Fate of Aflatoxin M_1 in Cottage Cheese

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ABSTRACT

Two batches of long-set cottage cheese were prepared from milk naturally contaminated with aflatoxin M_1. Cottage cheese was stored for 2 weeks at 7°C. Analyses for pH, moisture content and AFM_1 were done on days 0, 3, 7, 10 and 14 of storage. In comparison with the initial curd concentrations (18.3 and 20.5 μg of AFM_1/kg of cheese for trials 1 and 2, respectively), AFM_1 concentrations in the finished product did not decrease appreciably during storage. Overall average concentrations of AFM_1 in trials 1 and 2 from day 0 to day 14 were 15.0 and 20.5 μg of AFM_1/kg of cheese, respectively.

Aflatoxin M_1 (AFM_1), a highly toxic metabolite of aflatoxin B_1 (AFB_1) (1, 11, 12), is excreted into milk of cows fed aflatoxin-contaminated feedstuffs. Because AFM_1 has been found in commercial milk (8, 10) and cheeses (7, 10), it is of major concern to the dairy industry and the milk-consuming public.

A small number of reports are available on the fate of AFM_1 in the manufacture of dairy products produced from naturally contaminated milk (see Ref. 2 for review). However, the few studies (6, 13) done on cottage cheese have dealt exclusively with milk artificially contaminated with AFM_1. The purpose of the present investigation, therefore, was to determine the behavior of AFM_1 during the manufacture of long-set cottage cheese made from naturally contaminated milk.

RESULTS AND DISCUSSION

The AFM_1 content of cheese, curd, whey, wash waters, dressing and milk for the two trials of cottage cheese are given in Table 2. AFM_1 concentrations in the curd were 7.9 and 8.3 times higher (trials 1 and 2, respectively) than in the skim milk used in their manufacture. The whey and wash water from each trial contained less AFM_1 than did the original skim milks.

Concentrations of AFM_1 in the cheeses during the 2-week storage period did not decrease appreciably (Table 2). The average concentrations for trials 1 and 2 during the storage period were 15.0 and 20.5 μg of AFM_1/kg of cottage cheese, respectively. These values together with the individual day values indicate that AFM_1 is stable during the manufacture and storage of long-set cottage cheese.

Our findings suggest that cottage cheese manufactured from milk naturally contaminated with AFM_1 could contain more toxin than is thought to be acceptable. The partitioning behavior of AFM_1 between the curd and whey reflects an affinity of the toxin for the casein fraction, a characteristic already noted by other investigators (1, 4, 5). Further research is required to completely characterize the behavior of AFM_1 in cottage cheese made by various procedures.

MATERIALS AND METHODS

Preparation of toxic milk

Two fistulated Holstein dairy cows were given 13 mg of AFB_1 (Sigma Chemical Co., St. Louis, MO) per day for 7 d (3). Milk was collected twice daily and held at 7°C until it was manufactured into cottage cheese.

Cottage cheese manufacture

Cottage cheese was manufactured according to the long-set method as described by Kosikowski (9). The cheese was manufactured in small laboratory vats which contained 1.5 L of milk. Skim milk and cream were obtained by separating the contaminated milk using a hand-operated separator (SCB-ITAS Separator, Istanbul, Turkey). After separation, both milk and cream were pasteurized at 63°C for 30 min and then made into cottage cheese. All cottage cheese was creamed according to the Simplified-A formula of Kosikowski (9). Cottage cheese samples were stored at 7°C until analyses were done. Moisture content and pH value of the cheese samples were determined on days 0, 3, 7, 10 and 14 (Table 1).

Analysis for AFM_1

Amounts of AFM_1 were determined according to the method described by Stubblefield (14). Thin-layer chromatography (TLC) was done using RediPlate TLC plates precoated with Silica Gel G (Fisher Scientific Co., Pittsburgh, PA). Samples containing AFM_1 were analyzed in duplicate using a TLC scanner (G. K. Turner Associates, Inc., Palo Alto, CA). All solvents used for analysis and column chromatography were from Burdick and Jackson Laboratories (Muskegon, MI) and were of spectrophotometric grade. Chloroform used for extractions was analytical grade. The AFM_1 standard was obtained from Eureka Laboratories (Sacramento, CA).

ACKNOWLEDGMENTS

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TABLE 1. Yield (%), pH and moisture content of cottage cheese made from milk naturally contaminated with AFM₁.<sup>a</sup>

<table>
<thead>
<tr>
<th>Trial</th>
<th>Yield (%)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>pH&lt;sup&gt;c&lt;/sup&gt; at days</th>
<th>Moisture content&lt;sup&gt;c&lt;/sup&gt; at days</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>14.6</td>
<td>4.6</td>
<td>4.6</td>
</tr>
<tr>
<td>2</td>
<td>15.8</td>
<td>4.6</td>
<td>4.4</td>
</tr>
</tbody>
</table>

<sup>a</sup>1.5 L of AFM₁-contaminated skim milk was used to prepare cheese.<br><sup>b</sup>Yield based on a weight:weight basis.<br><sup>c</sup>Values represent the mean of triplicate samples.

TABLE 2. Concentration of AFM₁ in curd, whey, wash water, dressing, cheese and skim milk from which cottage cheese was made.<sup>a</sup>

<table>
<thead>
<tr>
<th></th>
<th>Milk AFM&lt;sub&gt;1&lt;/sub&gt; (µg/L)</th>
<th>Total AFM&lt;sub&gt;1&lt;/sub&gt; (µg/kg)</th>
<th>Curd AFM&lt;sub&gt;1&lt;/sub&gt; (µg/L)</th>
<th>Total AFM&lt;sub&gt;1&lt;/sub&gt; (µg/kg)</th>
<th>Whey AFM&lt;sub&gt;1&lt;/sub&gt; (µg/L)</th>
<th>Wash&lt;sup&gt;b&lt;/sup&gt; water (µg/L)</th>
<th>Dressing (µg/L)</th>
<th>AFM&lt;sub&gt;1&lt;/sub&gt; in cheese at days (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2.33</td>
<td>3.50</td>
<td>0.21</td>
<td>18.33</td>
<td>3.85</td>
<td>1.42</td>
<td>0.40</td>
<td>1.25</td>
</tr>
<tr>
<td>2</td>
<td>2.48</td>
<td>3.72</td>
<td>0.23</td>
<td>20.48</td>
<td>4.71</td>
<td>0.92</td>
<td>0.47</td>
<td>3.73</td>
</tr>
</tbody>
</table>

<sup>a</sup>Values for AFM<sub>1</sub> concentrations represent the mean of duplicate samples.<br><sup>b</sup>Average AFM<sub>1</sub> concentration of the combined wash waters from three washings of curd.

REFERENCES


Deibel and Banwart, cont'd from p. 902


