



Gossypol Toxicity in Livestock

Sandra E. Morgan, DVM, MS, ABVT

Center for Veterinary Health Sciences
Oklahoma State University

How to Convert Percent (%) to Parts per Million (ppm)

0.001% = 10ppm

0.02% = 200ppm

1.06% = 10,600ppm

Move the decimal point over four places to the right.

Introduction

Gossypol is a toxic compound found in the cotton plant. It is concentrated in the cottonseed but can also be found in other parts of the cotton plant such as hulls, leaves, and stems. Gossypol exists in two forms: free and bound. The free form is toxic, whereas gossypol that binds to proteins is in the "bound" or non-toxic form.

Why is this important?

The amount of free gossypol in the cottonseed can be quite variable. Many factors influence gossypol content such as: specie of cotton plant, climatic conditions, soil conditions, fertilizer, etc. This makes it impossible to know how much gossypol the cottonseed contains without having it tested.

Whole cottonseed contains the most free gossypol. Cottonseed meal is the byproduct of cottonseed oil extraction from the whole seeds. There are different extraction techniques which have considerable effect on the amount of free gossypol that is in the meal. The older screw-press method used heat which increased the protein binding, thus converting more free gossypol (toxic form) to the bound form (non-toxic). The solvent extraction is widely used now because more oil can be extracted. However, since heat is not used the amount of free gossypol in the meal is almost ten times higher than meal that has been processed by the screw press method. This can be a significant difference if very much gossypol is in the seed. This change to solvent extraction may be why we have seen an increase in gossypol toxicity in recent years.

Animals Affected

Gossypol primarily affects the heart and liver. The reproductive tract, abomasum, and kidney are also affected. Simple stomached (monogastrics) animals such as pigs have long been known to be susceptible to gossypol toxicity. Ruminants such as cattle and sheep can tolerate higher levels of free gossypol because gossypol binds to proteins in the rumen. Young calves and lambs are quite susceptible to gossypol

Oklahoma Cooperative Extension Fact Sheets
are also available on our website at:
<http://osufacts.okstate.edu>

toxicosis. Even though they are ruminants, their rumen is not considered to be fully functional and is unable to bind as much free gossypol as an adult.

Swine rations are not allowed to contain more than 0.01 percent or 100 ppm. Calves and lambs younger than four months of age are not recommended to have greater than 100 ppm in their concentrate ration. From four months to one year, it is difficult to recommend certain levels because of all the variables involved. The older an animal is, the more gossypol it should be able to detoxify. However, 400 ppm to 600 ppm has caused toxicity in young ruminants. Usually they are on free choice rations. Rumen function is dependent on many factors, but age, amount and type of roughage the animal has received, and how early it was received, are very important. Binding of gossypol is also dependent on amount of available proteins.

Adult cattle can tolerate much larger amounts of free gossypol but toxicosis has been reported with levels of 800ppm fed over a long period of time. The problem with gossypol is the toxic effect seems to be cumulative. The longer they are on a ration that contains much gossypol, the more likely they are to have problems.

Symptoms

Since gossypol affects the heart, gossypol toxicity has been manifested as two types of clinical syndromes particularly in young animals. One syndrome of sudden death (resembling a heart attack) has frequently been reported in calves and lambs. These animals seem healthy, have good appetites and are often one of the best ones in the group, but are found dead. This has often been mistaken as "overeating" in lambs. Calves on cottonseed may die suddenly during, or right after transport because it is stressful to them. The other syndrome is one of chronic labored breathing, which resembles pneumonia. Due to heart failure, the lungs fill up with fluid and breathing becomes very difficult. Since it is not an infection, these animals do not respond to antibiotics. Animals will be depressed, go off feed, may have a nasal discharge, may have red urine and may have a thin but "pot-bellied" appearance in contrast to the animals that died suddenly and appeared healthy. This will usually affect more than one animal in a group.

Adult dairy cattle have exhibited symptoms of weakness, depression, loss of appetite, difficult breathing, blood in the urine, inflammation of the intestines and reproductive problems.

Diagnosis

Gossypol toxicosis must be considered any time there is death loss in young animals that have been on cottonseed for several weeks (less time if levels of gossypol are extremely high). If a producer has a problem with his livestock, he should work with his veterinarian, have any dead animals necropsied and a feed sample sent to a diagnostic laboratory for necropsy and analysis.

Treatment

There is no treatment at this time for animals suffering from gossypol toxicosis. These animals must not be stressed. Animals have died even two weeks after gossypol was removed from the diet. Unless damage is severe, many of the lesions will be reversible with time and removal of cottonseed from the diet.

Prevention

If cottonseed or cottonseed meal is bought in bulk, it would be worthwhile to have it tested before feeding it. Depending on the level of free gossypol, the cottonseed could be utilized in the best interest of the livestock. For instance, if your cottonseed tested 0.07 percent free gossypol, this is 700 ppm. This level, even if it made up only one-half of the concentrate, would still have 350 ppm free gossypol in it, and

not be acceptable to baby calves and lambs. On the other hand, adults should be able to tolerate this level, especially if it were mixed with other concentrates. A stocker calf may be able to tolerate this level if it were mixed with other concentrates (particularly another protein) and not fed continually for a long period of time. Alternating cottonseed with other feedstuffs may help prevent or slow down the cumulative effects of the toxin.

Discussion

When whole cottonseed or cottonseed meal is purchased in bulk, it is possible that the level of free gossypol it contains is quite low, and might not ever cause any problems. Unfortunately, unless it is tested, there could always be the risk that the level of free gossypol can be extremely high. Feeding cottonseed is much like feeding sudan hay, except on a longer term basis. Without testing the hay for nitrate, you are gambling with the health of your livestock.

Reference

Morgan, S.E. Gossypol as a toxicant in livestock. In Burrows GE (ed): The Veterinary Clinics of North America: Food Animal Practice. Philadelphia. W.B. Saunders, 1989, pp 251-263.

Oklahoma State University, in compliance with Title VI and VII of the Civil Rights Act of 1964, Executive Order 11246 as amended, Title IX of the Education Amendments of 1972, Americans with Disabilities Act of 1990, and other federal laws and regulations, does not discriminate on the basis of race, color, national origin, gender, age, religion, disability, or status as a veteran in any of its policies, practices, or procedures. This includes but is not limited to admissions, employment, financial aid, and educational services.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, the Director of Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President, Dean, and Director of the Division of Agricultural Sciences and Natural Resources and has been prepared and distributed at a cost of 20 cents per copy. Revised 0215 GH.