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Plants Affecting the Mammary Gland (7-May-2004)

A. P. Knight[1] and **R. G. Walter**[2]

[1]Department of Clinical Sciences, College of Veterinary Medicine, Veterinary Teaching Hospital, Colorado State University, Fort Collins, CO, USA.
[2]Department of Biology, Colorado State University, Fort Collins, CO, USA.

Plant Toxins in Milk

Ever since the deaths of Abraham Lincoln's mother and others were shown to be caused by drinking milk from cows that had eaten white snakeroot, concern has existed regarding the presence of plant toxins in milk [1,2]. The best known plant toxicants secreted in milk are tremetol and tremetone found in white snakeroot (*Eupatorium rugosum*) and rayless goldenrod (*Isocoma pluraflora*) [3,4]. White snakeroot and rayless goldenrod poisoning has been reported in cattle, horses, sheep, pigs, dogs, and cats. It causes a syndrome of muscle tremors referred to as "trembles" [3,4]. Milk sickness develops in humans who drink the milk from cows that have eaten these plants. Because most milk consumed in North America is now produced under intensive management conditions, there is little risk of "milk sickness." However, the risk of milk sickness exists where pastured milk cows or goats gain access to white snakeroot and rayless goldenrod [5]. Details of these plants and the disease they cause are discussed in Chapter 6. Other plants known to affect milk quality are listed in Table 10 - 1.

A variety of ingested plant compounds and their metabolites, once absorbed into the blood, are secreted by the mammary gland into the milk. There the toxins cause changes in milk flavor, and may pose a hazard to animals and people drinking the milk [2]. Many toxicants diffuse readily into the milk from the blood and reach concentrations similar to that in the blood. The extent to which plant compounds diffuse into milk depends either their water or fat solubility, and whether or not they are protein bound or have a pH that enhances their diffusion into the milk. Toxins that are water soluble and have a basic pH (plant alkaloids) may concentrate in the milk because normally it is more acidic (pH 6.5) than the blood. The quantities of toxin are generally very low because most of the toxins are more readily excreted through the liver and kidneys. The lactating mammary gland however, is one of the ways that the animal's body is able to eliminate toxins.

Plant alkaloids, especially the pyrrolizidine alkaloids found in the plant genera *Amsinckia*, *Crotolaria*, *Cynoglossum*, *Echium*, *Heliotropium*, and *Senecio*, are readily secreted in milk and can be hazardous to the young animal suckling its mother [6-9]. The quantity of pyrrolizidine alkaloids secreted in milk is generally very low and can be considered of minimal risk to humans. However, the chronic long-term consumption of milk containing these alkaloids may be carcinogenic and cause chronic liver disease [9-11]. Further details on the plants containing pyrrolizidine alkaloids are covered in Chapter 4.

The important indolizidine alkaloid swainsonine found in the *Astragalus*, *Oxytropis*, and *Swainsona* spp. is excreted in milk [12,13]. Swainsonine is the plant toxin primarily responsible for the syndrome known as locoism in animals that consume locoweeds (*Astragalus* and *Oxytropis* spp.) Young animals are likely to be exposed to more swainsonine because they learn to eat locoweeds from their mothers and suckle their mothers that are also eating the plants. Because swainsonine is rapidly cleared from the serum of cattle and sheep through the urine (serum half-life of about 20 hours), the milk is also likely cleared of the alkaloid in 2 to 3 days after the ingestion of locoweed has ceased [14]. With the resurgence of small acreage farms in western rangelands where locoweeds are abundant, there is a potential health risk to people who drink raw milk from milking cows or goats that are eating locoweed. Swainsonine and the locoweeds are discussed in detail in Chapter 6.

Other toxic alkaloids with the potential for being excreted in milk are found in lupines (*Lupinus* spp.). A woman whose child was born with skeletal deformities was found to have consumed the milk of goats that had been eating lupines [15]. A dog that was fed the goat's milk also produced deformed puppies. Some of the goats aborted fetuses with skeletal abnormalities

[15]. Other plants with similar quinolizidine alkaloids include mountain thermopsis (*Thermopsis montanum*), Scotch broom (*Cytisus* spp.), and golden chain tree (*Laburnum* spp.) [16]. Alkaloids found in poison hemlock (*Conium maculatum*), tobacco (*Nicotiana* spp.), and various other genera including *Cassia*, *Sedum*, *Prosopis*, and *Lobelia* may be passed in the milk and can pose a hazard to pregnant women drinking the milk [17]. The piperidine alkaloids from these plants are capable of causing congenital defects in the fetus [18,19].

Other compounds found in plants that can be secreted into the milk of lactating animals eating the plants are the glucosinolates. Glucosinolates are found in the large mustard family and especially in the *Brassicaceae* that includes the mustards, cabbage, kale, rape, turnips, horseradish, radish, and watercress among others. The bitter-tasting compounds may flavor the milk of animals eating the plants. Hydrolysis of the glucosinolates produces compounds such as isothiocyanates, thiocyanates, and goitrin that have an antithyroid hormone effect and result in thyroid enlargement and decreased growth rates. Thyroid gland enlargement (goiter) may occur in young animals and human babies drinking the milk of animals that have eaten plants of the mustard family (*Brassicaceae*) [2,20]. Goat kids and rabbits fed milk from goats eating meadowfoam meal (*Limnanthes alba*) have been reported to develop thyroid abnormalities [20]. Thyroid enlargement was similarly seen in lambs born to ewes fed meadowfoam meal [21].

In Europe, poisoning in humans and animals has been associated with milk containing colchicine, a potent alkaloid found in the autumn crocus (*Colchicum autumnale*) [22].

Abnormal Milk Flavor

Objectionable flavors and odors are commonly encountered in milk and can result in its condemnation for human consumption. In many instances abnormal milk flavors are associated with bacterial spoilage and rancidity of the milk or absorption of odors from the cow's environment. At other times chemicals used to disinfect milking equipment or drugs used to treat mastitis and other diseases may accumulate in the milk and affect its flavor. The milk from cows that are severely ketotic due to metabolic disease may have a strong smell of ketones (acetone). Certain diets, especially those that are fermented such as silage or haylage, often cause a change in the flavor of milk. Brewer's grains, a by-product of the alcohol distillery industry, can cause a distinctive flavor in milk. Similarly, cull onions, cabbages, turnips, rape, and similar plants fed to lactating animals may induce an abnormal flavor to the milk. A sudden change of feed to a rich feed such as alfalfa or clover may cause a temporary change in milk flavor that some people find objectionable. Most grains, soybeans, sugar beets, potatoes, carrots, and grass hay do not affect the milk.

A variety of plants that individual cows and especially goats may ingest when they are on pasture and rangeland and that may affect the flavor of milk are listed in Table 10 - 1. A bitter taste to milk may result when a lactating cow or goat eats members of the buttercup family or the bitterweeds [23].

Table 10 - 1. Plant Toxins That May Affect Milk Quality

Common Name	Scientific Name	Principal Toxin
White snakeroot	*Eupatorium rugosum*	Acetylbenzofurans (tremetol)
Rayless golden rod	*Isocoma pluraflora*	Acetylbenzofurans (tremetol)
Groundsels, senecio	*Senecio* spp.	Pyrrolizidine alkaloids
Rattle pod	*Crotolaria* spp.	Pyrrolizidine alkaloids
Hound's tongue	*Cynoglossum* spp.	Pyrrolizidine alkaloids
Fiddleneck	*Amsinckia intermedia*	Pyrrolizidine alkaloids
Comfrey	*Symphytum* spp.	Pyrrolizidine alkaloids
Heliotrope	*Heliotropium* spp.	Pyrrolizidine alkaloids
Viper's bugloss	*Echium* spp.	Pyrrolizidine alkaloids

Table 10 - 1. Plant Toxins That May Affect Milk Quality		
Common Name	**Scientific Name**	**Principal Toxin**
Mustards, rape, cabbage	*Brassica* spp.	Glucosinolates*
Horse radish	*Amoracia* spp.	Glucosinolates*
Radish	*Raphanus* spp.	Glucosinolates*
Water cress	*Nasturtium officinale*	Glucosinolates*
Poison hemlock	*Conium maculatum*	Piperidine alkaloids (coniine)
Tobacco	*Nicotiana* spp.	Piperidine alkaloids (coniine)
Locoweeds	*Astragalus, Oxytropis* spp.	Indolizidine alkaloids (swainsonine)
Lupine	*Lupinus* spp.	Quinolizidine alkaloids (anagyrine)
Bitterweeds	*Helenium, Hymenoxys* spp.	Sesquiterpene lactones*
Bracken fern	*Pteridium aquilinum*	Ptaquiloside
Buttercups	*Ranunculus* spp.	Protoanemonins*
Onions, garlic	*Allium* spp.	N-propyl disulphide*
Autumn crocus	*Colchicum* spp.	Alkaloids (colchicine)
Avocado	*Persea americana*	Unknown toxin
Sage	*Artemisia* spp.	Monoterpenes, diterpenes*
Marijuana	*Cannabis sativa*	Cannabinol
* These plants impart an abnormal flavor to milk.		

Where lactating animals gain access to avocado leaves or fruits (*Persea americana*), they may develop a noninfectious mastitis, with a marked decrease in milk production. Cattle, horses, goats, and rabbits have been affected by this unique plant toxicity [24]. Goats fed as little as 31 g/kg body weight of avocado leaves showed dramatic reduction in milk production and developed hard swollen udders 24 hours after they had eaten the leaves. The milk was of a cheesy consistency and contained clots. The milk somatic cell counts also became markedly elevated. If no further avocado leaves were fed, the udder edema regressed and milk production returned, but not to the levels prior to feeding the avocado leaves [25]. Generalized necrosis of the mammary gland epithelium with sloughing of necrotic cells and minimal inflammation was the principle histologic finding [25]. Further discussion of the toxic effects of avocados is presented in Chapter 2.

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