004. Sustainable, non-chemical control of small ruminant nematode parasites in Europe. Proceedings from an International Workshop held at Danish Centre of Experimental Parasitology Royal Veterinary and Agricultural University.
54. Younie, D., S. Thamsborg, F. Ambrosini and S. Roderick, 2004. Grassland management and parasite control. Animal health and welfare in organic agriculture. Wallingford: Centre for Agriculture and Biosciences International, 45: 309-324.
55. Coop, R. and I. Kyriazakis, 2001. Influence of host nutrition on the development and consequences of nematode parasitism in ruminants. Trends in Parasitology, 17: 325-330.
56. Sykes, A.R. and R.L. Coop, 2001. Interactions between nutrition and gastrointestinal parasitism in sheep. New Zealand. Veterinary Journal, 49: 222-226.
57. Knox, D.P., D.L. Redmond, G.F. Newlands, P.J. Skuce, D. Pettit and W.D. Smith, 2003. The nature and prospects for gut membrane proteins as vaccine candidates for *Haemonchus contortus* and other ruminant trichostrongyloids. International Journal of Parasitology, 33: 1129-1137.
58. Vercruysse, J., T. Schetters, D. Knox, P. Willadsen and E. Claerebout, 2007. Control of parasitic disease using vaccines: an answer to drug resistance. Revue Scientifique Technique, 26: 105-115.
59. Hein, W.R. and B.L. Harrison, 2005. Vaccines against veterinary helminthes. Veterinary Parasitology, 132: 217-222.
60. Gasbarre, L.C. and J.E. Miller, 1999. Genetics of helminthes resistance in Breeding for Disease Resistance in Farm Animals. Centre for Agriculture and Biosciences International Publishing, 24: 129-152.
61. Bisset, S.A., C.A. Morris, J.C. McEwan and A. Vlassoff, 2001. Breeding sheep in New Zealand that are less reliant on anthelmintic to maintain health and productivity. National Veterinary Journal, 49: 236-246.

62. Chartier, C., E. Etter, H. Hoste, I. Pors, C. Koch and B. Dellac, 2000. Efficacy of Copper Oxide Needles for the Control of Nematode Parasites in Dairy Goats. Veterinary Research Communications, 24: 389-399.
63. Burke, J.M., J.E. Miller, D.D. Olcott, B.M. Olcott and T.H. Terrill, 2004. Effect of copper oxide wire particles dosage and feed supplement level on *Haemonchus contortus* infection in lambs. Veterinary Parasitology, 123: 235-243.
64. Bang, K.S., A.S. Familton and A.R. Sykes, 1990. Effect of copper oxide wire particle treatment on establishment of major gastrointestinal nematodes in lambs. Research in Veterinary Science, 49: 132-139.