

Gossypol Poisoning in Animals

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Abstract

Gossypol is naturally produced by the glands of the cotton plant causing toxicity in monogastric animals, ruminants, immature ruminants and poultry. Affected animals can show symptoms such as heart failure, sudden death; hepatotoxicosis; hepatic necrosis secondary to congestive heart failure; hematological effects, including anemia and increased red blood cell fragility; Effects on reproduction (including decreased libido and spermatogenesis in males; irregular menses, disrupted pregnancy and embryonic death in females; and greening of egg yolks and reduced hatchability in chickens); throbbing in pigs; and cardiotoxicosis in dogs. Treatment requires removal of the gossypol source, usually food, and supportive care.

Introduction

Cotton (*Gossypium* spp.) is one of the earliest plants cultivated by man belonging to the Malvaceae family. It is generally used for soft fibre in textile industry and as source of high protein material in animal feed. It belongs to genus *Gossypium* spp. including various species distributed throughout the world, but mainly four species are used for cotton fiber: *Gossypium hirsutum* (produce 90% of the world's cotton), *Gossypium barbadense* L., *Gossypium arboreum* L., and *Gossypium herbaceum* L. Gossypol plant contains a polyphenolic dinaphthalene pigment called gossypol toxic compound, gossypol existing in glands of cottonseed in both non-toxic and toxic forms. The toxic gossypol content of cottonseed meal generally decreases during processing or heating. However, in some cases it can be retained in significant concentrations to cause toxicosis.

Path physiology

It is lipid soluble compound and absorbed easily from the digestive tract. Its absorption is inversely proportional to concentration of iron in feed as it chelates with iron in the body and thus causing unavailability for hemesynthesis resulting in anaemia. Ruminant microflora degrades dietary free gossypol with proteins and amino acids i.e. lysine &

methionine. It acts as an inhibitor for several dehydrogenase enzymes and reversibly blocks calcineurin and binds to calmodulin. It also acts as inhibitor of testicular LDH enzyme and glutathione-S-transferase.

Gossypol toxicity

- Acute toxicity is generally low with an oral LD50 of 5 g/kg body weight, however long-term ingestion of small amounts of cottonseed cake or grist will result in toxicity.
- It should not be fed this cake in daily ration higher than 1kg
- After 2-3 months its admission should be interrupted for 3-4 weeks
- Various species including cattle, horses, swine, poultry and dogs are considered to be susceptible to gossypol poisoning.
- Except young calves, cattle are not very susceptible
- Use of gossypol in swine and poultry diets is restricted because of its potential toxicity to monogastric animals

Clinical signs in various species

It Occurs within 10-30 days (1-2 days if intake is large) and shows various sign as

- Loss of appetite
 - Restlessness
 - Gastroenteritis
 - Diarrhoea
 - Laboured
 - Shallow breathing
 - Spasms
 - Reduced RBC, Hb and PCV
- In acute cases death may occur during first few days and young lambs, goats, and calves may suffer cardiomyopathy.
- In chronic poisoning, they may be depressed, anorectic, and have pronounced dyspnea.
- Adult dairy cattle may show weakness, depression, anorexia, edema of the brisket, and dyspnea, and also have gastroenteritis and hemoglobinuria.
- Protein malnutrition and reduced weight gain .

- In monogastric animals, acute exposure may result in sudden circulatory failure, whereas subacute exposure may result in pulmonary edema secondary to congestive heart failure; anemia may be another common sequela.
- Violent dyspnea (“thumping”) is the outstanding clinical sign in pigs.
- In dogs, gossypol poisoning is primarily reflected by cardiotoxic effects; condition deteriorates progressively, and ascites may be marked. Affected dogs may show polydipsia and have serum electrolyte imbalances, most notably hyperkalemia, with pronounced ECG abnormalities.
- Gossypol appears to interrupt pregnancy by exerting a luteolytic action. In males, spermatozoal abnormalities and infertility due to inhibition of enzymes necessary for steroid synthesis and reduced libido.
- In layers, affect weight gain, feed intake and efficiency, egg production and quality, and hatchability.

Necropsy findings

Depending on the course of intoxication

- Gastritis and Hepatitis with generalized jaundice and an enlarged, congested, mottled or golden crumbly muscat liver with distinct lobular patterns.
- The kidneys, spleen, and other splanchnic organs may become obstructed, possibly with petechiae
- Mild renal tubular nephrosis and nephritis Cardiac muscle degeneration and pulmonary edema Enlarged, flaccid, pale, striated and mottled heart with pale myocardial stripes, enlarged and dilated ventricles, and valvular edema.
- Pulmonary edema and markedly edematous interlobular septa Straw-colored to reddish-tinged fluids may occasionally be found in the chest and abdomen.
- The kidneys, spleen, and other splanchnic organs may be congested, possibly with petechiae; mild renal tubular nephrosis and nephritis
- Degeneration of cardiac muscles and pulmonary oedema
- Enlarged, flabby, pale, streaked, and mottled heart with pale myocardial streaking, enlarged and dilated ventricles, and valvular edema

- Pale skeletal muscles and froth-filled trachea and edematous, congested lungs are common, with interstitial pulmonary edema and markedly edematous interlobular septa
- Straw coloured to red tinged fluids may occasionally be found in the thorax and abdomen

Diagnosis

- History such as dietary exposure to cottonseed meal or cottonseed products
- Clinical signs such as sudden death or chronic dyspnea, affecting multiple animals within a group
- Necropsy findings such as lesions consistent with the reported syndrome and associated cardiomyopathy and hepatopathy, with increased amounts of fluids in various body cavities
- No response to antibiotic therapy; and the presence of significant concentrations of free gossypol in the diet
- Tissue analyses

Differential diagnoses

- Poisonings by cardiotoxic ionophoric antibiotics (eg, monensin, lasalocid, salinomycin, narasin) and ammonia
- Nutritional or metabolic disorders (eg, selenium, vitamin E, or copper deficiency)
- Infectious diseases
- Noninfectious diseases (eg, pulmonary adenomatosis, emphysema)
- Mycotoxicoses caused by *Fusarium*-contaminated grain
- Toxicoses caused by plants with cardiotoxic and other effects.

Treatment

- No effective treatment.
- Adsorbents such as activated charcoal and saline cathartics are of little value because of the chronic exposure and cumulative nature of gossypol.
- If gossypol toxicity is suspected, all cottonseed products should be removed from the diet immediately.
- Detoxification process by addition of iron or calcium carbonate in the diet
- High quality diet supplemented with lysine, methionine and fat soluble vitamins

- Recovery depends primarily on the extent of toxic cardiopathy.
- Favorable prognosis for complete recovery may be unrealistic.
- Mild to moderate myocardial lesions may be reversible with time if stress is minimized and animals are carefully handled.
- Poor weight gains in affected livestock and increased susceptibility to stress may persist for several weeks after cottonseed products are removed from the diet.

Prevention and control

- Mature cattle should be given $\geq 40\%$ of dry-matter intake from a forage source, and dietary gossypol concentrations should be limited to $\leq 1,000$ ppm.
- Added iron of up to 400 ppm in swine diets and up to 600 ppm in poultry diets was reported to be effective in preventing signs and tissue residues of dietary gossypol exposure when used in ratios of 1:1 to 4:1 of iron to free gossypol.
- Selenium or copper deficiencies may potentiate gossypol toxicosis.

References

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