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Ethnoveterinary medicines used to treat endoparasites and stomach problems in pigs and pets in British Columbia, Canada

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Abstract

This paper documents the medicinal plants used to treat endoparasites and stomach problems in dogs, cats and pigs in British Columbia, Canada. Ethnoveterinary data was collected over a 6-month period in 2003. The majority of the information on pets came from 2 naturopaths, 10 herbalists, 5 dog trainers, breeders and pet shop owners, 9 holistic veterinarians and 6 of 27 organic farmers. Two pig farmers joined the study in the final stages. The following plants were used as anthelmintics: *Artemisia cina* O. Berg and C.F. Schmidt, *Artemisia vulgaris* L., *Artemisia annua*, *Calendula officinalis* L., *Echinacea purpurea* (L.) Moench (all Asteraceae), *Mentha piperita* L. and *Salvia officinalis* L. (Lamiaceae) (*Allium sativum* L. (Alliaceae), *Cucurbita pepo* L. (Cucurbitaceae), *Eugenia caryophyllata* Thunb (Myrtaceae), *Gentiana lutea* L. (Gentianaceae), *Hydrastis canadensis* L. (Ranunculaceae), *Juglans nigra* L. (Juglandaceae), *Olea europaea* L. (Oleaceae) and *Ruta graveolens* L. (Rutaceae)). Stomach problems were treated with: *Achillea millefolium* L. (Asteraceae), *Aloe vera* (L.) Burm. f. (Asphodelaceae), *Elytrigia repens* (L.) Desv. ex Nevski (Poaceae), *Frangula purshiana* (DC.) Cooper (Rhamnaceae), *Juniperus communis* L. (Cupressaceae), *Melissa officinalis* L. and *M. piperita* L. (Lamiaceae), *Petroselinum crispum* L. (Apiaceae), *Plantago major* L. and *Plantago ovata* Forssk. (Plantaginaceae) *Rumex crispus* L. and *Rumex obtusifolius* L. (Polygonaceae), *Ulmus fulva* Michx. (Ulmaceae) and *Zingiber officinalis* Roscoe (Zingiberaceae). There is insufficient information available to assess the anthelmintic efficacies of *C. officinalis*, *Salvia officinalis*, *Eugenia caryophyllata* and *O. europaea*; the other plants have mid- to high-level validity for their ethnoveterinary uses.

Keywords: British Columbia; Ethnoveterinary medicine; Pets; Endoparasites; Stomach problems

1. Introduction

In our research on the ethnoveterinary remedies used in British Columbia, Canada we documented and validated (in a non-experimental way) the ethnoveterinary medicines used by pet owners, holistic veterinarians and farmers. Ethnoveterinary medicine focuses on animal keepers' knowledge and approaches to animal health care and production. It includes information on diseases and their control; remedies and clinical practices for treatment and prevention; management strategies and spiritual elements among others (Mathias, 2004).

Due to the large amount of data collected in our research the results have been divided into several publications. The data on horses and ruminants has already been published (Lans et al., 2006, 2007). This paper presents the medicinal plants used to treat endoparasites and stomach problems in dogs, cats and pigs.

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Schillhorn van Veen (1997) claimed that some ethnoveterinary remedies are efficacious in controlling parasitic diseases; other remedies have complementary value, while some remedies have little or no value. Githiori et al. (2006) reviews many plants used as anthelmintics in small ruminants and lists typical examples such as garlic, onion, mint, walnuts, dill, and parsley all used for gastrointestinal parasitism. Cucumber and pumpkin seeds are traditionally used to remove tapeworms from the gastrointestinal tract. *Artemisia* spp. is used to treat animals infected with blood parasites, such as *Trypanosoma* and *Plasmodium* spp.

Some testing of anthelmintic plants has been conducted in Africa, where low-cost alternatives to Western drugs are needed. Githiori et al. (2004) found no anthelmintic efficacy in seven Kenyan plants used against *Haemonchus contortus* in four experiments. Gathuma et al. (2004) designed a commendable experiment to test ethnoveterinary remedies. The efficacy of *Myrsine africana*, *Albizia anthelmintica* and *Hilderbrantia sepalosa* was tested against mixed natural helminthosis in sheep (*Haemonchus* spp., *Trichostrogylu*s spp., and *Oesophagostomum* spp.) in the Samburu district of Kenya. Healers were included in the study and the extracts were prepared using traditional methods including mortar and pestle. *Albizia anthelmintica* and *Hilderbrantia sepalosa* treatments showed significant improvement over controls from day 4 after treatment to day 12. On day 12 the three plant remedies showed 100% efficacy while albendazole had an efficacy of 63%.

Veterinary clinics in British Columbia list the following endoparasites on their websites for the attention of their clients: coccidia, giardia, roundworms, whipworms and tapeworms. Hookworms are rarely seen and heartworm is found outside the major city of Vancouver. Veterinarians also list some of the causes of gastrointestinal problems on their websites: zoonotic agents such as *Cryptosporidium parvum*, *Giardia intestinalis, Salmonella typhimurium* or *Campylobacter jejuni*.

Two research participants were pig farmers on the Alberta/British Columbia border. Fifty pig operators in Alberta from a province-wide list of hog producers (convenience sample) took part in a recently conducted study (Guselle and Olson, 2005). Fecal samples were collected from floor-penned animals, barn pits and storage lagoons. Environmental samples were taken from hog drinking water sources and slurry-spread soil. Farmers had an average of 1551 pigs per farm. *Giardia* was found on 80% of the farms, *Cryptosporidium suis* on 34%, *Ascaris suum* on 56%, and *Isospora* on 16%. No *Escherichia coli* O157:H7 or *Salmonella* was found. Fecal samples from 2669 animals revealed that *Giardia* was present in 11% of animals, *Cryptosporidium suis* in 3%, *Ascaris* in 10% and *Isopora* in 2%. *Giardia duodenalis* genotype A was identified in Alberta pigs.

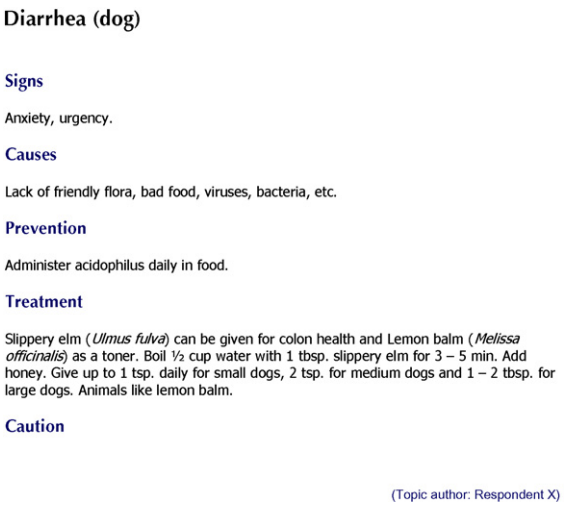
A survey of 1216 canine fecal samples from 15 veterinary practices across Canada, showed that 7.2% of samples were positive for *Giardia* antigen, and 73% of infections occurred in puppies. The majority of the infected dogs did not have diarrhoea (Weese et al., 2002).

In 1994, British Columbia was declared an endemic region for Lyme borreliosis. One study suggested that dogs in south-western British Columbia had acquired natural, indigenous infections of *B. burgdorferi* (Banerjee et al., 1996). *Anaplasma phagocytophilum* occurs in the geographical area (Poitout et al., 2005; Lester et al., 2005). *Cryptococcus gattii*, the cause of canine and feline cryptococcosis, was reported in south-western British Columbia and clinical signs in pets included respiratory and central nervous system problems (Duncan et al., 2006; Stephen et al., 2002). A toxoplasmosis outbreak took place in 1995 in Victoria, British Columbia, Canada. It was linked to the contamination of a surface water reservoir with *Toxoplasma gondii* oocysts by the domestic cat (*Felis catus*) or cougar (*Felis concolor*) or by deer mice (Aramini et al., 1999).

2. Materials and methods

Ethnoveterinary data for British Columbia was collected over a 6-month period in 2003. All available literature about livestock farmers and the secondary literature on ethnomedicinal plants, folk medicine and related fields in British Columbia was reviewed prior to and during the research. The research area in British Columbia consisted of the Lower Mainland, the Thompson/Okanagan region and south Vancouver Island (Lans et al., 2006).

A purposive sample of livestock farmers and pet owners was created to target key informants with the knowledge sought. The sample size was 60. The sample was obtained from membership lists of organic farmers, other specialists in alternative medicine and holistic veterinarians. The majority of the information on pets came from 2 naturopaths, 10 herbalists, 5 dog trainers, breeders and pet shop owners, 9 holistic veterinarians and 6 of 27 organic farmers. Two pig farmers joined the study in the final stages—they farmed on the Alberta/British Columbia border and belonged to the Certified Organic Association of British Columbia (COABC).



Diarrhea (dog)

Signs

Anxiety, urgency.

Causes

Lack of friendly flora, bad food, viruses, bacteria, etc.

Prevention

Administer acidophilus daily in food.

Treatment

Slippery elm (*Ulmus fulva*) can be given for colon health and Lemon balm (*Melissa officinalis*) as a toner. Boil ½ cup water with 1 tbsp. slippery elm for 3 – 5 min. Add honey. Give up to 1 tsp. daily for small dogs, 2 tsp. for medium dogs and 1 – 2 tbsp. for large dogs. Animals like lemon balm.

Caution

(Topic author: Respondent X)

Fig. 1. Draft discussion topic for diarrhoea in pets in British Columbia.

Two visits were made to each farm or respondent. All of the interviews at the initial stage were open-ended and unstructured and were between 2 and 4 h long depending on the amount of information presented by the respondent. A draft outline of the respondents' ethnoveterinary remedies was delivered and discussed at the second visit in order to confirm the information provided at the first interview (see Fig. 1 for a filled out participant form that formed the basis of the discussion at the second interview). Dosages were typically obtained on the second visit. Telephone interviews were conducted with participants whose location was distant from the research area to collect the relevant information. The draft outline was then posted to the relevant location and a second phone interview confirmed that the data collected in the first interview was accurate and dosages were asked for. Medicinal plant voucher specimens were collected where possible and were identified and deposited in the University of Victoria Herbarium.

The plant-based remedies were evaluated for safety and efficacy with a non-experimental method, prior to including them in the draft outline. Published sources such as journal articles and books and databases on pharmacology and ethnomedicine available on the Internet were searched to identify the plants' chemical compounds and clinically tested physiological effects. This data was incorporated with data on the reported folk uses, and their preparation and administration in North America and Europe. For each species or genus the ethnomedicinal uses in other countries are given; followed by a summary of chemical constituents, in addition to active compounds if known. This type of ethnopharmacological review and evaluation is based on previous work and the use of these methods in the same and previous research studies have been published (Lans et al., 2000, 2006, 2007). The non-experimental validation of the plants is presented in the discussion section of the paper. The strength of this method is limited by the availability of good quality research on the plants being investigated. The purpose of the method is to indicate which plants merit further scientific investigation and which plants can be recommended for use pending further study or warned against.

2.1. Validation workshop

Ten participants with experience in traditional human and ethnoveterinary medicine took part in a participatory 5-day-long workshop at the University of Victoria (BC) in October 2003. In the workshop the facilitator asked participants very specific questions in a supportive environment about the medicinal plants used. Each animal/livestock species was covered in a morning or afternoon session of 3–4 h—other than the core group, different participants came to different sessions. For the pet session, one ethnobotanist, one holistic veterinarian and two herbalists were present. There were two editorial assistants/facilitators in attendance. After the discussions, the pet section of the results was edited.

2.2. Non-experimental validation of ethnoveterinary remedies

The researcher and the ethnoveterinary consultant completed the non-experimental validation of the remedies in advance of the workshop. This method consisted of:

- obtaining an accurate botanical identification of the medicinal plants that were collected;
- searching the pharmaceutical/pharmacological literature for the plant's identified chemical constituents in order to determine the known physiological effects of either the crude plant drug, related species, or isolated chemical compounds that the plant is known to contain. This information was then used to assess whether the plant use is based on empirically verifiable principles (Lans et al., 2006).

Supporting ethnobotanical data and pharmacological information was matched with the recorded folk use of the plant species, to determine degrees of confidence

about its effectiveness. Four levels of confidence were established:

1. Minimal level: If no information supports the use it indicates that the plant may be inactive.
2. Low-level: A plant (or closely related species of the same genus), which is used in distinct areas in the treatment of similar illnesses (humans or preferably animals), attains the lowest level of validity, if no further phytochemical or pharmacological information validates the popular use. Use in other areas increases the likelihood that the plant is efficacious.
3. Mid-level: If in addition to the ethnobotanical data, available phytochemical or pharmacological information is consistent with the use, this indicates a higher level of confidence that the plant may exert a physiological action on the patient.
4. High-level: If both ethnobotanical and pharmacological data are consistent with the folk use of the plant, its use is classed in the highest level of validity and is considered efficacious.

3. Results

One hundred and twenty-eight plants are used in total. Fifteen plants are used to treat endoparasites and 14 plants are used for stomach problems. In many cases the respondents did not have the specific intestinal worms being treated identified at a laboratory or veterinary clinic. They used the clinical signs of large belly, lack of digestion, often hungry, weight loss and runny eyes as indications of a parasite infection. The results are summarised in Tables 1 and 2.

3.1. Treatment for gastroenteritis and intestinal problems

Gastroenteritis, stomach and intestinal inflammation caused by ingestion of rotten material (garbage gastritis), indigestion caused by overeating or eating something different are all treated with purchased capsules of slippery elm bark powder (*U. fulva*) (the loose herb equivalent dosage to the above capsules would be 500 mg for 22.6 kg bodyweight twice or three times a day). Alternatively 56.7 g slippery elm bark powder in 250 ml of water is given daily in the water or in the food for 2 weeks (4.5 to 6.8 kg dog). Pets are given 1 drop of peppermint oil (0.05 ml) in 1 l of water. The following teas are also given as the drinking water: peppermint (*M. piperita*) or lemon balm (*Melissa officinalis*). These teas are made by boiling 28.35 g herb in a glass pot with 250 ml of water and then steeping for 10–15 min. The dose used is 59.15 ml given orally with a syringe or in the drinking water for 2 days (9–11 kg bodyweight). Dogs are allowed to eat couch grass (*Agropyron repens*/*Elymus repens*). Owners claim that they self-medicate with it to purge their systems.

3.2. Treatment for diarrhoea prevention

One diarrhoea/upset stomach treatment consists of 56.7 g packed flowers of yarrow (*Achillea millefolium*) (steeped in 500 ml of boiling water for 15–20 min). It is

Table 1
Treatment for endoparasites in pets and pigs in British Columbia

Scientific name	Common name	Plant part used	Use
Allium sativum L. (Alliaceae) not collected	Garlic	Clove	Intestinal worms, *Ascaris suum* and *Giardia* in pigs
Artemisia cina O. Berg and C.F. Schmidt (Asteraceae)	Wormseed	Aerial parts	Roundworms and pinworms and amoebal infections
Artemisia annua (Asteraceae) JS105	Wormwood	Aerial parts	Roundworms, pinworms, *Giardia* in pigs
Artemisia vulgaris L. (Asteraceae) JS016	Mugwort	Leaves, root	Roundworms
Calendula officinalis L. (Asteraceae) JB84	Calendula	Flowers	Intestinal worms, amoebal infections
Cucurbita pepo L. (Cucurbitaceae) not collected	Pumpkin	Seeds	Tapeworms
Echinacea purpurea (L.) Moench (Asteraceae) JBCL 07	Echinacea	Roots	Microbial infections
Eugenia caryophyllata Thunb (Myrtaceae) purchased product	Cloves	Flowers	Roundworms, tapeworms
Gentiana lutea L. (Gentianaceae)	Gentian	Roots	Roundworms, tapeworms
Hydrastis canadensis L. (Ranunculaceae)	Goldenseal	Leaves	Antibiotic replacement
Juglans nigra L. (Juglandaceae)	Black walnut	Leaves, husks	Roundworms, helminths, protozoa
Mentha piperita L. (Lamiaceae) JS024	Peppermint	Leaves	Roundworms, *Giardia* and amoebal infections
Olea europaea L. (Oleaceae)	Olive	Leaf	Roundworms
Ruta graveolens L. (Rutaceae) not collected	Rue	Aerial parts	Roundworms, tapeworms
Salvia officinalis L. (Lamiaceae) JS035	Sage	Aerial parts	Roundworms

Table 2
Treatments used in British Columbia for pets and pigs with stomach problems

Scientific name	Common name	Plant part used	Use
Achillea millefolium L. (Asteraceae) JS 041	Yarrow	Flowers	Stop diarrhoea
Aloe vera (L.) Burm. f. (Asphodelaceae) Purchased product	Aloe vera	Gel	Vomiting and irritation
Elytrigia repens (L.) Desv. ex Nevski (Poaceae)	Couch grass	Aerial parts	Self-medication for gastroenteritis
Frangula purshiana (DC.) Cooper (Rhamnaceae)	Cascara	Bark	Constipation
Juniperus communis L. (Cupressaceae)	Juniper	Berries	Stop diarrhoea
Melissa officinalis L. (Lamiaceae) JS006	Lemon balm	Leaves	Toner, stop diarrhoea, gastroenteritis
M. piperita L. (Lamiaceae) JS024	Peppermint	Oil	Gastroenteritis
Petroselinum crispum L. (Apiaceae) not collected	Parsley	Aerial parts	Stop diarrhoea
Plantago major L. (Plantaginaceae) JB62a	Plantain	Seeds	Stop diarrhoea, constipation
Plantago ovata Forssk. (Plantaginaceae)	Psyllium	Seeds	Constipation
Rumex crispus L. (Polygonaceae) JS116	Yellow dock	Root	Constipation
Rumex obtusifolius L. (Polygonaceae) JB63	Yellow dock	Seed heads	Stop diarrhoea
Ulmus fulva Michx. (Ulmaceae) purchased product	Slippery elm	Bark powder	Gastroenteritis, food poisoning, colon health, stop diarrhoea
Zingiber officinalis Roscoe (Zingiberaceae) purchased product	Ginger	Rhizome	Colon health

given orally with a syringe or put in the drinking water. Another treatment consists of a dried parsley tincture (*Petroselinum crispum*) (113.4 g dried parsley 2:1 with vodka). Pets are given 1 ml (one drop) twice a day per 11 kg patient bodyweight. The tincture is given orally with a syringe or a drop is placed on the tongue.

A juniper tincture is also used. This is made with 113.4 g of semi-dry crushed juniper berries (*Juniperus* sp.) 1:1 with vodka. One or two drops (0.05–0.1 ml) are put on the tongue once a day for 2 days. Pets are also given a yellow dock (*Rumex crispus*) tea made with dried brown seed heads (not root or leaves) in a pot of water (500 ml). This is cooled and strained after 5 min. It is sweetened with honey or molasses if needed for palatability (large animals). An eyedropper is used to administer the medication orally to small animals. An 18 kg dog is given 2 ml every 3 h until the diarrhoea stops. Psyllium powder (*Plantago* sp.) is also used. Pets are given 3–6 g twice a day for 1 day per 18 kg patient bodyweight until the diarrhoea stops.

Pets are given slippery elm bark powder (*U. fulva*) for colon health (14 g slippery elm bark powder steeped in 118.3 ml boiling water for 3–5 min). Honey is added for palatability. The dose used is 3 g daily for small dogs, 9 g for medium sized dogs and 10–28 g for large dogs, administered with a syringe. Alternatively pets are given 7 g slippery elm bark powder (*U. fulva*) dissolved in water. This is allowed to thicken then given orally with a syringe. It is given up to three times a day for only 1 day, then once a day until no longer needed.

Animals like lemon balm tonic (*Melissa officinalis*) (28 g of the herb steeped for 10–15 min in 118.3 ml of boiling water per 11 kg patient bodyweight). This is added to the slippery elm preparation above. Purchased capsules of ginger (*Z. officinalis*) are also given.

One pet was given *Aloe vera* juice as a stomach tonic, for vomiting and irritation. The juice is made by pulverizing the leaf gel in water. The pet was given up to 3 ml orally with a syringe.

3.3. Treatment for endoparasites

For endoparasites 28 g of the following herbs are mixed with 500 ml of olive oil. Pets are given 59.15 ml of the mixture added to the food per 11–16 kg bodyweight. Equal parts of these herbs are used: wormwood (*Artemisia* sp.), rue (*R. graveolens*), peppermint (*M. piperita*), sage (*Salvia officinalis*) and mugwort (*Artemisia vulgaris*). This is given once. Rue (*R. graveolens*) is said to be toxic in high doses. Powdered, dried leaves of goldenseal (*H. canadensis*) are added to the mixture above if needed as an antibiotic replacement (3–4 g goldenseal is added to the food daily per 16 kg bodyweight or it is given orally 15 min before meals).

3.3.1. Specific plants listed below are said to be effective against specific parasites

Wormwood (*Artemisia absinthium*) aerial parts are said to be effective against roundworms and pinworms (1 handful/20–30 g of the aerial parts is steeped in 500 ml of boiling water for 20 min). Pets are then given 15 ml of the cooled, strained liquid per 25–27 kg bodyweight. Sweet wormwood (*Artemisia annua*) has fewer negative compounds than *A. absinthium*. Treating pets with essential or an infusion made with oil of wormwood (*A. absinthium*) is said to be dangerous and

Artemisia cina is used with caution. Calendula (*C. officinalis*) flowers are said to be effective against worms and amoebal infections (113.4 g flowers to 500 ml of boiling water). The dose is 14 g per 11 kg bodyweight for 2 days, repeated if so indicated by the pet's weight and body condition.

Pumpkin seeds (*Cucurbita pepo*) are said to paralyze tapeworms (10–15 seeds a day for 45 kg dogs given for 2–3 days). This treatment is then followed with a laxative, for example 30 ml castor oil 1 h after giving the seeds. Another owner gave 4 tsp freshly ground pumpkin seeds mixed with water, given with the food first thing in the morning every 2–3 months. Alternatively owners used 1 g of seeds per 250 ml of water (simmered for 30 min, cooled and filtered, the frothy top was skimmed off and discarded). The treatment was kept refrigerated until used. All of the filtered solution was given in the drinking water or placed on the food.

Echinacea (*Echinacea angustifolia*, *Echinacea purpurea*, *Echinacea pallida*) roots are said to be effective against microbial infections. The dose used was 0.25–0.5 ml of tincture daily, given orally with a syringe, or dropped on the tongue, for 2–3 days. For more serious cases 3 ml tincture was used per 11 kg patient bodyweight once or twice a day.

Dried ground flowers of cloves (*Eugenia caryophyllus*) were made into a tea using 4 g of powdered herb per 250 ml of boiling water. This was steeped for 10–20 min, cooled and strained. The dose used was 15 ml daily per 11 kg bodyweight for 2–3 days. Clove oil was not considered safe for pets.

Pets were given gentian (*Gentiana lutea*) dried roots, which were said to be effective against most species of intestinal worms. A tea was made by simmering 4 g of dried, shredded root, in 250 ml of water for 20 min; this was cooled then strained and sweetened with honey. The dose given was 15 ml per 11 kg bodyweight (given once).

Some owners used a commercial tincture made of wormwood (*Artemisia* sp.), cloves (*Eugenia caryophyllus*), garlic (*Allium sativum*), black walnut (*Juglans nigra*) and olive leaf (*O. europaea*) which has no stated quantities of each ingredient on the product label. Another commercial compound composed of black walnut (*Juglans nigra*) and artemisia (*Artemisia annua*) was given every day for 10–14 days for roundworms and the dose per weight given for humans on the product label was used for the equivalent weight in dogs.

Pets are given 1 ml twice a day for a month every 4 months (22 kg dog). Or it was used for 4–6 weeks every 6 months. If owners made their own tincture, they were careful not to exceed the recommended quantities (0.5 ml) of black walnut (*Juglans nigra*) or wormwood (*Artemisia* sp.). Other dogs are given 1–2 g of diatomaceous earth per 13–18 kg patient bodyweight in their food once a month or every 2 months.

Pet owners warned against the use of the following toxic plants for parasite control since overdoses are toxic: Santonica (*Artemisia cina*) seeds, male fern (*Dryopteris filix-mas*) rhizomes and tansy ragwort (*Senecio jacobaea*) aerial parts. Black walnut (*Juglans nigra*) is toxic to cats.

Pigs are treated with blended garlic (one to five whole bulbs of garlic per 45 kg of animal in one cup of milk) which is put in a rubber tub or trough for pigs to eat. This blend was given once a month from weaning to slaughter and was also given to the sows. Garlic was also added directly to the feed. Pigs were also given 25 kg of mixture made from diatomaceous earth and montmorillonite per 1500 kg feed every day from weaning to slaughter.

Wormwood (*Artemisia* sp.) is used to deworm pigs. Wormwood tops (2/3 m high or 2 feet high) are picked in summer and hung them to dry in the loft. A full armload was soaked in 20 l of water for 2 days and strained. Pigs are denied water until they are thirsty then they are given the liquid that the *Artemisia* tops has been soaked in. The liquid was blended with surplus milk or yoghurt and given as the drinking water. The quantities used are 20 l for 20 weaned pigs (25 kg), which is given once per cycle.

4. Discussion

4.1. Non-experimental validation

Emodin, an anthraquinone, is the virucidal agent (enveloped viruses) in *Aloe vera* and *F. purshiana* and also possesses antibacterial, diuretic, vasorelaxant effects, anti-inflammatory, anti-proliferative, and anti-carcinogenic properties (Alves et al., 2004). Dhananjeyan et al. (2005) successfully tested other anthraquinones against the human filarial parasite *Brugia malayi* and the pathogenic trematode *Schistosoma mansoni*. *Rumex obtusifolius* also contains anthraquinones (Spencer et al., 2007).

The antibacterial activity of essential oils derived from plants such as salvia and clove has been demonstrated against *Listeria monocytogenes*, *Salmonella typhimurium*, *E. coli* O157:H7, *Shigella dysenteria*, *Bacillus cereus* and *Staphylococcus aureus* in several *in vitro* studies at levels between 0.2 and 10 μl/ml. The antibacterial components in these oils have been identified as phenolic compounds such as

carvacrol, eugenol and thymol, perillaldehyde, cinnamaldehyde and cinnamic acid, camphor, alpha-pinene, β-pinene, 1,8-cineole and alpha-tujone with minimum inhibitory concentrations (MICs) of some of these at 0.05–5 μl/ml *in vitro* (Burt, 2004). The oils and their compounds are hydrophobic, which allows them to disturb the structures and membrane of bacterial cells rendering them more permeable and vulnerable (Burt, 2004). Anthraquinones are also hydrophobic (Alves et al., 2004).

The addition of 0.4–1.2% of peppermint oil to nutrient broth, either with or without glucose, reduced the total viable count of *S. aureus* by 6–7 logs colony forming units (cfu), while 0.1–1.0% reduced *Salmonella enteritidis* by 3 log cfu (McKay and Blumberg, 2006). At a concentration of 0.1% (v/v), peppermint oil inhibited the production of *S. aureus* toxin by a factor of 100,000. In drug resistant *S. aureus* and *Enterococcus faecium*, the effective bacteriostatic and bactericidal dose of peppermint oil was 0.5–2.0%. *M. piperita* oil was more effective against a multiresistant strain of *Shigella sonei* and *Micrococcus flavus* than oils from other *Mentha* species.

Githiori et al. (2006) and Jackson and Miller (2006) claim that plants with anthelmintic properties typically contain saponins, alkaloids, non-protein amino acids, tannins and other polyphenols, lignins, glycosidesalkaloids, terpenes, lactones, glycosides and phenolic compounds. Other active anthelmintic compounds include cysteine proteinases which digest the protective cuticle of the rodent gastrointestinal nematode *Heligmosomoides polygyrus* (Stepek et al., 2007), and anthraquinones which are active against *Schistosoma mansoni* (Dhananjeyan et al., 2005). Rogerio et al. (2003) claim that some flavonoids exert an antiproliferative action on T cells which could modulate lymphocyte activation and IL-5 production during a *Toxocara canis* infection.

The minimum inhibitory concentration (MIC) of 23 g of pumpkin seed (±73 seeds) (*Cucurbita maxima*) in 100 ml distilled water as an antiparasitic agent using canine tapeworms with an intestinal isolation of 5–6 h was determined. Alterations in helminthic motility were found at a dose of >23 g. There is a protheolithic effect with an average survival time of 38.4 min. The anthelmintic effect is increased at 30 and 32 g (Diaz Obregon et al., 2004).

The plant evaluation section includes research on those plants that have shown repellency against mosquito species since Jaenson et al. (2005) claim this is an indication that they may also repel *Ixodes ricinus* nymphs; these plants may have potential for study as novel anthelmintics. Jaenson et al. (2005) found that *A. absinthium* extracts in ethyl acetate had a repellent activity ≥70% and *A. absinthium* extracts in hexane had a repellent activity of ≥60%, on *I. ricinus* nymphs.

The sulphuric compound in garlic contributes to its anthelmintic effect, and walnut's active compound is naphthoquinone (Githiori et al., 2006). Many polyphenols (hydrolysable tannins, proanthocyanidins, caffeic acid derivatives) reduced the survival of the intracellular, amastigote parasite form of *Leishmania donovani* or *Leishmania major* strains *in vitro*. The effects of polyphenols on intracellular *Leishmania* parasites were due to macrophage activation rather than antiparasitic activity (Kolodziej and Kiderlen, 2005). *Rumex obtusifolius*, *O. europaea* and *Juglans regia* also have polyphenols (Bisignano et al., 1999; Bhatia et al., 2006; Spencer et al., 2007). Ethyl alcohol fruit extracts of *Juniperus drupacea* and *Juniperus oxcycedrus* have anthelmintic activity but aqueous fruit and leaf extracts are not very effective (Kozan et al., 2006). Eguale et al. (2007) speculated that the better activity of hydroalcoholic versus aqueous extracts in his study of the anthelmintic activity of *Coriandrum sativum* against *Haemonchus contortus* in sheep is due to easier transcuticular absorption of the hydroalcoholic extracts into the body of the parasite. He cites as an example the study by Iqbal et al. (2004) in which the methanol extract of *Artemisia brevifolia* at a concentration of 25 mg/ml had a significant *in vitro* anthelmintic activity on adult *Haemonchus contortus*, but the aqueous extract did not.

Calzada et al. (2006) found the following antiprotozoal activity of methanolic extracts of selected Mexican medicinal plants that are the same or closely related to those in this paper. Against *Entamoeba histolytica* the IC50 (μg/ml) (95% confidence intervals) values for *Allium sativum* were 61.8 (62.2–61.4); *A. absinthium*: 72.3 (72.5–72.1); *Artemisia ludoviciana*: 82.2 (84.8–81.7) and *Ruta chalepensis*: 61.9 (62.1–61.8). Against *Giardia lamblia* the IC50 (μg/ml) (95% confidence intervals) values for *Allium sativum*: 64.9 (65.0–64.8); *A. absinthium*: 135.4 (135.7–135.1); *Artemisia ludoviciana*: 95.1 (97.2–93.8) and *Ruta chalepensis*: 37.8 (37.9–37.7).

Extracts of *Artemisia annua* were 81.6–83.2% suppressive towards the development of *Cryptosporidium parvum* in mice (Youn and Noh, 2001). *Artemisia herba-alba* contains santonin which has a selective toxic action on the ganglion located in the nerve ring of *Ascaris* spp., but its narrow range of activity does not include *Oxyuris* spp., and cestodes (Waller et al., 2001). Santonin is active against the inflammation induced by a

Table 3
Non-experimental validation of plants used for pets and pigs in British Columbia

Medicinal plant	Validation information	Reference
Allium sativum	Experiments with the intestinal parasite *Entamoeba histolytica* have shown that pure allicin inhibits both the cytopathological effects associated with infection and the growth of the parasite. Allicin is said to be the active principle against *Haemonchus contortus* in ruminant hosts. Diluted liquid allicin proved useful against cryptosporidium parasites in humans in preliminary tests. Whole garlic extract gave an IC(50) at 24 h of 0.3 mg/ml against the microaerophilic flagellate *Giardia intestinalis*. Most of the components of garlic also assayed were inhibitory to the organism. Mid-level validity as an anthelmintic	Coppi et al. (2006), Githiori et al. (2006), Anon. (1996), and Harris et al. (2000)
Achillea millefolium	Different species from the *Achillea millefolium* aggregate are used against gastrointestinal and hepato-biliary disorders in traditional European medicine. An *Achillea* fraction produced choleresis that was two-to threefold higher than that of cynarin. Two yarrow compounds stimulated bile flow more effectively than cynarin. Due to their polar structure, these compounds are quantitatively extracted into teas and tinctures; and may be the choleretic active principles in the traditional application forms of yarrow. Yarrow contains sesquiterpene lactones, a germacrene derivative, flavonoid derivatives, apigenin, luteolin, rutin and chlorogenic acid. Mid-level validity for stomach problems	Benedek et al. (2005) and Innocenti et al. (2007)
Aloe vera	Fresh *Aloe vera* leaves are used to obtain a bitter yellow juice (exudate) with high content of 1,8-dihydroxyanthraquinone derivatives (aloe emodin, chrysophanol) and their glycosides (aloins), which are used for their cathartic effects. The antiparasitic action of an aqueous extract of *Aloe barbadensis* Miller against *in vitro* culture of *Trichomonas vaginalis* (three strains) was established. Within 24 h, percentages of inhibition greater than 50% were obtained from concentrations of 20.8 μg/ml. Barbaloin is said to be the most active component in *Aloe vera*. The anthraquinonic fraction showed activity against *Bacillus subtilis* in ethanol extracts of the leaf. A report of clinical cases suggested that the gel was bactericidal towards *Pseudomonas aeruginosa*. Inhibitory activity was reported against *Trichophyton* spp., by *A. ferox* 'juice'. Weak inhibitory activity was shown against *T. mentagrophytes* by high molecular weight components of *A. arborescens* leaves. Growth of the yeast *Candida albicans* was inhibited by *A. ferox* 'juice'. Extracellular killing of *Candida* by acemannan-stimulated macrophages was demonstrated. High-level validity for stomach problems	Vázquez et al. (1996), Reynolds and Dweck (1999), Rojas et al. (1995), and Ho et al. (2007)
Artemisia annua	A 1762 publication recommended wormwood for the treatment of ''flatworms''. Traditional treatments of the period for roundworms also included wormwood. An extract of leaves and stalks of *Artemisia asiatica* improved the survival rate of broiler chicks infected with *Eimeria tenella* (90%). An extract of the whole plant of *Artemisia annua* gave an 80% survival rate. Artemisinin fed for 4 weeks at levels of 2, 8.5, and 17 ppm for 3 weeks to chicks undergoing immunization with a live vaccine, significantly reduced oocyst output from separate *E. acervulina* and *E. tenella* infections and a dual species infection. When fed over a period of 3 weeks at a level of 5%, a dried leaf supplement of *A. annua* provided significant protection against lesions due to *Eimeria tenella*. *Artemesia santonica* has activity against *Ascaris lumbricoides*. The anthelmintic effects of crude aqueous (CAE) and methanol extracts (CME) of *Artemisia brevifolia* (whole plant) on live *Haemonchus contortus* as evident from their paralysis and/or mortality at 6 h post exposure was shown in sheep naturally infected with mixed species of gastrointestinal nematodes. Maximum reduction (67.2%) in eggs per gram (EPG) of faeces was recorded on day 14 post-treatment in sheep treated with *Artemisia brevifolia* CAE at 3 g kg^{-1} b.w. Levamisole produced a 99.2% reduction in EPG. An increase in EPG reduction was noted with an increase in the dose of *Artemisia brevifolia* administered as CP, CAE and CME. *Artemisia afra* water and ethanol extracts showed anthelmintic activity when tested against the free living nematode *Caenorhabditis elegans*. Thujone from *Artemisia* species is fatal in rats at a dose of 120 mg/kg. A typical human dose of *Artemisia afra* aqueous extract is 100 mg/kg. *Artemisia afra* aqueous extract proved relatively non-toxic in a 3-month chronic toxicity study with rodents, caused no apparent organ damage, and in high doses had a hepatoprotective effect. The anti-inflammatory effect of santonin a sesquiterpenoid found in *Artemisia* and other members of the Compositae family is similar to that of diclofenac sodium, an inhibitor of cyclooxygenase. *Artemisia absinthium* showed positive results against Crohn's disease in a double-blind placebo-controlled study of 40 patients. High-level validity as an anthelmintic	Wynn (1996), Youn and Noh (2001), Githiori et al. (2006), Iqbal et al. (2004), Poppenga (2007), McGaw et al. (2000), Omer et al. (2007), Mukinda and Syce (2007), and Allen et al. (1997)

C. officinalis	*C. officinalis* has many pharmacological properties. It is used for the treatment of skin disorders, pain and also as a bactericide, antiseptic and anti-inflammatory. The butanolic fraction of *C. officinalis* possesses a significant free radical scavenging and antioxidant activity. Chronic hyposecretory gastritis, chronic hepatocholecystitis and angiocholitis were treated with a herbal complex which included *Achillea millefolium*, *Urtica dioica*, *Cichorium* (aerial part), *Polygonum*, *Matricaria chamomilla* (flowers), *Helichrysum arenarium*, *Calendula* (flowers), corn stigmas, *Humulus lupulus* (racemes) in proportion 3:3:1:1:2:1:1:2:1, respectively. The herbal decoction was to be taken three times daily before meals. *C. officinalis* had an immunomodulation effect against three different live viruses in broiler chickens. Mid-level validity for amoebal infections, low-level validity as an anthelmintic	Cordova et al. (2002), Klouchek-Popova et al. (1982), Krivenko et al. (1989), and Barbour et al. (2004)
Cucurbita pepo	Cucurbitine from crushed pumpkin seeds is 55% efficacious against *Taenia saginata*. Cucurbitine is active on trematodes but inactive against nematodes and cestodes. Another study claims that cucurbitine is active against Taenia but a purge is necessary to expel the parasite. A fourth study indicates that the seeds are effective against Ascaris, Taenia and Oxiuris parasites. The median effective single dose of seeds in humans against the cestode, *Taenia saginata* L. (Taeniidae) is 42.8 ± 5.3 and the worm expulsion time is 10.1 ± 1.7 h. Mid-level validity as an anthelmintic	Wynn (1996), Oliver Bever (1986), Desta (1995), Akhtar et al. (2000), and Kozan et al. (2006)
Echinacea sp.	Echinacea can modulate the antigen-specific immune response, providing a sustained primary and secondary IgG response. Dried roots, rhizomes, tincture and fluidextracts of botanicals containing berberine such as *Echinacea angustifolia* are being prescribed for treatment of trichomonal infections. Mid-level validity for microbial infections	Rehman et al. (1999) and Vermani and Garg (2002)
Elytrigia repens	*Agropyron repens* reportedly contains a mucilaginous compound, triticin, and an antibiotic, agropirene. Mid-level validity if zoopharmacological observations are included	Viegi et al. (2003)
Eugenia caryophylla	The antibacterial activity of different extracts of *Eugenia caryophyllata* was demonstrated against pathogenic bacteria. The fungicidal activity of the essential oil of *E. caryophyllata* was demonstrated against several food-borne fungal species, on fungi isolated from onychomicosis and on the yeast model *Saccharomyces cerevisiae*. Clove essential oil has shown acaricidal activity against *Dermatophagoides farinae* and *D. pteronyssinus* with eugenol identified as the acaricidal constituent; and it also has activity against *Psoroptes cuniculi* and antiviral activity. Low-level validity as an anthelmintic	Fichi et al. (2007), Burt and Reinders (2003), Feres et al. (2005), Larhsini et al. (2001), Ranasinghe et al. (2002), Gayoso et al. (2005), Chami et al. (2005), and Chaieb et al. (2007)
Gentiana lutea	Terpenoids, linalool, decanal, and benzaldehyde may contribute to any insecticidal activity of *Gentiana lutea*. Benzoic acid and its derivatives possess antibacterial and antifungal activity. It is found in *G. lutea* and *G. punctata*. Two sulfones are found in *G. lutea*. Isoorientin was isolated from the EtOAc extract of *Gentiana olivieri* and is the active antihepatotoxic and antioxidant component. Isoorientin has antibacterial activity against *Staphylococcus aureus*, *Bacillus subtilis* and *P. aeruginosa* as well as a myolitic effect on uterus smooth muscles in rats and guinea pigs. *Gentiana lutea* roots had an MIC of 100 μg/ml, with a range of 3.125–100 μg/ml against 15 strains of *Helicobacter pylori*. Gentian tincture reportedly elevates gastric secretion in dogs. Mid-level validity as an anthelmintic	Georgieva et al. (2005), Wynn and Fougère (2007), Sezik et al. (2005), and Mahady et al. (2005)
H. canadensis	Goldenseal can modulate the antigen-specific immune response, enhancing the acute primary IgM response. Phytochemical-mediated modulation of cytochrome P450 (CYP) activity may underlie many herb-drug interactions. Botanical supplements containing goldenseal strongly inhibited CYP2D6 and CYP3A4/5 activity *in vivo* therefore serious adverse interactions may result from the concomitant ingestion of goldenseal supplements and drugs that are CYP2D6 and CYP3A4/5 substrates. Extracts of botanicals containing berberine such as *H. canadensis* are being suggested as treatments for trichomonal infections. Mid-level validity as an antibiotic substitute	Rehman et al. (1999), Blumenthal (2000), Luo et al. (1998), and Vermani and Garg (2002)
Juglans nigra	Six compounds were isolated from the MeOH extract of the leaves of *Juglans sinensis*. Compounds **1**, **2**, and **5** showed protective effects against nitrofurantoin-induced cytotoxicity, and compound **5** also exhibited a moderate protective effect on amiodarone-induced cytotoxicity in Hep G2 cells. Walnut (*Juglans regia* L.) bark is claimed to possess anti-inflammatory, blood purifying, anticancer, depurative, diuretic and laxative activities. It contains several therapeutically active constituents, especially polyphenols. Walnut bark extract has antioxidant potential against oxidative stress-mediated urotoxicity in mice. Plumbagin and a series of other structurally related naphthoquinones are found in the roots, leaves, bark, and wood of *Juglans regia*, *Juglans cinerea*, and *Juglans nigra*. Plumbagin has anti-proliferative, proapoptotic, anti-metastatic and anti-inflammatory properties. *Juglans regia* has shown anthelmintic activity against *Haemonchus contortus* from goats. Juglone and naphthoquinone are reported to be the anthelmintic compounds. Mid-level validity as an anthelmintic	An et al. (2005), Akhtar et al. (2000), Bhatia et al. (2006), Sandur et al. (2006), Duke (1990), and Githiori et al. (2006)

Table 3 (*Continued*)

Medicinal plant	Validation information	Reference
Juniperus communis	The aqueous ethanol extract of *Juniperus communis* (bark) showed pancreatic lipase inhibitory activity. Hexane extracts from *Juniperus communis* and methanol extracts of *Juniperus communis* inhibited the growth of *Mycobacterium tuberculosis*. Mid-level validity for diarrhoea	Kim and Kang (2005), Jimenez-Arellanes et al. (2003), and Kozan et al. (2006)
Melissa officinalis	Extracts from the plants *Iberis amara*, *Melissa officinalis*, *Matricaria recutita*, *Carum carvi*, *Mentha* × *piperita*, *Glycyrrhiza glabra*, *Angelica archangelica*, *Silybum marianum* and *Chelidonium majus*, singly and combined into a commercial preparation, STW 5 (Iberogast) and a modified formulation, STW 5-II, lacking the last three plants, were tested for their potential anti-ulcerogenic activity against indometacin induced gastric ulcers of the rat. All extracts produced a dose dependent anti-ulcerogenic activity associated with a reduced acid output and an increased mucin secretion. The most beneficial effects were seen with the combined formulations STW 5 and STW 5-II in a dose of 10 ml/kg b.w., comparable with cimetidine in a dose of 100 mg/kg b.w. High-level validity for stomach problems	Khayyal et al. (2001)
M. piperita	*M. piperita* possesses anti-nociceptive and anti-inflammatory effects that are dose dependent. *Mentha cordifolia* contains beta-sitosterols and glucosides and has been tested against *Ascaris suum* displaying similar activity to synthetic anthelmintic mebendazole on contact of the parasite with the preparations. *Menta* spp., have also been tested against *Haemonchus contortus* in ruminant hosts. *Mentha arvensis* var. *piperacens* is active against zoonotic enteropathogens including *Salmonella* spp., *Escherichia coli* O157, *Campylobacter jejuni* and *Clostridium perfringens*. The fungicidal activity of peppermint oil was demonstrated in 11 fungi, including *Candida albicans*, *Trichophyton mentagrophytes*, *Aspergillus fumigatus* and *Cryptococcus neoformans*, at an MIC range of 0.25–10 μl/ml. Animal model studies demonstrated a relaxation effect on gastrointestinal (GI) tissue, analgesic and anesthetic effects in the central and peripheral nervous system and immunomodulating actions. Mid-level validity as an anthelmintic. High-level validity for stomach problems	Atta and Alkofahi (1998), Githiori (2004), McKay and Blumberg (2006), and Wannissorn et al. (2005)
O. europaea	*O. europaea* is considered to have anti-malarial and anthelmintic activity in Kenya. The bark of O. europaea var. africana did not show anthelmintic activity in sheep infected with *Haemonchus contortus*. Oleuropein has shown microbial activity. Secoiridoides (oleuropein and derivatives), polyphenols found in olives and olive oil, inhibit or delay the rate of growth of a range of bacteria and microfungi. Oleuropein was ineffective against *Haemophilus influenzae* and *Moraxella catarrhalis*. Low-level validity as an anthelmintic	Njoroge and Bussmann (2006), Githiori et al. (2004), Fleming et al. (1973), and Bisignano et al. (1999)
Plantago major, *Plantago ovata*	*Plantago major* contains five classes of biologically active compounds: a benzoic compound (vanillic acid), flavonoids (baicalein, baicalin, luteolin), iridoid glycoside (aucubin), phenolic compounds (caffeic acid, chlorogenic acid, ferulic acid, *p*-coumaric acid) and triterpenes (oleanolic acid, ursolic acid). *Plantago major* has immune-stimulating properties. Plantain induces dose dependent proliferation patterns in human lymphocyte cultures. High concentrations (400, 600 μg/ml) of *Plantago major* enhanced phagocytosis in laying hens. Some hypercholesterolemic patients benefited from the use of psyllium (*Plantago psyllium*), a good source of soluble fiber (10–12% mucilage). *Plantago major* is weakly active against *S. aureus*. The median effective single dose of *Plantago lanceolata* whole plant in humans against the cestode, *Taenia saginata* L. (Taeniidae) is 60.2 ± 4.9 and the worm expulsion time is 18.0 ± . 2.4 h. Pounded leaf extract or juice obtained from the fresh leaves of *Plantago lanceolata* has anthelmintic activity in aqueous and EtOH leaf extracts against pinworms *Syphacia obvelata* and *Aspiculuris tetraptera*, in mice. Mid-level validity for stomach problems	Chiang et al. (2002), Dorhoi et al. (2006), Craig (1999), Holetz et al. (2002), Desta (1995), and Kozan et al. (2006)
Rhamnus purshiana/ *Frangula* purshiana	Cascara bark (*Rhamnus purshiana*) needs drying and curing for one to 2 years to be safe otherwise it is too strong a laxative. Long-term use or abuse of *Rhamnus purshiana* can increase loss of serum potassium, which potentiates the toxicity of cardiac glycosides and antiarrhythmic agents (e.g., quinidine). Potassium deficiency can be increased by simultaneous use of thiazide diuretics, corticosteroids, or licorice root. The FDA study on drug efficacy of 1990 considered cascara bark to be safe and effective. The Food and Drug Administration (FDA) issued a final rule stating that the stimulant laxative ingredients aloe (including aloe extract and aloe flower extract) and cascara sagrada (including casanthranol, cascara fluidextract aromatic, cascara sagrada bark, cascara sagrada extract, and cascara sagrada fluidextract) in over-the-counter (OTC) drug products are not generally recognized as safe and effective or are misbranded (Food and Drug Administration, HHS). High-level validity for constipation	Blumenthal (2000), Food and Drug Admin., HHS (2002).

Rumex crispus, *Rumex obtusifolius*	Crude extracts of leaves of *Rumex nervosus* and the root of *Rumex abyssinicus* have antibacterial activity against *Streptococcus pyogenes* and *S. aureus* and activity against Coxsackie virus B3 and influenza A. *Rumex abyssinicus* contains oxalic acid, chrysophanic acid, chrysophanol, emodine and physcion. An acetone:water (7:3) extract obtained from the leaves of *Rumex obtusifolius* contains epicatechin a chemical with activity against giardia. High-level validity for stomach problems	Getie et al. (2003), Lee et al. (2006), Spencer et al. (2007), and Barbosa et al. (2007)
R. graveolens	*R. graveolens* possesses an anti-nociceptive effect. The leaves of *R. graveolens* inhibit the growth of several bacteria including *Bacillus subtilis* and *S. aureus*. The essential oil has a slight anthelmintic effect attributed to nonylmethyl ketone. *R. graveolens* odour is less effective in inhibiting the fifth-instar of the triatomine *Rhodnius prolixus* than cinnamon odour. Mid-level validity as an anthelmintic	Atta and Alkofahi (1998), Anon. (1999), and Abramson et al. (2007)
Salvia officinalis	*Salvia officinalis* L. showed enhanced inhibitory activity against bacterial strains derived from 100 urine samples taken from subjects diagnosed with urinary tract infection living in the community. The extract showed 100% efficiency against *Klebsiella* and *Enterobacter* species, 96% against *E. coli*, 83% against *Proteus mirabilis*, and 75% against *Morganella morganii*. *Salvia officinalis* leaves had an minimum inhibitory concentration MIC (μg/ml) of 100 and an MIC range (μg/ml) of 25–100 when tested against 15 strains of *Helicobacter pylori*. *Salvia miltiorrhizae* extract reduced the injury area and depth of gastric mucosa caused by hemorrhagic shock and reperfusion, and protected gastric mucosa in a rat study. Low-level validity as an anthelmintic	Pereira et al. (2004), Zhang et al. (2005), and Mahady et al. (2005)
U. fulva	*Ulmus macrocarpa* improved the survival rate of broiler chicks infected with *Eimeria tenella* (100% survival). Herbal remedies used by patients for treatment of inflammatory bowel disease include slippery elm, fenugreek and devil's claw. Slippery elm scavenged superoxide dose-dependently. Oxygen radical release from biopsies was reduced after incubation with slippery elm which has antioxidant effects. High-level validity for stomach problems	Youn and Noh (2001) and Langmead et al. (2002)
Z. officinalis	*Zingiber officinale* is active against *Helicobacter pylori* strains, and also has anti-inflammatory, antioxidant and antitumoral activity. An extract from the root of *Zingiber officinale* reduced the minimum inhibitory concentrations of aminoglycosides in vancomycin-resistant enterococci. The effective compound [**10**]-gingerol with its detergent-like effect potentiated the antimicrobial activity of the aminoglycosides. Extracts of *Zingiber officinale* had an MIC of 25 μg/ml against 15 strains of *H. pylori*. The chloroform extracts from *Zingiber zerumbet*, had an IC50 of $<$100 μg/ml against trophozoites of *Giardia intestinalis*. Rhizomes of *Zingiber zerumbet* showed good *in vitro* anthelmintic activity against human *Ascaris lumbricoides*. Ginger rhizomes (ethyl acetate extract) contain one or more compounds that are active against adult *Schistosoma mansoni* and these compounds kill more male than female worms. A dose of at least 200 mg/l is needed. High-level validity for colon health	Nostro et al. (2006), Nagoshi et al. (2006), Akhtar et al. (2000), Mahady et al. (2005), Sanderson et al. (2002), and Sawangjaroen et al. (2005)

foreign body, but to a lesser effect than diclofenac sodium. Santonin oral administration decreased the body temperature of normal mice and had a significant antipyretic effect in yeast-fevered mice (Al-Harbi et al., 1994).

Allicin and ajoene, two active chemical compounds of garlic inhibit the growth of various protozoan parasites, including *Crithidia fasciculate*, *Cryptosporidium baileyi*, *G. duodenalis*, *Giardia lamblia* (syn. *G. duodenalis*), *Histomonas meleagridis*, *L. major*, *Leptomonas colosoma*, *Plasmodium berghei*, *Tetratrichomonas gallinarum*, *Trypanosoma brucei brucei*, *Trypanosoma brucei congolense*, *Trypanosoma brucei gambiense*, *Trypanosoma brucei rhodesiense*, *Trypanosoma cruzi*, *Trypanosoma equiperdum* and *Trypanosoma evansi* (Anthony et al., 2005). Allium sativum has mid-level validity as an anthelmintic. Contrary to the Alberta farmers who reported no ill effects from using garlic as a dewormer for pigs an Iowa study found the opposite. Holden et al. (1999) tested garlic in a standard antibacterial nursery dietary regimen in pigs. The 1997 trial had inclusion levels of 0.0, 0.5, 2.5 and 5%. These levels of garlic generally depressed feed intake and average daily gain in nursery pigs and depressed performance compared with the control diet with Mecadox.

Pumpkin seeds have mid-level validity as an anthelmintic and this use is widespread. The French Cevenol shepherds used herbs during transhumance including dosing *Cucurbita maxima* Duch seeds to purge their herd dogs of coenurosis (Martin et al., 2001). *Mentha piperita* has high-level validity for stomach problems. The methanol, dichloromethane, and *n*-hexane extracts of dry leaves *of Mentha* × *piperita* were found to have antigiardial activity in one study; the aqueous infusion did not (Vidal et al., 2007). *Mentha* species are also used for digestive problems in animals in Romania (Martin et al., 2001).

Gentiana lutea has mid-level validity as an anthelmintic and is used as such in the Ubaye Valley of France's Alpes de Haute Provence (Martin et al., 2001). *R. graveolens* and *Salvia officinalis* formed part of a multi-plant remedy used by 17th century blacksmiths in Luxemburg for internal inflammations in animals (Martin et al., 2001).

More on the non-experimental validation of the plants is given in Table 3.

5. Conclusion

The same herbs have been used against endoparasites for centuries (Wynn, 1996; Wynn and Marsden, 2003). These include some of the remedies described in this paper: wormwood, garlic, black walnut, pumpkin and cascara (Wynn, 1996). The Federal Drug Administration lists wormwood (*Artemisia absinthum*) as unsafe. Black walnut, rue and wormwood are regulated as drugs by several international herb regulatory agencies (Wynn, 1996).

H. canadensis, *Melissa officinalis*, *Rhamnus purshiana* and *U. fulva* are less well known as ethnoveterinary remedies than the other plants reported on in this paper. *H. canadensis* contains berberine which showed strong nematicidal activity against the larva of the dog roundworm *Toxocara canis* (Satou et al., 2002). These researchers claim that the isoquinoline alkaloids allocryptopine, dehydrocorydaline and papaverine are safer nematocidal agents than berberine, emetine, sanguinarine and chelerythrine. However, in a comprehensive review (Anon., 2000) that outlined the mechanisms by which berberine inhibits bacterial diarrhoea caused by *Vibrio cholera* and *E. coli*, and inhibits *Giardia lamblia*, *Entamoeba histolytica*, *Trichomonas vaginalis*, and *Leishmania donovani* it was stated that berberine is not considered toxic at doses used in clinical situations, nor is it cytotoxic or mutagenic. *Echinacea angustifolia* also contains berberine.

Salvia officinalis and *Eugenia caryophyllata* may contribute to the efficacy of combination formulas. *Salvia officinalis* contains alpha-thujone which is also the active ingredient in wormwood oil. Alpha-thujone is reported to have antinociceptive, insecticidal, and anthelmintic activity (Hold et al., 2000). *Salvia officinalis* has well established immune modulatory activities and its aerial parts have a phenolic composition of hydrolysable tannins and caffeic acid-derived metabolites which are being investigated for antileishmanial activity (Kolodziej and Kiderlen, 2005).

The eugenol and caryophyllene in *Eugenia caryophyllata* are reported to be its anthelmintic compounds (Pessoa et al., 2002; Park and Shin, 2005). Eugenol showed anthelmintic activity against *Caenorhabditis elegans* (Asha et al., 2001). Little information is available on *O. europaea* and insufficient information was available on the anthelmintic properties of *C. officinalis*; all of the other plants have mid to high-levels of validity for parasite control and stomach problems.

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