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Review
Herbal Dewormers in Livestock - A Traditional Therapy

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ABSTRACT

This review is a part of data being collected on the botanical anthelmintics being traditionally used in various parts of the world. Much of the review has been extracted from internet collections. Review presents some examples of herbal medicine used against helminths in livestock, and outlines potentials and limitations in the use of ethnomedicine, or ethnobotanical medicine - the utilization by humans of plants as medicines. "Traditional" refers to the sum total of all non-mainstream medical practices, usually excluding so-called "western" medicine. "Ethnoveterinary medicine" is defined as being the study of folk beliefs, knowledge, skills, methods and practices on the part of practitioners concerned with the health care of animals.

Key Words: Anthelmintic; Herbal; Dewormer; Livestock

INTRODUCTION

Helminths are recognized as a major constraint to livestock production throughout the tropics and elsewhere (Ibrahim *et al.*, 1984; Waller, 1987). Helminthiasis affects all species of wild and domesticated animals. For example, in Pakistan wild boar, *Sus scrofa* (Cheema *et al.*, 1992; Iqbal *et al.*, 1995, 1995a), jackal (Iqbal et al., 1996), dog (Iqbal *et al.*, 1996; Khan *et al.*, 1998), sheep (Hayat *et al.*, 1986, 1986a; Iqbal *et al.*, 1986a; Khan *et al.*, 1989; Maqsood *et al.*, 1996; Sajid *et al.*, 1999), goats (Iqbal *et al.*, 1986, 1986a), buffaloes (Hayat *et al.*, 1990), horses (Hayat *et al.*, 1987; Chaudhary *et al.*, 1991), poultry (Shah *et al.*, 1999; Khan *et al.*, 2001). The helminths cause adverse effects on the host like haematological and biochemical disturbances (Rasool *et al.*, 1995; Iqbal *et al.*, 1998; Hayat *et al.*, 1996; 1999), loss of body weight (Khan *et al.*, 1988) and huge economic losses (Iqbal *et al.*, 1989, 1993). Imported manufactured anthelmintics have long been considered the only effective way of controlling parasitic infection. However, as these are very expensive and often unavailable to farmers in rural areas, livestock producers have continued to use indigenous plants as dewormers, drawing upon centuries of knowledge of herbal medicine. Furthermore, some serious disadvantages of using manufactured drugs have become evident in the western world, such as drug resistance, food residues and environmental pollution. A general stagnation in the development of conventional medicine has led to an increased need for research into alternative therapeutic agents for the treatment and control of helminth infections. Knowledge about medicinal plants is not new to the western world; rather, it has been forgotten - 25% of all prescriptions dispensed in public pharmacies in the United States in 1973 contained drugs extracted from higher plants (Farnsworth & Morris, 1976).

Similarly, some plants have been listed as anthelmintics in the British Veterinary Codex, at least until 1965. Anthelmintic activity of some plants has also been reviewed by Akhtar *et al.* (2000). Such an activity has also been reported for some plants like that of *Chenopodium album* (Akhtar *et al.*, 1999), sorghum extract (Iqbal *et al.*, 2001), *Allium sativum, Zingiber officinale, Curcurbita mexicana and Ficus religiosa* (Iqbal *et al.*, 2001a) and tannin containing plants (Iqbal et al., 2002). Some common inorganic agents have also been tried in vitro against Haemonchus contortus, like urea, sodium chloride and calcium carbonate (Iqbal *et al.*, 2000; Munir *et al.*, 2001). Further some reports on anthelmintic activity of plants have been summarized in Table I. Extensive medicinal knowledge is to be found through research on the traditional use of herbal medicine, since an estimated 80 % of the populations of developing countries depend on traditional medicines for primary health care (WHO, cited by Plotkin, 1992). The same figure seems to hold for livestock and ethnoveterinary care (McCorkle *et al.*, 1996). It is considered that further research into this area will benefit both developed and less developed countries.

This review presents some examples of herbal medicine used against helminths in livestock, and outlines potentials and limitations in the use of ethnomedicine, or ethnobotanical medicine - the utilization by humans of plants as medicines (Farnsworth, 1994). "Traditional" refers to the sum total of all non-mainstream medical practices, usually excluding so-called "western" medicine (Farnsworth, 1994). "Ethnoveterinary medicine" is defined as being the study of folk beliefs, knowledge, skills, methods and practices on the part of practitioners concerned with the health care of animals (McCorkle, 1989).

Why use traditional herbal medicine? There is an increased awareness among medical and scientific communities that the importance of medicinal plant studies goes beyond mere anthropological curiosity. Plant anthelmintics have been in the forefront of this growing awareness (Hammond *et al.*, 1997). A reason for this could be that they fall into the category of readily applicable elements of ethnoveterinary medicine in livestock development (McCorkle & Mathias-Mundy, 1992). Studying herbal medicine can serve to validate and enhance existing local uses and can give clues to remedies with further potential. There are, however, other reasons for continuing interest and research.

First of all, locally produced plant anthelmintics are much cheaper than imported drugs. One striking example is a herbal wound powder in Sri Lanka, found to be as

Table I. Plants reported to be traditionally used as anthelmintics

Plant	Part used	Active constituent	Indication cited or activity	Animal species	Tested (T)	Reference
Acacia albida	Seeds		Worm infestation	Sheep, goat		Nwude and Ibrahim (1980)
Agrimonia eupatori			Anthelmintic	Humans		Farnsworth *et al.* (1985)
Alangium lamarckii	Root-bark		Ascarids	Poultry	T	Dubey and Gupta (1969)
Albizia anthelmintica	Bark Root Bark		Anthelmintic Fasciolosis, lungworms	Cattle, goat, sheep Cattle, goat, sheep, camel		Minja (1989); ITDG and IIRR (1996)
Albizia coriavera Allium sativum	Bark Bulb		Fasciolosis, lungworms Roundworms	Cattle, goat, sheep Cattle, goat, sheep		ITDG and IIRR (1996); ITDG and IIRR (1996)
Aloe barteri	Leaves	Anthraquinone	*Nippostrongyllus braziliensis*	Rat	T	Ibrahim *et al.* (1984)
Ananas comosus	Fruit		*Ascaridia galli*	Chicken	T	Fernandez (1991)
Annona cherimolia A. muricata braziliensis Molinema dessetae		Acetogenins	*Nippostroongylus*	Rat	T	Bories *et al.* (1991)
A. senegalensis	Leaf, bark, root	Anthraquinone	*Nippostrongyllus braziliensis*	Rat	T	Ibrahim *et al.* (1984)
Anogeissus leiocarpus	Bark, seed	Anthraquinone	*Nippostrongyllus braziliensis*	Rat	T	Ibrahim *et al.* (1984)
Areca catechu	Nut	Arecolin, other alkaloids	Taenicidal	Cattle, goat, dog	T	Roepke (1996)
Artemisia maritima		Santonin, Artemisin	*Neoascaris vitulorum*	Buffalo calves	T	Akhtar *et al.* (1982); Farnsworth *et al.* (1985); Sherif *et al.* (1987)
Bixa orellana	Seeds		*Ascaridia galli, Ascaris suum*	Chicken Pig	T	Fernandez (1991)
Boswellia dalzelii	Bark		Anthelmintic	Sheep, goat	T	Nwude and Ibrahim (1980)
Butea frondosa			Oxyurids	Mice	T	Mehta and Parashar (1966)
	Seeds		*Ascaridia galli*	In vitro	T	Lal *et al.* (1976)
Caesalpina crista	Seeds		*Toxocara vitulorum* *Ascaridia galli*	Buffalo calves, chicken	T T	Akhtar *et al.* (1985); Javed *et al.* (1994)
Callindra portoricensis	Root		*Toxocara canis*	Dog	T	Adewunmi and Akubue (1981)
Carica papaya	Latex from fruit		*Ascaridia galli* *Ascaris suum* *Heligmosomoides polygyrus*	Chicken Pig Mice	T T T	Mursof and He (1991); Satrija *et al.* (1994); Satrija *et al.* (1995)
Carissa edulis	>Root		Roundworms	Cattle, goat, sheep	T	ITDG and IIRR (1996)
Cassia alata	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
Cassia occidentalis	Leaf	Anthraquinone	*Nippostrongylus braziliensis*	Rat	T	Ibrahim *et al.* (1984)
Cassia spectalis	Root		Roundworms	Cattle, goat, sheep		ITDG and IIRR (1996)
Chrysanthemum spp.		Pyrethrin	*Ascaridia lineata*	Chicken	T	Rebrassier (1934)
Chrysophyllum cainito	Stem		*Haemonchus contortus*	Cattle	T	Fernandez (1991)
Cissampelos mucromata	Root		Anthelmintic			Minja (1989)
Clitorea ternatea	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
Combretum mucronatum	Root		Guinea worm	Humans	T	Sofowora (1982)
Croton macrostachys	Leaves		Anthelmintic			Minja (1989)
Diospyros mespilliformis	>Bark		Anthelmintic			Minja (1989)
Diospyros mollis		Diospyrol	*Necator americanus*	Golden hamster *Nematodirus dubius, Hymenolepis nana* Mice	T T	Sen *et al.* (1974) -
Diospyrus scabra	Seeds		Fasciolosis, lungworms	Cattle, goat, sheep, camel		ITDG and IIRR (1996)
Dodonea viscosa	Leaves		Intestinal worms			Sharma and Singh (1989)
Embelia kilimandschiraca	Root		Anthelmintic			Minja (1989)
Embelia Schimperi	Seed, root		Anthelmintic			Minja (1989)
	Fruit	Embelin	*Hymenolepis diminuta*	Rat	T	Bøgh *et al.* (1996)
Erythrina senegalensis	Bark		Fasciolosis	Ruminants		Nwude and Ibrahim (1980)
Evodia rutaecarpa		Atanin	Ascarid nematodes	Pig (in vitro),	T	Perrett and Whitfield (1995)
	L4 of Ostertagia circ.		Sheep (in vitro)	T	-	

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Plant	Part used	Active constituent	Indication cited or activity	Animal species	Tested (T)	Reference
Hagenia abyssainica	Fruit		Roundworms	Cattle, goat, sheep	ITDG and IIRR (1996)	
Lansium domesticum	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
			Ascaris suum	Pig	-	
			Haemonchus contortus	Goat	-	
Lantana trifolia	Fruit		Fasciolosis, lungworms	Cattle, goat, sheep		ITDG and IIRR (1996)
Lawsonia inermis	Leaf		Fasciolosis	Sheep, goat		Nwude and Ibrahim (1980)
Leucaena leucocephala	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
			Ascaris suum	Pig	-	-
			Haemonchus contortus	Goat	-	-
Mangifera indica	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
Mallotus philippinensis			Gastro-intestinal cestodes	Beetal goat	T	Akhtar and Ahmad (1992)
Melia azederach	Fruit		*Ascaridia galli*	Chicken	T	Akhtar and Riffat (1985)
			Haemonchus, Tricho- strongylus, Trichuris, Chabertia spp.	Goat		Akhtar and Riffat (1984)
Mimosa pudica	Stem		*Haemonchus contortus*		T	Fernandez (1991)
Mitragyna stipulosa	Root		Guinea worm	Humans	T	Sofowora (1982)
Momordica charantia	Stem		*Ascaris suum*	Pig	T	Fernandez (1991);
			Ascaridia galli	Chicken		Farnsworth *et al*. (1985)
			Haemonchus contortus	Goat	-	-
Moringa oleifera	Seeds		*Ascaridia galli*	Chicken	T	Fernandez (1991)
			Ascaris suum	Pig	-	-
			Haemonchus contortus	Goat	-	-
Myrsine africana	Leaf		Roundworms	Cattle, goat, sheep, donkey, camel		ITDG and IIRR (1996)
Peganum harmala	Seeds	Tetra-hydro- harmin	Mixed gastro-intestinal infection	Goat	T	Akhtar and Ahmad (1991)
			Cestiod infection	Sheep		Akhta and Riffat (1986)
Quisqualis indica	Stem		*Ascaris suum,*	Pig		Fernandez (1991)
			Ascaridia galli	Chicken	-	Farnsworth *et al*. (1985)
			Haemonchus contortus	Goat	-	
Rapanea melanoploeos	Seeds		Roundworms	Cattle, goat, sheep		ITDG and IIRR (1996)
Rhamnus principides	Leaves		Anthelmintic	Minja (1989)		
Rhus vulgaris	Root		Roundworms	Cattle, goat, sheep		ITDG and IIRR (1996)
Senecio lyratiparitus	Leaves		Anthelmintic			Minja (1989)
Solanum nodiflorum	Fruit		Worm infestation			Nwude and Ibrahim (1980)
Tamarindus indica	Root		Roundworms	Cattle, goat, sheep		ITDG and IIRR (1996)
Terminalia avicennoides	Leaf, root	Anthraquinone	*Nippostrongylus braziliensis*	Rat		Ibrahim *et al*. (1984)
Tiinospora rumphii	Stem		*Haemonchus contortus*	Goat	T	Fernandez (1991)
Tribulus terestris	Plant		*Ascaridia galli*	Poultry	T	Chakraborty *et al*. (1979)
Trichilia emetica	Bark		Fasciolosis, lungworms	Cattle, goat, sheep, camel		ITDG and IIRR (1996)
Uvaria hookeri	Root-bark	Acetogenins	*Haemonchus contortus*		T	Padmaja *et al*. (1993)
U. narum					-	
Vernonia anthelmintica			Oxyurids	Mice	T	Mehta and Parashar (1966)

effective as an imported powder, which cost 80 to 90% less than the western equivalent (Anjaria, 1986). Logically, peasant farmers choose not to buy the western drugs and this may make availability a problem in rural areas, as a result of lower demand. Safe, efficacious and high-quality anthelmintic products are a normal requirement in many countries. Unfortunately, they are not always available. A recent investigation found plausible evidence of direct fraud with commercially available products. This led Monteiro *et al.* (1997) to compare the actual content of active drugs with the contents claimed on the labels of nine anthelmintic products sold in Kenya. They found that the actual levamisole concentration varied from 0 to 114% and that the concentration in different batches of the same product varied from 0 to 85%. These deviations could be owing either to incorrect storage or to deliberate fraud, such as dilution. The effect of a product with no active drug is the continued suffering of the animal and lower production. Use of anthelmintic products with inadequate amounts of the active ingredient will, in turn, encourage the development of anthelmintic resistance, since sub-optimal dosing selects for chemoresistant populations (Martin, 1990) and overdosing can result in residual amounts in the faeces, which may influence resistance further. Illiteracy or unfamiliarity with imported anthelmintics, resulting in incorrect usage, is also a problem leading to the same consequences.

These constraints in the use of synthetic western anthelmintics in less developed countries underline the advantages of herbal remedies as an alternative treatment. They are cheaper and more reliable, they are known by the users and their supply is more sustainable. As they have undergone many years of clinical trials, most of them do not contain acutely toxic plants and do not produce serious unanticipated side-effects. Since they do not contain substances such as fixatives, preservatives or hormones, they are presumably more biodegradable and lead to less bioaccumulation in patients' bodies and the environment (McCorkle, 1995). Furthermore, it has been suggested that the diversity of herbal anthelmintics has precluded the occurrence of resistance despite many years of use, as discussed above (Hammond *et al.*, 1997).

Greater and more organized use of herbal medicine as a whole also supports the Convention on Biological Diversity, which at the June 1992 United Nations Conference on Environment and Development in Rio de Janeiro was signed by 154 countries (excluding the United States) and initiated in December 1993, after final ratification by 30 countries (Government of Denmark, 1996). The Convention aims at a commitment to cooperation between the contracting countries with regard to the conservation and sustainable use of the diversity of animals, plants and other living organisms and their habitats. Wider use of traditional herbal medicine can help fulfil these aims through the organized use of medicinal plants. Furthermore, the Convention seeks a reasonable division of the profit from the use of genetic resources. A country thus has a sovereign right over its resources (Government of Denmark, 1996, article 3) and is thereby assured of a monetary share in the possible marketing of a product from these natural resources. Organized cultivation of medicinal herbs and the creation of local trade and industry based on the herbal products can bring more jobs, income and status to rural inhabitants (McCorkle, 1995). Maintaining biodiversity in turn maintains the cultural diversity that is reflected in the people who administer the biodiverse habitats (Hyndman, 1994). These goals can be accomplished through ethnoveterinary research, development and extension (ERD&E / ER&D), which can be defined as "the holistic, interdisciplinary study of local knowledge and its associated skills, practices, beliefs, practitioners and social structures pertaining to the health care and healthful husbandry of food-, work- and other income-producing animals, always with an eye to practical development applications within livestock production and livelihood systems, and with the ultimate goal of increasing human well-being via increased benefits from stock raising" (McCorkle, 1995). The appreciation of traditional herbal medicine promoted by ER&D may lead to increased recognition of indigenous knowledge - the local knowledge unique to a given culture or society (Warren, 1995) - as a potential scientific resource. This may be regarded as one of the most important aspects of the re-emergence of herbal medicine.

Problems with the use of traditional herbal medicine. The case of ethnomedicine, human and veterinary, is not all straightforward. Because it is a very new area of academic study, many scientists and veterinarians still consider it pure superstition without a place in reality, the domain of "quacks" (Mesfin & Obsa, 1994). The main reason for this skepticism is basically a natural doubt about all that is alien and different, which all traditional methods must be to the western eye. Ethnomedicine does not follow western paradigms of scientific proof of efficacy, which might be one of the main arguments against the use of traditional medicine today (Sofowora, 1982). On the other hand, this may be one of the constraints that is easiest to reverse in the future, using organized investigative methods for scientific evaluation.

Among the limitations of ethnoveterinary medicine, Mathias-Mundy and McCorkle (1989) mention "the inconvenience of preparing or using some remedies, the seasonal availability of certain plants, the scarcity of treatments against infectious epidemic diseases, the ineffectiveness of some treatments, the existence of harmful practices and the often inadequate ethno-diagnoses".

The inconvenience of using some traditional remedies lies with the problems of collecting, preparing and administering the ingredients, which in some cases can be very time-consuming. Each constituent has to be found in special habitats and some ingredients might be seasonal. However, stock owners also have to go far to get imported medicine, which is currently the case in many rural areas in developing countries. The problem of time-consuming collection of some medicinal plants could be solved by organizing the most important of them into cultivation schemes. Seasonal availability, however, could not be overcome in this way, but developing proper storage techniques might be a solution.

Inadequate ethnodiagnosis is probably the weakest aspect of traditional health care practice, owing to a lack of pathophysiological understanding (Schillhorn van Veen, 1997). The understanding of disease causality is rarely developed, and hence treatment and prevention can be inappropriate. Lack of sophisticated modern diagnostic technology for proper diagnosing is also a problem, even when the cause of disease is understood. For instance, helminths might only be recognized when they are of a size that makes them visible in faeces. Recognition of parasite eggs and small worms and differentiation between species is in some cases difficult without even a microscope. Differential diagnosis of helminth diseases from other conditions can also be a problem, since gross clinical signs such as weight loss, diarrhoea and anaemia could be caused by many ailments other than helminthosis.

Poor diagnosis leads to some of the other constraints mentioned in the use of traditional medicine. Ineffectiveness of some treatments follows partly from poor diagnosis, leading to the application of inappropriate treatments. For instance, some plants only have a laxative effect and may expel only adult worms or parts of worms (Hammond *et al.*, 1997). Furthermore, inadequate diagnosis or a lack of understanding of the disease can also lead to harmful prescriptions. In the case of a bacterial disease such as anthrax, which can be transmitted from animals to humans, the danger is not always known and the disease may be spread accidentally by the consumption of contaminated meat (Bizimana, 1994). Another human example (Bourke & Petana, 1994) was an African miner who complained of abdominal pain and nausea. He consulted a native medicine man, who advised that a mixture should be prepared from the segments of the worm (*Taenia solium*) the miner had brought with him. He drank the mixture and was subsequently hospitalized with epilepsy and muscular pain. X-rays of his body showed multiple cystercerci in the musculature. The liquid had probably contained thousands of ova, which resulted in this condition with cystercerci in the musculature and brain tissue. It shortly thereafter caused his death.

Stories such as these understandably support the view of ethnomedicine as the domain of "quacks", not always without reason. Many traditional healers would never admit to a lack of knowledge. In some cases they would just order a remedy with no effects, or in the worst cases even harmful ones, in order to keep their reputation (Hammond *et al.,* 1997) or simply to make money. However, the above example of the wrong treatment most probably does not originate from ill intentions or motives, but simply from a lack of understanding.

Western science normally maintains a clear division between medicine and religion, so magico-religious practices are another cause of suspicion. In human ethnomedicine, as well as in ethnoveterinary medicine, magic and religion are integral parts of the whole (McCorkle, 1986) although Nwude and Ibrahim (1980) find the mystic rites that surround human traditional medicine virtually non-existent. Supernatural practices vary from simple recitations or incantations to complex ceremonies (Mathias-Mundy & McCorkle, 1989). Although such actions might have a psychosomatic effect in humans, their value in animals is uncertain. However, some factual knowledge with practical value may be hidden in magico-religious expressions. In ethnopharmacology, some remedies that were used for magic or symbolic purposes have been proved effective scientifically (McCorkle & Mathias-Mundy, 1992). Studying natural practices without the supernatural is hence "scientifically indefensible" (McCorkle & Mathias-Mundy, 1992).

How to go forward? To use the words of Plotkin (1992), veterinary and human ethnomedicine stand at a crossroads. The decline and possible disappearance of all traditional practices lie in one direction, as traditional cultures come into contact with the western world. In the other far more desirable direction lie validation and improvement of ethnomedical knowledge. The collection and testing of natural products is one of two ways to discover pharmaceuticals; the other is laboratory synthesis (Soejarto, 1996). Different approaches can be used to collect products such as plants with anthelmintic properties.

The biodiversity-based approach, also called the random collection and screening approach, involves the screening of a large set of diverse plant samples for one or more biological activities (Soejarto, 1996). The reservoir for discovery is almost inexhaustible, as it contains all plant species. However, this undoubtedly makes it the more expensive approach, considering the relatively low chances of discovery. A second approach is field observations for signs of interaction between organisms. This is based on the idea that plant secondary metabolites are a defence for the plant, acting against potential predators or pathogens such as viruses, bacteria, nematodes and others (Whitfield, 1995). A third approach arises from this, namely the selection of plants based on chemotaxonomy, since plant secondary metabolites are often species- or family-specific in their taxonomic distribution (Whitfield, 1995).

Finally, the ethnobotanical approach and investigation of self-medicating behaviour in animals (Huffman, 1997) offer opportunities for the discovery of medicinal plants. The ethnobotanical approach assumes that the indigenous use of plants can give hints about their biological activities (Cox & Balick, 1994). A comparison with human ethnomedicine is important for the discovery of veterinary plant anthelmintics, because in many cultures healers of human diseases treat corresponding animal disorders with the same herbs, drugs, methods, etc. (Mathias-Mundy & McCorkle, 1989; Nwude & Ibrahim, 1980). The follow-up investigation of the ethnomedical uses of plants is widely accepted as the most productive plant surveying method, since 74% of all plant-derived drugs in clinical use worldwide have been discovered in this way (Farnsworth *et al.,* 1985). Information on plants used medically can be obtained through literature search and analysis, and through field inquiries, although this makes it a very slow process. This is one of the limitations to this approach, and at the same time what constitutes its urgency. Rapid social and agricultural changes are taking place in many rural communities and therefore it is necessary to collect information on traditional patterns of use before these are disrupted. Many healers possessing information are elderly and lack successors and, as they die, their knowledge dies with them (Cox & Balick, 1994). However, reliance on healers' information might not be so important when collecting information on ethnoveterinary practices, because healers of human ailments keep their knowledge secret, while ethnoveterinary information circulates freely. Herders often possess knowledge of gross pathology through slaughtering, while human healers base their diagnoses solely on symptoms (Mathias-Mundy & McCorkle, 1989).

Another constraint to the ethnobotanical approach is the limitation of indigenous plant use to certain recognized disorders which do not fully correspond to the diseases western medicine concentrates on. Indigenous plant remedies are more focused on gastro-intestinal complaints, inflammation, dermatological ailments and obstetric disorders (Cox & Balick, 1994), which in the case of discovering anthelmintic herbs must be considered significant.

The most promising plants should be scientifically validated through systematic experiments, using indicator helminths in laboratory animals and toxicity studies and, if these are positive, screening in domestic animals (Hammond, 1997). In this way two plants, *Embelia schimperi* and *Carica papaya*, were found by the Danish Centre for Experimental Parasitology to be promising anthelmintic candidates (Bøgh *et al.*, 1996; Satrija *et al.*, 1994, 1995). To ensure benefit to the inhabitants, the plants should, as far as possible, be cultivated and packaged locally and commercially marketed.

CONCLUSION

The advantages of studying local knowledge of herbal medicine are numerous and most of them have already been outlined here. To sum up, it is important, in both a socio-economic and a scientific perspective, to draw upon the rich store of ethnomedicinal knowledge. Herbal medicine is still used by the majority of humans on earth, mainly among populations in less developed countries. To these people, herbal medicines offer cheaper, more sustainable, available, reliable and familiar alternatives to imported synthetic drugs. Furthermore, when put into production locally, they can reinforce the income and status of local inhabitants.

For both developed and less developed countries, the recognition and development of herbal medicine offers treatment methods that are more environmentally benign, since they tend to be less toxic, produce fewer unanticipated side-effects, are more biodegradable, accumulate no drug residues in meat or faeces and apparently do not trigger anthelmintic chemoresistance.

However, there are problems connected with the use of herbal medicine, the largest being the lack of scientific evaluation. Such evaluation is the most important step once information about indigenous uses of medicinal plants has been collected. The most effective approach to obtaining such knowledge is the ethnobotanical approach, which assumes that indigenous uses of plants indicate the presence of biologically active constituents in the plants. This is a slow but very urgent process, as young people desert the traditional knowledge and lifestyles of their elders, leading to the possible disappearance of this knowledge. Comparison with human ethnomedicine is also important when looking for plants against ailments of livestock, since healers often use the same medications for similar animal diseases.

Finally, ER&D offers a way to obtain ethnoveterinary practices as it seeks sustainable development through appreciating and building upon local knowledge of veterinary and husbandry practices. In this way, herbal medicine may very well become a pioneer in turning local knowledge into global knowledge, through the recognition of local knowledge as an indispensable source of sustainable development for both people and the environment all over the world. This of course does not mean that traditional medicine should take over western medicine, but rather that we may benefit from a harmonious balance of both.

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