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Plants as De-Worming Agents of Livestock in the Nordic Countries: Historical Perspective, Popular Beliefs and Prospects for the Future

By *P.J. Waller*[1], *G. Bernes*[2], *S.M. Thamsborg*[3], *A. Sukura*[4], *S.H. Richter*[5], *K. Ingebrigtsen*[6] and *J. Höglund*[7]

[1]Dept. Parasitology (SWEPAR), National Veterinary Institute, Uppsala, Sweden, [2]Dept. Agric. Research Nth. Sweden, SLU, Umeå, Sweden, [3]Dept. Anim. Science and Animal Health, The Royal Veterinary and Agricultural University, Frederiksberg, Denmark, [4]Dept. Basic Vet. Science, Univ. Helsinki, Finland, [5]Inst. Exp. Pathology, Univ. Iceland, Keldur, Reykjavik, Iceland, [6]Dept. Pharmacology, Microbiology and Food Hygiene, Norwegian School Vet. Medicine, Oslo, Norway, and [7]SWEPAR, Swedish University of Agricultural Sciences, Uppsala, Sweden.

Waller PJ, Bernes G, Thamsborg SM, Sukura A, Richter SH, Ingebrigtsen K, Höglund J: Plants as de-worming agents of livestock in the Nordic Countries: historical perspective, popular beliefs and prospects for the future. Acta vet. Scand. 2001, 42, 31-44. – Preparations derived from plants were the original therapeutic interventions used by man to control diseases (including parasites), both within humans and livestock. Development of herbal products depended upon local botanical flora with the result that different remedies tended to develop in different parts of the world. Nevertheless, in some instances, the same or related plants were used over wide geographic regions, which also was the result of communication and/or the importation of plant material of high repute. Thus, the Nordic countries have an ancient, rich and diverse history of plant derived anthelmintic medications for human and animal use. Although some of the more commonly used herbal de-wormers were derived from imported plants, or their products, many are from endemic plants or those that thrive in the Scandinavian environment. With the advent of the modern chemotherapeutic era, and the discovery, development and marketing of a seemingly unlimited variety of highly efficacious, safe synthetic chemicals with very wide spectra of activities, herbal remedies virtually disappeared from the consciousness – at least in the Western world. This attitude is now rapidly changing. There is a widespread resurgence in natural product medication, driven by major threats posed by multi-resistant pest, or disease, organisms and the diminishing public perceptions that synthetic chemicals are the panacea to health and disease control. This review attempts to provide a comprehensive account of the depth of historical Nordic information available on herbal de-wormers, with emphasis on livestock and to provide some insights on potentially rewarding areas of ”re-discovery” and scientific evaluation in this field.

plant anthelmintics; herbal remedies; helminth parasites; livestock; man.

Introduction

The use of plants, or their extracts, for treatment of gastro-intestinal parasites in humans and livestock is steeped in antiquity. It was Claudius Galënus (AD 130-200), a Greek physician of Pergamon, who received notoriety for applying medicines prepared from vegetable substances by infusion, or decoction. These became known generically as ”galenical” drugs, or preparations, and established the foundation for modern veterinary pharmacology. It is with some interest to note that the approach taken by Galënus was in contrast to the Hippocrates / Paracelsus school of thinking which espoused treating ”like with like” (*similia similibus curantur*), that later formed the basis for Hahneman’s concepts of homeopathy (*Vaarst* 1996).

In medieval times, plants with reputed anthel-

mintic properties were often mixed with mineral salts (arsenic, copper etc.), or more esoteric materials (blood, faeces, fluids from reptiles, wild animals etc.) to form quite bizarre and often hazardous concoctions – for both parasites and hosts alike. With time, trial and error, such preparations were refined in an attempt to at least moderate the undesirable consequences to the host, but with the advent of safer and more effective synthetic anthelmintic compounds, they rapidly disappeared from the veterinary anthelmintic market (*Gibson* 1980). Nevertheless, it is of interest to note that the World Health Organisation has recently estimated that 80% of the population of developing countries rely on traditional medicine, mostly plant drugs, for their primary health care needs (*Danøe & Bøgh* 2000). Also in a global context, modern pharmacopoeia still contain in the order of 25% drugs derived from plants and many others which are synthetic analogues built on prototype compounds isolated from plants.

However, there has been a resurgence of interest in traditional health practices throughout the world. In veterinary medicine, this interest encompasses ethnobotany and the use of herbal remedies. Workshops, forums and conferences are occurring with increasing regularity, which is obviously being driven by a concomitant increasing level of research acitvity. The forces responsible for this momentum are manifold. These include the perception that ”natural is nice”, concerns of synthetic drug residues in the environment and the food chain, and particularly the spectre of rapid emergence of multiple resistant pest organisms through misuse and overuse of these modern drugs.

Within the Nordic countries, the same holds true. This region of the world is at the vanguard of the organic farming movement, with major emphasis on livestock production. Many progressive and educated farmers who have chosen to farm livestock organically are well aware of the importance of nematode parasites affecting the productivity of their animals and adopt grazing strategies aimed at evading, or mitigating the effects of parasites in their animals (*Svensson et al.* 2000). However, others show less awareness and management of grazing livestock is largely determined by herbage supply and not by parasitological considerations (*Vaarst et al.* 1996). One specific strategy is to graze livestock on plants with purported anthelmintic properties. For example, a survey of Danish organic dairy farmers with 255 respondents, revealed the use of herbs in the leys on 26% of the farms. Of these, caraway (*Carum carvi*) [56%], parsley (*Petroselinum crispum*) [20%], chicory (*Cichorium intybis*) [10%], chervil (*Anthriscus cerefolium*) and dill (*Anethum graveolens*) [14%], used singly or in combination, were the most commonly used plants (*Smidt* 1997). For the purposes of deworming, the feeding of wormwood (*Artemisia absinthium*), mugwort (*A. vulgaris*), chicory (*Cichorium intybis*) and common tansy (*Tanacetum vulgare*) were expected by farmers to have anthelmintic properties (*Smidt* 1997).

In addition, there has been a major commitment to the development of sustainable disease control systems, which by definition means the integration of a range of non - chemical methods with the minimal use of drugs, to insure continued effectiveness for the foreseeable future. Control of internal parasites of livestock by these means has been a major focus of research activities in the Nordic countries for several years (*Thamsborg et al.* 1999).

Research in the Nordic countries on anthelmintic properties, or protective effects, of local plants against helminth parasites of livestock is very recent and limited at this stage to studies on tanniferous forages (*Kahiya et al.* 1999, *Bernes et al.* 2000). However, many of the earliest written reports of anthelmintic properties of plants originate from this region of the world

(eg., the writings of Henrik Harpestræng in the early 13th century). The purpose of this review is to provide a historical perspective and to present our view of the potential and possibilities for the use of plants that are endemic, or thrive in the Nordic environment, as de-worming agents. Due to the relatively wide variation in climate, soil, altitude etc. within this limited area, the total number of plant species is quite large.

Also, a brief consideration is made of the recent developments in the use of specialized crops, the so-called "nutraceuticals", which are bioactive crops that are either grazed, or fed after preservation, with the main purpose of preventing or curing disease. The ultimate objective would be to use these plants as additional means for the further development and refinement of sustainable parasite control systems of livestock.

Plants and parasites

There is an inextricable association between plants and parasites of livestock. Pastures provide the link between the free-living and the parasitic phases of helminth parasites for all grazing animals. At different stages of growth, pasture species may facilitate or impede the survival of free-living populations, the establishment of parasite burdens and lessen or intensify the effects of parasitism on the host. Competent management of pastures is needed for the twin goals of efficient conversion of herbage to animal products and effective control of gastrointestinal parasites.

Indirect effects of plants on parasites

It is reasonable to assume that the height, density and form of plant growth could affect the micro-environment of the free-living stages of parasites and thus play a role in transmission of infection. Because of the necessity of moisture films for movement of nematode larvae from faecal deposits to herbage, it might be expected that pastures consisting largely of erect, tall growing species would provide less protection from desiccation, and from removal by heavy rain, than those consisting primarily of prostrate species. Indeed, a factor considered to mitigate the high rates of contamination following increased stocking rates is the decreased availability of herbage, which provide conditions less favourable for the development and survival of the free-living stages of nematode parasites (*Thamsborg et al.* 1996). Although there has been a number of such ecological studies, little has been done in the Nordic countries and this aspect is outside the scope of this review. However, it is important to recognise these indirect effects of herbage when any grazing studies are conducted on plants with purported anthelmintic properties. It must be established that observed effects are directly plant related and not due to effects on development and survival of the free living stages of parasites, or the provision of an enhanced level of nutrition which helps the animal to rapidly mount an immune response against incoming or resident parasite infections.

Direct effects of plants on parasites

This relates specifically to anthelmintic properties of plants. Although there is a large and diverse range of herbal de-wormers that are used throughout the world, particularly in the Asian and African countries, generally there is a lack of scientific validation of the purported anthelmintic effects of these products. Evidence to date is almost entirely anecdotal. This also applies to the reports of de-worming properties of herbal preparations that have either Nordic origins, or a long history of use in this region (for some historical background, see *Grove* 1990). These can be broadly classified into the following classes (see Table 1):

Table 1. Plants said to have been used against internal parasites in the Nordic countries; their scientific names and names in English and in the Nordic languages.

Plant family	Scientific name	English	Swedish	Norweigan	Danish	Finnish	Icelandic	Host	Target	Part used	Reference
Lichens											
	Cetraria islandica	Iceland moss	islandslav	islandslav	lav *	jäkälä	fjallagrös *	M	H	W	8, 9, 33, 36, 37, 41
Ferns											
Dennstaedtiaceae	*Pteridium aquilinum*	bracken fern	örnbräken *	einstape *	ørnebregne *	sananjalka *	arnarburkni	M	H,C	R	9, 21, 35, 45
Dryopteridaceae	*Dryopteris carthusiana*	toothed wood fern	skogsbräken	broddtelg	smalbladet mangeløv	metsäalvejuuri *					31
	D. expansa	spring wood fern	nordbräken	sauetelg	finbladet mangeløv	isoalvejuuri *	flekkaburkni				31
	D. filix-mas	male fern	träjon *	ormetelg *	almindelig mangeløv *	kivikkoalvejuuri *	stóri burkni *	M,A,S,H	H,N,C,T	R	4, 5, 8, 9, 10, 30, 31, 33, 35, 44, 45, 53, 54, 70
Polypodiaceae	*Polypodium vulgare*	polypody	stensöta *	sisselrot	engelsød	kallioimarre *	köldugras	M	H,C	R	45, 49
Coniferous trees											
Pinaceae	*Picea abies*	spruce	gran	gran *	rødgran	kuusi *	rauðgreni	M,A	H	J	29, 55
	Pinus sylvestris	pine	tall *	furu	skovfyr	mänty *	skógarfura	M	C	H,P,T	45, 49
Cupressaceae	*Juniperus communis*	juniper	en *	einer *	enebær *	kataja *	einir *	M,A,C,H	H,N,C	B,R,P	9, 14, 25, 34, 44, 45, 53
	J. sabina	savin	sävenbom		sevenbom *	rohtokataja	sabínueinir	C,H,P		W	9
Trees, shrubs											
Salicaceae	*Populus tremula*	aspen	asp	osp *	bævreasp	haapa *	ösp	M,H	H,N,C	L,P	34, 45
	Salix spp	willow	sälg	vier	pil *	paju *	viðir *	M,S,H	H,C,T	L,P	9, 33, 45
Myricaceae	*Myrica gale*	sweet gale	pors	pors *	porse *	suomyrtti	mjaðarlyng	M,H	H	W,L,F	9, 35
Betulaceae	*Alnus glutinosa*	alder	al	or	el *	tervaleppä	rauðelri	S	T	H	9
	Betula pendula	silver birch	vårtbjörk	hengebjørk	vorte-birk	rauduskoivu *		M	C	L,J,P	45
	B. pubescens	downy birch	glasbjörk	bjørk	dun-birk *	hieskoivu *	birki *	M,S	H,C	L,J,P,C	9, 33, 37, 45, 50
Corylaceae	*Corylus avellana*	hazel bush	hassel	hassel	hassel *	pähkinäpensas	hesliviður	H		L	9
Grossulariaceae	*Ribes nigrum*	blackcurrant	svarta vinbär	solbær	solbær	musta viinimarja *	sólberjarunni	M	C	B	45
	R. rubrum	redcurrant	röda vinbär	hagerips	ribs *	punainen viinimarja	rifs	M			9
Rosaceae	*Prunus padus*	bird cherry	hägg	hegg	hæg	tuomi *	heggur	M	C	B,P	45
	Pyrus communis	pear	päron	pære	pære *	päärynä	perutré	S	N	O	9
	Sorbus aucuparia	rowan	rönn	rogn	røn	pihlaja *	reynir	M	C	P	45
Buxaceae	*Buxus sempervirens*	boxwood	buxbom	buksbom	buksbom *	puksipu	fagurlim	H		L	9
Rhamnaceae	*Frangula alnus*	buckthorn	brakved	trollhegg	tørst	paatsama *	porstatré	M	C	P	45, 53
Thymelaeaceae	*Daphne mezereum*	mezeron	tibast	tysbast *	pebertræ	näsiä *	töfratré	M	H,C	B,P	34, 35, 45, 55
Oleaceae	*Fraxinus excelsior*	ash tree	ask *	ask	ask	saarni *	askur	M	H,C	L,P	45, 49
Caprifoliaceae	*Sambucus nigra*	black elder	fläder	svarthyll	hyld *	selja *	svartyllir	M,S	C,T	B	9, 45

Host (if specified): M = human, A = animal, C = cattle, S = sheep, H = horse, P = pig.
Target (if specified): H = helminths, N = nematodes, C = cestodes, T = trematodes, P = protozoa.
Part used (if specified): W = whole plant, L = leaves, F = flowers, S = seeds, B = berries, H = shoots or buds, R = root or tuber, J = sap, P = phloem or bark, O = wood, C = charcoal or ashes, T = tar.
* Indicates that the plant is mentioned in literature from that Nordic country.
Note: Plants included in this table are based on generally historical reports. This does not imply endorsement by the authors in either their effectiveness against parasites, or safety for human and/or animal use.

Table 1. Continued

Plant family	Scientific name	English	Swedish	Norweigan	Danish	Finnish	Icelandic	Host	Target	Part used	Reference
Herbaceous plants											
Cannabaceae	*Humulus lupulus*	common hops	humle *	humle	humle *	humala *	humall	M,S	H,C,T	W,R,C	9, 45, 49
Urticaceae	*Urtica dioica*	stinging nettle	brännässla *	stornesle	stor nælde *	nokkonen	stórnetla	M,S	H,T	W,S	9, 23, 44, 49
	U. urens	small nettle	etternässla	smånesle *	liden nælde	rautanokkonen	brenninetla *	M	H	W,S	41, 55
Polygonaceae	*Rumex acetosa*	green sorrel	ängssyra	engsyre	rødknæ *	suolaheinä *	túnsúra	M,P	H,C	L,F,R	9, 45
Chenopodiaceae	*Chenopodium ambrosioides*	goosefoot	citronmålla	melde	gåsefod	savikka *					31
	C. bonus-henricus	good king Henry	lungrot *	stolt henrik	stolthenriks-gåsefod	hyvänheikinsavikka	hinriksnjóli	M	H,C	W	49
	C. rubrum	red goosefoot	rödmålla *	rødmelde	rød gåsefod	punasavikka		M	H	W	49
Portulacaceae	*Portulaca oleacea*	common purslane	portlak *	portulakk	portulak	vihannesportulakka	portúlakka	M	H	W	44
Caryophyllaceae	*Agrostemma githago*	corncockle	klätt	klinte	klinte *	aurankukka	akurstjarna	M			9
Ranunculaceae	*Hepatica nobilis*	hepatica	blåsippa	blåveis	anemone *	sinivuokko	blá-anemóna	M			9
Fumariaceae	*Corydalis intermedia*	corydalis	smånunneört *	lerkespore	lærkespore	hentokiurunkannus*		M	H,C	R	45, 49
	Fumaria officinalis	common fumitory	jordrök *	jordrøyk	læge- jordrøg	peltoemäkki	reykjurt	M	C	W	20
Brassicaceae	*Armoracia rusticana*	horseradish	pepparrot	pepperrot	peberrod *	piparjuuri	piparrót *	H	H	R	9, 41
	Brassica spp	cabbage	kål *	kål	kål *	kaali, nauris *	kál	M	H, C	S, R	9, 44, 45
	Cardamine hirsuta	hairy bitter-cress	ängsbräsma	rosettkarse	roset springklap	mäkilitukka	lambaklukka *		H	L	8, 36, 37
	C. pratensis polemonioides	cuckooflower	polarbräsma	polarkarse	polarkarse	pohjanlitukka	hrafnaklukka *	M	H	L	33, 41
	Descurainia sophia	flixweed	stillfrö *	hundesennep	finbladet vejsennep	liitutilli *	þefjurt	M	H,N,C	S	22, 45, 49
	Lepidium sativum	garden cress	kryddkrasse *	matkarse	karse *	vihanneskrassi	karsi	M,S	H,T	W,S	9, 44
	Raphanus sativus niger	garden radish	rättika *	reddik	ræddike *	retikka	radísa	C,H	H	R	9, 44
	Sisymbrium officinale	hedge mustard	vägsenap	vegsennep	vejsennep *	rohtopernaruoho	götudesurt	M			9
Crassulaceae	*Rhodiola rosea*	roseroot	rosenrot	rosenrot *	rosenrod	ruusujuuri	burnirót	C	H	R	55
	Sempervivum tectorum	house leek	taklök *	takløk	husløg *	mehitähti	húslaukur	M	C	W	9, 44
Rosaceae	*Agrimonia eupatoria*	agrimony	småborre *	åkermåne	agermåne *	maarianverijuuri		M	H	W	9, 44, 49
	Fragaria vesca	wood strawberry	smultron	markjordbær	skov jordbær *	mansikka *	villijarðarber	M	C	B	9, 45
	Potentilla anserina	silverweed	gåsört *	gåsemure	gåse-potentil	ketohanhikki	tágamura	M	H	W	44
	P. erecta	tormentil	blodrot *	tepperot	tormentil *	rätvänä	blóðmura	M,S	H,T	W,R	9, 44
	Rubus chamaemorus	cloudberry	hjortron	molte	multebær	lakka *	múltuber	M	C	B	45
	R. idaeus	red raspberry	hallon	bringebær	hindbær *	vadelma *	hindber	M	C	B	9, 45
	Sanguisorba officinalis	great burnet	blodtopp *	blodtopp	læge kvæsurt	punaluppio	blóðkollur	H	H	R	30
Fabaceae	*Vicia sativa*	common vetch	fodervicker	förvikke	vikke *	vikkeri	fóðurflækja	H		W	9
Rutaceae	*Ruta graveolens*	common rue	vinruta	vinrute	rude *	ruutakasvi	rúðujurt	M			9
Clusiaceae	*Hypericum perforatum*	perforate St.John's-wort	äkta johannesört *	prikkperikum	prikbladet perikon *	mäkikuisma	jónsmessurunni	M	H	F,H	9, 49, 51
	H. maculatum	imperforate St.John's-wort	fyrkantig johannesört	firkant-perikum	kantet perikon	särmäkuisma *	flekkjagullrunni	M	C		45
Violaceae	*Viola odarata*	sweet violet	luktviol	marsfiol	marts-viol *	tuoksuorvokki	ilmfjóla	M			9
Cucurbitaceae	*Cucumis sativus*	cucumber	gurka	agurk	agurk	kurkku *	agúrka	M	C	S	45

Table 1. Continued

Plant family	Scientific name	English	Swedish	Norweigan	Danish	Finnish	Icelandic	Host	Target	Part used	Reference
	Cucurbita pepo	pumpkin	pumpa	gresskar	mandel-græskar *	kurpitsa *	grasker	M	N,C	S	9, 45
Apiaceae	*Anethum graveolens*	dill	dill	dill	dild *	tilli	dill	C			9
	Angelica archangelica	angelica	kvanne	kvann	kvan	väinönputki	hvönn *	M,H	H	S,R	8, 32, 33, 36, 37, 41
	Anthriscus cerefolium	chervil	dansk körvel *	hagekjørvel	kørvel *	maustekirveli	garðakerfill	M	H	W	9, 44
	Apium graveolens	celeriac	selleri	hageselleri	selleri *	selleri	blaðselja	M			9
	Carum carvi	caraway	kummin	karve *	kommen *	kumina *	kúmen	M	H,C	W,S	9, 34, 45
	Coriandrum sativum	coriander	koriander	koriander	koriander *	korianteri	kóriandra	M			9
	Daucus carota	carrot	morot *	gulerot *	gulerod *	porkkana *	gulrót	M,P	H,C	R	9, 35, 44, 45, 49, 55
	Foeniculum vulgare	fennel	fänkål	fennikel	fennikel *	fenkoli	fennikka	S	T		9
	Levisticum officinale	lovage	libbsticka *	løpstikke	løvstikke *	liperi	tröllatryggð	M	H	S	9, 44
	Petroselinum crispum	parsley	persilja	persille	persille	persilja *	steinselja	C	P		29
Ericaceae	*Calluna vulgaris*	heather	ljung *	røsslyng	lyng *	kanerva	beitilyng	S	T		9, 49
	Vaccinium myrtillus	blueberry	blåbär	blåbær	blåbær	mustikka *	aðalbláberja-lyng	M	C	B	45
	V. oxycoccos	cranberry	tranbär	tranebær	tranebær	karpalo *		M	C	B	45
	V. uligunosum	bog bilberry	odon	blokkebær	mosebølle	juolukka *	bláberjalyng	M	C	B	45
	V. vitis-idaea	lingonberry	lingon	tyttebær	tyttebær	puolukka *	rauðberjalyng	M	C	B	45
Gentianaceae	*Centaurium littorale*	seaside centaury	kustarun	tusengylden	tusingylden*	isorantasappi	köldublóm	H			9
	Gentianella campestris	field gentian	fältgentiana	bakkesøte	bredbægret ensian	ketokatkero	maríuvöndur *	H	H	R	8, 32, 33, 36, 37
Menyanthaceae	*Menyanthes trifoliata*	marsh trefoil	vattenklöver *	bukkeblad *	bukkeblad *	raate *	horblaðka *	M,S,H,P	H,C,T	W,L,R	4, 8, 9, 32, 33, 36, 37, 41, 45, 52, 55
Verbenaceae	*Verbena officinalis*	vervain	läkeverbena *	jernurt	jernurt	tarhaverbana	járnurt	M	H	W,F	44
Lamiaceae	*Glechoma hederacea*	ground-ivy	jordreva	krossknapp	korsknap *	maahumala	krosshnappur	H		W	9
	Hyssopus officinalis	hyssop	isop *	isop	isop *	iisoppi	isópur	M	H,N	W	9, 44
	Leonurus cardiaca	motherwort	hjärtstilla	løvehale	almindelig hjertespand*	nukula		M			9
	Melissa officinalis	lemon balm	citronmeliss	sitronmelisse	hjertensfryd*	sitruunamelissa	hjartafró	C			9
	Mentha crispa	mint	krusmynta *	kattemynte	mynte *	minttu		M	N	W	9, 44
	Nepeta cataria	catnip	kattmynta *	lækjekatte-mynte	katteurt *	aitokissanminttu	kattarmynta	M	H	W	9, 44
	Origanum vulgare	wild majoram	kungsmynta	bergmynte	almindelig merian *	mäkimeirami	kjarrmynta	M			9
	Salvia spp	sage	salvia	salvie	salvie *	salvia	salvía	S	T	W	9
	Thymus serpyllum	wild thyme	backtimjan *	kryptimian	smalbladet timian	kangasajuruoho	blóðberg	M	H	W	38
	T. vulgaris	garden thyme	trädgårds-timjan *	kryddertimian	havetimian	timjami *	garðablóðberg	M	H,C	W	38, 45
Solanaceae	*Hyoscyomus niger*	henbane	bolmört	bulmeurt	bulmeurt *	hullukaali	skollarót	H		S	9
	Nicotiana rustica	small tobacco	tobak	tobakk	tobak *	tupakka	bónda-tóbaksjurt	S	T	R	9
	Solanum dulcamara	woody nightshade	besksöta	slyngsøtvier	bittersød natskygge *	punakoiso	eiturflækja	M			9
	S. nigrum	black nightshade	nattskatta	svart søtvier	sort natskygge *	mustakoiso	húmjurt	H		L,B	9
	S. tuberosum	potato	potatis	potet	kartoffel	peruna *	kartafla	M	C	R	45

Table 1. Continued

Plant family	Scientific name	English	Swedish	Norweigan	Danish	Finnish	Icelandic	Host	Target	Part used	Reference
Scrophulariaceae	*Rhinanthus spp*	yellow rattle	skallra	kall	skjaller *	laukku	lokasjóð̂ur	M			9
	Veronica anagallis-aquatica	blue water speedwell	vattenveronika	vassveronika	lancetbladet ærenpris	konnantädyke	laugadepla *	M	H	W	8, 36, 37
	V. chamaedrys	germander speedwell	teveronika *	tveskjegg-veronika	tveskægget ærenpris	nurmitädyke	völudepla	M	H	W	44
Planataginaceae	*Plantago lanceolata*	English plantain	svartkämpar	smalkjempe *	lancet-vejbred	heinäratamo	selgresi *	M	H	L,R	8, 33, 35, 36, 41
	P. major	great plantain	groblad	groblad *	vejbred *	piharatamo	græðisúra *	M	H	W,L,R	9, 35, 37, 41, 55
	P. maritima	sea plantain	gulkämpar	strandkjempe	strand-vejbred	meriratamo	kattartunga *	M	H	L,R	8, 36
Valerianaceae	*Valeriana officinalis*	valerian	vänderot *	lege-vendelrot	lægebaldrian*	rohtovirmajuuri	garðabrúða	M,H	H	W,R	4, 9, 44, 49
Asteraceae	*Achillea millefolium*	yarrow	rölleka *	ryllik *	røllike *	siankärsämö	vallhumall	M	H	W,L,F	9, 34, 35, 38
	Artemisia abrothanum	southernwood	åbrodd *	abrodd	ambra	aaprottimaruna		M	N	W	44
	A. absinthium	wormwood	malört *	ekte malurt *	malurt *	mali *		M,C,S,H	H,C	W,L,S	5, 9, 25, 34, 44, 45, 49, 53, 55, 58
	A. vulgaris	mugwort	gråbo *	burot	gråbynke *	pujo		M	H	W	9, 38, 49, 58
	Cnicus benedictus	blessed thistle	kardbenedikt *	kardobenedikt*	korbendikt *	karvasohdake		M	H	W,L	9, 35, 44, 55
	Helianthus annus	sunflower	solros	solsikke	solsikke	auringonkukka *	sólfifill	M	C	S	45
	Inula helenium	elecampane	ålandsrot	alantrot *	lægealant *	isohirvenjuuri	hálsurt	M	H	R	9, 55
	Matricaria maritima	sea mayweed	kustbaldersbrå	strand-balderbrå	kamille *	merisaunio	baldursbrá *	M	H	L,F	8, 9, 33, 36, 37, 41
	Senecio vulgaris	common groundsel	korsört *	åkersvineblom	almindelig brandbæger*	peltovillakko *	krossfífill	M,C	C	L	9, 22, 45
	Silybum marianum	milk thistle	mariatistel	mariatistel	marietidsel *	maarianohdake *	maríupistill	H		S	9, 53
	Tanacetum balsamita	alecost	balsamblad	balsam *	okseøje	palsamipäivän-kakkara		M	H	W	35
	T. parthenium	feverfew	mattram *	matrem	matrem	reunuspäivinkakkara		M	H	S	44
	T. vulgare	common tansy	renfana *	reinfann *	rejnfan *	pietaryrtti *	regnfang	M,A,S,H	H,N,C,T	W,L,F,S	1, 4, 9, 10, 19, 30, 34, 35, 44, 45, 49, 53, 55, 58, 70
Liliaceae	*Allium cepa*	onion	rödlök *	rødløk *	rødløg *	punasipuli	rauðlaukur	M	H	W	9, 35, 44, 55
	A. porrum	leek	purjolök	purreløk *	purløg	purjo	blaðlaukur	M	H	W	34
	A. sativum	garlic	vitlök *	hvitløk *	hvidløg *	valkosipuli *	hvítlaukur	M,A	W,N,C	W	4, 9, 35, 44, 45, 55, 70
	A. ursinum	ramson	ramslök	ramsløk *	rams-løg	karhunlaukka	bjarnarlaukur	M	H	W	34
	Asparagus officinalis	asparagus	sparris	asparges	asparges *	ruokaparsa		M			9
	Iris pseudocorus	iris	svärdslilja *	sverdlilje	gul sværdlilje*	keltakurjenmiekka	gula sverðlilja	C,P	H	R	9, 30
Araceae	*Acorus calamus*	sweetflag	kalmus	kalmusrot	kalmus	kalmojuuri *	kalmusrót	M	C	R	45
Grasses											
Poaceae	*Elytrigia repens*	couch grass	kvickrot *	kveke	almindelig kvikgræs *	juolavehnä	húsapuntur	M	H	W,R	9, 18
	Hordeum vulgare	barley	korn	bygg	byg *	ohra	bygg	M			9
	Secale cereale	rye	råg	rug	rug *	ruis	rúgur	M			9

Lichens and Ferns: One of the plants most commonly mentioned in the Nordic literature is male fern (*Dryopteris filix-mas*), a common fern that is widespread throughout the Northern hemisphere. Extracts from powdered rhizomes were first used by the Greeks (circa 350-250 BC) to treat tapeworm infections. This product (oil of aspidium) became an established product in many Pharmacopoeia of the Western World and was sold until the end of the 1940s. A number of active compounds have been isolated from this product, but it appears that the anthelmintic constituent is filicic acid.

Trees and Shrubs: Reports are few on the extensive use of trees and shrubs specifically to feed to livestock as treatment against parasites. However, products of willow (*Salix* spp). have been widely used as analgesics or antipyretics in humans, probably attributable to the content of salicin and derivatives. *Salix* spp. also has a reputation as an anthelmintic for humans and livestock. Horses fed leaves are not supposed to get worms and a decoction of the bark is efficacious against flukes (trematode parasites) and diarrhoea in sheep (*Brøndegård* 1980).

Herbaceous Plants: There is a great variety of these plant types that has been used as deworming preparations. Whilst most of those mentioned in Table 1 thrive in the Nordic environment, many originated from other countries. Possibly one of the most widespread and commonly used herbal anthelmintic is oil of chenopodium, derived from *Chenopodium ambroisoides,* popularly known as American wormseed, or goosefoot. Archeological and ethnological studies suggest that this material has been used for many centuries. It is of passing interest that in the early eighteenth century, Peter Kalm (1715-1779), a Swedish botanist and traveller, reported that it was used by both the indigenous inhabitants and European settlers in the American colonies for the treatment of *Ascaris* infections. Plants were taken to Europe, cultivated widely, and were soon in common usage. The active principle, ascaridol, a volatile terpene, was isolated and eventually synthesized. However, in the Nordic countries, *Chenopodium* is not one of the most commonly mentioned plant families.

Some of the plants mentioned are now commonly used as spices eg. caraway (*Carum carvi*), thyme (*Thymus* spp) and mint (*Mentha* spp). These have been found in Russian studies to have effect against *Trichostrongylus* larvae *in vitro* and also in sheep (*Gadzhiev & Eminov* 1986, *Eminov* 1982).

Members of the family *Asteraceae* have also a prominent position in the herbal de-worming literature. The Romans used dried, unexpanded flower heads obtained from several species of the genus *Artemisia* in the first century, for the treatment of *Ascaris, Enterobius* and tapeworm infections. The name given for this herbal preparation was *semen-contra vermes* (semen against worms), apparently because of its superficial resemblance to semen. It became an important member of the European pharmacopoeia until the early 20th century. The active principle was found to be the sesquiterpene lactone, santonin. More recent pharmacological studies have demonstrated the pharmacological basis of this chemical. Low concentrations of santonin are reported to have a selective toxic action on the ganglion located in the nerve ring of *Ascaris* spp. (*Sollmann* 1957). Against other nematodes, such as *Oxyuris* spp and the cestodes, santonin is not effective (*Steinegger & Hänsel* 1972). Pharmacological studies investigating the specific effects of santonin-containing herbal preparations are not known. This is probably because santonin had been isolated and used as a vermifuge as early as 1830. Due to its narrow therapeutic window (safety index) and toxicity, the crude drug santonin is no longer used (*Reynolds & Prasad* 1982, *Tyler et al.* 1988, *De Smet* 1997).

Another member of the *Asteraceae* family, more widely used in the Nordic countries, is common tansy (*Tanacetum vulgare*). The active component is claimed to be thujon. *In vitro* studies have shown an effect of this plant on *Trichostrongylus* and *Ostertagia circumcincta* spp. (*Gadzhiev & Eminov* 1986, *Eminov* 1982). Vegetables, such as carrot (*Daucus carota*), brassicas (*Brassica* spp), the onion group (*Allium* spp.), as well as all kinds of berries have had widespread use against parasites in the Nordic as well as most other countries. Seeds of pumpkin and cucumber (Cucurbitaceae) have been used in tropical America for centuries as a treatment of tapeworm infections. From there the popularity of this remedy spread to Europe. The active component, cucurbitine, was identified as an amino acid (3-amino 3 carboxy pyrorolidin). Leaves from another tropical plant, tobacco (*Nicotiana rustica*), have enjoyed universal popularity and latterly notoriety for use in smoking. However, infusions of this plant, or synthetic analogues (e.g. nicotine sulphate) were commonly used as anti-nematode preparations in ruminant livestock up until the advent of the modern broad spectrum anthelmintics in the mid 1950s. Both these plants have also been grown and used as anthelmintics in the Nordic countries.

Pasture plants: The possible use of specialised crops to control nematode infections in grazing ruminants has attracted considerable research interest in recent years. Bioactive plants or forages with secondary metabolites, particularly legumes with a high content of proanthocyanidins (condensed tannins) e.g. sulla (*Hedysarum coronarium*) or lotus major (*Lotus pedunculatus*) have been reported to reduce worm burdens in grazing lambs by up to 50% (*Niezen et al.* 1995). An *in vivo* anthelmintic effect has also been observed using quebracho, a condensed tannins extract, as a single high dose against sheep nematodes (*Athanasidou et al.* 1999) and the capacity of purified condensed tannins from Danish legumes to kill nematode larvae *in vitro* has been demonstrated (*Kahiya et al.* 1999). However, in several field studies it has been difficult to relate anti-parasitic effects to the actual amounts of condensed tannins (e.g. *Niezen et al.* 1998). A complicating factor is that condensed tannins are a poorly defined group of compounds (basically polymers capable of covalently binding protein) making standardised determinations in plant material difficult.

It has been postulated that the beneficial effects of tanniferous plants against internal parasites could be due to one, or a combination, of the following factors:

- Tanniferous plants increase the supply and absorption of digestible protein by animals. This is achieved by tannins forming non-biodegradable complexes with protein in the rumen, which dissociate at low pH in the abomasum to release more protein for metabolism in the small intestine of ruminants – in other words, "natures protected protein." This indirectly improves host resistance and resilience to nematode parasite infections.
- Tannins have a direct anthelmintic effect on resident worm populations in animals.
- Tannins and/or metabolites in dung have a direct effect on the viability of the free-living stages (development of eggs to infective larval stages).

Although there is some evidence to support each of these above claims (for review, see *Kahn & Diaz-Hernandez* 1999), we believe that the data are by no means clear-cut (*Bernes et al.* 2000).

Limitations with using plants as natural anthelmintics

It is not a simple matter of just growing these plants and expecting them to be used in a natural parasite control system. In a longer perspec-

tive, many issues need to be considered. These include, whether the chosen plants are amenable to cultivation and if so by what means (pure stands or as mixed leys), ease of harvesting seeds and thus their commercial availability, and means of use or administration (grazing, or individual stable feeding – short, or long term). In addition, factors such as palatability, stability, biodegradability of active compounds in preserved products, whether these are to be used curatively, or preventively, need to be considered. Finally, dosage may be difficult to control and the possibility of toxic side effects in animals needs to be considered.

Some of the potential candidate plants cannot withstand trampling by livestock, are poor competitors with other pasture species in mixed grazing swards (e.g. *Lotus* spp., *Beuselinck & Grant* 1995), or they are preferentially sought out by grazing animals and thus easily succumb to even light grazing pressure (e.g. *H. coronarium, Niezen et al.* 1995).

Plants which have a high content of known direct-acting parasiticides (e.g. santonin in wormseed) may be effective for short-term ”curative” use eg. a short grazing interval on a ”deworming” paddock before a pasture change. In other cases, plants may have to constitute a substantial proportion of the feed and may therefore be used in a preventive fashion mixed with grass and clover in larger grazing areas, or in pure stands for rotational grazing.

A word of warning – plant toxicity

The whole animal kingdom is dependent on the use of plant material. Plants have probably covered much of our planet throughout the history of multicellular life. This implies that herbivores have been too few in number to consume all the food available (*Hairston et al.* 1960), and probably more importantly, that some plants have evolved defence mechanisms against being eaten by herbivorous animals (*Murdoch* 1966). One of their defence principles is the production of chemical compounds, which may be harmful or distasteful to potential herbivores. The fact that certain plants could have adverse effects on man and livestock has been known since ancient times. Likewise, it has been recognised that some plants could be of benefit in disease conditions. These two aspects of the plant kingdom, the beneficial and the harmful properties of plants, strongly related to dosage, are described in the early medical literature of classical Greece and Rome (Hippocrates, Theophrastus, Dioscorides).

Modern scientific literature on plant effects on livestock deals mainly with adverse effects, and less attention has been paid to the curative potential of plant material. The complex nature of this discipline is reflected in the difficulties in classification of poisonous plants. Attempts to classify them according to the chemical nature of their active constituents are met with the obstacles that these may be either a single substance or a number of substances with wide differences in chemical properties. Accordingly, a chemical classification will lead to considerable overlapping with some plants featuring in several chemical groups. Albeit these difficulties, the majority of recent textbooks group the poisonous plants according to their known toxic constituents (*Cooper & Johnson* 1998). These include a vast range of compounds that may be classified as alkaloids, glycosides, nitrates, oxalates, photodynamic substances, thiaminases, local irritants and phytooestrogens. The most reputed plants in the Nordic flora with reported responsibility for livestock poisoning include wolf´s-bane (*Aconitum lycoctonum*) (alkaloids), cowbane (*Cicuta virosa*) (alkaloids), groundsel (*Senecio* spp.) (alkaloids), yew (*Taxus baccata*) (alkaloids), brassicas (*Brassica* spp.) (S-methyl cystein sulphoxide, progoitrin, nitrates, amongst others), foxglove (*Digitalis purpurea*) (digitalis-glycosides), bog

asphodel (*Narthecium ossifragum*) (saponin-glycosides), sorrel (*Rumex* spp.) (oxalates), St. John´s-wort (*Hypericum* spp.) (photodynamic substances), bracken (*Pteridium aquilinum*) (thiaminases, alkaloids), horsetail (*Equisetum* spp.) (thiaminases) and *Ranunculus* spp. (local irritants) (*Søli* 1981, *Laksesvala & Dishington* 1983, *Nærland* 1984. *Solberg* 1984, *Ulvund* 1984, *Waldeland* 1984, *Øverås* 1984, *Andersson et al.* 1989, *Sivertsen et al.* 1992, *Flåøyen et al.* 1995, *Flåøyen & Frøslie* 1997). Several of these plants appear in Table 1 and thus are examples of both beneficial (according to popular belief!) and harmful properties of plants. One should be aware that there is some structural overlap between these simple chemical groups and that other classifications are possible. Furthermore, it must be borne in mind that little is known of the toxic constituents of many plants and that the poisonous properties of a plant may be due to more than one substance.

It is also important to understand that natural, often genetically determined, variations exist between different populations of some plant species, which may affect their toxic potential. An example of this is birdsfoot trefoil (*Lotus corniculatus*), in relation to cyanogenic glycosides. In different populations (cultivars), these substances may be absent, or the enzymes that break them down to release hydrocyanic acid may be absent, or both of them may be present. Consequently, if one of these constituents is lacking, the plant is harmless, and only when both are present the plant is poisonous. This knowledge is essential to make a rational selection of non-toxic cultivars of *L. corniculatus* as an important constituent for pasture leys.

Like any 'new' area of treatment against target pest organisms, the use of plant materials to control internal parasites should be tempered with common sense and based on scientific validation of a useful measure of efficacy, which at the same time is host benign.

Conclusion

This review provides ample evidence that a considerable amount of information relating to the use of plant material as de-worming preparations for man and his livestock in the Nordic countries, is available. However, almost all of these reports are historical and/or anecdotal. Evidence for effectiveness of plant de-worming preparations has been rarely obtained and little has been made available in scientific publications. With respect to increasing interest in the therapeutic use of natural products, we believe that it is important that a systematic evaluation is made of the botanical resources of the Nordic countries in relation to the purported de-worming properties of those plants that are endemic, or thrive, in this region of the world.

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Sammanfattning

Växter för avmaskning av husdjur i de nordiska länderna: historiskt perspektiv, folklig tro och möjlig framtida användning.

Att söka efter substanser inom växtriket som ger bot och lindring mot sjukdomar (däribland parasiter) såväl hos sig själv som sin boskap är något som har varit föremål för mänsklig aktivitet sedan urminnes tider. Framställningen av örtmediciner har varit beroende av den lokala floran, vilket har medfört att olika preparat utvecklats i olika delar av världen. Dock har i vissa fall samma eller närbesläktade arter använts i många länder. Det har även varit vanligt med import av växter med högt anseende. De nordiska länderna har historiskt sett haft ett rikt och varierat utbud av anthelmintika från växtvärlden, för bruk till såväl människor som husdjur. Detta har varit såväl importerade preparat som endemiskt förekommande växter och växter som kan odlas i Norden. Mycket kännedom och erfarenhet av naturligt förekommande läkeväxter har emellertid gått förlorad i västvärlden. Detta som en konsekvens av utvecklingen och lanseringen av en mängd effektiva, säkra , syntetiskt framställda läkemedel med bred verkan. Under senare år har dock attityden till dessa produkter i viss mån förändrats och det finns ett förnyat intresse för olika typer av naturläkemedel. Det beror delvis på att vissa preparat blivit verkningslösa till följd av att resistens utvecklats hos sjukdomsorganismerna. Avsikten med denna litteraturöversikt är att redovisa uppgifter framförallt från äldre nordiska källor om vilka växter som har använts i avmaskande syfte. En diskussion förs också om på vilka områden ny forskning kan ge värdefull och användbar kunskap.

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Reprints may be obtained from: P.J. Waller, Department of Parasitology (SWEPAR), Statens Veterinärmedicinska Anstalt, S-751 889 Uppsala, Sweden. E-mail: Peter.Waller@sva.se, tel: +46 18 67 41 27, fax: +46 18 30 91 62.