Technical

Effect of Modular Storage of Arizona Seed Cotton on Levels of Aflatoxins in Seed

T.E. RUSSELL, University of Arizona Department of Plant Pathology, Cotton Research Center, Phoenix, Arizona 85040, and L.S. LEE, Southern Regional Research Center, U.S. Department of Agriculture, P.O. Box 19687, New Orleans, LA 70179

ABSTRACT

Samples were drawn from 40 free-standing modules of commercially grown Arizona seed cotton and analyzed for aflatoxin at the time of moduling and after 27 days of field storage. Thirty modules derived from spindle harvested cotton showed no significant increase in aflatoxins following modular storage, while all 10 modules packed with seed cotton derived from ground harvesters yielded significantly higher levels after storage than were detected at the time of moduling. Increases in toxin levels ranged from 12-232% with an average value of 67%. Even under ideal module making conditions significant increases in aflatoxins can be expected in ground-gleaned seed cotton harvested in areas where chronic aflatoxin contamination exists.

INTRODUCTION

Compacting effected by the module builder has revolutionized the harvesting and handling of seed cotton (1). This method allows a cotton grower to create a free-standing 6- to 8-ton stack of seed cotton that can be moved to the gin upon demand. Modular storage has replaced the use of trailers in Arizona by approximately 50%, the major reason being that the rate of harvesting is not dependent on the availability of trailers for transportation of seed cotton to the gin. Trailer capacities are also one-third to one-half those of the module builders. However, inherent problems are present in this method. The effects of modular storing seed cotton on lint and seed quality have been studied (2,3,4). Free fatty acid increases, which can be traced partially to microbial activity, are significantly affected when storage moistures are in excess of 12%. Deterioration of low quality seed may occur even if seed moisture is below the 12% guideline. Under Arizona's normally dry fall harvest conditions, seed moisture rarely exceeds 6% to 8%, but modular storage of cotton whose fiber may contain moisture from dew or green trash can lead to a moisture transfer to the seed and ultimately result in increased microbial activity when moisture levels in the seed exceed 12% (3).

Certain cotton production areas in the Southwestern United States are unique in the American cotton belt in that the fungus *Aspergillus flavus* is a chronic contaminant and aflatoxins are often formed in the seed. Seed infection and subsequent formation of aflatoxins in these areas generally is considered to occur only in the field (5). Due to the usually low moisture levels at harvest, non-storage of seed cotton in trailers, rapid turnover of seed at the gin, and aeration systems used at the oil mill, there appears to be little chance for additional seed infection and formation of aflatoxins. The module builder could affect aflatoxin-associated storage problems. Since the system was designed as a means of interim storage for periods as long as 90 days, the potential for additional production of aflatoxins is present.

Seed cotton is harvested or recovered in Arizona by 2 different methods. Over 90% of the seed cotton is recovered initially by a conventional spindle type harvester; a second or third picking is conducted by a ground gleaner to obtain that which is left on the plant and/or has fallen to the ground. Seed from this ground-gleaned seed cotton is 2-279X higher in aflatoxins than that found in spindle harvested seed obtained from the same field (6). The present study was designed to determine the effect of modular storage on oflatoxin content of seed from ground-gleaned and spindle-harvested seed cotton.

EXPERIMENTAL PROCEDURES

Seed cotton samples were obtained during the formation of the module, and sister samples were left in for comparison. In each module paired 22.7 kg samples were taken at 9 different points, 3 on the floor (each end and center) after 2 to 3 picker loads, 3 from the center and 3 from the top. An open-meshed string constructed sack was used to hold the samples. Construction allowed for compacting of its contents as if no container were present. One sack of each pair was left in the module while the sister sack was returned to the lab for processing. The stored member of the pair was removed as the module was vacuum unloaded at the gin. All samples were saw-toothed ginned, the fuzzy seed dehulled in a double-disked Bauer mill, and meats were separated from hulls and ground to pass a 2mm screen. Approximately 113.5 kg of ground meats were blended in a small cement mixer for 30 min and riffled to 250g. Four 50g sub-samples were analyzed for aflatoxins (7). High performance liquid chromatography (HPLC) was used for quantitation (8).

Thirty modules composed of spindle harvested first-picked seed cotton were sampled from the Phoenix, Buckeye and Gila Bend, AZ areas. Ten made up of ground gleaned seed cotton were sampled from Gila Bend. All modules were monitored for the first week after packing by the respective gins for temperature and signs of overheating. All modules were covered with a tarpoline but received some moisture by blowing rain during storage.

RESULTS AND DISCUSSION

No temperature spikes over 40 C were noted, and none of the modules was symptomatic of overheating. For this reason temperature measurements were discontinued after the first week.

There was no significant increase of aflatoxins in modules composed of spindle first-picked seed cotton when the in-going aflatoxin levels were non-detectable to approximately 100 μg/kg (Table 1). Stratification (i.e. top, middle or bottom) played no role in eliciting a change in total aflatoxins. Current results indicate that the average aflatoxin level for those cotton production areas in Arizona where aflatoxin can be detected in spindle first-picked seed is approximately 50 μg/kg (9). Therefore, the results of this portion of the study should be valid for most of the spindle first-picked seed harvested in the state during any given year. Since no modules of spindle first-picked seed contained seed with toxin levels exceeding 100 μg/kg, the

TABLE I

Aflatoxin Content of Paired Samples of Moduled Seed Cotton Harvested by Spindle Picking
Location: Gila Bend, AZ

Aflatoxins ($\mu g/kg$)[a]

Storage (days)	Control top	middle	bottom	Av.	Stored top	middle	bottom	Av.
68	ND[b]	ND	ND	ND	14	1	ND	5
"	89	170	105	121	29	66	1	32
"	29	114	10	51	3	4	ND	2
"	72	15	10	32	14	86	88	63
"	83	9	67	53	45	66	34	48
"	ND	ND	ND	ND	ND	2	4	2
"	ND	ND	ND	ND	ND	ND	ND	ND
"	ND	ND	ND	ND	ND	ND	ND	ND
"	ND	ND	ND	ND	ND	ND	ND	ND
"	ND	ND	ND	ND	ND	ND	ND	ND
78	1	1	1	1	ND	ND	3	1
"	ND	1	1	1	ND	ND	4	6
"	49	20	83	51	25	15	72	38
"	28	15	21	21	11	8	55	25
"	6	10	14	10	26	1	107	44
"	23	3	3	10	1	1	6	2
"	5	3	15	8	23	2	ND	11
"	52	8	30	30	129	19	59	69
MEAN	24	21	20	22	19	15	24	19

Location: Phoenix, AZ

Storage (days)	Control top	middle	botton	Av.	Stored top	middle	bottom	Av.
38	9	4	79	31	28	39	1	23
"	ND	1	40	14	8	ND	25	11
"	52	34	36	41	16	21	7	15
27	21	32	41	31	45	12	21	26
"	46	82	25	51	29	90	55	58
"	39	10	48	32	62	21	72	52
MEAN	28	27	45	33	31	30	30	31

Location: Buckeye, AZ
No toxins were detected in 6 samples before or after storage for 60 days.

[a]Each value represents a mean of 12 analyses or 4 sub-samples obtained from each of 3 22.7 kg paired samples.
[b]ND = None Detected.

TABLE II

Aflatoxin Content of Paired Samples of Moduled Seed Cotton Harvested by Ground-Gleaning

Location: Gila Bend, AZ

Aflatoxins ($\mu g/kg$)[a]

Storage (days)	Control top	middle	bottom	Av.	Stored top	middle	bottom	Av.
75	230	164	255	216	380	327	322	343
"	142	206	388	246	274	412	192	293
"	91	178	81	117	211	524	433	389
"	258	127	417	267	647	284	841	591
"	284	289	87	220	354	411	117	315
"	641	522	737	633	209	775	1154	712
"	865	323	402	530	1617	841	545	1001
"	524	162	575	420	826	856	759	813
"	837	438	270	515	738	1165	421	775
"	147	389	605	380	770	951	340	687
	402	280	382	354	603	654	512	592

[a]Each value represents a mean of 12 analyses or 4 sub-samples obtained from each of 3 22.7 kg paired samples.

implication is that modular storage does not increase toxin levels of spindle first-picked cotton.

In contrast, a significant increase in aflatoxins was observed in all modules containing ground-gleaned seed cotton (Table II). The overall increases on a module by module comparison ranged from 12-232% with an average increase of approximately 67%. There also was a trend toward greater increases in total aflatoxins in seed stored in the center of module. The increase here was approximately 134% compared to 50% for seed stored on top of the module and 34% for that stored in the bottom strata.

It is well established that cottonseed recovered by ground-gleaners is of poor quality, and such seed harvested in chronic aflatoxin areas in Arizona will almost always contain aflatoxins (6). This seed apparently falls into the category that has been described as being of low quality and subject to deterioration regardless of moisture level (2). Since no temperature increase was noted in any of these modules, we must assume that moisture remained below 12%. Since temperature measurements were discontinued after the first week, changes in temperature and moisture after several weeks of modular storage were not determined. It is possible that in selected areas of the modules a moisture transfer could have occurred between wet fiber or green trash and seed. Such a moisture increase would enhance microbial activity and promote toxin formation.

Our results show that modular storage of ground-gleaned cotton is ill advised.

ACKNOWLEDGMENTS

Arizona Cotton Growers, National Cottonseed Products Assoc., Anderson Clayton and Co., Producers Cotton Oil, and Case Grande Oil Mill and Cotton, Inc. provided financial support.

REFERENCES

1. Wilkes, L.H., R. Jones, G. Underbrink and W.H. Aldred. Proc. Beltwide Cotton Prod. Res. Conf. 73 (1972).
2. Wilkes, L.H. Ibid. 215 (1978).
3. Cherry, J.P., J.G. Simmons, A.H. Hyer, R.H. Garber, L.M. Carter and H.B. Cooper. Ibid. 36 (1979).
4. Eickhoff, W.D., and M.H. Willcutt. Summ. Proc. West. Cotton Prod. Conf. 58 (1978).
5. Ashworth, L.J. Jr., J.L. McMeans, B.R. Houston, M.E. Whitten and C.M. Brown. JAOCS 48:129 (1971).
6. Russell, T.E., P. von Bretzel and J. Easley. Phytopathology 71:359 (1981).
7. Pons, W.A., A.F. Cucullu and A.O. Franz Jr., J. Assoc. Offic. Anal. Chem. 55:768 (1972).
8. Pons, W.A. Jr., and A.O. Franz Jr. Ibid. 60:89 (1977).
9. Russell, T.E. Unpublished data. (1983).

[Received January 25, 1984]

Homogeneous Catalytic Hydrogenation of Soybean Oil: Palladium Acetylacetonate

S. KORITALA, Northern Regional Research Center, Agricultural Research Service, U.S. Department of Agriculture, Peoria, Illinois 61604

ABSTRACT

Soybean oil was hydrogenated with palladium acetylacetonate at 60-170 C, 150 psi hydrogen and 1-60 ppm palladium. The best linolenate selectivity (K_{Le}/K_{Lo} = 3.5-3.7) was found at 80-120 C. At 120 C palladium acetylacetonate hydrogenated faster than the heterogeneous Pd-on-carbon catalyst. *Trans* isomerization with the homogeneous catalyst was much higher compared to Pd-on-carbon catalyst. The low activity of the palladium complex at low temperatures was improved with the addition of triethylaluminum. Among other metal acetylacetonates tested only nickel and chromium were mildly active, whereas cobalt and copper were devoid of catalyst activity.

INTRODUCTION

One of the program objectives at this laboratory is to improve the stability of soybean oil through selective hydrogenation. Copper catalysts previously have been shown to be more selective than the commonly employed nickel catalysts (1). Homogeneous nickel acetylacetonate catalyst is more selective than heterogeneous nickel catalyst (2), but this homogeneous catalyst is active only in the presence of methanol solvent, and triglycerides are simultaneously transesterified to methyl esters.

Now we have observed that palladium acetylacetonate catalyzes selective hydrogenation of soybean oil. Since we started our study, another group reported on this catalyst (3). We also have studied acetylacetonates of several group VIII metals. Acetylacetonate complexes of Cu (III), Co (II) and Co (III) were devoid of catalytic activity, whereas Ni (II) and Cr (III) acetylacetonates showed only slight activity for the hydrogenation of soybean oil.

EXPERIMENTAL

Materials

Central Soya Co., Inc. (Fort Wayne, Indiana) supplied the refined and bleached soybean oil (IV 136.8). Acetylacetonate complexes of Pd (II), Ni (II) (Strem Chemicals Inc., Newburyport, Massachusetts); Co (II), Co (III), Cr (II) (Pfaltz & Bauer, Inc., Stamford, Connecticut); and Cu (II) (Aldrich Chemical Co., Inc., Milwaukee, Wisconsin) were purchased from commercial sources.

Hydrogenation

Palladium acetylacetonate dissolved in 75 g soybean oil was placed in a 150-ml magnetically stirred Magna-Dash autoclave which was electrically heated under nitrogen pressure. When the reaction temperature was reached, the stirrer was stopped and nitrogen was vented to the atmosphere. Hydrogen (150 psi) gas was admitted into the reactor from an external reservoir (250 ml) through a pressure regulator valve, which maintained a constant pressure (150 psi hydrogen + 15 psi nitrogen) in the autoclave. The reaction started when stirring began, as no hydrogen uptake was observed without stirring. The extent of hydrogenation was followed by measuring the drop in hydrogen pressure in the external reservoir and by taking samples at intervals for analysis.

Analytical Methods

The hydrogenated soybean oil containing the catalyst was converted directly to methyl esters with sodium methoxide catalyst, according to the method of Christopherson and