Note on Inactivation of Aflatoxin in Ammonia-Treated Shelled Corn at Low Temperatures

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Scientists at the Northern Regional Research Center have done extensive research to determine the optimum reaction parameters for inactivating aflatoxin in shelled corn (Brekke et al 1976, 1977). These reports detail the conditions of corn temperature, moisture, and ammonia (NH_3) levels for reducing aflatoxin to the guidelines set by the FDA (1977). Brekke et al (1977) reported inactivation experiments at −18 and 1°C on one lot of contaminated corn (aflatoxin B_1 content, 510 ppb) using 0.5% (db) NH_3 on 15% moisture content (wb) corn. The aflatoxin B_1 content of this corn was reduced to <120 ppb at −18°C in 69 days and to <70 ppb at 1°C in 39 days.

Our purpose was to extend these experiments by using lots of corn differing in initial aflatoxin content and by varying the levels of NH_3 added. We also wanted to explore the rate and degree of aflatoxin inactivation at less than ideal reaction conditions, particularly under variable, ambient winter temperatures.

MATERIALS AND METHODS

Three different lots of naturally contaminated corn were used. Their moisture contents before and after ammoniation and initial and final aflatoxin contents are reported in Table I. ACS grade ammonium hydroxide was used as the NH_3 source. The NH_3 added to the corn is expressed as weight percent, based on dry matter content of the corn. Unlike previous work, the corn was not moistened before NH_3 addition but was treated on an "as is" basis. For treating each contaminated lot at each NH_3 level, six 5-lb samples of the grain were placed in double plastic (2-mil thickness polyethylene) bags, aqua ammonia was added, and the bags were tied shut. The contents were mixed by hand manipulation for a few minutes, placed in a fiber drum, and stored in an unheated shed. A hygrothermograph was placed beside the drum to monitor temperatures during the 179-day storage. Each contaminated lot was ammoniated at levels of 1 and 1.5% and stored. Individually bagged 5-lb samples of each lot at both treatment levels were removed for aflatoxin analyses after 8, 15, 31, 59, 88, and 179 days. On removal from storage, the entire 5-lb sample was ground through a Raymond Laboratory Mill fitted with a 3-mm round hole perforated full-circle screen, blended, and 150 g neutralized for aflatoxin analyses according to procedures reported by Brekke et al (1977). The samples for aflatoxin analyses were processed the same day the samples were removed from storage. Quantitative aflatoxin analyses were made by an AOAC method recommended for corn (1975).

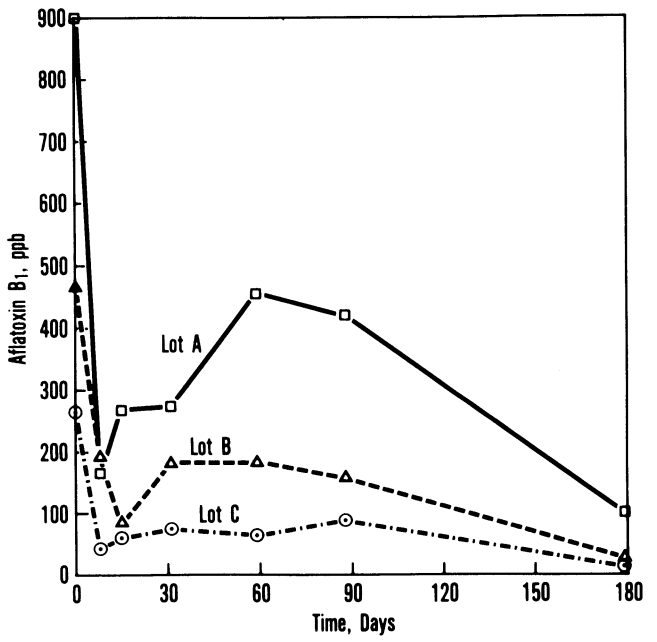

Fig. 1. Aflatoxin B_1 inactivation in corn using ammonia at 1% db level.

RESULTS AND DISCUSSION

Addition of NH_3 causes corn to change color; the extent of change depends on NH_3 level, corn moisture, and reaction temperature and time (Brekke et al 1977, Black et al 1978). Corn adjusted to 17% moisture content, treated with 1−1/2% (db) NH_3, and held at 30°C for 24 hr has a deep mahogany color. At the conclusion of this experiment (low-temperature/moisture), the corn had a burnt-orange color at both levels of NH_3 treatment.

The rate and extent of aflatoxin B_1 inactivation are shown in

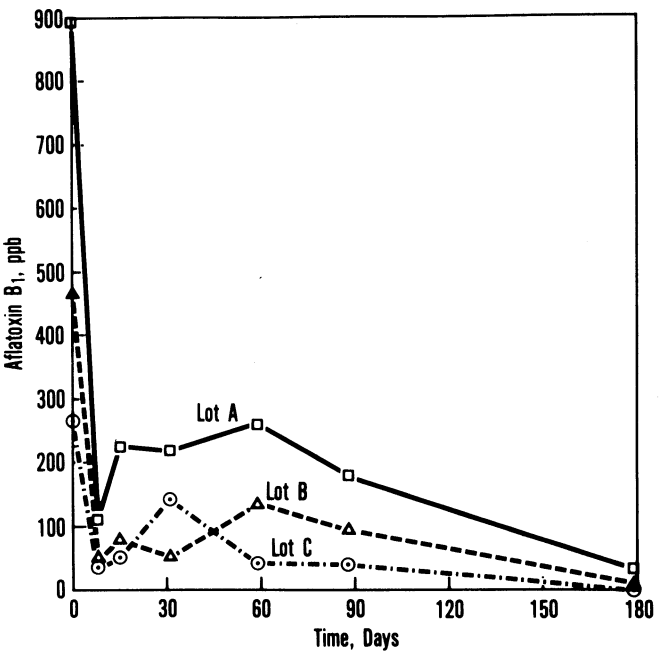

Fig. 2. Aflatoxin B_1 inactivation in corn using ammonia at 1.5% db level.

[1]Mention of firm names or trade products does not imply their endorsement or recommendation by the US over other firms or similar products not mentioned.

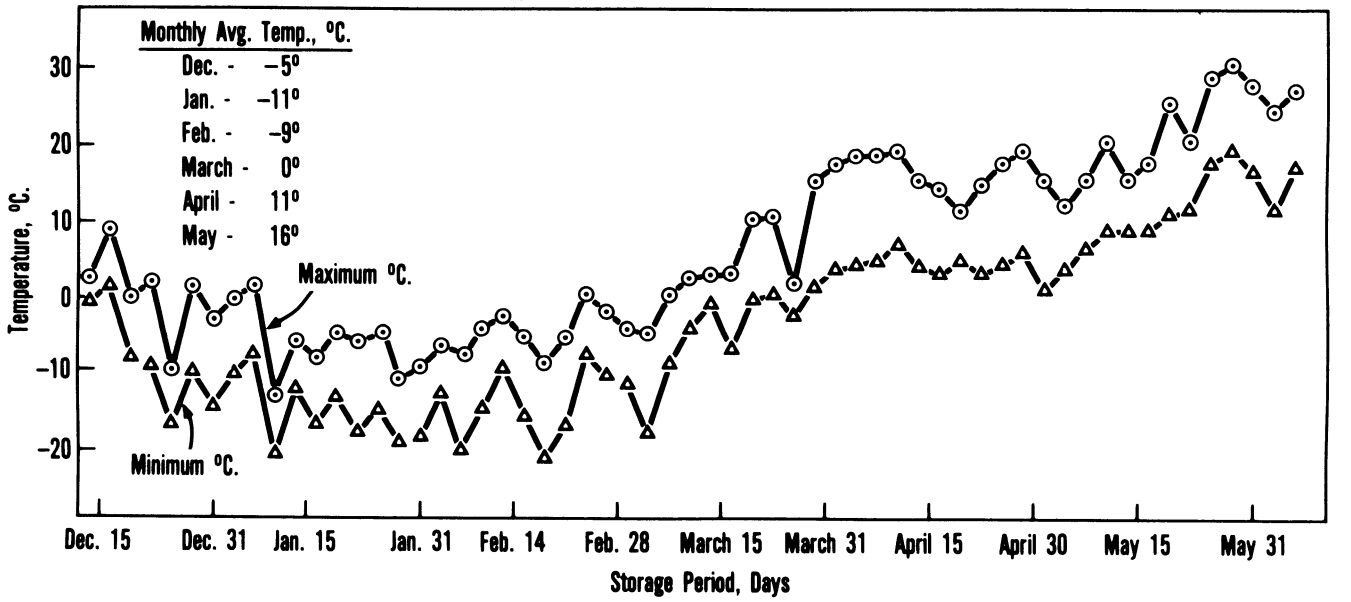

Fig. 3. Ambient temperatures during storage period.

TABLE I
Effect of Ammonia Level on Aflatoxin-Contaminated Shelled Corn Stored at Low Temperatures

Corn Lot	Initial Moisture Content (% wb)	Ammonia Added (% db)	Moisture in Ammoniated Corn[a] (% wb)	Aflatoxin Content (ppb) Initial B_1	B_2	G_1	G_2	Final[b] B_1	B_2	G_1	G_2
A	11.4	1.0	13.4	896	115	ND[c]	ND	103	11	ND	ND
A	11.4	1.5	14.4	896	115	ND	ND	32	3	ND	ND
B	12.2	1.0	14.2	461	71	ND	ND	27	3	ND	ND
B	12.2	1.5	15.2	461	71	ND	ND	8	1	ND	ND
C	9.9	1.0	12.0	266	22	ND	ND	15	1	ND	ND
C	9.9	1.5	13.0	266	22	ND	ND	2	ND	ND	ND

[a]Calculated values based on NH_4OH (27.4% NH_3) addition.
[b]Aflatoxin content after 179 days of storage.
[c]ND = not detectable.

Figs. 1 and 2. Addition of 1% NH_3 (Fig. 1) reduced the B_1 content by one-half or more in the three lots in 60 days. After 179 days, the B_1 content in the three lots was reduced either to or below 100 ppb. Addition of 1.5% NH_3 (Fig. 2) reduced the B_1 content in the three lots to less than one-third the initial level within 60 days. After 179 days, the B_1 content in the three lots was less than 50 ppb. During the first 90 days these levels of inactivation were attained at temperatures seldom exceeding 0°C (Fig. 3). The aflatoxin B_1 content was considerably reduced through the first eight days of the experiment in the three lots of corn (Figs. 1 and 2). However, we noted a general increase in B_1 from 8 to 59 days, especially in Lot A (initial B_1 content, 896 ppb). The cause of this apparent intermediate increase is unknown and should be investigated.

We also wish to emphasize that not all of the final samples had assay values below the FDA guideline of 20 ppb total aflatoxin-B_1, B_2, G_1, and G_2 (Table I).

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LITERATURE CITED

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. 1975. Official Methods of Analysis (12th ed.). Sections 26.037-26.039. The Association: Washington, DC.

BLACK, L. T., SPENCER, G. F., and BREKKE, O. L. 1978. Reaction of lipids in corn with ammonia. J. Am. Oil Chem. Soc. 55(6):526.

BREKKE, O. L., PEPLINSKI, A. J., and LANCASTER, E. B. 1977. Aflatoxin inactivation in corn by aqua ammonia. Trans ASAE 20(6):1160.

BREKKE, O. L., PEPLINSKI, A. J., NOFSINGER, G. W., CONWAY, H. F., MONTGOMERY, R. R., SILMAN, R. W., SOHNS, V. E., and BAGLEY, E. B. 1976. Aflatoxin inactivation in corn by ammonia gas: A field trial. ASAE Paper 76-3526, St. Joseph, MI 49085.

FDA proposed guidelines for aflatoxin. 1977. Cereal Foods World 22(10):532-533, 541.