Herbs and Other Functional Foods in Equine Nutrition

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Abstract

A majority of the many herbs and other functional foods on the market today have not been scientifically tested; this is especially true in equine research. The following paper will review literature pertinent to herbal supplementation in horses as well as other species. Common equine supplements like, echinacea, garlic, ginger, ginseng, and yucca among many others, are not regulated and few studies have investigated a safe yet effective dose of these compounds. Ginseng is commonly studied and has been found to exert an inhibitory effect on IL-1β and IL-6 gene expression, decrease TNF-α production by macrophages, decrease cyclooxygenase-2 expression, and suppress histamine and leukotriene release. On-going studies in horses are testing the anti-inflammatory effects of a single dose of ginger, post-exercise. Echinacea, a common immunostimulant, or 'cold fighter', has been reported to have an anti-inflammatory and antioxidant properties. Equine studies found that garlic fed at > 0.2 g kg^{-1} d^{-1} developed Heinz body anaemia. Yucca contains steroid-like saponins, which produce an anti-inflammatory, antioxidant, and anti-spasmodic effect to reduce pain associated with arthritis. Herbs can have a drug-like action that can interact with other components in the horses' diet. Some herbs contain prohibited substances like salicylates, digitalis, heroin, cocaine and marijuana. Drug-herb interactions are also common side effects and caution needs to be taken when determining which 'natural product' to use. Few herbs have had sufficient research to warrant concrete recommendations for efficacy and dosage in equines.

Keywords: antioxidant, anti-inflammatory, herb, horse, immunostimulant, nutrition, phytomedicine

Introduction

Herbal medicine, also called "phytomedicine", is the use of therapeutic plants, plant parts or plant derived substances to aid in fighting against infections, diseases or enhancing overall health (Jonas, 1997). In the United States, the herbal market exceeds $3.2 billion, where 32 to 37 % of Americans use herbal agents each year (Johnston, 1997). This number is thought to be much higher in Europe where herbal agents are more widely accepted by medical professionals. In 2005 this number for the herbal market was thought to be higher, with garlic and echinacea being the top two selling herbs, respectively (Blumenthal, 2005). The horse industry in the United States was surveyed in 1997 regarding supplement use and found that about 70 % of horse operations fed one type of supplement or another. Furthermore, nearly 5 % of those operations fed herbal supplements (USDA, 1998). Since then, it is thought that the herbal market targeting horses has grown exponentially; however no new statistical data is available on the subject.

Herbal supplements that affect the immune system can be classified as adaptogens,

immunostimulants or both. Adaptogens increase resistance to stressors, physical, chemical or biological, where immunostimulants activate the nonspecific, or innate defense mechanisms against viral, bacterial or cellular infections. Most of the studies to date in laboratory animals, humans and other species have determined that the immunologic effect of herbal supplements does not enhance normal immune response but may help if the immune system is compromised.

This review will focus on specific herbs and other functional foods that are commonly used in the horse industry. Published literature however, is scarce on this front, so research in human and other species is included to better illustrate the benefit of the supplements.

Herbal Actions and Uses

Table 1 summarizes the active component, action, drug interactions, and equine research present for the major herbs described.

Bee Pollen and Propolis

Bee pollen and propolis are similar resinous substances collected from various plant sources by honeybees. Propolis has been found to contain polyphenols, flavonoids, as well as several specific antioxidant compounds including beta-carotene, caffeic acid, kaempferol, and phenethyl caffeate, p-hydroxyacetophenone, benzylhydroxybenzoate, coumaric and cinnamic acid (Ahn et al., 2004; Gomez-Caravaca et al., 2006; Christov et al., 2006). The composition of propolis varies greatly as a result of collection from different geographic regions, the time of collection, and various species of vegetation from which the pollen is collected. Reported biological properties include antioxidant, antimicrobial, antifungal, anti-inflammatory, and immunoregulatory actions, as well as being a nearly nutritionally complete foodstuff (Liebelt and Calcagnetti, 1999).

Propolis with strong antioxidant activity, as determined by beta-carotene bleaching, 1,1-diphenyl-2-picrylhydrazyl free radical scavenging, and 2,2'-azinobis(3-ethylbenzothiazoline-6-sulfonic acid) radical cation declorization assays, was also found to have high total polyphenol content (Ahn et al., 2004). Additionally, propolis and polyphenolic compounds derived from propolis were found to have immunomodulatory effects evidenced by decreased pulmonary tumor nodules in mice with experimentally transplanted tumors (Orsolic et al., 2004). Tichy and Novak (2000) found a mixture of antimicrobial compounds in ethanol extracts of propolis that were effective in inhibiting *viridans Streptococci*. Furthermore, several different propolis samples were found to exhibit significant antimicrobial activity against gram-positive bacteria and yeasts (Uzel et al., 2005). Anti-inflammatory effects of propolis were found in a mouse paw edema model in which nitric oxide inhibition occurred after propolis administration (Tan-No et al., 2006). Ethanol and water extracts of propolis were effective in reducing inflammation purportedly through the inhibition of prostaglandin E_2 and nitric oxide levels in ICR and Wistar rats with induced edema, pleurisy, and acute lung damage. Additionally, these same rats with induced arthritis exhibited reduced interleukin (IL)-6 in inflamed tissues after administration of propolis extracts (Hu et al., 2005).

Little research has been done to evaluate the efficacy of bee pollen or propolis supplements in horses. There are numerous anecdotal reports of the benefits of supplemented bee pollen in horses including improved oxygen utilization, lower heart rates, and firmer muscle tone (Turner et al., 2006). A recent pilot study in horses examined the effects of bee-pollen based supplementation on physical fitness parameters, immunological status, and nutritional variables in Arabian horses in training. Results indicated that supplementation

with a commercial 55 % bee-pollen supplement for 42 days did not alter physical fitness or immunological variables in the horses. However, supplementation did significantly increase feed intake and nutrient retention in the same horses (Turner et al., 2006). Similar results were seen in rats supplemented with propolis showing increased weight gains, improved utilization of iron, increased calcium and phosphorus absorption, and improved regeneration efficiency of hemoglobin (Haro et al., 2000).

Devil's Claw

Devil's claw (*Harpagophytum procumbens*) is reported to have an anti-inflammatory effect in humans and laboratory animals. On the animal health market devil's claw is primarily used for its painkilling and anti-inflammatory properties, and has many testimonials claiming relief from rheumatism and other joint disorders (Anon, 2003). Its effectiveness could be dependent upon the route of administration and may not be effective in the form of an intra-peritoneal injection. The active ingredients are various iridoid glycosides, acetylated phenolic glycosides, and terpenoids. Studies have shown that extracts with > 50 mg of harpagoside (a glycoside) per day are helpful in alleviating lower back pain in humans (for review see Chrubasik et al., 2002). Most of the human clinical studies reported a decrease in pain intensity and an increase in flexibility after being supplemented with devil's claw extract.

Studies in laboratory animals have shown that topical application of devil's claw decreases the expression of cyclooxygenase (COX)-2, which is a rate-limiting enzyme involved in the inflammatory cascade (Kundu et al., 2005). However, it was not clear in this study as to which specific herbal components were contributing to this action. Harpagoside alone has been shown to suppress COX-2 and inducible nitric oxide synthase (iNOS) at both the mRNA and protein level in vitro (Huang et al., 2006). However, it did not exhibit any inhibitory effect on COX-1 activity, thus the activity of harpagoside is not attributed to the antioxidant properties of devil's claw. Its effectiveness in reducing pain and inflammation associated with rheumatoid and osteoarthritis can be explained by its ability to block the production of inflammatory mediators like prostaglandin E_2 (PGE_2; Chantre et al., 2000). A study in horses with naturally occurring osteoarthritis looked at the effect(s) of 'Mobility', a proprietary polyherbal composite joint supplement containing devil's claw. An anti-inflammatory effect was observed in the horses due to a reduction in PGE_2 synovial fluid content (Pearson et al., 1999).

There is a potential for devil's claw to cause gastrointestinal upset linked to gastric ulcers (for review see Harman, 2002). However, other drug interactions have not been reported.

Echinacea

Echinacea (*Echinacea sp.*), a common immunostimulant, or 'cold fighter', has been reported to have anti-inflammatory and antioxidant properties. The equine industry typically uses echinacea as an immune booster to compliment a healthy immune system (Anon, 2003). It is recommended that the best way to use echinacea is to supplement at the first signs of illness or infection. If administered too late in the cycle the herb will be less effective.

In humans (Wagner & Jurcic, 1991) and mice (Roesler et al., 1991), echinacea extracts have been shown to stimulate phagocytosis. Other studies have demonstrated a stimulating effect on lymphocyte function and proliferation in normal and diseased human mononuclear cells (See et al., 1997).

Three main species include *Echinacea purpurea, E. angustifolia,* and *E. pallida.*

These species have been studied for their medicinal properties and were found to have a wide range of benefits (for review see Block & Mead, 2003). Many research studies have looked at the biochemistry, immunopharmacology and clinical use of echinacea, however most of those papers are in German. The common active components of these various echinacea species include polysaccharides, glycoproteins, alkamides, and cichoric acid, which is a derivative of caffeic acid. However, it must be noted that depending on the species and commercial preparation of these products, the concentrations of these components will vary greatly. Some human studies have found that echinacea can enhance cytokine production, including tumor necrosis factor alpha (TNF-α), IL-1, IL-6, and IL-10 by macrophages (Burger et al., 1997).

One case study on two horses with strangles showed improved symptoms and a return to normal appetite after 24 hours of administration (unknown citation). Another study used eight horses that were supplemented echinacea for 42 days at a level equivalent to 1000 mg standardized extract (O'Neill et al., 2002b). They concluded that the horses treated with echinacea were immune stimulated, however results only showed increases in lymphocyte count and decreases in neutrophil count at day 35 of the 42 day supplementation period. Increases in red blood cell count and hemoglobin were also found over time.

Flaxseed

Flaxseed (*Linum usitatissimum*) contains high levels of omega-3 fatty acids, and is often reported to enhance a horses' hair coat. In horses, this supplement is marketed for its high omega-3 fatty acid content and is used in coat, skin, and hoof conditioners. Flaxseed is one of the highest sources of α-linolenic acid, and also contains phytoestrogens, flavonoids, and various amino acids and minerals (Cunnane et al., 1993). Due to its soluble fiber content comparable to that of oat bran, flaxseed is used most often in humans as a laxative. Recently there have been an increased number of supplement companies incorporating flaxseed or linseed components into their products, however published research is limited.

One study tested flaxseed as a treatment for allergic skin diseases in horses and found a significant improvement in a skin test response to Culicoides or 'sweet itch' as compared to placebo treated horses (O'Neill et al., 2002a). Research studies in other species have reported antioxidant, anti-inflammatory, and chemopreventive properties of flaxseed and flaxseed oil. One study reported that in male Fischer rats with experimentally-induced carcinogenesis of the gastrointestinal tract, 15 % flaxseed diet supplementation significantly increased colon tissue and serum levels of omega-3 fatty acids, a decreased size and incidence of tumors, as well as decreased COX-1 and -2 levels (Bommareddy et al., 2006). Another study evaluated the antioxidant properties of flaxseed supplementation in albino rats challenged with CCl toxin. Results indicated a 1.2-fold increase in the lipid peroxidation value, increased restoration of catalase, superoxide dismutase, and peroxidase compared to CCl challenged control animals (Rajesha et al., 2006). Additionally work was done to evaluate nutrient utilization in dairy cows following flaxseed supplementation and found that total tract nutrient utilization was improved without adverse effects on ruminal fermentation (Gonthier et al., 2004).

There is some concern for cyanide poisoning in horses fed flaxseed, which is why it is commonly boiled to remove the potentially toxic cyanide components (Oomah et al., 1992). However, symptoms do not become evident for a long time and no reported symptoms were evident in the study by O'Neill. In theory, the lack of toxicity was attributed to the ability of the stomach acid to inactivate enzymes within the seeds, which are required to interact with the glycosides to form cyanide.

Garlic

Garlic (*Allium sativum*) has properties including anti-bacterial, anti-viral, anti-fungal, and anti-parasitic. Garlic's active components include organosulphur compounds, which are responsible for the majority of garlic's physiological effects. The intact bulb of the garlic plant contains a complex mixture of cysteine sulfoxides, and γ-glutamylcysteines. When the bulb is disrupted the sufloxidases are cleaved to the active form of thiosulfinate allicin (Munday and Munday, 2001). Garlic is typically included in equine supplements for its expectorant action to help break up mucous. However, this action is secondary to the primary use of garlic in the horse industry – fly control. The sulphur content is also theorized to help cleanse the blood (Anon, 2003). In one study, the efficacy of 'Breath', a polyherbal composite supplement containing garlic, was evaluated in horses with naturally occurring, symptomatic chronic obstructive pulmonary disease (COPD). A significant decrease in respiratory rate was found with no deleterious effects detected in hematology and biochemistry screenings (Pearson, 2003).

Garlic extracts containing phytochemicals have been shown to have antioxidant properties in other species. The antioxidant characteristics of garlic extract manifest themselves in reactive oxygen specie (ROS) scavenging, enhancing cellular antioxidant enzyme status including superoxide dismutase, catalase and glutathione peroxidase. Garlic extract is further attributed to inhibiting lipid peroxidation, protecting DNA against free radical-mediated damage and mutations, inhibiting multi-step carcinogenesis, protecting against some forms of ultraviolet-induced immunosuppression, and preventing age related deterioration of brain function (in a senescence-accelerated mouse model) (reviewed in Borek, 2001; Thabrew et al., 2000).

Toxicity is a possibility with symptoms including gastric irritation, decreased sperm production, Heinz body anemia, and occupational asthma. In dogs, 5 g of fresh garlic kg^{-1} increased oxidation of hemoglobin within red blood cells and decreased total hemoglobin concentration (Hu et al., 2002). Garlic consumption also led to oxidation of red blood cells in sheep (Stevens, 1984). Equine studies found that freeze dried garlic fed at > 0.4 g kg^{-1} d^{-1} resulted in symptoms indicative of Heinz body anaemia (Pearson et al., 2005). In this study 100 % of the horses (n = 2) fed garlic showed an increase in mean corpuscular volume and hemoglobin, Heinz body score, platelet count, serum-free and total billirubin concentration, and decreases in red blood cell count, blood and mean corpuscular hemoglobin concentration, and serum haptoglobin concentration.

Ginger

Ginger (*Zingiber officinale*) has been shown to have anti-thrombitic, antioxidant, anti-inflammatory, and anti-bacterial properties. In the 1970's ginger was first found to have anti-inflammatory properties including inhibition of prostaglandin synthesis. After that time more research was completed and found that major constituents in ginger include paradol, gingerol, and myoga (for review see Grzanna et al., 2005).

[8]-Paradol, a natural constituent of ginger, has shown anti-inflammatory properties as a potent COX-1 inhibitor and anti-platelet aggregation in human whole blood. These properties make it a potential treatment for musculoskeletal disorders (Srivastava and Mustafa, 1992). Ginger has shown potential for use in cancer treatment. 6-gingerol, another natural constituent of ginger, protected human leukemic HL60 cells from oxidative stress and induced cell death in promyelocytic leukemia HL60 cells. It also caused DNA fragmentation and inhibited Bcl-2 expression. Another component of ginger, myoga (*Zingiber mioga* Roscoe), showed powerful cytotoxic effects on human T lymphoma Jurkat cells. Recently

ginger has received attention due to anti-inflammatory properties extending beyond the inhibition of prostaglandins (for a review of this literature see Grzanna et al., 2005).

On-going studies in horses are testing a single dose of ginger on anti-inflammatory and cardiovascular effects post-exercise (Liburt, 2005). Intensely exercised horses, until the point of fatigue, administered with ginger extract one hour prior to exercise had a reduced recovery time in the fast phase of the VO_2 recovery curve where the metabolic cost of exercise rapidly is replenished. On the other hand, ginger has a tendency to increase pro-inflammatory cytokines TNF-α and interferon (IFN)-γ. It was speculated that the caustic ginger extract solution irritated the gastrointestinal tract after ingestion, which could be confounded by the increased creatine kinase levels seen after this administration as well (Liburt, 2005). Even though ginger has been theorized in horses and proven in humans to cause gastric ulcers, many ulcer relief herbal supplements for horses contain ginger as a major ingredient.

Ginseng

Ginseng (*Panax sp.*) is commonly studied in terms of its immunostimulating properties. It has been found to exert an inhibitory effect on IL-1β and IL-6 gene expression, decrease TNF-α production by macrophages, and decrease COX-2 expression, and suppress histamine and leukotriene release (for review see Radad et al., 2006). On the equine supplement market ginseng is marketed and sold for use in stimulating the immune system, decreasing stress, and increasing optimal performance, however no published research was found at this time.

Ginseng has three main species of interest, the Asian ginseng is *Panax ginseng,* the American ginseng is *Panax quinquefolius,* and the Siberian ginseng is correctly called "eleuthero" or *Eleutherococcus senticosus* (for review see Block & Mead, 2003). The main component of each of these species includes glycosidal saponins called ginsenosides. Other minor components include essential oils, phytosterols, amino acids, peptides, vitamins and minerals. Many of the ginsenosides have antioxidant properties that protect membranes of nerve and immune cells.

Studies using human immune cells have demonstrated a stimulating effect on lymphocyte function and proliferation in normal and diseased human mononuclear cells (See et al., 1997). The results from this study are consistent with other published research on its immune-stimulating properties in laboratory animals and humans.

Valerian

Valerian (*Valeriana sp.*) has tranquilizing and sedative properties due to its influences on neuromediators such as μ-aminobutyric acid (GABA; Peeters et al., 2004). There is strong scientific evidence that it decreases CNS activity in mice equal to that of Phenobarbital (Hendriks et al., 1985). Valerian is also effective in treating insomnia and other sleep disorders in humans. The mechanism of action starts with valerenic acid inhibiting the enzyme system that causes the breakdown of GABA in the brain. This respective increase of GABA is associated with sedation and a decrease in CNS activity (Riedel et al., 1982; Houghton, 1999).

The components of valerian include valerenic acids, such as monoterpenes and sesquiterpenes, and iridoid glycosides that give the root a sedative and anti-spasmodic activity. In the volatile oil component of valerian, sesquiterpenes, are responsible for its biological effect (Houghton, 1999). *Valeriana fauriei*, *V. officinalis, V. edulis,* and *V. wallichii* are more commonly studied species of valerian. The amount of active ingredient in each depends on the form and preparation of the product (e.g. capsule, tincture, tea, etc.). It

has been determined that the highest concentration of valerenic acids were recovered in powder capsules, whereas the lowest amount was found in tinctures and teas (Lefebvre et al., 2004).

No known studies have been done in horses to date, but many 'calming aids' or 'stress relief' supplements include valerian as one of the major active ingredients (Anon, 2003). Caution needs to be taken when supplementing valerian however, as certain show organizations, such as the International Federation for Equestrian Sports (FEI), ban this product from use during competition.

One study evaluated the effectiveness of 'Sedafit', a commercial herb product containing *Valeriana officinalis L.* and *passiflora incarnate L.*, in reducing the physiological response to stress in pigs undergoing transportation simulation (Peeters et al., 2004). Data showed a significantly reduced increase in cardiac response variables including heart rate, ventricular ectopic beats, and sinus tachycardia (ST) elevation. Additionally, the supplement did not affect intermediate metabolites (glucose, lactate, creatine kinase, and nonesterified fatty acids). Therefore it was suggested that the supplement is effective as a mild sedative with anti-anxiety properties (Peeters et al., 2004). Another study evaluated the tranquillizing effect of a 31.6 mg kg^{-1} dose of valeranone in rats administered an electric shock avoidance test. Results indicated a mild sedation, however not to the extent of a 10 mg kg^{-1} dose of chlorpromazine (Rucker et al, 1978).

Yucca

Yucca (*Yucca schidigera*) contains steroid-like saponins, which produce an anti-inflammatory, antioxidant, and anti-spasmodic effects to reduce pain associated with arthritis. Many equine joint supplements contain yucca among other anti-inflammatory agents. Yucca is theorized to decrease respiratory problems, such as COPD in horses. The saponins are natural detergents that form stable foams, which contain both fat- and water-soluble components. As much as 10 % of the yucca stem contains saponins making it one of the richest sources (Cheeke et al., 2006). Yucca also contains other active components including polyphenols like resveratrol and yuccaols A-E (Oleszek et al., 2001; Piacente et al., 2004). These phenols are exclusively found in the bark and are not present in the mechanical extraction of the yucca extract.

As of the late twentieth century, the only studies performed on the anti-arthritic effects of yucca were in the 1970's by Bingham who reported that pain and swelling of human arthritic patients were relived by yucca supplementation. The theory behind this efficacy was due to the saponins anti-protozal activity. More recently the potent antioxidant activity of the polyphenols is also thought to give yucca its anti-arthritic properties. It has been proven that yuccaols inhibit iNOS, an inflammatory agent that increases during inflammatory responses. Resveratrol along with the yucca phenols was also found to inhibit NFκB, a transcription factor that controls the expression of iNOS (Tsai et al., 1999; Marzocco et al., 2004).

Yucca has also been proven to have various anti-platelet effects. One study found resveratrol and other yucca phenolics to reduce the level of ROS in blood platelets, along with changes in the production of superoxide radicals, inhibition of free radicals activated by thrombin, and decreased lipid peroxidation (Olas et al., 2003).

At this time there are no equine studies showing the benefits of yucca supplementation, however studies have looked at ruminal fermentation and metabolism of yucca in sheep (Eryavuz & Dehority, 2004; Santoso et al., 2006) and cattle (Hristov et al., 2003). For a review on research in other animals (chickens, mice, pigs, sheep, cattle, rabbits and quail) and the biochemistry of yucca see Piacente et al, 2005.

Other Herbs and Functional Foods

Black tea, orange peel, and cranberry extracts have also been studied in intensely exercising horses (Liburt, 2005; Streszalova et al., 2006). Black tea contains aflavin, a polyphenol, which is a strong inhibitor of the gene expression for IL-8. Black tea extract administered prior to horses exercising until exhaustion on a treadmill, decreased mRNA expression of TNF-α and IFN-γ, but produced higher lactate levels throughout exercise (Streltsova et al., 2006). Orange peel extract contains citrus-derived polymethoxylated flavones that have an inhibitory effect on TNF-α expression. The same study in horses found that orange peel extract decreased IFN-γ expression at fatigue, and appeared to decrease recovery time of cardiovascular parameters.

Cranberry (*Vaccinium macrocarpon*) polyphenols have been shown to protect endothelial cells against stress-induced up-regulation of oxidative and inflammatory mediators. Phenolics in cranberries, like quercetin and cyanidin, have highly effective radical scavenging structures. Cranberry appears to attenuate the TNF-α response, but not the appearance of IFN-γ (Liburt, 2005). This may prove useful in lessening delayed onset of muscle soreness (DOMS) following strenuous activity.

Herb-Drug Interactions

Many people believe that because herbs are 'natural' products that it also qualifies them as 'safe' however, evidence of various herb toxicities and negative side effects has shown this to be a dangerous misnomer. Herbs can have a drug-like action that can interact with other components in the horse's diet. Some herbs contain prohibited substances like salicylates, digitalis, heroin, cocaine and marijuana. Drug-herb interactions can create various side effects ranging from mild to severe; thus caution needs to be taken when determining which 'natural product' to use.

A general review of various species and drug herb interactions can be found in Miller, 1998 and Izzo et al., 2005. Harman (2002) and Poppenga (2001) have written extensive reviews on the toxicology of herbs in equine medicine. Below is a list of a few known interactions or negative effects, which are also summarized in Table 1.

Valerian components have been found to prolong the action of barbiturates (Dunayev et al., 1987) and can interact with alcohol (Miller. 1998). It has also been shown to inhibit cyotchrome P450, the body's major detoxification enzyme, which can lead to multiple drug interactions if not used with caution (Lefebvre et al., 2004). Echinacea has shown that persistent use is related to hepatotoxic effects and should not be taken with other hepatotoxic drugs like steroids. Garlic, along with the potential to cause Heinz Body Anemia in horses as detailed above, was found to create gastrointestinal upset, allergic reactions and dermatitis in humans. Garlic also decreased systolic and diastolic blood pressure, however, there was insufficient evidence to recommend its use in clinical hypertension (Miller, 1998). Ginger has proven to inhibit thromboxane synthetase and increase bleeding time, which could be detrimental if used with anti-clotting drugs like warfarin. Some of ginseng's adverse effect includes hypertension, insomnia, vomiting, headache, nervousness, sleeplessness, and epistaxis in humans. It is also recommended when utilizing ginseng, to discontinue use of warfarin, heparin, aspirin, and other NSAIDs (Miller, 1998; Poppenga, 2001).

Summary

In conclusion various herbs are being used in the equine industry, some of these include bee pollen, devil's claw, echinacea, flaxseed, garlic, ginger, ginseng, valerian and yucca. Despite many anecdotal reports of efficacy, most of the herbal supplements have never been proven safe and effective in horses; therefore caution must be taken when selecting a supplement. Herb drug interactions are also a potential problem and if a horse is at risk of developing a potential toxicity or drug interaction, a veterinarian or nutritionist should be contacted.

References

Anon. 2003. Herbs & remedies for fabulously healthy animals. Brookby Herbs, Clevedon, NZ. www.brookbyherbs.co.nz

Ahn, M.R., S. Kumazawa, T. Hamasaka, L.S. Bang, & T. Nakayama. 2004. Antioxidant activity and constituents of propolis collected in various areas of Korea. J. Agric. Food Chem. 52:7286-7292.

Block, K.I., & M.N. Mead. 2003. Immune system effects of echinacea, ginseng, and astragalus: A review. Integ. Cancer Ther. 2:247-267.

Blumenthal, M. 2005. Herb sales down 7.4 percent in mainstream market. HerbalGram. 66:63.

Bommareddy, A., B.L. Arasada, D.P. Mathees, & C.Dwivedi. 2006. Chemopreventive effects of dietary flaxseed on colon tumor development. Nutr. Cancer. 54:216-222.

Borek, C. 2001. Recent advances on the nutritional effects associated with the use of garlic as a supplement: Antioxidant health effects of aged garlic extract. J. Nutr. 131:1010-1015.

Bringham, R., B.A. Bellow & J.G. Bellow. 1975. Yucca plant saponin in the management of arthritis. J. Appl. Nutr. 27:45-51.

Burger, R.A., A.R. Torres, R.P. Warren, V.D. Caldwell, & B.G. Hughes. 1997. Echinacea-induced cytokine production by human macrophages. Int. J. Immunopharmacol. 19:371-379.

Chantre, P., A. Cappelaere, D. Leblan, D. Guedon, J. Vandermander, & B. Fournie. 2000. Efficacy and tolerance of *Harpagophytum procumbens* versus diacerhein in treatment of osteoarthritis. Phytomedicine. 7:177-183.

Cheeke, P.R., S. Piacente, & W. Oleszek. Anti-inflammatory and anti-arthritic effects of yucca schidigera: a review. J. Inflam. 3:6-13.

Christov R., B. Trusheva, M. Popova, V. Bankova, & M. Bertrand. 2006. Chemical composition of propolis from Canada, its antiradical activity and plant origin. Nat. Prod. Res. 20:531-536.

Chrubasik, S., S. Pollak, & A. Black. 2002. Effectiveness of devil's claw for osteoarthritis. Rheumatol. 41:1332-1333.

Cunnane, S.C., S. Ganguli, & C. Menard. 1993. High alpha-linolenic acid flaxseed (*Linum usitatissimum*): some nutritional properties in humans. Br. J. Nutr. 69:443-453.

Dunayev, V.V., S.D. Trzhetsinsky, V.S. Tishkin, N.S. Fursa, V.I. Linenko, & V.R. Stets. 1987. Biological activity of the sum of valepotriates isolated from Valalliariifolia Adams. Farmakol. Toksikol. 50:33-37.

Eryavuz, A. & B.A. Dehority. 2004. Effect of *Yucca schidigera* extract on the concentration of rumen microorganisms in sheep. Anim. Feed Sci. Technol. 117:215-222.

Gomez-Caravaca, A.M., R. Gomez-Romero, D. Arraez-Roman, A. Segura-Carretero, & A. Fernandez-Gutierrez. 2006. Advances in the analysis of phenolic compounds in products derived from bees. J. Pharm. Biomed. Anal. 41:1220-1234.

Gonthier C., A.F. Mustafa, R. Berthiaume, H.V. Petit, R. Martineau, & D.R. Ouellet. 2004. Effects of feeding micronized and extruded flaxseed on ruminal fermentation and nutrient utilization by dairy cows. J. Dairy Sci. 87:1854-1863.

Grzanna, R., L. Lindmark, & C.G. Frondoza. 2005. Ginger – An herbal medicinal product with broad anti-inflammatory actions. J. Medicinal Food. 8:125-132.

Harman, J. 2002. The toxicology of herbs in equine practice. Clin. Tech. Equine Pract. 1:74-80.

Haro, A., I. Lopez-Aliaga, F. Lisbona, M. Barrionuevo, M.J.M. Alferez, & M.S. Campos. 2000. Beneficial effect of pollen and/or propolis on the metabolism of iron, calcium, phosphorus, and magnesium in rats with nutritional ferropenic anemia. J. Ag. Food Chem. 48:5715-5722.

Hendriks, H. R. Bos, H.J. Woerdenbag, & A.S. Koster. 1985. Central nervous depressant activity of verenic acid in the mouse. Planta. Med. 1:28-31.

Houghton, P.J. 1999. The scientific basis for the reputed activity of valerian. J. Pharm. Pharmacol. 51:505-512.

Hristov, A. N., M. Ivan, L. Neill, & T. A. McAllister. 2003. Evaluation of several potential bioactive agents for reducing protozoal activity in vitro. Anim. Feed Sci. Technol. 105:163-184.

Hu, F. H.R. Hepburn, Y. Li, M. Chen, S.E. Radloff, & S. Daya. 2005. Effects of ethanol and water extracts of propolis (bee glue) on acute inflammatory animal models. J. Ethnopharmacol. 100:276-283.

Hu, Q., Q. Yang, O. Yamato, M. Yamasaki, Y. Meade, & T. Yoshihara. 2002. Isolation and identification of organosulfur compounds oxidizing canine erythrocytes from garlic (*Allium sativum*). J. Agric. Food Chem. 50:1059-1062.

Huang, T.H., V.H. Tran, R.K. Duke, S. Tan, S. Chrubasik, B.D. Roufogalis, & C.C. Duke. 2006. Harpagoside suppresses lipopolysaccharide-induced iNOS and COX-2 expression through inhibition of NF-κβ activation. J. Ethnopharmacol. 104:149-155.

Izzo A.A., G. Di Carlo, F. Borrelli, & E. Ernst. 2005. Cardiovascular pharmacotherapy and herbal medicines: the risk of drug interaction. Int. J. Cardiol. 98:1-14.

Johnston, B. 1997. One-third of nation's adults use herbal remedies: market estimated at $3.24 billion. HerbalGram. 40:552.

Jonas, W.B. 1997. Alternative medicine. J. Fam. Pract. 45:34-37.

Kundu, J.K., K.S. Mossanda, H.K. Na, & Y.J. Surh. 2005. Inhibitory effects of the extracts of *Sutherlandia frutescens* (L.) R. Br. and *Harpagophytum procumbens* DC. on phorbol ester-induced COX-2 expression in mice skin: AP-1 and CREB as potential upstream targets. Cancer Letters. 218:21-31.

Lefebvre, T., B.C. Foster, C.E. Drouin, A. Krantis, J.T. Arnason, J.F. Livesey, & S.A. Jordan. 2004. *In vitro* activity of commercial valerian root extracts against human cyotchrome P450 3A4. J. Pharm. Pharmaceut. Sci. 7:265-273.

Liburt, N.R. 2005. Effects of ginger and cranberry extracts on markers of inflammation and performance following intense exercise in horses. Rutgers, the State University of New Jersey, New Brunswick, NJ. Masters Thesis.

Liebelt, R.A., & D. Calcagnetti. 1999. Effects of a bee pollen diet on the growth of the laboratory rat. Am. Bee J. 139:390-395.

Marzocco, S., S. Pacente, C. Pizza, W. Oleszek, A. Stochmal, A. Pinto, R. Sorrentino, & G. Autore. 2004. Inhibition of inducible nitric oxide synthase expression by yuccaol C from *Yucca schidigera roezl*. Life Sci. 75:1491-1501.

Miller, L.G. 1998. Herbal medicinals. Selected clinical considerations focusing on known or potential drub-herb interactions. Arch. Int. Med. 158:2200-2211.

Munday, R., & C.M. Munday. 2001. Relative activities of organosulfur compounds derived from onions and garlic in increasing tissue activities of quinone reductase and glutathione transferase in rat tissues. Nutr. Cancer. 40:205-210.

Olas, B., B. Wachowicz, A. Stochmal, & W. Oleszek. 2003. Inhibition of oxidative stress in blood platelets by different phenolics from *Yucca schidgera* Roezl. bark. Nutr. 19:633-640.

Oleszek, W., M. Sitek, A. Stochmal, S. Piacente, C. Pizza & P. Cheeke. 2001. Resveratrol and other phenolics from the bark of *Yucca schidigera Roezl*. J. Agric. Food Chem. 49:747-752.

O'Neill, W., S. McKee, & A.F. Clarke. 2002a. Flaxseed (*Linum usitatissimum*) supplementation associated with reduced skin test lesional area in horses with *Culicoides* hypersensitivity. Can. J. Vet. Res. 66:272-277.

O'Neill, W., S. McKee, & A.F. Clarke. 2002b. Immunological and haematinic consequences of feeding a standardized Echinacea (*Echinacea angustifolia*) extract to healthy horses. Equine Vet. J. 34:222-227.

Oomah, B.D., G. Mazza & E.O. Kenaxcuk. 1992. Cyanogenic compounds in flaxseed. J. Agr. Food Chem. 40:1346-1348.

Orsolic, N., A.H. Knezevic, L. Sver, S. Terzic, & I. Basic. 2004. Immunomodulatory and antimetastatic action of propolis and related polyphenolic compounds. J. Ethnopharmacol. 94:307-315.

Pearson, W. 2003. Ethnoveterinary medicine: The science of botanicals in equine health and disease. Proc. 2nd Eu. Equine Health Nutr. Congress. Lelystad, The Netherlands. pg. 31-40.

Pearson, W., H.J. Boermans, W.J. Bettger, B.W. McBride, & M.I. Lindinger. 2005. Association of maximum voluntary dietary intake of freeze-dried garlic with Heinz body anemia in horses. Am. J. Vet. Res. 66:457-465.

Pearson, W., S. McKee, A.F. Clarke. 1999. The effect of a proprietary herbal product on equine joint disease. J. Nutraceuticals Functional Med. Foods. 2:31-46.

Peeters, E., B. Driessen, R. Steegmans, D. Henot, & R. Geers. 2004. Effect of supplemental tryptophan, vitamin E, and a herbal product on responses by pigs to vibration. J. Anim. Sci. 82:2410-

2420.

Piacente S., P. Montoro, W. Oleszek, & C. Pizza. 2004. *Yucca schidigera* bark: phenolic constituents and antioxidant activity. J. Nat. Prod. 67:882-885.

Piacente S., Pizza C., & W. Oleszek. 2005. Saponins and phenolics of *Yucca schidigera* Roezl: Chemistry and bioactivity. Phytochem. Rev. 4:177-190.

Poppenga, R.H. 2001. Risks associated with the use of herbs and other dietary supplements. Vet. Clin. N. Am.: Equine Pract. 17:455-477.

Radad K., G. Gille, L. Linlin, & W.D. Rausch. 2006. Use of ginseng in medicine with emphasis on neurodegenerative disorders. J. Pharmacol. Sci. 100:175-186.

Rajesha J., K.N. Murthy, M.K. Kumar, B. Madhusudhan, & G.A Ravishankar. 2006. Antioxidant potentials of flaxseed by in vivo model. J. Agric. Food Chem. 54:3794-3799.

Riedel, E., R. Hansel, & G. Ehrke. 1982. Inhibition of gamma-amino butyric acid catabolism by valerenic acid derivatives. Planta. Med. 46:219-220.

Roesler, J., A. Emmendorffer, C. Steinmuller, B. Juttig, H. Wagner & M.L. Lohmann-Matthes. 1991. Application of purified polysccharides from cell cultures of the plant *Echinacea purpurea* to test subjects mediates activation of the phagocyte system. Int. J. Immunopharmacol. 13:931-941.

Rucker, G., Z.J. Tautges, A. Sienck, H. Wenzl, & E. Graf. 1978. Untersuchungen zur Isolierung und pharmakodynamischen Aktivitat das sesquiterpens Valeranon aus *Nardostachys jatamansi* D.C. Arzneim. Forsch. 28:7-13.

Santoso, B., B. Mwenya, C. Sar, & J. Takahashi. 2006. Ruminal fermentation and nitrogen metabolism in sheep fed a silage-based diet supplemented with Yucca schidigera or Y. schidigera and nisin. Anim. Feed Sci. Technol. 129:187-195.

See, D.M., N. Broumand, L. Sahl, & J.G. Tilles. 1997. *In vitro* effects of echinacea and ginseng on natural killer and antibody-dependant cell cytotoxicity in healthy subjects and chronic fatigue syndrome or acquired immunodeficiency syndrome patients. Immunopharmacol. 35:229-235.

Srivastava, K.C., & T. Mustafa. 1992. Ginger (Zingiber officinale) in rheumatism and musculoskeletal disorders. Med. Hypo. 39:342-348.

Stevens, H. 1984. Suspected wild garlic poisoning in sheep. Vet. Rec. 115:363.

Streltsova, J.M., K.H. McKeever, N.R. Liburt, M.E. Gordon, H.M. Filho, D.W. Horohov, R.T. Rosen, and W. Franke. 2006. Effect of orange peel and black tea extracts on markers of performance and cytokine markers of inflammation in horses. Equine Comp. Exer. Physiol. (in press).

Tan-No, K., T. Nakajima, T. Shoji, O. Nakagawasai, F. Niijima, M. Ishikawa, Y. Endo, T. Sato, S. Satoh, & T. Tadano. 2006. Anti-inflammatory effect of propolis through inhibition of nitric oxide production on carrageenin-induced mouse paw edema. Biol. Pharm. Bull. 29:96-99.

Thabrew, M.I., N. A. Samarawickrema, L.G. Chandrasena, & S. Jayasekera. 2000. Protection by garlic against adriamycin Induced alterations in the oxido-reductive status of mouse red blood cells. Phytotherapy Research. 14:215-217.

Tichy J., & J. Novak. 2000. Detection of antimicrobials in bee products with activity against viridans streptococci. J. Altern. Complement. Med. 6:383-389.

Tsai, S.H., S.Y. Lin-Shiau, & J.K. Lin. 1999. Suppression of nitric oxide synthase and the down-regulation of the activation of NFkappaB in macrophages by reseratrol. Br. J. Pharmacol. 126:673-680.

Turner, K.K., B.D. Nielsen, C.I. O'Connor, & J.L. Burton. 2006. Bee pollen product supplementation to horses in training seems to improve feed intake: a pilot study. J. Anim. Physiol. Anim. Nutr. 90:414-420.

Wagner, H. & K. Jurcic. 1991. Immunological studies of plant extract combinations: *in vitro* and *in vivo* studies on the stimulation of phagocytosis. Arzneim. Forsch. 41:1072-1076.

USDA. 1998. Part II: Baseline reference of 1998 Equine Health and Management. USDA:APHIS:VS, CEAH, National Animal Health Monitoring System. Fort Collins, CO. #N318.0400.

Uzel, A., K. Sorkun, O. Oncag, D. Cogulu, O. Gencay, & B. Salih. 2005. Chemical compositions and antimicrobial activities of four different Anatolian propolis samples. Microbiol. Res. 160:189-195.

Table 1. Herbal supplements and other functional foods.

Common name	Scientific name	Active components	Actions	Potential toxicity or interaction	Equine research
Bee pollen	*Propolis*	β-carotene, caffeic acid, kaempferol, phenethyl caffeate, p-hydroxyacetophenone, benzylhydroxybenzoate, coumaric, cinnamic acid	antioxidant, antimicrobial, antifungal, anti-inflammatory, immunoregulatory	None reported	Y
Devil's claw	*Harpagophytum procumbens*	Iridoid glycosides, acetylated phenolic glycosides, terpenoids	anti-inflammatory	May effect blood sugar, gastric ulcers, prolong bleeding time	Y
Echinacea	*Echinacea purpurea, E. angustifolia, E. pallida*	Polysaccharides, glycoproteins, alkamides, cichoric acid	anti-inflammatory, antioxidant	May interfere with drugs processed by liver enzymes, not for use with a depleted immune system, or during pregnancy	Y
Flaxseed	*Linum usitatissimum*	omega-3 fatty acids, phytoestrogens, flavonoids	antioxidant, anti-inflammatory, chemopreventive	May decrease or prolong absorption of other drugs, prolong bleeding time	Y
Garlic	*Allium sativum*	sulfoxides, gama-glutamylcysteines	Anti-bacterial, anti-viral, anti-fungal, anti-parasitic	Heinz body anemia, uterine stimulant, prolong bleeding time, gastric ulcers	Y
Ginger	*Zingiber officinale*	paradol, gingerol, myoga	anti-inflammatory, anti-thrombitic, antioxidant, anti-bacterial	May effect blood sugar, prolong bleeding time, gastric ulcers	Y
Ginseng	*Panax ginseng, Panax quinquefolius, Eleutherococcus senticosus*	ginsenosides, essential oils, phytosterols	anti-inflammatory, antioxidant	May interfere with drugs processed by liver enzymes, potentate diuretics, decrease blood sugar, prolong bleeding time	N
Valerian	*Valeriana fauriei*, *V. officinalis, V. edulis, V. wallichii*	valerenic acid, iridoid glycosides	Sedative, anti-spasmodic	May enhance effect of tranquilizers and anesthetics, may be prohibited substance, cause diarrhea and colic	N
Yucca	*Yucca schidigera*	saponins, resveratrol, yuccaols A-E	anti-inflammatory, antioxidant, anti-spasmodic, anti-platelet	May potentate NSAID's, cause diarrhea	N