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Ira C. Nation
Manager, Safety and Health
Office of Compliance and Ethics
Archer Daniels Midland Company
1001 North Brush College Road
Decatur, Illinois 62521

Dear Mr. Nation:

This letter summarizes our observations and recommendations regarding butter flavoring use at the ADM packaged oil plants in Decatur and Granite City, Illinois. A team (physician, medical epidemiologist, and two industrial hygienists) from the National Institute for Occupational Safety and Health (NIOSH), Division of Respiratory Disease Studies visited these facilities on November 9 and 10, 2004, in response to a request for a health hazard evaluation submitted by PACE International Union. The union wanted to know if any of its members were at risk for lung disease from exposure to butter flavorings or diacetyl. At each plant, we had an opening meeting with you, John Embleton (ADM industrial hygienist), and the plant manager. During these meetings we obtained information on the plant production process and manner in which butter flavorings are used, and discussed NIOSH's findings regarding inhalation exposure to butter flavorings and occupational lung disease in the microwave popcorn industry. We reviewed the results of diacetyl air sampling performed by Mr. Embleton at each plant. We then conducted walkthrough surveys at each facility and observed ADM workers using butter flavorings in the course of their usual work duties. We used a photoionization detector (PID) to measure real-time air concentrations of total volatile organic compounds (VOCs) emitted when a worker poured liquid butter flavorings into a container in the plant laboratory, and later when a worker poured the flavoring into a large tank filled with vegetable oil.

Background

In August 2000, NIOSH learned that eight former workers of a microwave popcorn production plant in Missouri had moderate to severe fixed obstructive lung disease consistent with the rare illness, bronchiolitis obliterans. A NIOSH investigation at the Missouri plant revealed an excess of current workers with obstruction on spirometry testing. Increasing cumulative exposure to diacetyl, the predominant butter flavoring chemical present in the air of the plant, was associated with an increased prevalence of abnormal lung function. In animal exposure experiments conducted by NIOSH, rats exposed to vapors from a butter flavoring used at this plant developed severe injury to the lining of their airways.

In bronchiolitis obliterans, inflammation and scarring occurs in the small airways of the lung and can lead to severe, permanent shortness of breath. The main respiratory symptoms are cough and shortness of breath on exertion that typically do not improve much when the worker goes home at the end of the workday or on weekends or vacations. Usually symptoms are gradual in onset and progressive, but severe symptoms can occur suddenly. Most cases do not respond to medical treatment. Lung function testing with spirometry generally reveals fixed airways obstruction, and some workers develop obstruction before they become symptomatic. Because medical treatment does not reverse the condition, some workers with severe disease have been placed on lung transplant waiting lists.

In addition to lung disease, workers exposed to butter flavoring vapors may develop problems with their eyes and skin. Eye irritation is common, and occasionally workers report chemical burns of the eyes requiring medical treatment. Similarly, exposed workers may report skin irritation, and one worker at another plant developed a disabling skin allergy to butter flavorings.

Flavorings are often complex mixtures of ingredients, many of which can be irritating to the skin, eyes, and respiratory system. The effects of these ingredients may be additive, such that exposures to concentrations of compounds that would not cause harm as a sole exposure may be harmful if combined with exposures to other compounds. Animal experiments at NIOSH indicate that diacetyl is one of the chemicals in butter flavoring that can lead to airway injury. The other chemical components that may contribute to toxicity, and the levels of exposure that are considered safe, are still not known. Flavoring chemicals are generally evaluated for safety to consume in small amounts in food, not for their safety for inhalation by workers in the workplace. Recommended air exposure limits have not been established for most chemicals used in flavorings. Also unknown is the relative safety of powdered flavorings compared to liquids or pastes. Powders that are formulated (i.e., encapsulated) to have lower emissions of volatile flavoring chemicals may pose lower risk. However, inhalation of powder of respirable size (i.e. particles small enough that they can be inhaled into the lung) during the handling of these flavorings may increase worker risk for lung problems. Since encapsulated flavorings release their flavoring chemicals upon contact with water, they may pose risk if this occurs on the moist lining of a person's airways.

In four of six microwave popcorn plants evaluated by NIOSH, workers who mixed butter flavorings into heated soybean oil developed lung disease. One of the four was the plant in Missouri. At this plant, the eight-hour time-weighted average air concentration of diacetyl in the oil and flavoring mixing room was 38 parts per million (ppm). In the other three plants this concentration ranged from 0.2 to 1.2 ppm. The finding of workers with lung disease in the setting of much lower air concentrations suggests that workers may be at risk from brief, intense exposures during open handling of flavorings and looking into tanks of heated oil and flavorings, even when ventilation maintains low average air concentrations of flavoring chemicals.

Butter Flavoring Use at ADM Packaged Oil Plants

At the Decatur plant, powder and liquid butter flavorings are used. Liquid flavorings are stored in a refrigerator unit and are kept tightly sealed when not in use. We observed a worker in the laboratory weigh liquid flavoring by pouring approximately 22 pounds of flavoring from a five-

gallon bucket into a metal container which was then covered with a lid. This task was performed under an exhaust hood. However, since the scale was on the floor, the worker had to stand under the hood to pour the flavoring, such that flavoring vapors were drawn through the worker's breathing zone before being exhausted out of the work area. A different worker then carried the metal container to a large oil-containing tank located in the blending tank area, and poured the flavoring into the tank through a small opening at the top. The opening in this tank and others is kept tightly sealed except when flavorings or other ingredients are to be added. Neither worker used respiratory protection. Management and workers reported that liquid flavorings were added to tanks approximately one or two times per week. NIOSH measurements with a PID during the weighing of flavoring in the laboratory showed that the air concentration of VOCs near the workers breathing zone briefly increased to approximately 40 parts per million parts air (ppm), from a background meter reading of 3 to 4 ppm. The level of VOCs during the pouring of the flavoring into a tank increased to 1.5 ppm, from a background meter reading of 0 ppm. (Note: The PID provides an indirect estimate of the concentration of total VOCs, including diacetyl, in the air at a given point in time. The concentration in ppm on the PID's digital display is not an actual concentration; the actual air concentration can be determined with volumetric air sampling using the NIOSH approved method for VOCs.)

We did not observe the use of the powdered butter flavoring during our visit. We were told by management that, once per day, a worker poured a box of flavoring into a tank through a funnel-type opening (otherwise kept sealed). We were told by management that the funnel design, and manner in which the box was handled relative to the funnel, minimized airborne dust when the powder was poured.

At the Granite City plant, workers add liquid butter flavorings to tanks approximately one or two times per work shift. Flavorings are kept sealed when not in use. We observed a worker in the laboratory weigh approximately three to four pounds of liquid flavoring by dispensing the liquid from a sealed container into a small open plastic container, which was then poured into an open metal container located on a scale. There was no local exhaust ventilation for this process. Testing with smoke tubes over the table where the flavorings were handled showed that there was essentially no ventilation to this area. The worker in the laboratory used a half-mask, negative pressure respirator with organic vapor cartridges, gloves, and eye protection while measuring the flavoring. A second worker (using a similar respirator, gloves, and eye protection) carried the metal container (covered with a loose-fitting metal lid) to a tank in the production area and poured the flavoring into an opening at the top of the tank. The opening to this tank was tightly sealed before and after the flavoring was added. VOC levels measured with a PID were 0.4 ppm in the laboratory before flavorings were weighed and increased to 114 ppm during weighing. VOC levels at the oil tank increased to 10 ppm when the worker poured the flavoring, from a background meter reading of 0 ppm. As part of the production process, workers evaluate nearly finished product in a small tank that is not tightly sealed. We did not detect an elevation of VOC levels at the opening of this tank.

The manager at the Granite City plant reported that that he implemented respirator use for workers handling flavorings earlier this year, after reading a newspaper article about lung disease in microwave popcorn workers exposed to butter flavorings. He reported that, two weeks prior to NIOSH's visit, the organic vapor cartridges on the respirators for workers pouring flavorings

into tanks were replaced with oil-resistant particulate filters, after discussions with the respirator equipment supplier regarding the proper device to use. We explained to the manager that particulate filters should be used with an adapter so that both filters *and* organic vapor cartridges can be used on the respirator for the worker adding flavoring to tanks.

Discussion

Compared to microwave popcorn plants evaluated by NIOSH, the two ADM packaged oil plants that we visited differ with regard to factors that would affect worker exposure to airborne butter flavoring chemicals. The main difference is that tanks that contain oil and flavorings are tightly sealed at ADM (with the exception of one small tank at the Granite City plant), whereas tanks in the microwave popcorn plants were not sealed. Also, the proportion of flavorings relative to the amount of oil in the tanks is much lower in the ADM plants. However, the quantities of liquid flavorings that some ADM workers measure and pour using open containers are only slightly less than the quantities that workers handle in microwave popcorn plants, and the quantities of powdered flavorings used are greater. In most large popcorn plants, mixers of butter flavoring and oil measure and pour flavorings into tanks several times per work shift, while mixers in smaller plants may only do this once or twice a shift. The frequencies of potential peak exposures to butter flavorings at these two ADM plants are similar to those of smaller microwave popcorn plants. At one of three small microwave popcorn plants evaluated by NIOSH, a mixer of oil and flavorings had evidence of lung disease consistent with bronchiolitis obliterans.

While the air concentrations of diacetyl measured by ADM during flavoring use were low (all less than 0.07 ppm), these are time weighted averages and do not indicate the peak concentration that the worker may have experienced. As mentioned previously, these peak exposures may pose risk to workers. Our measurements with a PID indicate that brief, peak exposures can occur during weighing and pouring of liquid flavorings at both ADM plants.

Overall, ADM workers at the two plants we visited appear to have less opportunity for exposure to butter flavoring chemicals than workers in microwave popcorn plants. However, we can not rule out possible risk from brief, intense exposures during open handling of flavorings. In the absence of information about safe levels of either average or peak exposures, it would be prudent to prevent such exposures to ADM workers.

Recommendations

1. Implement mandatory respirator use by all workers handling open containers of butter flavorings at your Decatur plant, and continue this practice at your Granite City plant. Use NIOSH-certified, half-mask negative pressure respirators with organic vapor (OV) cartridges for workers in the laboratory, and use the same type of respirator with OV cartridges *and* oil-proof particulate filters for workers adding liquid and powder flavorings to oil tanks.
2. Continue weighing butter flavoring under the exhaust hood in the laboratory at the Decatur plant. However, the worker should not stand under the hood during this task.

The solution to this problem may include raising the height of the scale, utilizing a device to pump the flavoring from the five-gallon container into the container on the scale, or redesign of the existing hood so that air contaminants are drawn away from the worker's breathing zone. If the exhaust hood is redesigned, its effectiveness should be verified by testing with smoke tubes.

3. At the Granite City plant, install an exhaust hood over the table in the laboratory where flavorings are weighed, and perform all pouring/weighing (and storing of resealed containers of flavorings) under the hood. Provide general dilution ventilation to this room and assure that it does not interfere with the proper function of the exhaust hood (i.e. vapors from flavorings should be exhausted by the hood, not moved into the room by the dilution ventilation). Obtain information about the design of appropriate ventilation systems from a qualified ventilation engineer, or from Industrial Ventilation—A Manual of Recommended Practice [ACGIH 2001]. Both entrances to this room should have doors, and the doors should be closed when flavorings are being handled. With the doors closed, verify the proper functioning of the exhaust hood by testing with smoke tubes.
4. Provide and require mandatory use of gloves and safety glasses or goggles for workers handling open containers of flavorings.
5. Obtain baseline lung function testing with spirometry for all workers that handle open containers of butter flavorings and repeat the test at least once a year. In order to increase the likelihood of high quality testing, the provider that you select should indicate adherence to the American Thoracic Society guidelines for performing spirometry (enclosed). High quality testing is important in order to compare results over time. Refer any new worker with an abnormal baseline test to their physician for further evaluation and do not allow the worker to weigh or pour butter flavorings. Workers that currently weigh or pour butter flavorings and that have a baseline or follow-up test that indicates obstruction, or a follow-up test indicating a decline in the forced expiratory volume in the first second of exhalation (FEV1) of 15 percent or more compared to baseline, should be referred to a pulmonary or occupational medicine physician for additional evaluation. Provide the physician with a copy of the NIOSH *Alert*, Preventing Lung Disease in Workers Who Use or Make Flavorings (on the internet at <http://www.cdc.gov/niosh/docs/2004-110/>). Prevent any further exposure of the worker to butter flavoring if the physician diagnoses flavoring-related lung disease or other lung disease that may be exacerbated by exposure to flavoring chemicals. Any suspicion of flavoring-related lung disease in a current worker should prompt an evaluation of the workplace to identify any contributing factors. These may include ventilation or other equipment malfunction, or a lack of worker compliance with, or understanding of, company policies regarding respiratory protection or work practices to prevent exposure to flavoring-related chemicals.
6. Assure that all workers that handle butter flavorings, their supervisors, and all managers are familiar with the contents of the NIOSH *Alert* indicated above.

These recommendations should also be implemented at other ADM plants where workers handle open containers of butter flavorings.

This letter will serve to close out this health hazard evaluation. In accordance with the Code of Federal Regulations, Title 42, Part 85, please post copies of this letter in prominent places accessible to all workers who handle butter flavorings for a period of 30 calendar days. Please feel free to contact me at 304-285-5932 if you have any questions.

Sincerely,



Richard Kanwal, MD, MPH



Greg Kullman, PhD CIH
Respiratory Disease Hazard Evaluation
and Technical Assistance Program
Field Studies Branch
Division of Respiratory Disease Studies

Enclosure

American Thoracic Society Spirometry Guidelines

cc:

OSHA, Region 5
Illinois Health Department
Kevin Swanson
Harry Johnson
John Embleton
PACE International Union
HETAB (HETA 2004-0391)
Close-out file