



A Practitioners Perspectives: Traditional Tannin-Treatment Against Intestinal Parasites in Sheep and Cattle

Eilif Aas

Abstract

Around the world indigenous groups have traditionally used leaves, bark and roots containing tannins to treat diarrhea and intestinal parasites in humans and livestock. Traditional veterinary medicine has largely been replaced by pharmaceuticals throughout most of the world. My aim is to revitalize traditional veterinary practices and connect them to novel research. This study includes a literature review based mostly on three articles about condensed tannins (CT), all from New Zealand: Barry & McNabb (1999), Niezen et al. (1995 & 1996), and Høeg (1974). These are considered in light of my observations and experiences of beneficial effect from feeding sheep with high-tannin forage.

CT have been reported to increase absorption of essential amino acids in the small intestines. This results in increased wool growth, body mass, milk production and amount of protein in milk. CT seem to counteract protein loss caused by gut parasitism and may stimulate the immune system. CT may also inactivate parasite larvae during passage through the gut. Forage containing CT could offer a nutritionally-based ecologically sustainable system for controlling the effects of parasites. Tannins might also be a way to reduce the large amount of grain fed to sheep and cattle.

Traditional practices could be a means to better health and economy for traditional societies. This is especially important when crops containing CT are available in great amounts or can be grown in mountain or cold districts where grains are difficult to grow.

Introduction

50 years ago genetic resistance to gastrointestinal parasites was common in sheep and cattle all around the world, because less resistant individuals were culled through natural selection. With the introduction of chemical worming or anthelmintics, individuals with less resistance have

been allowed to reproduce and retain their lack of resistance in the gene pool. As anthelmintics have been used for many years, and in many cases not properly, parasites have developed resistance to most of the modern anthelmintics. Some parasites have even become multi-drug resistant (vanWyk et al. 1997).

Anthelmintics are harmful to dung organisms (Nilssen et al. 1999) and possibly also harmful to beneficial microorganisms in the digestive tract, especially in ruminating animals. Residues may be found in dung from drenched animals up to 30-40 days after treatment. Anthelmintics may cause cancer and liver damage in both humans and treated animals. Most organic certification agencies around the world have some restrictions on anthelmintics, even if few have been placed under total usage bans (Sprinkel 1999). Parasite resistance and multi-drug resistance to anthelmintics is a growing problem. This has been reflected by concerned individuals searching the ISI-database for solutions. For example, on February 22, 2002 there were 284 hits on a search for *Ivermectin* and *resistance*. Research from South Africa has uncovered field strains of *Haemonchus contortus* resistant to 5 mod-

Correspondence

Aas, Eilif, AmTewa LeHarim / Native Mountainers Foundation, 4985 Vegårshei, NORWAY.
etaasnam@online.no

Ethnobotany Research & Applications 1:31-37 (2003)

ern anthelmintics (vanWyk et al. 1997). Therefore, what are the real sustainable solutions to this problem?

1. Genetic resistance and immunoglobulins

In the American Livestock Breeds Conservancy "A Conservation Breeding Handbook" states:

"Exposure to parasites (in absence of anthelmintics) is the only practical way that individual animals can demonstrate their degree of parasite resistance.... Selection for parasite resistance can be most effectively accomplished by saving those animals that keep the bloom of health in the face of a challenge, and culling those who show the adverse effect" (Bixby 1999:9).

Heritable resistance to gastro-intestinal parasites is found in various levels in old breeds all around the world and is documented in: Gulf Coast Native sheep (Fernandez, Hoover and Miller 1994), St.Kilda Soay sheep (Smith et al. 1999), and Merino D'Arles (Gruner et al. 1998). Research in Poland (Gruner et al. 1998) shows a similar mechanism of defense against all the species of gastro-intestinal parasites found on the same natural pasture. (Out of 12 species - only 2 of them were found in significantly different numbers in respectively male and female lambs)

Immune system defenses called immunoglobulins, are in some cases specially designed to eliminate gastro-intestinal parasites. Of these, immunoglobulin E (IgE) has been considered the most important. Experiments in Louisiana suggest that "infection acquired on pasture, and not experimental infection or environmental allergens encountered when grazing or in the barn, stimulated an IgE response" (Miller et al. 1996). Sheaffer et al. (2001) writes that :

"Breast-fed babies have a greater resistance to gastrointestinal infections, because human milk contains large amounts of iron-binding lactoferrin and has the ability to maintain a low pH in the babies intestinal tract. In other words, with a more acid intestinal tract, their resistance to gastrointestinal infections is increased. This milk also contains large amounts of IgA and small amounts of IgG and IgM. A combination of lactoferrin and specific antibodies has a powerful bacteriostatic effect on *E. coli*. With the buffering capacity and bacterial fermentation of lactose, *E. coli* is inhibited and this allows for normal growth of *Lactobacillus bifidus*.... "IgA has the ability to attach itself to the mucosal epithelium of the intestines and prevent the attachment, and possibly invasion of, specific infectious agents. It is the first-line defense in infections that enter via mucosal surfaces."

2. Biological control

95-99% of parasite eggs deposited on a pasture do not survive, largely due to abiotic factors such as extremes in temperature and desiccation (Besier & Dunsmore 1993; Moss & Vlasoff 1993). Nematophagous fungi can be used to reduce the worm burden even more (Niezen et al. 1996). In an organic pasture with a diversity of plant species and good soil structure, there will also be a diversity of micro-organisms in the soil, and it will be harder for the parasites to survive. Resting of the pasture is essential to survival of diversity, because if the pasture is not given rest, the bad tasting plant-species will soon dominate, as the good tasting are killed by overgrazing.

In the temperate regions of the world, a large portion of the fields have to be devoted to production of hay or silage for winter use, and parasite-control becomes easier, as one can have grazing animals on each piece of land only a few times each season. Rotation between animal-species (cattle, sheep & horses) is another way to reduce the parasite problem.

3. Prevent overcrowding

Parasites are one of nature's ways to prevent overpopulation. With overcrowding the weakest animals fall prey to parasites, as they are forced to eat parasite-contaminated grass and have less power to fight back the parasites. Reducing the number of animals and giving them plenty of good food is also a strategy against gastro-intestinal parasites. On Färöyene, halfway between Norway and Iceland - there was a ruling document called the Seyda-letter, that regulated how many sheep each farm could have and how they should move between mountain-pastures and domestic pastures. The sheep were feed outside most of the winter, but people knew that it was important to feed the lambs with hay in hard periods of the winter. (Husdyr i Norden 1993) This is a good strategy, as the weakest were given special care and prevented from succumbing to parasites.

4. Tannins

Tannins (polyphenols) are one category of organic compounds commonly found in plants. Malvidin, found in the skin of blue grapes and purple fava beans, is one tannin. Cyanidin found in apple rind, blackberries, red cabbage and elderberries is another. Pelargonidin, found in strawberry fruit and pomegranate flowers, is a third. Each of these are classified as anthocyanins.

Tannins are classified into two groups ; Hydrolysable and condensed (or non-hydrolysable) tannins. The hydrolysable tannins are usually compounds containing a central core of glucose or other polyhydric alcohol esterified with gallic acid (Gallotannins) or hexahydroxy-diphenic acid (ellagitannins).

Condensed tannins are mostly flavolans or polymers of flavan-3-ols (catechins) and / or flavan 3:4-diols (leucoan-

tocyanidins). They are more resistant to degradation and typically show a tendency to polymerize in hot acid solutions to yield reddish-brown colored products. This is the well-known "phlobaphene" reaction and is used as a test for leucoanthocyanindins. (Walker 1978:36)

All around the world leaves and bark of various species containing tannins (or tannic acid as it is many times called) have been used against gastro-intestinal parasites or worms. At the same time, tannin-containing leaves, and bark have been used as food or appetizers for sheep, cattle and horses. However, few people have been aware of their medical properties. Balick and Cox (1996) have stated that many cultures do not make a clear distinction between food and medicine. I consider this to be same for food and medicine fed to animals. For instance aspen fed to cattle, sheep and horses may serve as both food and medicine. Some of these remedies against worms taste very astringent to humans, but cattle and sheep are very found of the taste.

4a. How do tannins work?

In New Zealand there has been on-going research on condensed tannins (CT) for several years. Most of the information on this subject presented here is from Barry & McNabb (1999) and Niezen et al. (1995 & 1996). Some browsing animals such as deer and moose have evolved production of CT-binding proline-rich salivary proteins to reduce the anti-nutritional effect of high CT concentrations (Austin et al. 1989). In some cases these salivary proteins can be highly specific, as in the case of moose (*Alces alces*) and only bind the type of CT that is present in the normal diet eaten and will not bind other types of CT (Hagerman & Robbins 1993). Studies conducted on domesticated sheep and cattle (i.e. grazers) indicate that they do not produce CT-binding proteins in their saliva (Austin et al. 1989) This is indeed fortunate, as it means dietary CT can be used to manipulate digestion in sheep and cattle fed on fresh forage (Barry & McNabb 1999). CT reduce protein degradation in the rumen by binding to protein at pH 7.5 - 3.5 and dissociating and releasing protein when pH falls below 3.5 post ruminally. By this mechanism, more essential amino acids can be absorbed in the small intestines, which should increase wool growth, body growth and milk secretion and also increase the amount of protein in the milk.

"Ruminants grazing forage diets are subject to a number of diseases, some of which have a nutritional component. Two such conditions are rumen frothy bloat in cattle and internal parasite infections in grazing sheep, cattle, deer, and goats. Both are currently controlled by regular oral administration of chemicals, detergent in the case of bloat to disperse the foam and anthelmintic drenches in the case of internal parasites to kill the parasites. These remedies control both conditions in the short term but have long time prob-

lems. First, they treat the symptoms and not the cause. Second, they cause consumer concerns about sustained use of chemicals and possible product residues, leading to longer withholding periods. Finally, in the case of anthelmintics, sustained regular use over many years has led to the development of parasites that are resistant to the drugs used" (Barry 1999:269).

Grazing CT-containing legumes have long been known to eliminate bloat (Jones et al. 1973). The minimum CT concentration to make forage bloat-safe was not known. This has recently been proposed to be 5g CT/kg dry matter (DM) or greater (Li et al. 1996). High CT concentrations might depress voluntary feed intake (VFI) as with big trefoil (*Lotus pedunculatus* L) measured to 63 and 106 g CT /kg DM, that substantially depressed (VFI) in sheep (-27%) (Barry & Duncan 1984), while medium CT concentrations in sulla (*Hedysarium coronarium* L) on 45g/kg DM, and in birdfoots trefoil (*Lotus corniculatus* L) - 34 and 44g/kg DM, had no effect on VFI (Terril et al. 1992b; Wang et al. 1996a,b). CT will preferably react with proteins in the forage of the CT-containing plants and beneficial effects of forage mixing can only be expected if the CT content is extremely high and the protein content relatively low in the CT-containing plant. Surplus or "free"CT may bind with proteins in the non CT-containing plant (Barry, 1999:267) I consider this to be the case with oak (*Quercus* spp) and also aspen (*Populus tremula* L)

"Subsequent studies have shown that lambs grazing CT-containing forages (*Hedysarium coronarium* and *Lotus pedunculatus*) are better able to tolerate parasite infections than lambs grazing non CT-containing forage (lucerne), and show both increased growth and lower gut-worm burdens (Niezen et al. 1995) Two possible mechanisms could be involved. First, improved essential amino acid supply from the action of the CT may counteract the protein loss caused by gut parasitism and may stimulate the immune system, and second the CT may directly react with and inactivate parasite larvae during passage through the gut. (Lower values of *Trichostrongylus colubriformis* and *T. axei* in lambs grazing sulla, as a direct effect of CT, is documented by Niezen et al. 1995:287) Forages containing CT may offer a nutritionally-based system for controlling the effects of parasites which is ecologically sustainable, thus allowing use of anthelmintic drugs to be reduced" (Barry 1999:269).

4b. My own experience with tannin-treatment of sheep.

In 1992, my sheep came in contact with an aggressive strain of gastrointestinal parasite, mostly on one specific pasture. I had to impose new strategies for fighting the parasites. I started to feed affected lambs with dried leaves of aspen (*P. tremula*) in the winter of 1993/94, and provided fresh branches of the same to some adult sheep from the winter of 1992-93.

As an ordinary farmer, I didn't involve fecal egg count, and could not determine which species of parasites the sheep were infected with, other than what I learned from necropsy of two lambs. But, what I saw was that I was able to fight back the parasites with the leaves and bark I provided for the sheep. From the summer of 1996 I started to systematically provide leaves of oak, aspen and salix to most sheep on pasture (as documented by Svalheim 1996: 3.3.7) and even if some lambs were infected, they were in good shape by fall (in contrast to 1993). In fact I only lost one sheep from the winter of 1993/94 until 19th of March 1997, and that was a sheep grazing on a faraway field (Kil) where I could not provide many leaves. (Necropsy was impossible because it had already lain some days when I found it, but I suspect the cause of death was to be found in the gastro-intestinal tract)

I had four sheep put into a pasture with some worm burden (Lunde) in May 1996. Mostly birch (*Betula pubescens* Ehrh.) and a few runners of aspen (*Populus tremula* L) were present in the field. Three black sheep that were not raised in my flock were included in the field. At least two of these were treated with anthelmintics as lambs (1995). The three black sheep showed signs of gastrointestinal parasites far into the winter, but the fourth (a white sheep raised from my own flock) showed no such sign -- indeed its dung were perfectly pelleted, and showed excellent conditions all summer and winter. This white sheep was treated with aspen leaves the winter of 1993/94 because it was infected with parasites on the lakeside pasture early in the summer of 1993. Then, on pasture, it got diarrhoea and I had to shear its tail to wash away some fly maggots. Later it was sent to the pasture on Kil, and I didn't discover its bad condition until it was sheared in fall. But, it recovered and was later very resistant to parasite infections.

On the lakeside pasture where my sheep first came in contact with the aggressive strain of intestinal parasites mentioned earlier, I had a total number of 16 sheep during the summer of 1996. From the 18th of June I started to cut down oak branches for the sheep, as a response to loose dung. The sheep had a great appetite for the leaves and after 5 days the dung was back to normal. Only 1 sheep showed signs of parasitism into winter; one young ewe not raised in my flock, and treated with anthelmintics in 1995. All the rest of them, lambs and adults, were in perfect condition, except from a serious ear-infection of one male lamb. Most of the reminding sheep were never treat-

ed with anthelmintics. This is a contrast to 1993, when grazing the same pasture, but not given the oak, many of those lambs were infected by parasites, and showed signs of parasites far into winter.

On the 19th of March 1997, all my sheep were removed by "animal welfare" officials and later killed (I have been told). These officials claimed that I should feed the sheep with grain, give anthelmintic treatments and put the ewes inside for lambing. I refused as I said they had no legal right to force me into such a practice and it would destroy my research on immunity and natural treatments. In April 1998 I was convicted in a local court and sentenced to not tend sheep or cattle five years, beginning with the Spring of 1997.

I had to place my field research on hold because of this action from the "animal welfare" officials. My research has thus been retarded some 10 years because of this action and because I had animals with ancestral and ailment records many years back. Of course it will cost me a lot to get a flock of the same size and of the same races again. But, I have some suggestions for further research on the subject. I consider it to be a very important area of research as it can discourage the destructive practice of anthelmintic treatment and grain-feeding of ruminators. I therefore ask the following questions:

1. Will there be different immune responses later in young lambs treated with anthelmintics versus never treated?
2. How do tannins of oak and aspen influence proteins and digestion in sheep and cattle? (compared to CT in sulla and *Lotus corniculatus*; Niezen et al)
3. Research on these species (tannin-content, structure, feeding on sheep and cattle) e.g., *Populus* spp, *Salix* spp, *Quercus* spp, *Psidium* spp, *Geranium maculatum* (root, wild cranesbill) *Calluna vulgaris*, *Vaccinium myrtillus*, *Potentilla erecta* (root), *Acacia angustissima*, *Manilkara zapota*, *Euclea divinorum*, *Calliandra calothyrsus*
4. How do tannins influence immunoglobulines?
5. Does fresh bark influence teeth-condition in old sheep?
6. How can we determine if parasites are present? My view is that healthy sheep have pelleted dung, and mucus and blood in dung is a sign of parasite presence. Usually, if a sheep has internal parasites from grazing, the mucus and dung will leave by midwinter if fed aspen-bark.

Grazing animals need leaves and bark for their health. I have seen many cases where animals have been allowed to walk outside in a fenced yard, but not given branches from which to eat bark. The result has been severe damage to trees inside the fence. If not given any branches, they will destroy every tree inside the fence. First apple,

then *Salix*, cherry, even spruce and pine, as long as the bark is not too coarse.

4c. Sustainable harvest of tannin trees.

Of the local trees I would first of all recommend the use of oak, aspen and different *Salix* species. Each species has its own season and I would suggest

Oak: Branches cut down from June to August, especially for animals feeding on lush green pasture. If the bark of the trunk shall be used in tanning, it is easier to peel off the bark if the trunk is cut down in the next spring.

Aspen: Some leaves for fresh consumption, some more stored as dried leaves for winter use, but most cut down in winter as a source of fresh bark. It is very hardy and grow up to at least 70 degrees north in Norway. It is easy to propagate from root cuttings and is seldom over-harvested. Aspen can be cut at ground level and plenty of runners will appear if there is sunlight and it is not constantly browsed. It should be thinned and the best size to harvest for winter use is 5-10 years of fast growth, but older fast growing trees are also good. Sheep and cattle can be let out all winter to gnaw bark, and as the branches dry up in the spring, it can be chopped and used for firewood, for making bread, etc. The larger trunks are good as a horizontal fence, as they are very durable and light weight when dry. In parts of Norway there has been a tradition of harvesting aspen leaves from the ground in the fall. The ground below a cluster of trees, called "ospedøtter", were cleaned in late summer, and then when the leaves fell following a heavy frost in late September or early October, they were swept together and brought into the barn for winter use as a feed stuff.

Salix: The best time to harvest is in spring, as fresh branches, and it is also best fed outside. This species is also good for firewood. It should not be cut at ground-level, but at least 2 meters above ground, to prevent it from being killed by grazing animals. It can then be coppiced every second, third or fourth year. Many *Salix* species will put out roots if a branch is put in moist soil in the spring. It is therefore well suited for hedgerows and living fence-posts. *Salix alba* L or *S. caprea* L. have been planted and pruned for hundreds of years in parts of Norway; and the pruned or coppiced tree is called "seljekall"

4d. Traditional "tannin" treatment of worms around the world.

In Scandinavia, dried leaves of many tree-species have been fed to cattle, sheep and horses as winter forage. Additionally, some fresh bark in spring, and fresh leaves in summer have also been used. It have been used as a foodstuff or appetizer for sheep, cattle and horses, but few people have been aware of its medical properties. In the historic record, aspen is mostly said to be used against worms in horses, but the natural reason for this is that sheep and also cattle were much less subject to in-

testinal parasites because they used to feed on mountain- and forest-pastures most of the summer. As noted by both Sæland and Høeg; aspen was the most important tree for the harvest of leaves in the area where it is common, (mostly eastern mountain-valleys and lowland).

On the west-coast and mountain districts *Calluna vulgaris* and *Vaccinium myrtillus* were important forage plants and as with aspen were considered to raise the milking capacity of cattle. In parts of coastal Norway this was the only winter-food for free ranging sheep, and still is for one strain of sheep. Another plant, that is referred to as only medicinal, is *Potentilla erecta*. Its root contain about 10% tannin, but can come close to 20 % in some cases. It was used as a tonic against worms in both humans and live-stock.

I have not yet searched much in ethnobotanical literature from the rest of Europe and central/ north Asia, but I expect to find many of the same practice in the Pyrenees, Kaukas, Tirol and Switzerland where there are pastoral cultures closely related to the cultures in the mountain districts of Norway.

Many places in America and Africa also have traditional herbal treatments for intestinal parasites and diarrhoea in humans. These follow the same pattern as animal treatments from Europe. Some examples are:

- According to Kindscher and Hurlburt (1998) the Hockak (Winnebago) of Wisconsin use *Populus grandidentata*, *P. tremuloides*, *Quercus rubra* and apple bark to cure worms.
- Among the Tzotzil and Tzeltal Maya of Chiapas: *Acacia angustissima* is used to cure bloody diarrhea (Berlin et al. 1996).
- In Belize -- Guava (*Psidium* spp) is used against diarrhoea (Don Eligio Panti) and as Schrader (1993) write; "Denn die Guava wirkt offenbar nur wegen ihres Tannin-Gehaltes. Dieser Gerbstoff kann Zellen abschirmen; bei Durchfall etwa überzieht er die Schleimhäute mit einem Film und schützt sie dadurch - doch das is seit langem gekannt."
- In Western Tanzania and Kenya is *Euclea divinorum* (Ebenaceae) used medicinally and as a dietary additive by Maasai, Batemi, Luo, and other people in Western Tanzania and Kenya ... "we were impressed by the high tannin content of *E. divinorum*...." (Grinsven et al. 1999)
- Among the Yucatec Maya, *Manilkara zapota* (mostly bark, also roots and fruits) is employed for diarrhoea and is best known for yielding chicle. The bark is also known to be rich in tannins (Ankli et al. 1999).

Literature Cited

Ankli, A., O. Sticher, and M. Heinrich. 1999. Ethnobotany of the Yucatec Maya. *Economic Botany* 53(2):149

- Austin, P.J., L.A. Suchar, C.T. Robbins & A. E. Hagerman. 1989. Tannin-binding proteins in salvia of deer and their absence in salvia of sheep and cattle. *Journal of Chemical Ecology* 15 1335-1347.
- Balick, M.J. & P.A.Cox. 1996. *Plants People and Culture, the Science of Ethnobotany*. Scientific American Library, The New York Botanical Garden Press :70
- Barry, T. N. & S. J. Duncan. 1984. The role of condensed tannins in the nutritional value of *Lotus pedunculatus* for sheep. 1. Voluntary intake. *British Journal of Nutrition* 51:485-491.
- Barry T.N. & W.C. McNabb. The implication of condensed tannins on the nutritive value of temperate forages fed to ruminants. 1999. *British Journal of Nutrition* 81:263-272.
- Berlin B., D.E. Breedlove, X. Lozoya, M. Meckes, M.L. Villarreal, J. Tortoriello, & M.G. Rodriguez. 1996. Pp. 204-53 in *Medical Ethnobiology of the Highland Maya of Chiapas, Mexico: The Gastrointestinal diseases*. Princeton University Press, New Jersey.
- Besier, R.B. & J.D. Dunsmore. 1993. The ecology of *Haemonchus contortus* in a winter rainfall region in Australia: the development of eggs to infective larvae. *Veterinary Parasitology* 45:275-292.
- Bixby, D. 1999. To Worm or Not to Worm. *The American Livestock Breeds Conservancy News* 16 (1):9.
- Fernandez, J.M., D.T. Hoover & J.E. Miller. 1994. The Gulf Coast Native Sheep: A Breed Tailored for the South. *The American Livestock Breeds Conservancy News* 16(1):1&8.
- Grinsven, M., M. L. Parkipuny, & T. Johns. 1999. *Euclea divinorum* (Ebenaceae) bark is a high-potential tanning material. *Economic Botany* 53(2):220.
- Gruner, L., A. Malczewski, J. Gawor, B. Nowosad, J. Krupinski & J. Bouix. 1998. Stability of nematode parasite communities of sheep in a Polish flock in relation to years, seasons and resistance status of host. *Acta Parasitologica* 43(3):154-161.
- Gruner, L., J. Bouix and J. VutienKhang. 1998. La résistance génétique aux parasitoses internes : exemples de travaux engagés en France et en Pologne. *Le Point Vétérinaire* 29(195):33-41.
- Hagerman, A. E. & C. T. Robbins. 1993. Specificity of tannin-binding salivary proteins relative to diet selection in mammals. *Canadian Journal of Zoology* 71:628-633.
- Høeg, O.A. 1974. Planter og tradisjon. *Universitetsforlaget* :76-105.
- Husdyr i Norden. 1993. *Årbok for Norsk Landbruksmuseum*. Landbruksforlaget, Oslo :15.
- Kindscher K. & D.P. Hurlburt. 1998. Huron Smith's Ethnobotany of the Hockak (Winnebago). *Economic Botany* 52(4):362-364
- Li, Y. G., G. Tanner & P. Larkin. 1996. The DMCA-HCl protocol and threshold proanthocyanidin content for bloat safety in forage legumes. *Journal of the Science of Food and Agriculture* 70:89-101.
- Miller, J.E., D.G. Baker, L.J. Gershwin, J. Canales & M.T. Kearney. 1996. Serum IgE levels in dairy calves: evaluation of parasite and pasture exposure as possible determinants of IgE response. *Veterinary Parasitology* 63: 337-343
- Moss, R.A. & A. Vlasoff. 1993. Effect of herbage species on gastrointestinal roundworm population and their distribution. *New Zealand Journal of Agricultural Research* 36:371-375.
- Niezen, J.H., T.S. Waghorn, W.A.G. Charleston and G.C. Waghorn. 1995. Growth and gastrointestinal nematode parasitism in lambs grazing either lucerne (*Medicago sativa*) or sulla (*Hedysarum coronarium*) which contains condensed tannins. *Journal of Agricultural Science* 125:281-289.
- Niezen, J.H., W.A.G. Charleston, J. Hodgson, A.D. Mackay & D.M. Leathwick. 1996. Controlling internal parasites in grazing ruminants without recourse to anthelmintics: approaches, experiences and prospects. *International Journal of Parasitology* 26 (8/9):983-992.
- Nilssen, A.C., K. Åsbakk, R. Haugerud, W. Hemmingsen & A. Oksanen. 1999. Treatment of Reindeer with Ivermectin - effect on dung insect fauna. *Rangifer* 19(2):61-69.
- Sæland, J. 1944. Sau og sauestell - Lærebok i saueal, *Gvarv*:143-146
- Schrader C. 1993. Die Spur der grünen Medizin. *Geo Wissen* 1:150
- Shaeffer, E.C., A.L. Sheaffer & B.M. Sheaffer. 2001. *The Natural Veterinarian Acres U.S.A.* (2):38
- Smith, J.A., K. Wilson, J.G. Pilkington & J.M. Pember. 1999. Heritable variation in resistance to gastrointestinal nematodes in an un-managed mammal population. *Proceedings of the Royal Society of London series B-Biological Sciences* 266(1425):1283-1290.
- Sprinkel, S. 1999. Transitions - Certified Organic Industry News. *Acres USA* 1:6

Svalheim, E. 1996. *En studie av kulturlandskapet i Vegårshei*

Terril, T.H., A.M. Rowan, G.B. Douglas & T.N. Barry. 1992. Determination of extractable and bound condensed tannin concentrations in forage plants, protein concentrate meals and cereal grains. *Journal of the Science of Food and Agriculture* 58:321-329.

vanWyk, J.A., F.S. Malan & J.L. Randles. 1997. How long before resistance makes it impossible to control some field strains of *Haemonchus contortus* in South Africa with any of the modern anthelmintics? *Veterinary Parasitology* 70:111-122.

Walker, J.R.L. 1978. The Biology of Plant Phenolics. *Studies in Biology* no 54. Edward Arnold, London

Wang, Y., G.B. Douglas, G.C. Waghorn, T.N. Barry & A.G. Foote. 1996a. Effect of condensed tannins in *Lotus corniculatus* upon lactation performance in ewes. *Journal of Agricultural Science, Cambridge* 126:353-362

Wang, Y., G.B. Douglas, G.C. Waghorn, T.N. Barry, A.G. Foote & R.W. Purchas. 1996b. Effect of condensed tannins upon the performance of lambs grazing *Lotus corniculatus* and lucerne. *Journal of Agricultural Science, Cambridge* 126:87-98

Editors Note

Ethnobotany Research and Applications is eager to publish observations by traditional practitioners. Such observations do not need to be couched within the restrictions of science, but are reviewed by scientists with expertise in the topic. Eilif Aas has shared his stressful experiences and observations with some references to literature (although citation of literature is not expected of a practitioner). Hopefully he is able to resume animal husbandry and continue to make observations about plants and animals important in Norwegian culture.