

Note on Aflatoxin Decomposition in the Process of Making Tortillas from Corn

M. ULLOA-SOSA and H. W. SCHROEDER¹, Department of Plant Sciences, Texas A&M University, College Station, Texas 77843

The aflatoxins, metabolic products of the mold, *Aspergillus flavus* Link, are highly toxic to a number of animals and might be toxic to man. Decomposition and removal of aflatoxins from agricultural products has been attempted² (1,2). Fischbach and Campbell (1) reported that temperatures of 300°C. or above were required to decompose aflatoxins. They also reported that aflatoxin extracts treated for a few seconds with 5% sodium hypochloride lost their fluorescence, and that the reaction products were nontoxic in chick embryo bioassay.

Dollear and Gardner² cooked 700 g. of contaminated meal (30% moisture) in 2% sodium hydroxide for 2 hr. at 100°C. Aflatoxin concentration was reduced from 113 p.p.b. to traces. Goldblatt (2) studied the alkali treatment of oilseeds during processing to oil and meal; NaOH effectively decomposed aflatoxin. Alkali treatment has, therefore, been considered as a promising approach to the elimination of aflatoxin from some foods and feeds.

The process of making "tortillas" (pancakes) from "masa" (dough made out of corn), as followed in Mexico and in other Latin American countries, uses lime (CaO) which reacts with water to form calcium hydroxide. Experiments were made to determine the effect of this process on corn kernels contaminated with aflatoxins.

MATERIALS AND METHODS

About 5 lb. of white corn kernels was inoculated with spores of *A. flavus* Culture No. XVI-1 (originally isolated from yellow field corn) and incubated at 30°C. and 90% relative humidity for 2 weeks. Then the moldy kernels were washed with tap water to eliminate most of the spores and mycelium infesting their surfaces. The washed kernels were then dried at room temperature on wire screens.

¹Respectively, Fellow of the Ford Foundation and Investigations Leader, Southwestern Field Crops Pathological Investigations, ARS, U.S. Dept. of Agriculture, P.O. Box ED, College Station, Texas 77840.

²F. G. Dollear and H. K. Gardner, Jr. Inactivation and removal of aflatoxin. Fourth National Peanut Res. Conf., Tifton, Ga. (1966).

Three hundred grams of dry contaminated corn was mixed in a Patterson-Kelley twin-shell blender with 900 g. of sound white corn to give a total of 1,200 g. (3:1 ratio).

The procedure for making "nixtamal," "masa," and "tortillas," a domestic recipe from Mexico, was as follows: To 1,200 g. of mixed corn, 2 liters of tap water and 1½ serving spoon (about 150 g.) of lime were added and the mixture was boiled for about 1 hr. When the outer seed coat could be removed easily with the fingernails, the mixture was taken from the heat and cooled. The treated corn, after straining, is called "nixtamal" in Mexico. Three 50-g. samples of the "nixtamal" were then assayed for aflatoxin content. The remaining 1,050 g. was comminuted in an electric blender and then mashed in a "molcajete" (a sort of mortar made out of volcanic rock) to soft masa (dough). Again, three 50-g. samples were assayed for aflatoxin content. Three other 50-g. samples of masa were incubated at 25°C. for 72 hr. before assay. The remaining masa was made into tortillas. Small balls of masa were pressed with a metallic press, and the flat tortillas were cooked on a hot pan. Three 50-g. samples of cooked tortillas were analyzed for aflatoxin immediately and three other 50-g. samples were incubated at 25°C. for periods up to 72 hr. before the aflatoxin assay. The experiment was repeated and the water in which the contaminated corn was boiled was also assayed for aflatoxin. In this part of the experiment, the masa and tortillas were stored for 72 hr. only.

Aflatoxins were extracted and determined by a modification of the thin-layer chromatography method of Pons and Goldblatt (3).

RESULTS AND DISCUSSION

Results indicated that aflatoxin concentration is reduced in the preparation of tortillas from contaminated whole-kernel corn (Fig. 1); with heavily contaminated corn, however, the toxins were still found in the tortillas.

About two-thirds of the aflatoxins was removed by boiling the corn in lime water (Table I). Most of the B aflatoxins were found in the residual water; although G aflatoxins were reduced more than B, none was found in the water. Apparently, the G toxins are largely decomposed during the process of making "nixtamal." Variation in toxin content among the subsamples of contaminated corn was very high and persisted in the "nixtamal" (Table I). Data of Cucullu et al. (4) indicate that aflatoxin contamination varies exceedingly among individual kernels of peanuts. Apparently, this is also true of corn, even when artificially inoculated under conditions that could be expected to yield uniform contamination. After grinding and thorough mixing in the making of "masa," variation among the subsamples was reduced to zero (Table I).

Although the present method of determining aflatoxins lacks precision, cooking of the masa as "tortillas" apparently caused some decomposition of the toxins (about 36%). This could be a continuation of the degradation occurring during the preparation of "nixtamal." According to Dollear and Gardner, aflatoxins B₁ and G₁, which have a double bond, are susceptible to the attack of oxidizing or reducing agents. The storage of masa and/or tortillas resulted in no significant changes in aflatoxin contamination.

Since corn consumed by humans in most of Latin America is largely in the form of tortillas, these findings might be important to the health of millions of people.

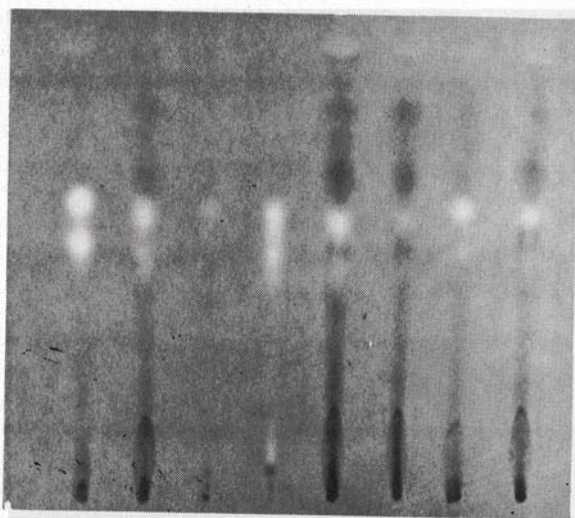


Fig. 1. Thin-layer chromatogram of extracts of corn in the various stages in the preparation of tortillas. From left to right: 1) mixed sound and contaminated corn (3:1); 2) nixtamal; 3) lime water after boiling corn; 4) aflatoxin standard (fluorescent spots from top to bottom): aflatoxin B₁ -0.08 γ B₂ -0.03 γ G₁ -0.10 γ G₂ -0.02 γ 5) fresh-made masa; 6) fresh tortillas; 7) masa after 72 hr. at 25° C.; and 8) tortillas after 72 hr. at 28° C.

The method of making tortillas followed in this experiment has been used in Mexico for centuries. The corn is boiled in lime water to facilitate the peeling and softening of the kernels before they are ground for the preparation of masa, tortillas, and other foods; but the procedure also appears to increase the healthfulness of the final food product by greatly reducing aflatoxin

TABLE I. AVERAGE (OF THREE SAMPLES) AFLATOXIN CONCENTRATION IN THE SEVERAL STAGES IN THE PREPARATION OF TORTILLAS FROM CONTAMINATED CORN

Stage of tortilla preparation	Aflatoxins per 50-g. sample			
	B γ	G γ	Total ^a γ	
Mixed sound and contaminated corn	19.51	29.60	49.11	± 20.92
Nixtamal	9.61	7.37	16.98	± 13.65
Water (used to boil corn)	7.60	7.60	± 0.00
Masa	12.09	7.70	19.79	± 0.00
Tortillas	7.57	5.11	12.68	± 0.00
Masa (after 72 hr. at 25° C.)	7.27	7.59	14.86	± 0.00
Tortillas (after 72 hr. at 25° C.)	9.06	6.40	15.46	± 3.53

^aStandard error refers primarily to sampling error within treatment. The authors minimized analytical error by comparing all replications of each treatment on one TLC plate with the same set of standard quantities of aflatoxins.

contamination. However, Parker and Melnick (5) have reported that mild alkaline treatment of aflatoxin decreases the fluorescence of B₁, but the reaction is reversible by acidification. Bioassays to determine the extent of detoxification will be necessary to clarify the present finding.

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