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College of Agricultural and Environmental Sciences
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Feeding Whole Cottonseed to Dairy Cows and Replacements

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Whole cottonseed is a popular feed for dairy producers. Usage has increased during the past 10 years. It can be fed just as it comes from the gin without processing or may be pelleted before feeding. Pelleting substantially improves its handling properties, especially the ability to flow with augers. Pelleting reduces the bulkiness and allows more to be hauled in a truck or freight car. Pelleting will reduce the effective fiber of whole cottonseed and may affect the impact of the oil on fiber digestion.

Seed prices are a function of supply and demand. Demand may be for use as feed or to be crushed for oil. Whole cottonseed is an excellent feed for dairy cattle due to its high level of fiber, protein and energy (fat) in a compact package. Whole cottonseed can also be used to stretch limited forage supply. Dairymen should capitalize on this situation as much as possible. Some limiting factors to consider when feeding whole cottonseed are gossypol, high fat content, and the potential for aflatoxin. Clean, dry and store whole cottonseed in a dry place. Do not stack cottonseed too high if long term storage is being considered. This prevents heating and/or moisture build-up.

Fat content of the whole cottonseed is the primary factor limiting the amount fed. Increased levels of fat in the diet will interfere with fiber digestion. Gossypol may be a limiting factor in intake. Although whole cottonseed has higher amounts of gossypol than cottonseed meal, the gossypol in cottonseed meal is more readily available. Consider total cotton products in the diet when calculating gossypol availability. Gossypol is a yellow polyphenolic pigment found in the cotton plant and in the small pigment glands in the seed. During processing some of the glands are ruptured and the gossypol released. It may become bound with various compounds of the seed. The remaining gossypol, termed "free" gossypol, is harmful when fed at high levels. The bound gossypol has less of an effect in the animal.

It has been known for many years that gossypol is harmful to monogastrics such as chickens, swine, and young ruminants. It was thought mature ruminants were not affected by gossypol. However, in 1975, while working with a 700-cow dairy herd in Alabama, gossypol toxicity developed when large amounts of cottonseed meal were fed as the single source of protein to achieve high levels of milk production. Approximately 25 head of mature cows exhibited classical gossypol toxicity symptoms and died. These symptoms were depression, loss of appetite, anorexia, labored breathing and red blood cell fragility. Later, in a controlled study at Auburn University, these same symptoms were demonstrated when cows consumed an average of 24 grams of free gossypol per cow per day. At the end of the study, the livers of

cows contained free, bound and total gossypol levels in relationship to the level of intake. The 24 grams per cow per day calculated to approximately 18 milligrams of gossypol per pound of body weight per day or approximately 0.1 percent gossypol in the total dry matter. A good source of available Fe (iron) can reduce the risk of gossypol toxicity.

How to Determine Safe Levels to Feed

Table 1. Gossypol Levels in Selected Cottonseed Products (Martin)		
Product	% Total Gossypol	%Free Gossypol
Whole Cottonseed	--	0.47-0.63
Delinted Whole Cottonseed	--	0.47-0.53
Cottonseed Meal		
Screwpress	1.02	0.02-0.05
Prepress solvent extracted	1.13	0.02-0.07
Direct Solvent Extracted	1.04	0.1-0.5
Cottonseed hulls	--	0.06
Adapted from an article in <i>Feedstuffs</i> , August 6, 1990, Table 1 shows the ranges in gossypol content of various cottonseed products.		

Using the information in Table 1 and the limited research that indicate that 0.1 percent or 18 milligrams per pound of live animal weight is the maximum that can be fed, one can begin to estimate an amount that might be fed safely. Since the 0.1 percent caused deaths, certainly this amount should not be fed. Based on field experience, 6 pounds of whole cottonseed have been successfully fed for fairly long periods of time and up to 8 pounds have been fed for short periods without apparent harm. Using the information in Table 1, assume the cows are consuming 45 pounds of dry matter and there is 0.5 percent free gossypol present and 6 or 8 pounds of whole cottonseed is being fed. How much free gossypol are cows consuming?

For a group consuming 6 pounds of whole cottonseed, the calculations are:

$$(6 \times 0.5) \times 100 = 0.03 \text{ lbs. of gossypol}$$

$$(0.03 \text{ lbs.} \div 45 \text{ lbs. DM}) \times 100 = 0.067\% \text{ free gossypol}$$

For a group consuming 8 pounds of whole cottonseed, the calculations are:

$$(8 \times 0.5) \times 100 = 0.04 \text{ lbs. of gossypol}$$

$$(0.04 \text{ lbs.} \div 45 \text{ lbs. DM}) \times 100 = 0.089\% \text{ free gossypol}$$

Another way of calculating this is to calculate the grams of gossypol intake. This is done by multiplying 454 grams by the pounds of gossypol. For the above example, 6 pounds of whole cottonseed contains 0.03 pounds of gossypol or 13.62 grams ($454 \times 0.03 = 13.62$) and 8 pounds yield 0.04 pounds or 18.16 grams ($454 \times 0.04 = 18.16$) of gossypol. Similar calculations can be made for various combinations of cottonseed products by calculating the amount of gossypol contributed by each source and adding the amount contributed by each source.

An example of this is illustrated as follows:

The dairyman is feeding 3 pounds of whole cottonseed and 6 pounds of direct solvent extracted meal that contains 0.3 percent free gossypol.

$$(3 \text{ lbs.} \times 0.5) \div 100 = 0.015 \text{ lbs. gossypol}$$

$$(6 \text{ lbs} \times 0.3) \div 100 = 0.018 \text{ lbs. gossypol}$$

$$0.015 + 0.018 = 0.033 \text{ lbs. of gossypol being fed}$$

$$0.033 \times 454 = 15 \text{ grams of gossypol being fed}$$

Based on the limited data, we would expect the 15 grams of free gossypol to be an upper limit for safe feeding. This may not be a safe level for long term feeding during summer when respiratory stress is extremely high.

How to Feed Young Stock?

Limited research indicates young ruminants may safely be fed 5 to 10 milligrams per pound of live weight of gossypol. Suggested upper limits for various size replacements are shown in Table 2 using 10 milligrams per pound of live weight or 1 gram per 100 pounds of body weight.

Body Weight	Gossypol (grams)	Whole cottonseed (lb)
300	3	1.30
500	5	2.20
700	7	3.10
900	9	4.00
1,000	11	4.85
1,200	13	5.70
1,500	15	6.60

Fat Content

Limit feeding whole cottonseed to about 6.0 pounds per cow per day since the fat content is 18 percent. Six pounds of whole cottonseed will yield approximately 1.0 pounds of fat, which is about the maximum recommended from oilseeds. Higher levels of whole cottonseed can be fed but other sources of fat should be limited. Too much fat in the ruminant's diet will decrease rumen fiber digestion and cause a laxative effect. As much as 12 pounds per dairy cow has been fed during periods of high milk production.

Aflatoxin

Aflatoxin can be a problem in feeding whole cottonseed. Plants under stress (drought, insects) can develop high levels of aflatoxin. Cottonseed batches dried or handled improperly in storage may mold and contain aflatoxin. The dairy cow is very efficient in converting aflatoxin in the plant to aflatoxin in the milk. Every load of milk is tested for aflatoxin and must be below 0.5 parts per billion to be sold. The diet should be below 20 parts per billion of aflatoxin to ensure the milk is safe.

Whole cottonseed is an excellent feed and should be used extensively whenever practical. It is an excellent source of protein (20%) crude fiber (22%) and TDN (87%). Finally, do not overfeed whole cottonseed because they are a good buy. Good things can be overdone.



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