Multiple Outbreaks of Niacin (Nicotinic Acid) Intoxication Due to Addition of Meat "Enhancer" to Products by Two Different Meat Processors

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ABSTRACT

Five outbreaks of facial flushing accompanied by a feeling of warmth and pruritus were reported in people eating commercially prepared frozen ground beef or processed veal steaks. The outbreaks occurred during a seven-month period in Israel. In all instances niacin (nicotinic acid), a substance known to cause these signs and symptoms was measured in amounts ranging from 0.3 to 6.0 g/kg of raw beef. The chemical was illegally added by two producers in order to enhance color of the meat.

Certain substances may be added to some raw meat products in Israel on conditions that the additive is not specifically prohibited by law, and that the final product is labeled with the added ingredients. Edible salts, sugars, acids, spices, vegetable protein and oils may be included in these products in order to preserve color, increase tenderness, improve flavor, and to allow sale of a product more economically than nonprepared meat.

Opportunities for mislabeling or nonlabeling of additives whether intentional or not can occur in various ways. Suppliers of additives to meat processors may not properly label ingredients. Labeling of the finished product may be incomplete because of lack of proper information given by additive manufacturers or because the producer for any reason does not label the final product accurately.

For the past several years there have been scattered reports of allergic-like reactions in people throughout the country following consumption of various prepared meat products. The products, usually ground beef, did not list any additives. When available, samples of the meats were submitted for histamine analysis. Results were unrewarding. Histamine levels were uniformly much lower than 0.5 g/kg of food, the minimal histamine content generally recognized as being associated with adverse reactions (10).

We wish to report five outbreaks of niacin intoxication due to the illegal addition of the chemical to ground meat by two manufacturers and addition of the substance to prepared steak by one of these manufacturers. In one of the outbreaks, niacin poisoning was diagnosed retrospectively following the discovery of niacin as the causative agent in the latter outbreaks.

MATERIALS AND METHODS

Nicotinic acid measurements

A thin layer chromatography (TLC) method was developed in the Ministry of Health Laboratories in order to measure niacin content of products based, in part, on the previous experiences of others (5,9) and is briefly described.

In order to prepare samples, 50 g of minced or finely chopped meat was homogenized with 200 ml of water and then brought to boiling. The water extract was ice-cooled to separate most of the fat and filtered to obtain the sample solution. Standard comparison solutions consisted of three different solutions each containing 250 mcg/ml in water of either nicotinic acid, nicotinamide, or ascorbic acid.

For TLC, silica gel 60 F-254 plates 0.5 mm thick (E. Merck Darmstadt, Darmstadt, Federal Republic of Germany) were employed. In order to detect nicotinic acid and to distinguish it from nicotinamide, 0.1 ml quantities of the sample solution, the standard nicotinic acid solution, and the nicotinamide solution were applied in bands to the TLC plate. The plate was developed in ethyl-acetate:methanol:water 160:40:20 as mobile phase. Detection of bands was carried out under UV light (254 nm). The Rf of nicotinic acid was 0.4 and of nicotinamide 0.7.

Samples showing a band with an Rf identical to that of nicotinic acid were further evaluated as follows in order to quantify the nicotinic acid and distinguish it from ascorbic acid: 0.1 ml quantities of sample solution and ascorbic acid solution and different quantities (0.05 ml, 0.1 ml, 0.15 ml, and 0.2 ml) of nicotinic acid standard solution were applied in bands to the TLC plate. The plate was developed in acetic acid:acetone:methanol:tolulene 5:5:20:70 as mobile phase. Detection of bands was carried out under UV light (254 nm). Quantitative evaluation of nicotinic acid in the meat was accomplished by comparison...
with the standard nicotinic acid bands. The Rf of nicotinic acid was 0.37 and of ascorbic acid 0.1. When necessary, sample solutions were further diluted and rechromatographed to enable quantitation.

In order to quantitate the nicotinic acid in the meat "enhancer", 100 mg of the "enhancer" was dissolved in 100 ml water, and 0.1 ml of this solution was submitted to the same TLC method as described above.

To confirm the above described method for the identification and quantification of niacin, two samples were further examined in the following manner. After TLC of the sample solution, the band with the Rf identical to that of nicotinic acid was scratched off of the plate and extracted with H₂SO₄ n/10 for 20 min with mechanical shaking. The acid extract was filtered and diluted with n/10 H₂SO₄ to obtain a solution of about 10 mcg/ml. The UV spectrum of this solution showed an inflection at 255 nm, a maximum at 260.5 nm and a smaller maximum at 266.5 nm, identical with the spectrum of nicotinic acid standard treated in the same way. These spectral data are in accordance with literature data for nicotinic acid (5) and thus prove the presence of nicotinic acid in the meat samples.

For the quantitative estimation, the UV absorption of the sample acid solutions was read at 260.5 nm and the concentration of nicotinic acid calculated from the absorption of a standard solution of nicotinic acid. The results obtained confirmed our former quantitative evaluation of the TLC plates.

RESULTS

The outbreaks and subsequent investigations

Outbreak I. During July 1990, five of nine adults eating meat loaf made from commercially prepared frozen ground beef from producer A complained of flushing and a sense of warmth within 1/2 h of the meal. Symptoms lasted for about 1 h. A neighbor physician diagnosed nonspecific allergic-like reactions. No treatment was given. A sample of the beef in the original package was submitted for examination. The package did not list additives to the ground meat. The sample was sent to our laboratory for analysis of histamine and niacin content. The histamine content was subsequently reported at 0.005 g/kg of beef, measured by the fluorometric method (I). For technical reasons the niacin content was not assayed. The meat was stored at -18°C for future analysis. A visit to the processor revealed that commercially prepared additives were used in the ground meat. According to the additive labels each contained some of the following: vitamins, nitrates, monosodium glutamate, hydrolyzed vegetable protein, vegetable oil, spices, salt, starch, sodium erythorbate, ascorbic acid, and anticaking agents. The additive manufacturer that did not label specific vitamins in his mixture was asked to change his labels, listing all ingredients that were added.

Outbreak II. On December 16, 1990, eight of nine people eating ground beef patties made from frozen ground beef from producer B complained of flushing and a feeling of warmth after finishing the meal, symptoms compatible with an acute allergic-like reaction. The packaging did not list any additives. Meat samples from the family were not sent for laboratory analysis. However, 2 d later three samples of ground beef taken from the factory were submitted for niacin analysis. Niacin content was reported to be 2.4, 4.8, and 6.0 g/kg of beef.

Outbreak III. On December 24, 1990, 50 of 103 factory workers eating ground meat patties for lunch in a company cafeteria were taken acutely ill with allergic-like reactions. All were taken to hospital and stayed for observation for up to 12 h. The ground meat was supplied frozen by producer B. No additives were listed on the package. Raw meat from the cafeteria was submitted for niacin analysis. Results revealed from 0.6-0.9 g of niacin per kg of ground meat in three different samples. Following the outbreak, ground meat products from this producer were recalled from the market and announcements on television, radio, and in newspapers urged people to return the products. A revisit to the food processor and a more thorough investigation led to the discovery that "homemade" meat "enhancer" was used that included niacin.

Outbreak IV. On the same day as outbreak III, 13 of 112 children aged 9-14 years and three of 88 adults eating processed veal steaks for lunch in the dining room of a kibbutz, a communal settlement, complained of symptoms compatible with niacin poisoning: facial flushing, blotching, and a feeling of warmth. Symptoms lasted between 1 and 4 h. No treatment was given. The dietician noted that only those that ate veal steaks had signs and symptoms of intoxication. Diners eating chicken or roast beef, the other choices for lunch, did not. The veal steaks were from processor A. Packages of the steak listed the addition of water, sugars, phosphates, and ascorbic acid to the meat. Investigation at the factory revealed that the meat was "enhanced" with a similar product used in preparing the ground meat responsible for outbreak I. The meat "enhancer" had niacin listed as one of the ingredients. Analysis yielded about 0.3 g of niacin per kg of the veal steaks. According to the meat processor, this was an "experimental" product of which one ton was manufactured and all was sent to the kibbutz.

Outbreak V. In January 1991, approximately 70 of about 100 adults in a sheltered home who ate meatballs, developed signs and symptoms compatible with niacin poisoning. All were given nonprescription antihistamines. Investigation revealed that the meatballs were prepared from frozen ground beef from producer B. This meat was among the products that had been recalled. The kitchen supervisor denied awareness of the recall notice. Analysis revealed 1.6 g of niacin per kg of the uncooked product. Following these later outbreaks, two packages of ground meat from outbreak I that had been stored frozen was analyzed. In these packages, 0.4 and 1.1 g of niacin per kg of ground beef was measured.

Table 1 summarizes the number of people in each outbreak and the various niacin concentrations found in the meat products.

Factory ingredient analysis

Premixed "enhancer" containing nicotinic acid manufactured by producer A was sent for niacin analysis. According to the manufacturer, 60 g of additive was to be used for 100 kg of ground beef. Analysis of the "enhancer" revealed a niacin content of 15%. Assuming that this percentage of niacin was true of all enhancer used, and mixing of the additive in the ground beef was homogenous.
**TABLE 1.** Outbreaks of nicotinic acid intoxication after ingestion of prepared meat products in Israel, 1990-1991.

<table>
<thead>
<tr>
<th>Outbreak</th>
<th>No. of symptoms</th>
<th>No. at risk</th>
<th>Attack rate (%)</th>
<th>Niacin g/kg raw beef in different samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>5</td>
<td>9</td>
<td>(56)</td>
<td>1.1</td>
</tr>
<tr>
<td>II</td>
<td>8</td>
<td>9</td>
<td>(89)</td>
<td>2.4*</td>
</tr>
<tr>
<td>III</td>
<td>50</td>
<td>103</td>
<td>(49)</td>
<td>0.6</td>
</tr>
<tr>
<td>IV</td>
<td>16</td>
<td>200</td>
<td>(8)</td>
<td>0.3</td>
</tr>
<tr>
<td>V</td>
<td>70**</td>
<td>100**</td>
<td>(70)**</td>
<td>1.5</td>
</tr>
</tbody>
</table>

* Taken from meat processor supplying product.
** Estimated. The residents of this home are mentally retarded which made an accurate history difficult.

Nicotinic acid combines with iron complexes in meat and gives the product a bright red color. This color is stabilized when combined with ascorbic acid and certain sugars (6). Thus, for manufacturers of meat products, its use is desirable because it can disguise deterioration (6) and can be substituted for added coloring agents.

Niacin is one of the vitamins of the B complex. Recommended daily intake ranges from 6-19 mg (2). Acute intoxication is due to niacin causing peripheral vasodilation and the subsequent, usually self limiting, signs and symptoms of that may include flushing, pruritus, a sense of warmth, and possibly gastrointestinal upset (11). Since the addition of niacin may deceive consumers about meat quality and because of its potential in causing side effects, nicotinic acid is an illegal meat additive in Israel.

Worldwide, niacin may be added to various enriched grain products to prevent deficiency syndromes. Outbreaks of intoxication have been reported from time to time in the

English language literature. Intoxications due to excessive niacin in pumpernickel bagels (0.16 g per bagel; 4) and in corn meal (2.9-3.9 g/kg of cornmeal; 3) have been described.

Meatborne outbreaks of niacin poisoning were noted in the late 1950s and early 1960s in the United States. A report of one of these outbreaks and a review of some of the others was published in 1962 (8). In these incidents niacin was found in the amounts of 0.5-3.7 g/kg of ground beef and 0.6 g/kg of chop suey. All were associated with either the addition of niacin in the kitchen or by the local butchers. The outbreaks that we report appear to be unique in that they were due to commercially prepared frozen meat products by more than one manufacturer.

The clustering of outbreaks may be due to the recent addition of niacin by these two large manufacturers; we have no previous reports of allergic-type reactions following eating of meat produced by these companies. Another possible explanation is that niacin may have been used by these producers in the past, but this was the first time that the chemical was added to shipments for large institutions where an outbreak possibly would be more likely to be reported than a small household outbreak. A third explanation may be the coincidental association with public health personnel in at least two of the outbreaks. In outbreak I, the family affected was a friend of one of us (EB) to whom the incident was mentioned when it occurred. In outbreak IV, one of us (EG) was investigating a rabies outbreak at the kibbutz and the incident was brought to his attention.

In the outbreaks that we report, niacin concentration ranged from 0.3 to 6.0 g/kg of raw meat product. Naturally occurring niacin concentrations in skeletal muscle meat may be up to 0.07 g/kg (7). Although populations at risk are small, higher attack rates appear to be associated with higher niacin concentrations. In outbreak IV, children appear to have had a higher attack rate than adults perhaps due to increased sensitivity by children to the substance. Niacin is heat stable, thus cooking will not inactivate its toxic properties (2). The amount ingested depends on the quantity of meat eaten and possibly how the meat is cooked and served. Meats served with their juices may contain more niacin than meats grilled with subsequent juice loss.

Prevention of further outbreaks depends on enforcement of existing laws, the education of meat product manufacturers about the serious side effects of different additives and the legal consequences of unauthorized additive use. In addition, thorough investigation by public health authorities of foodborne outbreaks and examination of all products added to meats will help assure safe, wholesome foods.

REFERENCES

niacin in enriched cornmeal, Public Health Rep. 97:258-260