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Review

Pathogenesis and preventive treatment for animal disease due to locoweed poisoning

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ABSTRACT

Locoweeds are perennial herbaceous plants included in *Astragalus* spp. and *Oxytropis* spp. that contain the toxic indolizidine alkaloid swainsonine. The livestock that consume locoweed feeding can suffer from a type of toxicity called "locoism." There are aliphatic nitro compounds, selenium, selenium compounds and alkaloids in locoweed. The toxic component in locoweeds has been identified as swainsonine, an indolizidine alkaloid. Swainsonine inhibits lysosomal α-mannosidase and mannosidase II, resulting in altered oligosaccharide degradation and incomplete glycoprotein processing. As a result, livestock that consume locoweeds exhibit several symptoms, including dispirited behavior, staggering gait, chromatopsia, trembling, ataxia, and cellular vacuolar degeneration of most tissues by pathological observation. Locoism results in significant annual economic losses. Recently, locoweed populations have increased domestically in China and abroad, resulting in an increase in the incidence of poisoning. Therefore, in this paper, we review the current research on locoweed, including on species variation, pathogenesis, damage and poisoning prevention measures.

Contents

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1. Introduction

Locoweeds (*Astragalus* spp. and *Oxytropis* spp.) are perennial flowering plants found frequently in the rangelands of the western United States, Asia, and South America. According to statistics, the hazard area of natural grassland, 33.3 million hm^2, in which the main poisonous weed is locoweed, accounted for approximately 33% of the damage area of poisonous weeds in China. At present, there are 44 types of locoweeds, and among these, 15 species of locoweed are serious grassland hazards. These serious hazardous weeds are mainly distributed in Inner Mongolia, Gansu, Qinghai, Tibet and Xinjiang in China. Locoweed poisoning causes billions of RMB of direct or indirect economic losses in China each year (Zhicheng Shi, 2001). Economic losses due to toxic poisoning from plants total more than US 340 million dollars in the western United States every year (Kingsbury, 1961). The consumption of locoweeds by cattle, sheep, and horses induces a neurological condition called locoism. Locoweed causes livestock death and damages livestock breeding in addition to causing grassland degradation and reductions in pasture utilization. Locoweed is one of the most serious poisonous weeds, damaging grassland animal husbandry production and development worldwide (Braun et al., 2003; McLain-Romero et al., 2004). Swainsonine, a trihydroxy indolizidine alkaloid, is the main toxic component in locoweed. The structure of the swainsonine cation is similar to the structure of mannose, and it has a higher affinity than mannose for mannosidase. Swainsonine is a well-known inhibitor of lysosomal α-mannosidase and Golgi mannosidase II. Poisoning induces enzymatic dysfunction and the accumulation of complex oligosaccharides in lysosomes; therefore, swainsonine has a significant inhibitory effect on α-mannosidase in lysosome, and it inhibits glycoprotein synthesis and the production of a mixture of mannose and asparagine polysaccharide, resulting in vacuolation in different cells, especially in neurons. The clinical syndrome is characterized by neurological and behavioral disorders as well as gait abnormalities difficulty standing, abnormal posture, emaciation, symmetrical ataxia and posterior limb paresis. Other signs include reproductive disorders, as well as abnormal gastrointestinal and immune system function (Das et al., 1995; Jacob, 1995).

Locoweed poisoning is related to animal production performance indicators, including the feed conversion rate, weight, susceptibility to other diseases, and reproductive capacity. The above indicators can be used to assess the economic consequences of locoweed poisoning and develop effective management measures to reduce losses. In addition, α-mannose glucoside enzyme levels in serum are one of the important markers of locoweed poisoning, and its inhibitory action and swainsonine level are significant. Changes in blood biochemical indicators, such as serum aspartate aminotransferase, lactate dehydrogenase, and alkaline phosphatase, increase during locoweed poisoning. Albumin and thyroid hormone levels decrease, resulting in a severe proteinuria nonspecific index that is used clinically as a diagnostic indicator of locoweed poisoning. These techniques could be used in the future to diagnose subclinical locoweed poisoning of animals.

There is currently no effective antidote for locoweed poisoning in clinical use either domestically in China or abroad. At present, mainly preventative measures are applied, including chemical elimination, artificial excavation, and detoxification methods. Chang et al. (2007) used a “locoweed detoxification pellet” on livestock suffering locoweed poisoning and found that the pellet played a significant role in delaying and preventing poisoning, but there was no significant treatment effect (Chang et al., 2007). Other treatments, such as bacterial strain degradation, mineral adsorption and vaccines, are still in the research phase.

Locoweed research has mainly concentrated on areas such as locoweed toxin composition, the poisoning mechanism, the toxin-producing mechanism, prevention and animal poison control. This paper mainly examines the current research trends regarding locoweed species variation, pathogenesis, damage, and animal poisoning prevention measures.