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Review

Possible Role of Ethnoveterinary Medicine in Poverty Reduction in Pakistan: Use of Botanical Anthelmintics as an Example

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ABSTRACT

Livestock raisers and healers everywhere have traditional ways of classifying, diagnosing, preventing and treating common animal diseases. Many of these "ethnoveterinary" practices offer viable alternatives or complement to conventional, western-style veterinary medicine - especially where the latter is unavailable or inappropriate. The use of medicinal plants constitutes major part of ethnoveterinary medicine (EVM). The climatic conditions and geographic location of Pakistan provides conducive conditions for the growth and propagation of widely diverse species of medicinal plants. The inventory of flora of Pakistan indicates richness of this part of the world in medicinal plants in mountainous as well as plain regions. These plants are used both in animal and human healthcare. In contrast to the other countries, efforts have not been made to compile the databases of medicinal plants used in veterinary medicine. This paper overviews the prospects of medicinal plants used in EVM as a tool for poverty reduction through increasing productivity of small ruminants by using locally available economical remedies. Use of medicinal plants as an anthelmintic (de-wormer) has been given as an example. The limitations and strengths of EVM have been discussed.

Key Words: Ethnoveterinary; Poverty reduction; Small ruminants; Anthelmintics

INTRODUCTION

Ethnoveterinary medicine (EVM) is defined simply as the medicines that livestock keepers are using now, other than modern synthetic drugs (Mathius-Mundy & McCorkle, 1989). EVM covers people's knowledge, skills, methods, practices and beliefs about the care of their animals (McCorkle, 1986).

EVM provides valuable alternatives to and complements western-style veterinary medicine. This is increasingly evident in the West where herbal medicine is becoming mainstream. EVM is of specific value in developing countries where allopathic veterinary medicines are often beyond the reach of livestock producers. It can play an important role in grassroots development, which seeks to empower people by enhancing the use of their own knowledge and resources. Many indigenous veterinary beliefs and practices persist in a wide majority of stock raisers and farmers, particularly in the developing countries.

Pakistan, China and India have much to teach the world. These nations are the greatest users of medicinal plants; their traditions of plant remedies date back at least 7000 years. Between them, they now account for two-fifths of humanity (in other words, more than 2 billion people), the bulk of whom rely heavily on medicinal plants. Certain of the experiences in these countries can be used to facilitate medicinal-plant conservation, cultivation, community participation and sustainable development not even in these countries but also in the rest of the world.

Livestock farmers all over Pakistan can draw on over 4000 years of knowledge and experience conserved in oral histories and traditions amongst different groups. Over time, this information has got scattered and diffused. However, traditional practices still form the building blocks on which the foundations of development lie. In view of their struggling economies plus the everywhere-escalating costs of high-tech healthcare, there is little prospect that a significant percentage of livestock farmers will replace their EVM practices in the foreseeable future. Therefore, reduction in poverty of the poor farmers (landless and those having small householders) is possible if an economical solution is provided to the animal production problems like heavy worm burdens.

Information on EVM used to be hidden in the grey literature, but a sizeable body of published literature now exists, including an annotated bibliography abstracting over 1200 documents (McCorkle *et al*., 1995; Mathias *et al*., 1999; Martin *et al*., 2001). This paper describes the prospects and role of EVM in poverty reduction in Pakistan,

particularly with reference to the use of botanical anthelmintics.

Role of livestock in national economy of Pakistan. Agriculture being the dominant sector of economy of Pakistan contributes 23.3% to the GDP and employs 42.1% of the total work force. Almost 68% of the country's population lives in rural areas and is directly or indirectly linked with agriculture for their livelihood. Livestock, the largest contributor to overall agriculture value added (contributing 49.1 percent), grew by 2.6 percent in 2003-04 as against 2.8 percent in 2002-03. Livestock is an important sector of agriculture in Pakistan, which accounts for 49.1 percent of agricultural value added and about 11.4 percent of the GDP. The role of livestock in rural economy may be realized from the fact that 30-35 million rural population is engaged in livestock raising, having household holdings of 2-3 cattle/buffalo and 5-6 sheep/goat per family which help them to derive 30-40 percent of their income from it. The livestock include: cattle, buffalos, sheep, goats, camels, horses, asses and mules (Anonymous, 2003-04).

Helminthiasis – A major production limiting factor in small ruminants. Small ruminants play an important role in the national economy of Pakistan. There is no organized sheep farming in Pakistan except at some Government Livestock Farms. The major share of national sheep population out of total estimates of 24 million heads (Anonymous, 1998-99) comes from the small flocks maintained by the landless families or small land holders in the villages. These sheep flocks are the main stay of the livelihood of these people. They sell sheep to meet their day-to-day needs of life. There are no permanent pastures for sheep and flocks are grazed on canal banks, roadsides and crop residues in the fields. The Livestock and Dairy Development Department of the Government partially provides health care to these animals. The sheep owners, therefore, have to rely on the ethnoveterinary medicinal practices being inherited by their predecessors generation to generation. The animals usually remain under-fed and victim of diseases. The bacterial and viral diseases come as outbreak and result in huge mortality, if proper therapy is not instituted at proper time. Helminths, however, are the permanent parasites and their prevalence has been reported very high throughout Pakistan (Durrani *et al.*, 1981; Mohiuddin *et al.*, 1984; Khan, 1985; Iqbal *et al.*, 1993; Qayyum, 1996; Iqbal *et al.*, 2002). Among helminths, gastrointestinal nematodes carry high importance because of their insidious and severe pathological effects. They lead to lowered productivity, retarded growth rate and even death of lambs (FAO, 1974; Barger, 1982; Steel & Symons, 1982; Sykes, 1982; Holmes, 1986; Al-Quaisy *et al.*, 1987; Sykes, 1994).

Limitations of synthetic drugs. Modern anthelmintics can be dramatically effective when correctly used. But, the cost of these drugs and its consequences is a major disadvantage. If the cost of a treatment is a significant proportion of the value of the animal that is being treated then one or more things may happen:

- the animal is left untreated or a low cost EVM method is used
- the seller of the drug dilutes it to make it cheaper, which results in supply of inferior quality medicines.

Monteiro *et al.* (1998) in Kenya found that of seven anthelmintics marketed as containing levamisole, an effective anthelmintic agent, two contained none, whilst two others had levels of levamisole of 11.8 and 78.7% of the amount stated on the label, livestock owners who buy costly drugs may also try to make them 'go further' by diluting them, by under-dosing or by not completing the full recommended treatment, as is often the case with antibiotics. Similar problems have also been reported in Pakistan (Afaq, 2003). Even when properly administered, the long-term use of anthelmintics leads to the loss of an animal's natural resistance and development of resistance in the helminths. If for whatever reason the anthelmintics are suddenly unavailable the animal is totally exposed to the worst effects of the parasites and organisms which these drugs are keeping under control. For this reason, the routine use of chemicals, for example, has been questioned for some time (Norval, 1983). The supply of anthelmintics and other medicines to government hospitals and livestock farms is also interrupted in Pakistan due to complicated purchase procedures resulting in untimely treatment of the animals (Afaq, 2003).

Traditional use of medicinal plants in Indo-Pakistan subcontinent with particular reference to botanical anthelmintics. Plants have been used from ancient times to cure diseases of man and animals. This system of therapy is commonly referred as "unani, folk, eastern or indigenous" medicine (Nadkarni, 1954). There are a many plants[1] which have been reported in literature for their medicinal importance (Akhtar *et al*., 2000). For example *Caesalpinia crista* (Leguminosae[2]; karanjwa[3]), *Melia azedarach* (Meliaceae; bakain), *Saussurea lappa* (Compositae; qust-e-shireen), *Morringa oleifera* (Moringaceae; sohanjna), *Trachelospermum jasminoides* (Apocynaceae; zard chambeli), *Butea frondosa* (Leguminosae; Dhak) etc. have been quite commonly used (Nadkarni, 1954). The medicinal properties ascribed to these plants include anthelmintic, antiperiodic, antipyretic, febrifuge, antiphlegmatic, antiflatulant etc. In addition, these plants have also been used to cure nervous problems, skin diseases, cough, rheumatism, chronic fever, eczema and dyspepsia (Anonymous, 1956; Chopra *et al*., 1956; Ikram & Hussain, 1978; Awan, 1981). The fruit of *Mallotus phillippinensis* (Euphorbiacea; kamala) has been used as an anthelmintic,

[1]Taxonomic family and local names are given in parenthesis; where, they have not been given, it indicates authors could not get such information or the same information has been given in the preceding text.
[2]Taxonomic family
[3]Local name

cathartic, aphrodiasiac, lithotropic and styptic. It has also been used in external applications for the control of parasitic infections of the skin, as an antiseptic for ears and systemically for urinary disorders (Chopra *et al*., 1956; Ikram & Hussain, 1978; Satyavati *et al*., 1987). The British Pharmaceutical Codex (1934) and the British Veterinary Codex (1953) cite kamala as having anticestodal properties for man and dog (Akhtar & Ahmad, 1992).

Seeds of *Butea superba* (Leguminosae; palaslata) are extensively used as sedative and anthelmintic in the indigenous system of medicine (Charka, 1948; Chopra *et al*., 1958). The powdered seeds and various extracts of plant *Peganum harmala* (Rutaceae; harmal) have been used as narcotic, analgesic, antispasmodic in colic and as a remedy against tapeworm infection in man and animals (Chopra, 1956; Said, 1969). *Vernonia anthelmintica* (Compositae; kali-zeeri), *Embellia ribes* (Myrsinaceae; babrung), *Psoralea corylifolia* (Leguminosae; babchi) and *Punica granatum* (Punicacae; anar) have been reported to possess anthelmintic, laxative, expectorant, diuretic and tonic properties (Nadkarni, 1954; Chopra *et al*., 1956; Srivastava *et al*., 1967; Said, 1969; Ikram & Hussain, 1978; Awan, 1981, Akhtar & Riffat, 1985a). Various parts of *Lagenaria siceraria* (Cucurbitacae; kaddoo) have been used for different ailments. For example, pulp of its fruit to treat cough, as an adjunct to purgatives and antidote to certain poisions and for scorpion stings (Nadkarni, 1954; Ahmed, 1965), decoction of its leaves to treat jaundice (Chopra *et al*., 1956; Said, 1969) and its seeds to treat tapeworm infections in children (Awan, 1981). *Fumaria parviflora* (Fumariaceae; pit-papra or shahterah) is traditionally used as an antidiabetic, diaphoretic, diuretic, anthelmintic (Nadkarni, 1954; Chopra *et al*., 1956). *Nigella sativa* (Ranunculaceae; kalonji) is used on empirical grounds as an anthelmintic, stimulant and diuretic (Nadkarni, 1954; Said, 1969). The roots of *Morus alba* (Urticaceae; toot or tut) are considered as an anthelmintic and vermifuge, whereas root bark and stem bark are reported to be vermifuge and purgative.

Indigenous system of medicine reports a number of plants for their anthelmintic efficacy. However, their scientific evaluation as compared to commercial anthelmintics is limited. Alkaloid hydrochlorides extracted from seeds of *Butea frondosa* @ 0.1-2.0 mg/mL proved 100% lethal to earthworms within 24 h indicating their anthelmintic activity (Kalesaraj & Kurup, 1962). Garg and Atal (1963) reported remarkable vermicidal activity of Calotropain {proteolytic enzyme isolated from the latex of *Calotropis procera* (Asclepiadaceae; ak)} and Bromelain (an enzyme obtained as a by-product from pineapple industry) against *Oesophagostomum columbianum* and *Bunostomum trigonocephalum* of sheep origin compared to phenothiazine.

The aqueous extracts of *Chebulic myrobalans* (local name harar), *Belleric myrobalans* (local name bahera) and *Emblic myrobalans* (local name ambla), separately and as a mixture in equal parts (locally known as triphala) were each found to possess good anthelmintic activity. However, triphala had greater activity indicating the synergistic action of the three constituents (Gaind *et al*., 1964). *In vitro* anthelmintic activity of the aqueous and alcoholic extracts of *Ananas sativus* (Bromeliaceaea; anannas), *Embellia ribes, Macuna prurita* (Leguminosae; kouchkari) and *Melia azedarach* has significant activity against *Taenia canina* and *Paramphistomum cervi; Macuna prurita* was especially quite active against trematodes (Neogi *et al*., 1964). The anthelmintic property of the aquoeus extract of the seeds of *Carica papaya* (Carbicaeceae; ppiya) against *Ascaris lumbricoides* and *Ascaridia galli* has been evaluated (Dhar *et al*., 1965).

A steam volatile oil from the petroleum ether of *Withania coagulans* (Solanaceae; khumazare) has been found to possess lethal effect on earthworms (Gaind & Budhiraja, 1967). The aqueous, etheral and alcoholic extracts of *Cucurbita mexicana* (Cucurbitaceae; kuddu) seeds have exhibited good anthelmintic activity against *Moniezia expansa, Fasciolopsis buski, Ascaris lumbricoides Hymenolepis diminuta*. The order of decreasing potency of the extracts *in vitro* was aqueous, alcoholic and etheral in decreasing order (Shrivastava and Singh, 1967). The root bark of *Alangium larmarckii* (Alangiaceae; akola) has exhibited good efficacy against the hookworms of dogs and poultry ascarids (Dubey & Gupta, 1968).

Anacardic acid isolated from the oil of nuts of *Semecarpus anacardium* (Anacardiaceae; bhinladar) and its sodium salt has been found to be potent anthelmintic agent (Chattopadhyaya & Khare, 1969). The essential oil of *Piper betle* (Piperaceae; pan) has revealed anthelmintic effect on earthworms *in vitro* (Ali & Mehta, 1970). The anthelmintic activity of essential oil *P. betle* against tapeworms has been found better than that of piperazine phosphate, and the activity against hookworms has been reported greater than that of hexyle resorcinol (Garg & Jain, 1992). Anthelmintic studies of the essential oils of *Cymbopogon nardus* (Graminaceae; ganjni), *C. citratus* (Graminaceae; khawi) and *Zanthoxylum alatum* (Rutaceae; tejbal) have revealed that the oil of *C. nardus* has very good effect against earthworms while the oils of *C. citratus* and *Z. alatum* have moderate activity (Kokate & Varma, 1971).

Sharma *et al*. (1971) have reported significant *in vitro* effect of extracts of *Cucurbita pepo* (Cucurbitaceaea; halwa kuddu), *Calotropis gigantea* (Asclepiadaceae; ak), *Juglans regia* (Juglandaceae; akhrot), *Momordica charantia* (Cucurbitaceae; karela), *Musa paradisaca* (Musaceae; kela) and *Scindapsus officinalis* (Araceae; gajapipal) on the motility of mature *Haemonchus contortus* of goat origin. The anthelmintic activity of alcoholic extracts of stem of *Helleborus niger* (Ranunculaceae; katurchini), rhizomes of *Zingiber officinale* (Zingiberaceae; adrak), seeds of *Carum copticum* (Umbelliferae; ajwain-e-khurasani), *Agati gratifola* (Leguminosae; agasti) and *Mangifera indica* (Anacardiaceae; aam) against human *Ascaris lumbricoides*

is appreciable (Kalesaraj, 1974). Rhizomes of *Zingiber zerumbet* (Zingiberaceae) showed good *in vitro* anthelmintic activity against human *Ascaris lumbricoides*, while the alcoholic extract of the bark of *Albizzia lebbek* (Leguminosae; siris), the bulb of *Allium sativum* (Litiaceae; lahsan), rhizomes of *Alpinia calcarata* (Zingiberaceae; toroni), rind of *Citrus acida* (Rutaceae) rind of *Citrus aromatica* (Rutaceae; santara), rind of *Citrus medica* (Rutaceae; kaghzi nibu), rhizomes of *Cucuruma aromatica* (Zingiberaceae; banhalud), rind of *Punica granatum* showed moderate *in vitro* activity (Kalesaraj, 1975).

The oils of the rhizomes of *Hedychium coronarium* (Zingiberaceae) and *H. spicatum* (Zingiberaceae; karchura) possess better anthelmintic activity than piparazine phosphate against earthworms and tapeworms but the activity against hookworms and nodular worms does not, however, compare favourable with that of hexyle resorcinol (Dixit & Varma, 1975). The *in vitro* anthelmintic activity *Caraca papaya, Sapindus trifoliatum* (Sapindaceae; raitha), *Butea frondosa* and *Momordica charantia* has been reported (Lal *et al*., 1976) against *Ascaridia galli* worms of the birds. Palasonin, the active principle of *Butea monosperma* (Leguminosae; palas) @ 1 mg/mL was an effective anthelmintic against *Ascaris lumbricoides* using *in vitro* assay (Lal *et al*., 1978).

Essential oils of *Boswellia serrata* (Burreaceae; kunder) and *Cinnamomum tamala* (Lauraceae; tejpat) had better *in vitro* activity than piperazine citrate against earthworms and tapeworms (Girgune *et al*., 1978). The essential oils of *Gardenia lucida* (Rubiaceae; dekamali) and *Cyperus rotendus* (Cyperaceae; mutha) have exhibited good anthelmintic activity against tapeworms and earthworms (Girgune *et al*., 1979). Varying degrees of anthelmintic efficacy of the essential oils of *Inula racemosa* (Compositae; rasan), *Psitacia integrrima* (Anacardiaceae; kak), *Litsea chinensis* (Lauraceae; medalakri) and *Randia dumetorum* (Rubiaceae; arara) seeds against earthworms and tapeworms have been reported (Mishra *et al*., 1979).

Essential oil from leaves and flowers of *Ageratum conyzoides* (Compositae; Pum-pillu) proved to be very potent anthelmintic against tapeworms (Sharma *et al*., 1979). Essential oil of *Cyathocline lyrata* (Poaceae; local name knot known) @ 0.1, 0.2 and 0.4% concentrations was found better effective against tapeworms and hookworms compared with piperazine phosphate and hexylresorcinol, respectively; whereas, compared favourably against nodular worms with that of hexyleresorcinol (Shrivastava, 1979). The essential oil of *Lantana camara* var. *aculeata* (Verbeuaceae; pulikampa) has exhibited good anthelmintic activity (Avadhoot *et al*., 1980). The anthelmintic activity of *Zanthoxylum alatum* has been found better than piperazine phosphate against earthworms and could be compared well against roundworms (Mehta *et al*., 1981). Likewise, the essential oil from the fruits of *Zanthoxylum limonella* (Rutacae; local name knot known) against earthworms, tapeworms and hookworms has been found better than that of piperazine phosphate (Kalyani *et al*., 1989).

The alcoholic extract of *P. granatum* showed anthelmintic activity as revealed by a dose dependant inhibition of transformation of eggs to filariform larvae of *Haemonchus contortus* (Prakash *et al*., 1980). The *Punica granatum* fruit rind powder @ 3 g/kg, its equivalent water extract and Morantel tartrate @ 0.01 g/kg were used to compare their effectiveness against gastro-intstinal nematodes of sheep; the reduction in EPG was 85, 80 and 99.96%, respectively. The anticestodal efficacy of the *P. granatum* fruit rind powder @ 3 g/kg, its equivalent water extract and Nilzan @ 5 mL/15 kg was evident from 76, 77 and 99.75% reduction in EPG in sheep naturally infected with mixed cestode species (Akhtar & Riffat, 1985a). The anticestodal efficacy of the glycosides (=225 mg/kg), alkaloids (=225 mg/kg b.w.) of *P. granatum* fruit rinds and Nilzan @ 5 mL/15 kg was 6±2, 95±12 and 100±0%, respectively in goats (Akhtar & Aslam, 1988). Therapeutic efficacy of *P. granatum* and *Cucurbita maxima* (Cucurbitaceae; tarbuz) against clinical cases of nematodiasis in calves has been documented (Pradhan *et al*., 1992).

Kaushik *et al*. (1981) evaluated extracts of 11 plants which proved lethal to *Ascaridia galli in vitro* including those from *Amomum aromaticum* (Zingiberaceae; bari ilaichi) root and rhizome, *Ammora wallichii* stem, *Anthocephalus indicus* (Rubiaceae; kadamba) stem and bark, *Calamintha umberosa* (Labiatae; local name knot known) plant, *Dalbergia latifolia* (Leguminosae; shishapa) stem and bark, *Datura quercifolia* (Solanaceae) fruit, *Datura metal* (Solanaceae; kaladhatura) plant, *Ficus religiosa* (Urticaceae; pipla) stem and bark, *Sentia myrtina* plant and *Sumplocos crataegoides* (Sumplocos; lodar) leaves. The anthelmintic activity of the essential oils of *Callistemon viminalis* (Myrtaceae; bottle brush) and *Anacardium occidentale* (Anacardiaceae; kaju) against earthworms and tapeworms has revealed these to exhibit *in vitro* efficacy better than piperazine phosphate. The activity of these oils against hookworms was comparable to that of hexyle resorcinol (Garg & Kasera, 1982). Anthelmintic activity of the essential oils of *Buddlea asiatica* (Loganiaceae; newarpati) and *Chloroxylon swientenia* (Rutaceae; bhirra) against earthworms, tapeworms and hookworms has been reported (Dengre, 1982). The essential oil obtained from oleo-gum resin of *Commiphora mukul* (Buberaceae; guggal) has good anthelmintic activity against tapeworms and hookworms comparable to that of piperazine phosphate and hexyl resorcinol (Kakrani & Kalyani, 1984).

Akhtar and Riffat (1984) evaluated efficacy of *Melia azedarach* against gastro-intestinal nematodes of goats. They have reported 99.4±12 and 90.2±16% reduction in EPG in *M. azedarach* fruit powder @ 30 mg/kg and Morantel tartrate @ 0.01 g/kg treated animals. In another study, *M. azedarach* fruit powder @ 20 mg/kg, its equivalent water extract, methanol extract, ethanol extract,

and piperzine @ 200 mg/kg were found to reduce EPG in *Ascaridia galli* infected chickens by 57.8±2.4, 15.7±4.3, 18.5±1.8, 67.8±4.6 and 75±2%, respectively (Akhtar & Riffat, 1985).

The whole plant powder of *Fumaria parviflora* @ 2 g/kg, its water extract, ethanol extract and Morantel tartrate @ 0.01 g/kg were compared for their efficacy against Trichostrongylus, Haemonchus and Trichuris nematodes in sheep. The respective reductions in EPG were 99.6±0.13, 29±4, 99.8±0.08 and 99.8±0.3% (Akhtar & Javed, 1985). *Saussurea lappa* roots powder @ 2 g/kg, its equivalent water extract, methanol extract and Morantel tartrate @ 0.01 g/kg reduced EPG by 99±21, 48±32, 100±21 and 100±36% in sheep infected with mixed species of nematodes (Akhtar & Hassan, 1985). Glycosides (=300 mg/kg) extracted from roots of *S. lappa* and Morantel tartrate @ 0.01 g/kg resulted in reduction of EPG by 93±11 and 92±8% in sheep, and 93±4 and 97±8% in buffalo-calves infected with mixed species of nematodes, respectively (Akhtar & Makhdoom, 1988).

Akhtar *et al*. (1985) reported 100±0%, 81±2% and 100±0.2% reduction in EPG in buffalo calves infected with *Neoascaris vitulorum* on day 15 PT treated with powdered *C. crista* seeds @ 4 g/kg or its equivalent methanol extract, water extract and Morantel tartrate @ 0.01 g/kg. In another study, glycosides @ 200 mg/kg extracted from *C. crista* seeds and Morantel tartrate @ 10 mg/kg caused 94±8% and 100±0% reduction in EPG on day 15 PT in sheep (Akhtar & Aslam, 1989) having mixed nematode infection (predominantly *Haemonchus contortus*). The anthelmintic activity of powdered *C. crista* seeds and its water and methanolic extracts was also reported in chickens (Fayomi breed) infected with *Ascaridia galli* by Javed *et al*. (1994). The results revealed 94±3%, 98±1% and 100±0% reduction in EPG by day 15 PT in chickens treated with powdered *C. crista* seeds @ 50 mg/kg, its equivalent methanol extracts, and piperazine adipate @ 200 mg/kg, respectively, whereas, water extract of *C. crista* seeds was least effective (24±15% reduction in EPG).

The *Psoralea coylifolia* seed powder @ 2 g/kg, its equivalent water extract, methanol extract, and Morantel tartrate @ 0.01 g/kg caused reduction in EPG of mixed gastro-intestinal nematodes in sheep on day 15 PT by 98±0.1, 99±0.09, 18±2 and 99.9±0.6%, respectively (Javed & Akhtar, 1986). Akhtar and Riffat (1986) reported anthelmintic efficacy of *Peganum harmala* against gastro-intestinal cestodes of goats. The treatments; *P. harmala* seed powder @ 3 g/kg, its equivalent water and methanol extract, and Nilzan @ 5 ml/15 kg resulted in 100±0, 89±32, 92±41 and 98±62% reduction in EPG, respectively. *Morus alba* stem bark powder @ 3 g/kg, its equivalent water extract, methanol extract and Morantel tartrate @ 0.01 g/kg b.w. were found to reduce EPG by 82±47, 79±69, 81±67 and 98±32%, respectively in sheep infected with mixed species of nematodes. Similar treatments except Morantel tartrate was replaced with Nilzan @ 5 ml/15 kg were used to treat cestode infection in sheep. This resulted in reduction in EPG by 85±66, 70±33, 79±42 and 99±29% in respective treatment groups (Riffat *et al*., 1986).

Lagenaria siceraria seeds powder @ 3 g/kg, its equivalent water extract, methanol extract and Niclosamide @ 100 mg/kg caused 89±14, 67±15, 81±13 and 91±13% reduction in EPG, respectively in sheep infected with cestodes, predominantly being the Moniezia and Avitellina species (Akhtar & Riffat, 1987). The essential oil of *Aglaia odorattissima* (Meliaceae) has been found effective against earthworms (Nanda *et al*., 1987).

Taenil, a combination of Male fern (Filix mass) 30%, *M. phillipinensis* 25%, Barbrung 22%, Senna 10%, Ajwain 10%, Sounf 7.5%, @ 6 g/12 kg have been reported to be effective in expelling Taenia species and *Dipylidium caninum* in 56.7% (68/120) dogs (John & Raghavan, 1987). Taenil @ 2 g/bird in feed was also found 100% effective in removing tapeworms of poultry within one week after treatment (Bagherwal, 1989). Powdered *Hyoscyamus niger* (Solanaceae; ajwain) seeds @ 3 g/kg, its equivalent water extract, methanol extract; and powdered *Morringa oleifera* roots @ 3 g/kg, its equivalent water extract, methanol extract and Oxfendazole @ 4.5 mg/kg reduced EPG by 95±5.6, 91.8±2.3, 85.5±9.8; and 94.4±2.6, 93.5±2.9, 91±3.5 and 98.8±1.3%, respectively in sheep having mixed nematode infection (Akhtar & Ahmad, 1990).

The oil (hexane extract) from the flowers of *Artemesia scoparia* (Compositae) has exhibited good anthelmintic activity (Naqvi *et al*., 1991). The essential oil of *Limnophila conferta* (Scrophulariaceae) has exhibited good anthelmintic activity (Reddy *et al*., 1991). The essential oil of *Artemisia pallens* (Compositae) has shown strong anthelmintic activity against *Pheritima posthuma, Taenia solium* and *Ascaris lumbricoides* even better than piperazine phosphate (Nakhare & Garg, 1991). The essential oil from the flowers of *Eupatorium triplinerve* (Compositae; ayapana) has shown to possess good efficacy against *Ascaris lumbricoides* and *Taenia solium* (Garg & Nakhare, 1993). Similarly, the aqueous extract of *Artemisia brevifolia* whole plant (local name afsanteen) @ 3 g/kg body weight was found to possess good anthelmintic activity against trichostrongylid nematodes of sheep (Iqbal *et al*., 2004).

Akhtar and Ahmad (1992) reported 89.8±4.3, 80.3±4.3, 89.2±3.7 and 96±5% reduction in EPG on day 15 PT in Beetal goats infected with gastro-intestinal cestodes treated with *Mallotus philippinensis* fruit powder @ 375 mg/kg, its equivalent water and methanol extract, and Nilzan (Levamisole hydrochloride + Oxyclozanide) @ 5 ml/15 kg, respectively. However, *M. phillipinensis* was not found effective against gastro-intestinal nematodes of goats (Jost *et al*., 1996).

Embellia seeds were found to be 100% effective in removing tapeworms of poultry. The evaluation was based on the absence of any worm, eggs or segments of tapeworms in faeces of chickens one week after the administration of Embellia seeds as pills compared with the

pre-treatment presence of parasitic forms (Qureshi & Sabir, 1979). Various extracts of *Vernonia anthelmintica* have been tested for their anthelmintic activity. Alcoholic extract has been found to possess maximum anthelmintic activity, followed by etheral extract, whereas, aqueous extract has no anthelmintic activity (Singh *et al*., 1985). The antinematodal activity of a mixed prescription of *Vernonia anthelmintica* seed (kali zeeri) and *Embellia ribes* fruit (babrung) was evaluated in goats by Javed and Akhtar (1990). The results revealed that EPG was reduced by 83±2, 27±3, 93±3 and 99.8±0.06% when goats were treated with mixed prescription @ 2 g/kg powder, its equivalent water extract, methanol extract, and Morantel tartrate @ 0.01 g/kg, respectively.

The crude aqueous extract of *Adhatoda vesica* roots @ 3g/kg body weight in sheep showed mild anthelmintic activity (37.4%) against mixed species of gastrointestinal nematodes (Lateef *et al*., 2003). The essential oils from the leaves of *Artabotrys odoratissimus* (Annonanceae; madan mast), inflorescence of *Capillipedium foetidum* (Poaceae) and the grass of *Cymbopogon martini* (Poaceae; lemon grass or rusa grass) have been reported to possess better anthelmintic activity compared to piperazine phosphate against *Pheretima posthuma* (earthworms), *Taenia solium* and *Ascaris lumbricoides* (Siddiqui & Garg, 1990).

The anthelmintic studies on the essential oils of *Nigella sativa* against earthworms, tapeworms, hookworms and nodular worms have exhibited fairly good activity against earthworms and tapeworms, the activity against hookworms and nodular worms being comparable with that of hexyle resorcinol (Agrawal *et al*., 1979). *Nigella sativa* seeds powder @ 2.5 g/kg, its equivalent water extract, ethanol extract and Niclosamide @ 0.1 g/kg caused 99±0.03, 74±4, 99±0.02 and 100±0.6% reduction in EPG of Moniezia in sheep (Akhtar & Javed, 1991). The active principles of *N. sativa* have also been evaluated for their anticestodal efficacy in goats. Glycosides (=200 mg/kg), Saponins (=200 mg/kg), Anthraquinones (=200 mg/kg) of *N. sativa*, and Nilzan @ 5 ml/15 kg reduced EPG by 94±5, 8±4, 6±3 and 97±4%, respectively (Akhtar & Aslam, 1997).

Kailani *et al.* (1995) evaluated antifasciolic efficacy of powdered *Nigella sativa* seeds, *Fumaria parviflora* aerial parts and *Caesalpinia crista* seeds in buffaloes. Maximum antifasciolic efficacy, judged on the basis of per cent reduction in EPG was shown by *F. parviflora* @ 60 mg/kg (93.2±0.5%) followed by *C. crista* @ 40 mg/kg (89.7±1.7%) and *N. sativa* @ 25 mg/kg (88.2±0.4%) at day 15 post-treatment (PT).

Economics of EVM. Up to now, the literature offers little data on the economic impact of promoting EVM. There are some indications that the use of EVM can have economic advantages.. Plant preparations that livestock keepers can prepare themselves from crude materials will cost them less than the allopathic alternatives. The plant materials scientifically validated for their anthelmintic activity in Pakistan (Akhtar, 1988; Lateef, 2003; Iqbal *et al*., 2004) are much cheaper than the commercially available compounds. Other sources also state that effective local plant medicines can reduce both household and project expenditures on commercial drugs (Lans, 2001). It is, however, advisable that control studies on the economics of using plant materials be carried out.

Limitations and strengths of EVM. Like any other type of medicine, EVM has both limitations and strengths. Common complaints by stockraisers, extensionists and scientists include:

- Some remedies are inconvenient to prepare or use
- Certain plants are available only at some times of the year
- Some treatments are ineffective
- Some practices are harmful
- Traditional diagnoses may be inadequate (typically identifying symptoms rather than underlying causes of a disease)
- Dosages are uncertain and remedies are not standard
- The resource base is deteriorating, making ingredients unavailable for preparing medicines

Understanding and documenting EVM. Both conventional and participatory methods have been used to document local knowledge in general and EVM in particular. Both approaches have their place, and their results can be complementary and possibly cross-validate each other. The choice and mix of methods should be flexible and depend on a study's objectives. Important is that the study fulfils at least basic scientific standards to counteract the frequent reproach that the data presented are anecdotal or based on relatively small samples. This does not mean to use complicated statistical methods, but sample sizes should be large enough to be significant, and the different strata of a community should be considered when selecting respondents from stock-raising communities. Depending on the study's objectives, men, women, and children should be interviewed, poor and rich farmers, healers and non-healers, users of EVM and non-users.

Validating EVM. Ethnoveterinary practices need to be validated before they can be widely promoted. Several levels of validation are possible:

- Tapping the experience of local people, for example, by asking them to rank local treatments according to their perceived efficacy
- Searching the literature for available information on the botany, phytochemistry, and *in-vitro, in-silico* (i.e., computer-based) and *in-vivo* tests, and other relevant aspects
- Conducting laboratory tests
- Conducting clinical tests on station or in experimental herds
- Conducting clinical tests in selected herds kept by smallholders and pastoralists
- Alternatively, farmers may conduct their own tests
- Monitoring the use of remedies in the field
- Studying a remedy's influence on production and

economic parameters

Validation for drug development. If a plant remedy is to be studied for its suitability for drug development, tests have to meet scientific standards. And if a preparation is to be commercialized, it has to be tested according to a country's laws.

Intellectual property rights. Traditional practices can be the starting point for the development of technologies, especially commercial drugs. The following activities can help ensure that the originators of the knowledge benefit from its wider adaptation and use:

- Lobby for policies and legalization to address the protection of the local flora from over exploitation and the issue of intellectual property rights
- Inform healers and other community members on IPR issues
- Provide name of informant (or local innovator) for any piece of information (e.g., a local practice, a method) that is not common knowledge in community
- Help local people to publish the information they provide under their name

This way it would be possible to pinpoint to specific individuals or groups as originators if a remedy turns out to be so valuable that patency issues arise.

CONCLUSIONS

The key issues highlighted above are as follows:

- Parasites are a major constraint in livestock production in Pakistan like throughout the world leading to significant production losses
- EVM knowledge is a great blessing for Indo-Pakistan subcontinent which can be used to increase livestock productivity, thus, may contribute in poverty reduction
- The knowledge with "village veterinarians" holds considerable benefit in the vast areas of Pakistan where the average farmer can seldom obtain or afford veterinary drugs
- EVM methods are appropriate for majority of livestock owners in the tropics
- Scientific validation and use of EVM can play a role in poverty reduction by improving productivity of animals through convenient, accessible and economical use of EVM practices
- The concept of local knowledge is global in its importance its practical application is very much at the local level where further investments should be concentrated in improving, if possible, a range of practices that are appropriate and sustainable
- The fact that medicinal plants are predominantly harvested in an unregulated manner undermines the whole industry. Yield from the wild is wholly unpredictable. Supplies are at the mercy of the weather, pests, and other uncontrollable variables. Farming these species would help even out the supply, regularize the trade, provide certifiable products of uniform quality, and make available to rural areas new sources of income. This would also indirectly help in poverty alleviation.

RECOMMENDATIONS

Keeping in view the importance and circumstantial evidence of EVM practices in Pakistan, Establishment of an Ethnoveterinary Research and Development Centre (EVRDC) is proposed. The objectives of the EVRDC will be i) compilation of a database on EVM practices in Pakistan, ii) scientifically validate the claims/effectiveness of EVM practices, and iii) promotion of validated EVM in livestock development.

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