Strategies on poisonous plants problem in China

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Abstract. Poisonous plants are widely distributed on large areas of native grasslands of China, causing livestock poisoning and grassland degradation, which severely impacts the development of animal husbandry. Of the almost 300 poisonous species that are responsible for livestock losses in China, locoweed, drunken horse grass and Langdu cause the greatest impact. Many strategies have been developed to minimise the impact of poisonous plants including the treatment of livestock that have been poisoned, controlling poisonous plants and managing livestock grazing. Both physical and chemical traditional methods are still used to eliminate poisonous plants while biological control using specific insects may eventually be used to control certain species. According to a grassland law, grazing systems (rotational, rest and forbidden grazing) may be applied on dense stands of poisonous plants.

Keywords: Locoweed, drunken horse grass, livestock, China.

Introduction

About 40% of China's area is grassland, which is the base for animal husbandry production (Zhao *et al*. 2005). Animal husbandry plays an important role in China's national economy (Wang and Yang 2003). However, the development of animal husbandry has been impacted by poisonous plants on the grassland (Wang and Yang 2003).

Poisonous plants are a natural component of the grassland ecosystem and are widely distributed in China. There are about 1,300 species (in over 140 families) of poisonous plants in China (Zhao *et al*. 2008). Of these, about 300 species affect the development of animal husbandry (Shi 1997), with species such as *Oxytropis* and *Astragalus*, drunken horse grass (*Achnatherum inebrians* [Hance] Keng ex Tzvelev) and Langdu (*Stellera chamaejasme* L.) being the most severe threats (Zhao *et al*. 2013).

The direct threat of poisonous plants is livestock poisoning, causing body weight loss, reproductive losses and death (Luan *et al*. 1993). Their indirect threat to livestock production is through grassland degradation. Many poisonous plants species tolerate drought and alkaline conditions (Xing *et al*. 2001). This makes them more competitive in over-grazed grasslands where they become dominant, reducing forage quality and accelerating the degradation of these grasslands. According to statistics (Bai 1997), *Stellera chamaejasme* has formed a dominant community on the grassland of Horqin Banner that occupies about 400×10^4 hectares which accounts for 7% of the available grassland areas in Inner Mongolia. Lastly, the economic losses are borne by both herders and country, and the sustainable development of animal husbandry is affected (Luan *et al*. 1993).

Herders have gained considerable experience in controlling poisonous plants, treating livestock that have been poisoned and grazing so as to reduce economic losses caused by poisonous plants. However, their toxins are highly variable, containing various alkaloids, glycosides, polyphenols, terpenoids, toxic proteins and photosenstitive substances (Zhao *et al*. 2013), so that the efficacy of treatments are inconsistent. To control poisonous plants or to manage livestock to prevent poisoning, grazing management should be adjusted depending on the actual situation. Here, we review several strategies on poisonous plant issues from the published Chinese literatures and provide references for research on poisonous plants.

Treatments before and after livestock poisoning

Locoweed

Locoweed is widely distributed in northwest pastoral area of China, which include certain species of *Oxytropis* and *Astragalus* that contain swainsonine.(Gao *et al*. 2011) The toxin swainsonine is produced by endophytic fungus, *Undifilum oxytropis* (Pryor *et al*. 2009). Livestock will become addictive and poisoned after ingesting locoweed (Yang 2002).

At present, no specific drug can help to detoxify swainsonine after livestock poisoning, but some reagent combinations have been developed to relieve poisonous symptoms. Zhao *et al*. (1999) reported that a mixture of vinegar and coarse flour is beneficial to goats poisoned with swainsonine. Guo *et al*. (2008) treated 53 poisoned sheep by using a combination of Chinese and Western medicine. The Fengcaoling bolus, which has been developed from a fungus, could relieve suffering in sheep poisoned with swainsonine and delay the onset of toxicity

(Chang *et al*. 2007). However, the livestock don't completely recover from injuries caused by locoweed poisoning, and their tissues and organs (liver, kidney and muscle) could be permanently damaged (Yang 2002).

Before livestock poisoning, some measures can be made to prevent livestock poisoning from locoweed. Immunization against swainsonine offers some promise. Tong *et al*. (2001) reported that a swainsonine-protein conjugates can produce an immunologic response in sheep. Dong *et al*. (2005) inoculated goats with the conjugates and evaluated the safety of anti-swainsonine substance. Swainsonine-antiserum was reported to have a beneficial effect on poisoned sheep (Yang *et al*. 2008).

Drunken Horse Grass

Drunken horse grass (*Achnatherum inebrians)* is a species in the Poaceae family and grows on the western grassland of China (Dai 2010). The toxins in drunken horse grass are *ergot* alkaloids produced by *Neotyphodium gansuense*, an endophytic fungus in drunken horse grass (Dai 2010). Poisoning symptoms appear 30-60 min after the livestock consume the plants (Ji 2009).

As with locoweed, no specific drug exists to treat animals poisoned with drunken horse grass. To date, there have been many studies conducted on treating poisoned livestock. One therapy uses appropriate amounts of water and various acids such as acetic acid, lactic acid or diluted hydrochloric acid to relieve symptoms (Ji 2009); with severe poisoning, it is necessary to inject glucose and saline, and possibly a cardiotonic (Ji 2009). Chinese and Western medicine may be combined to treat a cattle poisoning by Cai *et al*. (2002) and Luo and Mamati (2011). Danengtai *et al*. (2012) reported that liquor can also help poisoned cattle to recover.

There are few published Chinese studies on the prevention of drunken horse grass poisoning. Only one paper reported on aversive conditioning to prevent livestock grazing the plants by mixing ground plants of drunken horse grass with urine and putting it in the animals mouth (Ji 2009), but the effect is unknown.

Other poisonous plants

Other poisonous plants found on grasslands in China, and their treatment, are reported in Table 1.

Management of poisonous plants and grazing

Eliminate poisonous plants

For management strategies of poisonous plants, the first is to eliminate the threat of poisonous plants. The traditional method uses physical or chemical methods.

The physical method includes artificial digging and burning, which is suitable for small area and areas where poisonous plants are concentrated, but it is time-consuming and may not be effective. The chemical method uses herbicides to kill the plants. 2, 4-D, a selective herbicide, is usually used to kill annual or perennial dicotyledonous weeds and may also kill some dicotyledonous poisonous plants, such as locoweed and Langdu (Li 2003; Zhao *et al*. 2004). Glyphosate is a widely used non-selective herbicide that can be used to eliminate drunken horse grass (Su 2005; Ji 2009). The chemical methods are very effective in killing poisonous plants but it may not be completely effective because of their huge root systems and numerous seeds. Also, it can also kill some other beneficial forages and causes environmental pollution if abused.

A biological control method that uses specific insects is being developed. *Procecidochares utilis*, a natural enemy of *Eupatorium adenophorum*, has been adapted to control *E. adenophorum* in Yunnan (Tao *et al*. 2002). Two specific insects *Aphthona chinchihi* and *Aphthona seriata*, which is the natural enemy of *E. esula*, have been found and studied primarily in Inner Mongolia (Wang and Wang 1992). This method is economical and environmentally safe but still difficult to implement effectively.

Proper grazing management

The incidence of livestock poisoning has increased due to overgrazing, which reduces the ability of forages' to regenerate and weakens their competitive ability. Livestock generally will not select poisonous plants because of their poor palatability. However, when forage yield decreases with overgrazing, livestock are forced to ingest poisonous plants and become poisoned. Thus, a reasonable grazing system should be established.

Rotational, rest and forbidden grazing systems have been proposed for grasslands with high concentrations of poisonous plants (Zhao *et al*. 2008). It may be necessary to adjust the herd composition and artificial pastures. Animals that are naive to poisonous plants are more vulnerable because they do not recognize them (Luan *et al*. 1993). Therefore, poisoning may be reduced by training young animals and those new to the area to avoid poisonous plants. For artificial pastures, the competitive forage, such as sainfoin (*Onobrychis viciaefolia*), should be seeded to reduce the productivity and survival rate of drunken horse grass (Ji 2009). Furthermore, these measures need also to be flexible and specific to the situation.

In addition, a government's policy for grazing should not be ignored. The "Grassland Law of the people's Republic of China" provides a legal basis for the management of poisonous plants (Zhou *et al*. 2008).

Conclusions

Livestock losses as a result of poisonous plants negatively impact the herder's quality of life and seriously hinder the development of animal husbandry in China. Poisonous plants are widely distributed in the grasslands of China, and their toxicological properties are species specific. Suitable control measures for different poisonous should be developed. At present, many studies on the management of poisonous plants have been conducted with useful results, but some problems have not been completely solved, and some research has not yet been completed. It is essential to integrate knowledge of the pathological symptoms of livestock poisoning and the toxicological properties of different poisons to develop detoxification drugs. Research should continue to be made into developing finding effective methods for controlling poisonous plants, improving grazing management and agronomic systems to lessen the impact of poisonous plants on the herders' livelihood. Considerable effort, and integrated approach with many disciplines, will be required to develop effective management strategies to manage poisonous plants.

Table 1. treatment measures of livestock poisoning caused by some poisonous plants in China

Species	Treatment measures of livestock poisoning	Reference
Aconitum kusnenzoffii	Gastric flushing with potassium permanganate or tannin solution; Take orally belladonna tincture; Intramuscular inject atropine, cardiotonic,such as Caffeine, when paralysis or heart failure.	Jiang and Gao 1987
Cicuta virosa	Take vinegar or sour milk as soon as possible; Gastric flushing with tannin or iodine solution; Intravenous inject chloral hydrate or hypodermic inject atropine.	
Datura stramonium	As soon as possible; Gastric flushing, take orally medicine to produce diarrhea or take charcoal or magnesium oxide to detoxify.	
Delphinium grandiflorum	Gastric flushing with potassium permanganate or tannin solution; Take orally sodium sulfate, magnesium sulfate, castor oil or vegetable oil to produce diarrhoea; Inject cardiotonic, antispasmodic or narcotic.	
Euphorbia esula	Gastric flushing with tannin solution; Take orally, castor oil or vegetable oil to produce diarrhoea; Also take magnesium oxide and activated carbon to detoxify.	
Papaver nudicaule	Gastric flushing with potassium permanganate solution; Take orally, sodium sulfate to produce diarrhoea; Also take charcoal, ash or green bean soup to detoxify.	
Veratrum nigrum	Gastric flushing with strong tea;take sour milk and tannin solution; Intramuscular injection of atropine or a cardiotonic such as caffeine, when paralysis or heart failure.	
Rhododendron molle	Gastric flushing with potassium permanganate solution; Take fresh egg whites and Chinese chive or green bean soup to detoxify.	Zhao 1997
Cynanchum komarovii	Intravenously inject 5% glucose and 0.9% sodium chloride solution;Take orally an antidiarrheic; take edible vinegar, sour milk and green bean soup to detoxify.	Danengtai *et al.* 2002
Stellera chamaejasme	Gastric flushing with tannin solution; Take orally magnesium sulfate; Intramuscular inject cardiotonic, such as Caffeine.	Ji 2003

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