Aflatoxin: Ammonia is helping scientists bag the problem of contaminated cottonseed

By R. G. Fowler

At the root of this story lies a fungus, *aspergillus flavus* by name.

The fungus has worldwide distribution, a fact likely to stir only passing interest, except that Arizona farmers grow cotton on almost half of their irrigated acres.

Within developing cotton bolls during the growing season, the fungus can attack seed walls and penetrate into the meats to form a chemical described as an "agent"—aflatoxin.

In this case, aflatoxin is one of those things that has earned a place for itself on the suspect list of cancer causes in humans.

In addition to some foods—like peanut butter—which may contain aflatoxin, one possible entry into the human food chain is through milk.

It does so because dairymen feed cottonseed to their cows as an energy and fiber supplement. Yes, dairymen could feed other supplements. Soybean meal, for one, but that costs about $80 a ton more in Maricopa County than locally produced cottonseed and does not offer the best balance of energy and fiber.

In Arizona, the aflatoxin problem really came to the forefront during August 1978. Then, the state's leading newspaper, the *Arizona Republic*, trumpeted the news that milk offered to the public contained the alleged cancer-causing agent, as indicated by State Health Department tests. The tip-off leading to the milk tests was another test, this one in California. There, and later in Arizona, routine examination by the Food and Drug Administration revealed that some Arizona-grown cottonseed contained high amounts of aflatoxin—amounts well over the 20 parts-per-billion (ppb) permitted in interstate shipment by the federal agency.

Nor was cottonseed the only problem. In the cleanup campaign by health authorities, 700,000 pounds of milk which tested higher than a permitted .5 ppb aflatoxin was dumped. Another $50,000 worth of milk was withdrawn from retail shelves.

In the backwash of the publicity on TV, radio and in newspapers, the United Dairymen of Arizona (UDA), a co-op whose 160 members produce 85 to 90 percent of the milk in the state, issued an ultimatum to the membership: Feed no more cottonseed until further notice.

As you can imagine, the edict caught the membership with large stocks of cottonseed on hand. "At the time of our ban against feeding cottonseed, we had 500 tons—worth $50,000," says Jim Tappan, managing partner at Arizona Dairy Co., Maricopa County, where the milking strings total 3,000 head.

"I don't know of anyone who was feeding soybean meal or other types of protein, so everybody was caught," says Tappan.

Detoxification Trials

The UDA asked Otis Lough, dairy agent in Maricopa County, to investigate a method for detoxifying cottonseed containing aflatoxin using heat, pressure and ammonia. However, escaping ammonia fumes, particularly in a congested area, make this method an affront to the environment. Cost of such a plant is something else.

Lough learned of a method for detoxifying corn that had been developed by the USDA lab in Peoria, Illinois. The method employed normal temperature and pressure, and ammonia, by sealing the corn in plastic.

With cottonseed, a similar method had been tried unsuccessfully. Lough, a member of the University of Arizona Cooperative Extension Service, wondered if the reason for failure was due to low moisture content of the cottonseed. "Where cottonseed averaged about 7 percent moisture, the tests had not been run with higher moisture levels—15 to 25 percent," he notes.

So, with cooperation from the aflatoxin lab of UA plant pathologist Dr. Tom Russell, Lough treated two-pound samples of cottonseed in his office by adding 1.5 percent ammonia and enough water to raise the moisture content to 20 percent. Sealed in plastic sacks, he placed his samples in 30-pound butter boxes and exposed them to direct sunlight. Three weeks later, Lough found: "Untreated samples contained 1,500 to 1,900 ppb aflatoxin while ammoniated samples had dropped to the 30 to 80 ppb range."

Lough's next step was to develop a practical method of application. With special funding from UA administrators, the Maricopa County Farm Bureau and the UDA, he contracted for the Ag-Bagger Company of Astoria, Oregon to bring a silage-bagging machine to Arizona. Similar arrangements were made with the West Plains Distributing Company to supply a companion ammoniating rig. With this equipment, Lough set up a field trial at a dairy owned by Conrad Gringg.

Gringg is a UDA boardman who milks 1,500 cows and had several hundred tons of "useless" cottonseed on hand. Seventy tons of Gringg's seed got the first full-scale field treatment of ammoniation. After two weeks of sealed treatment, a short-term trial was conducted with the help of Arizona State University. Four cows ate five

Extension Agent Otis Lough draws a sample of cottonseed from one of the large plastic bags in which aflatoxin-contaminated seed is treated with ammonia.

pounds of treated seed as part of their daily ration for five days. The result: no detectable aflatoxin in their milk.

Full-Scale Test

When these results were reported to the UDA Board, it agreed to finance a full-scale test in cooperation with Gringg. He put together a representative, 90-cow string. Cottonseed that had tested 650 ppb in the stack before treatment was fed for 14 days at an average of 7.25 pounds per cow daily. This was more than a normal feeding of three to five pounds daily. Meantime, milk aflatoxin levels ranged from .08 to .18 ppb, with an average of .14 ppb. This was about the same as the pre-seed-feeding level, and well under the tolerance level of .5 ppb set by health authorities.

A second batch of cottonseed that tested in the 290 to 879 ppb range prior to treatment was bagged for 10 days, opened, and fed for seven days. Aflatoxin levels in the milk samples ranged from .11 to .16 ppb for an average .14 ppb—again, well within the tolerance.

Then, for six days, untreated seed from the same lot testing 320 ppb aflatoxin was fed. Milk readings were .27 to .55 ppb, the latter too high.

To wind up the test, treated cottonseed that tested negative for aflatoxin was fed for three days, and again milk levels dropped to normal.

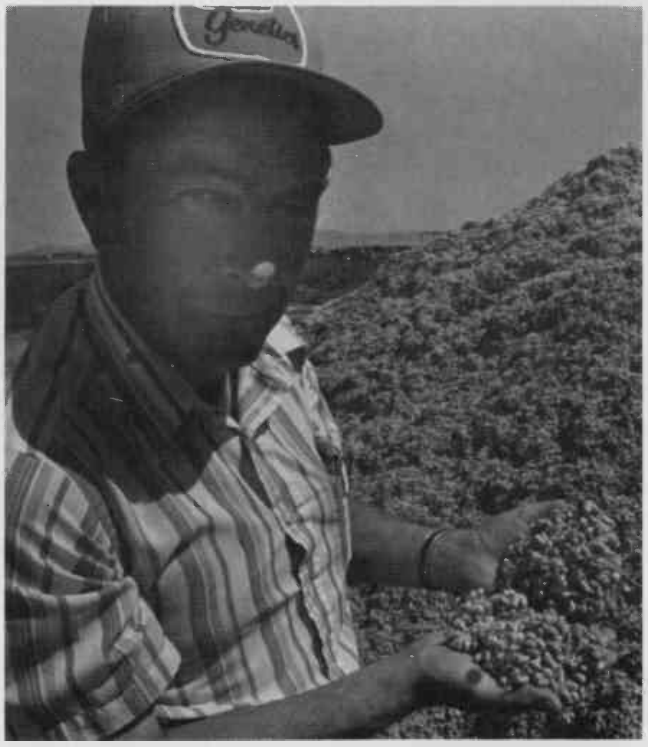
Results of the Gringg test reported to the Arizona Dairy Herd Improvement Association prompted Tappan to start detoxifying his 500 tons of cottonseed. To bag his cottonseed, Tappan employed the Agro-American Corporation, a new, custom cottonseed-ammoniating firm. They add 30 pounds of ammonia in 200 pounds of water per ton of seed as the bag is filled.

The investment in nine-foot diameter plastic bags that hold 80 tons is $235 each. The two-wall plastic bags have a five-mil black thickness inside and a four-mil white plastic outside. In the Gringg trial, some single-thickness black bags burst, due to hot seed and Arizona sunshine.

Since then, two other bagging contractors have moved in on the ammoniating market, charging $15 to $25 per ton.

"Cottonseed is inclined to heat and you lose feed value. But with the water-ammonia sealed treatment, it doesn't, nor do you find mold—a side benefit from the treatment," concludes Tappan.

As a postscript, the board of the United Dairymen of Arizona lifted its "no feed" cottonseed edict last April 26. It's OK now, if the cottonseed is treated, using the method pioneered by County Agent Lough.



Jim Tappan, managing partner of Arizona Dairy Company, handles some of the 500 tons of cottonseed he hopes to salvage by ammoniation.

Other Aflatoxin Work

Beyond the dairy aspect of the aflatoxin problem, the College of Agriculture is involved with cotton growers through Dr. Tom E. Russell, plant pathologist. He has been unraveling the cultural side of the question for the past seven years. Supported by a grant from the Arizona Cotton Growers Association, his "laboratory" includes commercial fields stretching from eastern Arizona into Imperial County, Calif.

Russell has found that cottonseed grown at elevations higher than 1,800 feet averages much less aflatoxin contamination than seed grown in the lower, hotter valleys. Most of the Cochise and Graham county cottonfields are above that elevation. He has further pinpointed the problem to ground-picked scrap cotton. This small part of the cotton crop averages about 50 times the aflatoxin content of spindle-picked cotton. Scrap cotton can be left in the field or separated at the gin to be kept out of the food chain.

In other aflatoxin-related research, Dr. Ralph L. Price, UA food scientist, who has surveyed milk supplies for aflatoxin since 1976, is working on detoxification methods for food products. For example, one question: Do stomach acids regenerate aflatoxin in something like a corn tortilla? They don't, he found.

Dr. William Schurg, animal scientist, has tests underway feeding cottonseed meal containing high levels of aflatoxin to horses.

Russell and Price served with two other scientists from the college and four from other parts of the university on the University Aflatoxin Committee appointed by UA President Dr. John Schaefer in December 1978. Dr. Roger Caldwell, director of the College's Council for Environmental Studies, chaired the committee. Animal nutritionist Dr. William Hale was the fourth member from the College of Agriculture. Hale assembled a large amount of information about aflatoxin through research reports and personal communications from scientists in other states.

The committee prepared an unofficial report, "Scientific and Technical Review of Aflatoxin," and testified to the Arizona State Chemist in January.

Plant pathologist Tom Russell uses a liquid chromatograph to measure the level of aflatoxin in a cottonseed sample.