Evaluation of respiratory concerns at a cream cheese manufacturing facility

Rachel L. Bailey, DO, MPH
Chris A. Piacitelli, MS, CIH

Report No. 2011-0102-3194
September 2013

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

Contents

The employer is required to post a copy of this report for 30 days at or near the workplace(s) of affected employees. The employer must take steps to ensure that the posted report is not altered, defaced, or covered by other material.

The cover photo is a close-up image of sorbent tubes, which are used by the HHE Program to measure airborne exposures. This photo is an artistic representation that may not be related to this Health Hazard Evaluation.

Highlights of this Evaluation

The Health Hazard Evaluation Program received a confidential request from employees to investigate respiratory concerns at a cream cheese manufacturing facility in New York.

What NIOSH Did

- We visited the cream cheese manufacturing facility in July and September 2011.
- We toured the plant and talked with employees and managers.
- We conducted in-person, private interviews with 13 employees.
- We collected flavorings, strawberry puree, and cardboard debris samples.
- We performed personal and area air sampling alongside the production and packaging of various cream cheese products and area air sampling during clean-in-place and clean-out-of-place procedures.
- We provided recommendations to decrease exposures to flavorings and cardboard dust.

We evaluated the workplace for exposure to flavoring chemicals, cleaning products, and dust. While some controls were already in place to reduce exposures, we noted potential opportunities for exposure during our site visits. We recommended addressing the exposures through enhanced engineering controls and modified work practices.

What NIOSH Found

- We observed airborne dust when cooks scooped and weighed powder ingredients for cream cheese batches.
- We observed no local exhaust ventilation at the cook stations.
- We noted that air from the ventilation supply vent above the whipped cook station created airborne dust while the cook scooped and weighed powdered ingredients.
- We identified diacetyl, 2,3-pentanedione, and acetoin in liquid dairy flavoring.
- We identified diacetyl and 2,3-pentanedione in liquid strawberry flavoring and a liquid smoke flavoring.
- We identified small amounts of diacetyl in a powder cheesecake flavoring, a powder cheese flavoring, a liquid blueberry flavoring, a liquid kosher strawberry flavoring, and strawberry puree.
- We identified diacetyl in air samples at levels above the National Institute for Occupational Safety and Health's proposed recommended exposure limit in several areas (free ingredients room, free cook room, cook room, 703 fill room) and jobs (703 fill operator, free cook, condiment cook, soft cook).
- We identified 2,3-pentanedione and 2,3-hexanedione in air samples in the free ingredients room during clean-in-place and clean-out-of-place operations.

What the Employer Can Do

- Handle ingredients that contain these flavoring chemicals as respiratory hazards.
- Install local exhaust ventilation at cooking kettles that use ingredients containing diacetyl, 2,3-pentanedione, 2,3-hexanedione, or other alpha-diketones (e.g., liquid dairy, strawberry, smoke, and blueberry flavorings; powder cheese and cheesecake flavorings; and strawberry puree).
- Conduct additional air sampling after the addition of local exhaust ventilation.
- Install a new hood in the free ingredients room that pulls air to the rear of instead of overhead the barrels from which ingredients are being scooped and/or a semicircular hood that pulls air at the rear half of the barrel rim, and provide long-handled scoops.
- Conduct additional air sampling during cleaning operations (clean-in-place and clean-out-of-place) using Occupational Safety and Health Administration's Sampling Methods 1012 for diacetyl and 1016 for 2,3-pentanedione.
- Include local exhaust ventilation system (e.g., clean-out-of-place stations and measuring hood in free ingredients room) checks in the preventative maintenance schedule to ensure they continue to operate appropriately.
- Ensure workers use proper techniques when using ventilation hoods.
- Substitute vacuum cleaning with high-efficiency particulate air filters for cleaning with compressed air and brooms, wherever feasible. Those present during the use of compressed air should wear N-95 respirators.
- Encourage employees to report new or ongoing respiratory symptoms to their personal healthcare provider and, as instructed by their employer, to a designated individual at their workplace.

What Employees Can Do

- See a healthcare provider if you develop or have developed persistent or worsening respiratory or other health symptoms.
- Use local exhaust ventilation systems as instructed by your employer.
- Follow your employer's rules about mandatory use of respiratory protection and other personal protective equipment and clothing.
- Report new or ongoing respiratory symptoms to your personal healthcare provider and a designated individual at your workplace, as instructed by your employer.

This page left intentionally blank

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
CIP	Clean-in-place
COP	Clean-out-of-place
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
cfu/g	Colony forming units per gram
GC-MS	Gas chromatography and mass spectrometry
LEV	Local exhaust ventilation
mg/m^3	Milligrams per cubic meter
NAICS	North American Industry Classification System
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible exposure limit
ppb	Parts per billion
REL	Recommended exposure limit
STEL	Short-term exposure limit
TLV	Threshold limit value
TWA	Time-weighted average
VOC	Volatile organic compounds

The recommendations in this report are made on the basis of the findings at the workplace evaluated and may not be applicable to other workplaces.

Mention of any company or product in this HHE does not constitute endorsement by the National Institute for Occupational Safety and Health (NIOSH).

Citations to Web sites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these Web sites. All Web addresses referenced in this document were accessible as of the publication date.

Summary

In April 2011, the National Institute for Occupational Safety and Health received a confidential employees' request for a health hazard evaluation at a cream cheese manufacturing plant. The employees submitted the request because of respiratory concerns related to exposures during the manufacturing and packaging processes. We visited the plant on two occasions. On our initial site visit, we toured the plant, talked with employees, and collected bulk samples of flavorings and cardboard debris.

We analyzed the headspace air over each bulk sample we collected during our initial visit and identified the ketone chemical compounds diacetyl, 2,3-pentanedione, and acetoin in the headspace of a liquid dairy flavoring. We identified diacetyl and 2,3-pentanedione in the headspace of a liquid strawberry flavoring and liquid smoke flavoring. We found small amounts of diacetyl in the headspace of a powder cheesecake flavoring, a powder cheese flavoring, a liquid blueberry flavoring, and a liquid kosher strawberry flavoring. We also found a small amount of diacetyl in the headspace of a strawberry puree.

On our follow-up industrial hygiene survey visit, we performed area and personal air sampling alongside the production and packaging of various cream cheese products. We identified diacetyl in air samples at levels above the NIOSH proposed recommended exposure limit in several areas (free ingredients room, free cook room, cook room, 703 fill room) and jobs (703 fill operator, free cook, condiment cook, soft cook). We identified 2,3-pentanedione and 2,3-hexanedione in air samples in the free ingredients room during clean-in-place and clean-out-of-place operations.

We have provided recommendations to decrease exposures to flavoring chemicals, cardboard dust, and cleaning chemicals. We recommended additional sampling for diacetyl and 2,3-pentanedione during cleaning operations and after the additional of local exhaust systems. We also recommended that employees see a healthcare provider if they develop or have developed persistent or worsening respiratory or other symptoms.

Introduction

The Health Hazard Evaluation Program of the National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees at a cream cheese manufacturing facility in New York. The requestors had concerns about health issues related to the manufacturing and packaging process. Their health concerns included breathing problems, coughing, bloody noses, and laryngitis. They also had concerns about dusty conditions, lack of ventilation, and cleaning procedures. We visited the plant on two occasions and provided an interim report with recommendations.

Process Description

During our visits in July 2011 and September 2011, the plant employed approximately 318 persons and produced cream cheese. We briefly describe the process at the time of our visits.

Initial Steps

Large refrigerated trucks delivered milk and cream into silos. The milk and cream were pasteurized and homogenized, and skim milk and cream enriched with milk fat were produced. A starter culture was added to the cream/milk fat mixture which was then sent to tanks to ferment. The cream cheese mix was then put through separators to collect curd and remove the whey. The remaining cheese mixture was piped to cook rooms and the chill room. In the chill room, chill rolls pressed the cheese and piped it to the rigid cream cheese fill room. Fill rooms and cook rooms are described below.

Powder Rooms

In the powder rooms, workers prepared powder ingredients for delivery to processing areas. Ingredients included locust bean gum, guar gum, xanthum gum, sorbic acid, salt, milk powder, and whey protein concentrate. These rooms were maintained below 58% relative humidity.

Ingredients Cooler Room

Condiments (such as shredded salmon and strawberry puree) and powder and liquid flavorings including strawberry, blueberry, pineapple, honey nut, pumpkin, cheese, cheesecake, smoke, and others that required chilling were kept in the ingredients cooler room.

Free Ingredients Room

Barrels of powder ingredients for free (as workers refer to fat-free products) cream cheese were stored in the free ingredients room under a ventilation hood. Working under the hood, a worker scooped ingredients from barrels, weighed them, and placed them into plastic bags for future use by cooks. Also in this room, a free condiment cook prepared and cooked condiments (such as strawberry puree) for free cream cheese blends.

Free Cook Room

In the free cook room, free soft body cream cheese formulas were blended, condiments added, and product was brought to temperature specifications by the free cook. Several ingredients were weighed and added by hand.

Cook Room

Soft body and whipped cream cheese formulas were blended, condiments added, and product was brought to cooking temperature. Cooks ran the machinery and weighed and added several ingredients by hand. A condiment cook also located in the room prepared condiments (such as salmon) for cream cheese blends; he also weighed and manually added the ingredients. When the condiment cook worked with allergens, such as salmon, a plastic sheet was placed around the condiment cook station.

Fill Rooms

Fill operators ran filling machines that placed cream cheese products into containers. These rooms were maintained near 30% relative humidity.

Packaging Rooms (Large and Small Room)

Packaging machine operators ran packaging machines that placed containers coming by conveyor belts from the fill rooms into cardboard boxes. Filled cardboard boxes were then palletized.

Warehouse and Coolers

Forklift operators transferred materials from the warehouse to the production areas. They also transferred product to the finished goods cooler.

Quality Control Lab

Quality control technicians performed quality checks throughout the production process.

Other Areas

Other areas in the facility (such as the salvage room, maintenance shop, and boiler and compressor rooms) are not described.

Sanitation

Workers in the various production areas cleaned and sanitized equipment. Room floors, walls, and outer surfaces of equipment were sprayed with diluted cleaning chemicals onto the surfaces and then rinsed with water. Workers also used buckets and brushes to wash exteriors of equipment. The insides of cooking tanks were washed in a process called "clean-in-place" (CIP) that involved dilution of cleaning agents in hot water inside the cooking tank followed by water rinse. In the cook rooms, the cleaning solution and water rinse were emptied through a piped drain system or directly onto the cook room floor near floor drains. Some equipment parts were placed in large wash tanks for a similar type of cleaning that was called "clean-out-of-place" (COP). There were dedicated COP tanks to clean equipment that had been used to prepare condiments or make cream cheese blends that had potential allergens (such as salmon or honey nut). Material data safety sheets (MSDSs) indicated that many of the cleaning products contained inorganic acids (nitric, phosphoric, and sulfuric), sodium hydroxide, chlorine compounds, and/or quaternary ammonium compounds. Cardboard debris and dust were cleaned with compressed air (blowdown), vacuums, and brooms in the fill and packaging rooms.

Personal Protective Equipment

Employees wore company-provided uniforms, hair coverings, beard covers (if applicable), hearing protection, safety glasses, and steel toe shoes in all production areas. Workers also wore goggles, a face shield, apron, and rubber gloves when dispensing undiluted chemicals, foam cleaning, or transporting cleaning products in an open container. When dispensing ready-to-use chemicals, bucket and brush cleaning, or transporting closed cleaning containers, workers wore goggles.

Company's Respiratory Protection Plan (Dated 2011)

The Respiratory Protection Plan indicated required use of organic vapor cartridge respirators for hydrogen peroxide by sanitation workers and self-contained breathing apparatus (SCBA) for ammonia by hazardous materials responders. The company provided voluntary-use respirators for paints and nuisance mists, dusts, and food ingredients. Without specifying the type of respirator, another section of the Respiratory Protection Plan listed the following as "respirator-required" activities: utility and refrigeration department maintenance of ammonia lines, pesticide spraying, and painting with inadequate ventilation or as called for by the manufacturer.

Methods

We made our initial site visit to the plant on July 6-7, 2011. We toured the plant, talked with employees, and collected bulk flavoring samples and cardboard debris samples. On our follow-up industrial hygiene survey visit on September 26-28, 2011, we performed air testing during cleaning procedures and alongside the production and packaging of various cream cheese products, including free plain soft cream cheese, free strawberry soft cream cheese, strawberry soft cream cheese, and salmon soft cream cheese. We chose to sample alongside these operations because the products used one or more of the powder cheese flavoring, liquid strawberry flavoring, or smoke flavoring, all of which were found during headspace analyses to contain ketone compounds. Other cream cheese products were being produced simultaneously with our air sampling with different ingredients from those in which we had measured ketone compounds. We also collected additional bulk flavoring and condiment samples.

Bulk process ingredient samples for headspace analyses

We used 50-milliter sterile polypropylene centrifuge tube containers to collect approximately 40-milliliter bulk samples of twelve flavorings in July 2011 and one flavoring (inadvertently duplicated a July sample) and one condiment in September 2011. In the laboratory, we used thermal desorption, gas chromatography, and mass spectrometry to analyze the headspace over the samples for volatile organic compounds (VOCs). This involved collecting a sample of the headspace at room temperature using a stainless steel thermal desorption tube and then desorbing it at 300° C for 10 minutes in a Unity/Ultra automatic thermal desorption system (Markes International, Inc., Cincinnati, Ohio) with an internal focusing trap packed with graphitized carbon sorbents. The thermal unit was interfaced directly to an HP6890A gas chromatograph (Agilent Technologies, Inc., Santa Clara, California) with an HP5973 mass selective detector using a 30-meter HP-1MS fused silica capillary column.

Sorbent tubes for ketones in production and packaging areas

During the September 2011 survey visit, we collected personal and general area air samples in sets of two silica gel sorbent tubes in series. These were analyzed for diacetyl and acetoin by gas chromatography with electron capture detection (GC-ECD) in accordance with OSHA Sampling Method 1012 [OSHA 2008]. When production was using flavorings that contained 2,3-pentanedione, we placed an identical set of tubes alongside those tubes and analyzed them for 2,3-pentanedione using OSHA Sampling Method 1016 [OSHA 2010], which utilizes gas chromatography with flame ionization detection (GC-FID). We collected parallel samples at a small subset of the area locations using o-phenylenediamine-treated silica gel sorbent tubes, which were analyzed for 2,3-pentanedione with NIOSH Draft Sampling Procedure SMP2 using gas chromatography with nitrogen phosphorus detection.

Canisters and sorbent tubes for alongside cleaning

During the September visit, we used evacuated canisters near cleaning activities to collect area air samples for VOCs, including diacetyl, 2,3-pentanedione, and 2,3-hexanedione. The 450-milliliter canisters were equipped with either instantaneous grab sampling attachments or restricted flow controllers which allow for calculation of a time-weighted average (TWA) concentration. The air samples were analyzed for VOCs using a pre-concentrator-gas chromatograph-mass spectrometer (GC-MS) system pursuant to a recently published method validation study [LeBouf et al. 2012] with the following modifications: the pre-concentrator was a Model 7150 (Entech Instruments, Inc.); three additional analyte compounds, 2,3-butanedione (diacetyl), 2,3-pentanedione, and 2,3-hexanedione, were included; and qualitatively identified compounds were compared to National Institute of Standards and Technology 2008 Mass Spectral Library and included in the analytical report if the quality factor was greater than 75%. At present, this canister method is partially validated and is in the process of being reviewed for incorporation into the NIOSH Manual of Analytical Methods. We used silica gel sorbent tubes to collect area air samples near cleaning activities to measure inorganic acids using ion chromatography according to NIOSH Sampling Method 7903 [NIOSH 1994].

Real-time Monitoring

To evaluate some process tasks during the September visit, we used direct-reading monitors to obtain real-time continuous relative levels of dust or total VOCs. For dust, we used a *personal*DataRAM pDR-1000AN monitor (Thermo Scientific Corporation, Franklin, MA), an instrument that is optimized for detection of particles in the size range of 0.1 to 10 micrometer, or approximately respirable. For total VOCs, we used a photoionization detector (ToxiRAE PGM-30, Rae Systems, Inc., San Jose, CA). The instruments were set to record data at 5-second averaging periods and were either strapped to the chest of the worker being evaluated or held close to the worker by a NIOSH investigator shadowing them as they worked. To record events that might be associated with any observed peaks in real-time readings, we utilized video cameras during those measurements.

Cardboard debris samples

During the July visit, we collected two cardboard debris samples – one under a conveyor on the mezzanine level in the large packaging room and the other on and around the conveyor for packaging line 9. The material consisted of a mix of cardboard remnants, ranging from small slivers from the cut edges of boxes to fine dust, and was identified as the material that compressed air was used to remove during cleaning. The samples were cultured for fungi on malt extract agar and for bacteria on tryptic soy agar.

Results

Summary of prior industrial hygiene evaluations

The company provided the following exposure assessment records (all assessments included less than five samples):

2004 – Air sampling results indicated no concentrations in the salt & gum room and powder room above the OSHA permissible exposure limits (PEL) of 5 milligrams per cubic meter of air (mg/m^3) for respirable dust or 15 mg/m^3 for total dust [29 CFR 1910.1000].

2006 – Consultant determined that welding operations and cleaning operations with strong caustics and alkalis were exempt from the OSHA hexavalent chromium standard because air sampling results revealed concentrations less than 0.5 mg/m^3.

2008 - Air sampling results showed that the TWA of two samples collected on an employee (one while he was working in the packaging room and the other while in the free ingredients room) did not exceed the 8-hour OSHA PEL for titanium dioxide (PEL=15 mg/m^3) or total dust (PEL=15 mg/m^3), but that the total dust concentration during the time in the free ingredients room was 21 mg/m^3 .

March 2010 - Personal air sampling results indicated no respirable or total dust overexposures during manipulation of raw cardboard into packaging boxes at a packaging line.

September 2010 - Personal air sampling results showed no exposures over OSHA PELs or American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLV) to 11 amine, 6 aldehyde, or 10 organic acid compounds during typical heat shrink wrap operations at a packaging line.

Company OSHA injury logs

Company OSHA injury logs for 2009-2011 showed two reports of respiratory illness: March 2009 asthma attack (attributed to milk powder) and February 2010 breathing difficulties (attributed to cardboard dust and plastic fumes).

NIOSH site visits

Workplace Observations and Employees' Reports

We found the facility clean and organized. We observed employees in the production area wearing facility uniforms, hair covers, beard nets (if applicable) and personal protective equipment including hearing protection, eye protection, and steel-toe shoes with non-skid soles.

In many rooms, including the free cook room and cook room, we observed alcohol hand cleaner and foot wash stations. There was extensive use of cleaning products in many areas of the plant for cleaning room floors, walls, and outer surfaces of equipment by spraying the diluted cleaning chemical onto the surfaces and rinsing with water. We observed several CIP and COP operations in progress. During one CIP, the hot cleaning solution was released onto the floor and flowed rapidly to the floor drain where it formed a large slowly draining puddle (Figure 1).

Health Concerns

During informal interviews of 13 employees during the July visit, some workers reported they or others complained of upper respiratory symptoms (such as dry throat and sneezing) or lower respiratory symptoms when working with powder ingredients. Others reported symptoms included rash on arms while working in the condiment area, laryngitis while working on the packing line around the ink, or asthma symptoms (wheezing and shortness of breath) when working with cleaning products or around cardboard dust in the packaging area. We were told during our walk-through of complaints that cardboard dust was generated from handling of boxes in the packaging area and when it was cleaned from equipment with compressed air (blowdown).

Headspace analyses

We identified diacetyl, 2,3-pentanedione, and acetoin in the headspace of a liquid dairy flavoring. We identified diacetyl and 2,3-pentanedione in the headspace of a liquid strawberry flavoring and a liquid smoke flavoring. We found small amounts of diacetyl in the headspace of a powder cheesecake flavoring, a powder cheese flavoring, a liquid blueberry flavoring, a liquid kosher strawberry flavoring, and a strawberry puree.

Sorbent tubes for ketones in production and packaging areas

Table 1 shows area (n=15 near full-shift) and personal (n=14 near full-shift and n=6 short-term) air sampling results for flavoring compounds in production areas using sorbent tubes, by type, date, shift, job title, work area, product, and sampling time. **Diacetyl** was measured above sampling analysis detection limits for all samples inside the building. Inside area concentrations ranged from 0.3 parts diacetyl per billion parts air (ppb) to 13.8 ppb. The four highest concentrations were greater than 11 ppb; three of these were collected near the cook room soft-body condiments area, and the other was collected in the 703 fill room. Near full-shift personal samples ranged from 0.4 ppb to 8.3 ppb, while short-term samples collected during the task of adding ingredients to cook kettles and another from a product fill room ranged from 4.4 ppb to 15.1 ppb. For comparison purposes, the NIOSH draft recommended exposure limit (REL) for diacetyl is 5 ppb for an 8-hour TWA, with a recommended short-term exposure limit (STEL) of 25 ppb for 15 minutes [NIOSH 2011]. The ACGIH has adopted a TLV for diacetyl of 10 ppb as an 8-hour TWA and 20 ppb as a 15-minute STEL [ACGIH 2012]. **Acetoin** concentrations ranged from 1.2 ppb to 39.4 ppb for near full-shift samples and up to 85.1 ppb for 15-minute samples. Occupational exposure limits have not been established for acetoin. **2,3-pentanedione** concentrations were less than the limit of detection for all samples, including two of the three analyzed using the more sensitive SMP2 method. The only detectable concentration was 0.9 ppb while processing salmon cream cheese at the cook room soft condiments area. For comparison, the NIOSH draft REL for 2,3-pentanedione is 9.3 ppb, with a STEL of 31 ppb for 15 minutes. The liquid smoke flavoring was added along with shredded salmon to batches of salmon cream cheese. We did not collect a sample of the shredded salmon for headspace analysis, but we noted that natural smoke flavor was listed as an ingredient on its container label.

Among each day's samples clustered by cream cheese product, the area samples in the cook rooms were the highest or next-to-highest for diacetyl, with four of five above the NIOSH draft REL (Table 1). The near-full-shift personal samples for cooks showed a similar pattern, with four of five above the draft REL. None of the short-term samples were above the draft STEL for diacetyl. Packaging room area samples and personal samples for packagers were the lowest in each grouping for diacetyl; all were below the draft REL.

Real-time monitoring

Real-time total VOC measurements collected by a NIOSH investigator shadowing a cook at the condiment cooking station are shown in Figure 2. The figure provides a graph of the continuous measurements of concentration by the real-time instrument. Also included are time frame bars of the events that occurred during measurement. These were produced by examination of the video camera recording that was obtained simultaneously. The worker was loading shredded salmon from 5-gallon pails into the cooking tank inside an area enclosed with a plastic sheet curtain that was used when allergenic ingredients were used. Entering and exiting the enclosure coincided with increases and decreases, respectively, in concentration. Tasks within the enclosure that coincided with increased concentrations included opening pails of salmon, adding the salmon to the cooking tank, and adding liquid smoke into the tank. Outside the enclosure, the concentration rose when the worker poured liquid smoke at the scale in preparation for the next addition of the ingredient to the tank. Note: These measurements indicate the amount of total VOCs in the air, and they do not provide the concentrations of any ketone compounds that may be included.

Figure 3 provides dust measurements collected by a real-time monitor worn on the cook at the whip cooking station. Several sharp increases and decreases in concentration coincided with weighing powder ingredients, which involved scooping them from totes, pails, and bags into smaller pails on a scale. Visible clouds of dust were seen during several of these peak measurements. Another task that produced visible dust (see Figure 4) and peak concentrations (no graph shown) in the breathing zone of a worker was the compacting by hand during disposal of empty bags of milk powder into waste cans.

Canisters for VOCs alongside cleaning

The evacuated canister area samplers that were placed alongside cleaning operations (Table 2) measured diacetyl, but the presence of an interfering compound (2-methylpentane) made these results unreliable by introducing the possibility of overestimation. Of the six samples, only the free ingredients room sample had measurable results: 2,3-pentanedione at 6.2 ppb and 2,3-hexanedione at 9.0 ppb. This sample was obtained during CIP and COP procedures of equipment containing remnants of free strawberry cream cheese ingredients from a previous shift; no cream cheese was being made in the free cook room at the time of sampling; strawberry cream cheese was being made in the cook room. Based on the detection limits, all of the other in-plant canister samples were below 2.9 ppb for 2,3-pentanedione and 3.6 ppb for 2,3-hexanedione. All of the canisters, including the sample taken outside the facility, measured ethyl alcohol, isopropyl alcohol, and acetone, and all in-plant samples detected hexane and trichloromethane; every level was very low, as none of these compounds were at a concentration greater than 1/50 of its NIOSH REL [NIOSH 2005].

Sorbent tubes for inorganic acids alongside cleaning

Table 3 shows the results of area sorbent tube air sampling near cleaning operations for inorganic acids. Nitric acid was the only inorganic acid detected, and most measurements were below detection limits. The two measurable longer-term concentrations, both about 0.01 mg/m^3, were well below the NIOSH 8-hour REL of 5 mg/m^3. The shorter-term 17-minute measurement of 0.04 mg/m^3 was also well below the NIOSH STEL of 10 mg/m^3.

Cardboard debris samples

Table 4 shows microbial agents cultured from cardboard debris samples collected from underneath a packaging conveyor system on the mezzanine level and around the conveyor system on the ground level on packaging line 9 in the main packaging room. In the two samples, total fungi ranged from 3,300 colony forming units per gram (cfu/g) on the ground level to 13,000 cfu/g on the mezzanine level. Total bacteria ranged from 700 cfu/g on the mezzanine level to 6,100 cfu/g on the ground level. Currently, there are no accepted quantitation levels for health effects for microorganisms in dust. During our sampling in the large packaging room, the temperature ranged from 74 to 79 degrees Fahrenheit while the relative humidity ranged from 31 to 45 percent.

Updates Since Site Visits

After our site visits, we provided recommendations to the company regarding evaluation of existing and installation of additional local exhaust ventilation (LEV). We also recommended air sampling after new LEV is installed and during cleaning operations, training on proper use of LEV when weighing powders, and using N-95 respirators during compressed air cleaning or eliminating the practice of cleaning with compressed air. We recommended that employees see a healthcare provider if they develop or have developed persistent or worsening respiratory or other health symptoms.

The company has since reported that they increased the amount of fresh air introduced into the cook rooms. Products made with salmon and other allergens are now cooked in a new isolated room with dedicated ventilation rather than within a plastic sheet curtain enclosure inside the main cooking room as was done during our visits. The company has verified the proper performance of local exhaust systems and included these checks in their preventative maintenance schedule. Workers have been trained on proper techniques when using the ventilation hood in the free ingredients room; the training has been included in the company's safety training. The free ingredients room is currently being reconfigured. The company is working at replacing blowing dust (with compressed air) out of areas with vacuuming. The cleaning is still done during production times. N-95 respirators are available for voluntary use for workers performing or adjacent to compressed air cleaning. Employees see a healthcare provider if they develop symptoms that may be work-related. Individualized plans (such as moving an affected employee to a different work area or location) are utilized when needed.

Discussion

Flavorings (alpha-diketones)

Results from the NIOSH industrial hygiene survey conducted in September 2011, indicated that **diacetyl** was present at levels above the NIOSH proposed REL in several areas and jobs. Unfortunately, for the set of samples analyzed for **2,3-pentanedione** with OSHA Sampling Method 1016, the limit of detection achieved during analysis was not low enough to assess whether exposures exceeded the NIOSH draft REL for that compound. However, when we had simultaneous measurement with NIOSH Draft Sampling Procedure SMP2, results were well below the OSHA Method 1016 detection limit and the draft REL. A canister sample did measure 2,3-pentanedione in the free ingredients room during CIP and COP activities at a concentration (6.2 ppb) closer to the draft REL of 9.3 ppb. Our sample was collected over 2.6 hours, so direct comparison to the proposed 8-hour REL is not possible. No other activities took place in the room that day, so if the concentration was zero for the remaining 5.4 hours, the 8-hour TWA diacetyl concentration would be 2 ppb [(6.2 x 2.6)/8], well below the proposed REL of 9.3 ppb. The actual 8-hour TWA 2,3-pentanedione concentration on that day in the free ingredients room was likely somewhere between 2.0 ppb and 6.2 ppb. Diacetyl and 2,3-pentanedione likely share the same mechanism of toxicity. Although the draft REL for 2,3-pentanedione is above that of diacetyl (5 ppb), 2,3-pentanedione has recently been shown to be as hazardous as diacetyl [Hubbs et al. 2012; Morgan et al. 2012]. The NIOSH draft REL is higher for 2,3-pentanedione than for diacetyl largely because analytic measures are not available in a validated OSHA method to detect 2,3-pentanedione at lower levels. The canister measurement is more sensitive than the validated OSHA method. There is no draft REL for **2,3-hexanedione**, as its toxicity has not been studied. However, the active chemical structure that is believed to be responsible for the butter smell and taste is consistent among diacetyl (also known as 2,3-butanedione), 2,3-pentanedione, and 2,3-hexanedione. 2,3-hexanedione may have comparable toxicity to the respiratory epithelial (surface) cells in the smallest airways of the lung. Accordingly, the canister measurement of 9.0 ppb for 2,3-hexanedione in the free ingredients room is concerning from a health point of view, despite there being no recommended guidance. The measurable concentrations of these compounds during cleaning processes demonstrate the ongoing potential for exposure even after a product has left the immediate production area for packaging. Using evacuated canisters, we were not able to obtain reliable measurements of diacetyl at cleaning operations because of an interfering chemical compound, so it would be reasonable to conduct additional sampling for diacetyl during cleaning operations using OSHA Sampling Method 1012. With simultaneous analysis for 2,3-pentanedione and 2,3-hexanedione during this sampling, a more complete understanding of potential exposures during these operations would be gained.

The risk assessment underlying the NIOSH draft recommended standards is based on preventing lung abnormalities after a 45-year working life. Thus, the presence of these chemicals, even at a low level, is potentially hazardous. The hazard potential may increase when these chemicals occur in combination with each other or with other flavoring ingredients. For example, many flavorings contain butyric acid in combination with diacetyl, and butyric acid may impair the metabolism of diacetyl [Morris and Hubbs 2009], resulting in higher possible levels of exposure in the airways. Having exposure to three chemicals with the same functional alpha-diketone group may result in additive effects.

In summary, we did not measure chemical concentrations that violate existing regulations. However, the facility has some concentrations of flavoring ingredients that would be prudent to reduce or to protect against with respiratory protection. The sampling results suggest that there may be increased potential for exposure associated with the process of cooking in the plant, which seems reasonable given that this process involves mixing of the individual ingredients as well as heating of the mixture, which increases vaporization of VOCs into the air. Targeting cooking in any implementation of controls would be a sensible approach. Installation of local exhaust at cooking kettles that use flavorings or condiments with alpha-diketones (such as diacetyl, 2,3-pentanedione, or 2,3-hexanedione) is one way to reduce exposure. Another is to adjust the supply ventilation above the whip cook's station so it does not blow in the direction of the weighing station. In the free ingredients room, the overhead ventilation hood arrangement may potentially result in contaminated air being pulled through a worker's breathing zone when a worker places his head over an open barrel while scooping powdered material from it. One worker who frequently measures the ingredients in the free ingredients room was aware of this fact. He described how he intentionally moves barrels to the edge of the hood and scoops while standing outside the hood to ensure emissions are pulled away from him into the hood. This is a good practice with the available arrangement as long as all workers practice it. However the effectiveness of the practice decreases as the material in the barrel is depleted, and the worker is forced to bend over more into the barrel to scoop. Effective alternatives would include a hood that pulls air to the rear of the barrel instead of overhead and/or a semicircular hood that pulls air at the rear half of the barrel rim. Long-handled scoops could supplement ventilation control so the worker does not need to bend into the barrel while scooping. Real-time air monitoring for VOCs during our survey indicated tasks that present potential for exposure while producing salmon cream cheese. The company has since made an effort to minimize exposure by moving cooking operations with salmon and other allergens into a new isolated room with dedicated ventilation rather than within a plastic sheet curtain enclosure inside the main cooking room as was done during our visits. Real-time dust monitoring indicated certain tasks that produced airborne dust, some of which could irritate or exacerbate respiratory conditions. Dusty conditions could also be produced with powder flavorings.

Cardboard debris/dust

Regarding the cardboard dust with potential for microbial contamination, there are no standards for what level or what species of molds constitute a health risk. We measured them because of concern for asthma and knowledge that microbially-contaminated cardboard (and contaminated heating-cooling ventilation units containing open water spray chambers) had been found in another factory with multiple cases of immune-mediated lung disease [Woodard et al. 1988]. All molds have the potential to be allergenic, but there is a lack of knowledge on the antigens or allergens found in the vast majority of molds. General good housekeeping, and maintenance of heating and air conditioning equipment, is important for controlling microbial contaminants. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) recommends for sorting, packaging, and light assembly areas, at least 7.5 cubic feet per minute (cfm) of outside air per person (cfm/person) and an additional 0.12 cfm of air for every square foot of occupied floor space [ANSI/ASHRAE 2010A]. ASHRAE also recommends that relative humidity be maintained at or below 65% [ANSI/ASHRAE 2010B]. The U.S. Environmental Protection Agency recommends maintaining indoor relative humidity below 60%, ideally between 30-50% because excessive humidity can promote the excessive growth of microorganisms [EPA 2008]. Our relative humidity measurements were within these guidelines.

Cleaning products

Cleaning products have been identified as an occupational risk for asthma and asthma-like symptoms [Ng et al. 1994; Kogevinas et al. 1999; Medina-Ramon et al. 2003; Zock et al. 2001; Le Moual et al. 2004; Quirce and Barranco 2010; Labrecque 2012]. In addition, acute respiratory distress syndrome in relation to exposure to cleaning products has been reported [Mapp et al. 2000]. Rosenman et al. [2003] evaluated data from the California, Massachusetts, Michigan, and New Jersey state-based surveillance systems from 1993 to 1997. These states conducted surveillance for work-related asthma as part of NIOSH's Sentinel Event Notification System for Occupational Risks (SENSOR) Program. Of the confirmed cases of work-related asthma identified by these states, 12% were associated with cleaning products. Of the cases, 80% had new-onset asthma while 20% had aggravation of pre-existing asthma. For many individuals, cleaning often was not the usual primary task; however, based on the California data, janitors and cleaners were the most common occupations reported. Nurses, nurse aides, and clerical staff were the next most common occupations. Often the specific cleaning agents were not identified during the interviews of individuals with work-related asthma; however, of the cleaning agents identified, the most common were irritants (such as acids, ammonia, or bleach) and disinfectants (such as formaldehyde, glutaraldehyde, and quaternary ammonium compounds). Our air sampling near cleaning operations found nitric acid at concentrations well below occupational exposure guidelines.

The company requires two different levels of personal protective equipment depending on the type of cleaning. In the cook room, we observed employees not involved with the cleaning walking through hot cleaning solution that had been emptied from the bottom of a cooking kettle to flow across the floor to open drains. Wet floors can result in slipping, tripping, and falling. Also hot cleaning solution on the floor may result in vaporization of cleaning chemicals into the air. Skin irritation and burns are also possible.

Ergonomic Issues

At one cook station, we observed repetitive lifting and emptying of 50-pound bags of ingredients; the lifting procedures often involved twisting of the worker's trunk which may lead to musculosketal problems such as back pain. Workstations can be designed to accommodate the individual worker's height and reach. This may involve adjustable platforms, scales, or work tables. Employees may have useful ideas on how to adjust their workstations to make them more user friendly and decrease workplace risk factors.

Conclusions

While some controls were already in place to reduce exposures to airborne flavorings chemicals, cleaning chemicals, and cardboard dust, we noted potential opportunities for exposure during our site visits that can be addressed through enhanced engineering controls and modified work practices.

Recommendations

Our recommendations are based on an approach known as the hierarchy of controls. This approach groups actions by their likely effectiveness in reducing or removing hazards. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or feasible, administrative measures and personal protective equipment may be needed.

Elimination and Substitution

Eliminating or substituting hazardous processes or materials reduces hazards and protects employees more effectively than other approaches. Prevention through design, considering elimination or substitution when designing or developing a project, reduces the need for additional controls in the future.

1. Until more is known about the safety of diacetyl and 2,3-pentanedione substitutes (e.g., 2,3-hexanedione and 2,3-heptanedione), handle ingredients that contain these flavoring chemicals as respiratory hazards.

Engineering Controls

Engineering controls reduce employees' exposures by removing the hazard from the process or by placing a barrier between the hazard and the employee. Engineering controls protect employees effectively without placing primary responsibility of implementation on the employee.

1. Install local exhaust ventilation at cooking kettles that use ingredients containing diacetyl, 2,3-pentanedione, or 2,3-hexanedione (e.g., liquid dairy, strawberry, smoke, and blueberry flavorings; powder cheese and cheesecake flavorings; and strawberry puree). Conduct additional air sampling after the addition of local exhaust ventilation.

2. Install a new hood in the free ingredients room that pulls air to the rear of instead of overhead the barrels from which ingredients are being scooped and/or a semicircular hood that pulls air at the rear half of the barrel rim. Provide long-handled scoops.

3. Evaluate cook stations for possible ergonomic changes.

Administrative Controls

The term administrative control refers to employer-dictated work practices and policies to reduce or prevent hazardous exposures. Their effectiveness depends on employer commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that policies and procedures are followed consistently.

1. Conduct additional air sampling during cleaning operations (CIP and COP) using OSHA Sampling Method 1012 for diacetyl and OSHA Sampling Method 1016 for 2,3-pentanedione.

2. Include local exhaust system (e.g., COP stations and measuring hood in free ingredients room) checks in the preventative maintenance schedule to ensure they continue to operate appropriately.

3. Ensure workers use proper techniques when using ventilation hoods.

4. Avoid the use of compressed air during cleaning in the packaging room. As an alternative, consider using vacuums with high-efficiency particulate air filters. If compressed air is used, it should be done during non-production times with minimal staff in the area. Those present during the use of compressed air should have N-95 respirators available for use.

5. Avoid walking through cleaning solution or water on the floor that has drained from kettles after clean-in-place procedures. If feasible, install piping from kettles to the drainage system instead of allowing cleaning solution to drain onto cook room floor.

6. In the packaging rooms, follow ASHRAE recommended guidelines for indoor relative humidity and outside air flow rates.

7. Employees should report new, persistent, or worsening symptoms to their personal healthcare provider and, as instructed by their employer, to a designated individual at their workplace. An individualized management plan (such as assigning an affected employee to a different work location) is sometimes required, depending upon medical findings and recommendations of the individual's physician.

Personal Protective Equipment

Personal protective equipment is the least effective means for controlling hazardous exposures. Proper use of personal protective equipment requires a comprehensive program and a high level of employee involvement and commitment. The right personal protective equipment must be chosen for each hazard. Supporting programs such as training, change-out schedules, and medical assessment may be needed. Personal protective equipment should not be the sole method for controlling hazardous exposures. Rather, personal protective equipment should be used until effective engineering and administrative controls are in place.

1. Continue to provide N-95 respirators for voluntary use. Dusty tasks where workers may consider wearing them include the following:
    - weighing powder ingredients
    - manual addition of powder ingredients into tanks/kettles
    - emptying bags of ingredients into bins
    - manual compaction of empty bags during disposal in waste cans
    - use of compressed air

    Ensure that each potential N-95 user receives a copy of Appendix D of the OSHA Respiratory Protection Standard (http://www.osha.gov/pls/oshaweb/owadisp.show_ document?p_table=standards&p_id=9784). A NIOSH document showing how to put on and take off a disposable respirator correctly can be obtained at http://www.cdc.gov/niosh/docs/2010-133/pdfs/2010-133.pdf. Further information on respirators can be obtained at http://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/RespSource.html.

Please be aware that N-95s are not protective against alpha-diketones (diacetyl, 2,3-pentanedione, and 2,3-hexanedione). In cases of dual exposure to dust and alpha-diketones, NIOSH-certified organic vapor cartridges (for the alpha-diketones) and particulate cartridges/filters (for the dust) would be warranted.

2. Update the Respiratory Protection Plan to specify the type of respirator and cartridges/filters to use during the following "respirator-required" activities: utility and refrigeration department maintenance of ammonia lines, pesticide spraying, and painting with inadequate ventilation or as called for by the manufacturer.

References

ACGIH [2012]. 2012 TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

American National Standards Institute (ANSI)/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) [2010A]. Ventilation for acceptable indoor air quality, standard 62.1-2010. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Atlanta, GA.

American National Standards Institute (ANSI)/ American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) [2010B]. Thermal environmental conditions for human occupancy, standard 55-2010. American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Atlanta, GA.

CFR. Code of Federal Regulations. Washington, DC: U.S. Government Printing Office, Office of the Federal Register.

Environmental Protection Agency (EPA) [2008]. Mold remediation in schools and commercial buildings. http://www.epa.gov/mold/mold_remediation.html. Date accessed: September 2013.

Hubbs AF, Cumpston AM, Goldsmith WT, Battelli LA, Kashon ML, Jackson MC, Frazer DG, Fedan JS, Goravanahally MP, Castranova V, Kreiss K, Willard PA, Friend S, Schwegler-Berry D, Fluharty KL, Sriram K [2012]. Respiratory and olfactory cytotoxicity of inhaled 2,3-pentanedione in Sprague-Dawley rats. Am J Pathol. Sep;181*(3)*:829-44.

Kogevinas M, Antó JM, Sunyer J, Tobias A, Kromhout H, Burney P [1999]. Occupational asthma in Europe and other industrialised areas: a population-based study. European Community Respiratory Health Survey Study Group. Lancet 353(9166):1750-1754.

Labrecque M [2012]. Irritant-induced asthma. Curr Opin Allergy Clin Immunol *12*(2):140-144.

LeBouf RF, Stefaniak AB, Virji MA [2012]. Validation of evacuated canisters for sampling volatile organic compounds in healthcare settings. J Environ Monit. Mar;14*(3):*977-83.

Le Moual N, Kennedy SM, Kauffmann F [2004]. Occupational exposures and asthma in 14,000 adults from the general population. Am J Epidemiol 160:1108-1116.

Mapp CE, Pozzato V, Pavoni V, Gritti G [2000]. Severe asthma and ARDS triggered by acute short-term exposure to commonly used cleaning detergents. Eur Respir J *16*(3):570-572.

Medina-Ramon M, Zock JP, Kogevinas M, Sunyer J, Anto JM [2003]. Asthma symptoms in women employed in domestic cleaning: A community based study. Thorax 58:950-954.

Morgan DL, Jokinen MP, Price HC, Gwinn WM, Palmer SM, Flake GP [2012]. Bronchial and bronchiolar fibrosis in rats exposed to 2,3-pentanedione vapors: implications for bronchiolitis obliterans in humans. Toxicol Pathol. 2012 Apr;40*(3)*:448-65.

Morris JB, Hubbs AF [2009]. Inhalation dosimetry of diacetyl and butyric acid, two components of butter flavoring vapors. Toxicol Sci. Mar;108*(1)*:173-83.

NIOSH [1994]. Acids, inorganic: Method 7903. In: NIOSH manual of analytical methods (NMAM). 4th ed. Cincinnati, OH. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication Number 94-113.

NIOSH [2005]. NIOSH pocket guide to chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2005-149. Available at www.cdc.gov/niosh/npg/. Date accessed: September 2013.

NIOSH [2011]. Draft criteria for a recommended standard: Occupational exposure to diacetyl and 2,3-pentanedione. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, NIOSH; external review draft; August 12, 2011. Available at: http://www.cdc.gov/niosh/docket/archive/docket245.html. Date accessed: September 2013.

Ng TP, Hong CY, Goh LG, Wong ML, Koh KT, Ling SL [1994]. Risks of asthma associated with occupations in a community-based case-control study. Am J Ind Med 25:709-718.

OSHA [2008]. Sampling and analytical methods: Method 1012 – Acetoin and diacetyl. Available at http://www.osha.gov/dts/sltc/methods/validated/1012/1012.html. Date accessed: September 2013.

OSHA [2010]. Sampling and analytical methods: Method 1016 – 2,3-Pentanedione. Available at http://www.osha.gov/dts/sltc/methods/validated/1016/1016.html. Date accessed: September 2013.

Rosenman KD, Reilly MJ, Schill DP, Valiante D, Flattery J, Harrison R, Reinisch F, Pechter E, Davis L, Tumpowsky CM, Filios M [2003]. Cleaning products and work related asthma. J Occup Environ Med. 45(5):556-563.

Quirce S, Barranco P [2010]. Cleaning agents and asthma. J Investig Allergol Clin Immunol *20*(7):542-550.
Woodard ED, Friedlander B, Lesher RJ, Font W, Kinsey R, Hearne FT [1988]. Outbreak of hypersensitivity pneumonitis in an industrial setting. JAMA. Apr 1;259*(13)*:1965-9.

Zock JP, Kogevinas M, Sunyer J, Almar E, Muniozguren N, Payo F, Sanchez JL, Anto JM [2001]. Asthma risk, cleaning activities and use of specific cleaning products among Spanish indoor cleaners. Scand J Work Environ Health 27:76-81.

Tables

Table 1. Air sampling results for diacetyl, acetoin, and 2,3-pentanedione using sorbent tubes in production and packaging areas, NIOSH survey, Sept. 2011.

Sample Type	Date	Shift	Job Title	Work Area	Cream Cheese Product in Room	Sampling Duration (minutes)	Diacetyl Concentration (ppb)*	Acetoin Concentration (ppb)†	2,3-Pentanedione Concentration (ppb)‡
Area	9/26	1	---	Free Cook Room	Free Plain	369	4.6	11.0	
Area	9/26	1	---	Line 10 Packaging Room	Free Plain	369	0.8	2.3	
Area	9/26	1	---	703 Fill Room	Free Plain	376	**5.9**	23.0	
Area	9/26	2	---	Free Cook Room	Free Strawberry	372	**7.9**	33.4	< 15.8 [< 0.5]
Area	9/26	2	---	Line 10 Packaging Room	Free Strawberry	369	1.5	3.9	< 15.9
Area	9/26	2	---	703 Fill Room	Free Strawberry	354	**11.4**	22.1	< 16.6
Area	9/26	2	---	Free Ingredients Room	Free Strawberry	375	**6.7**	12.6	< 15.6
Area	9/27	1	---	Cook Room-Soft (Cond.)	Strawberry	366	**13.8**	39.4	[< 0.5]
Area	9/27	1	---	Line11 Fill Room	Strawberry	358	3.6	13.2	
Area	9/27	1	---	Line 7 Fill Room	Strawberry	362	1.7	13.0	
Area	9/27	1	---	Line 7 Packaging Room	Strawberry	247	0.3	2.7	
Area	9/28	1	---	Cook Room-Soft (Cond.)	Salmon, Plain, C&O€	364	**13.0**	23.3	< 16.1 [0.9]
Area§	9/28	1	---	Cook Room-Soft (Cond.)	Salmon, Plain, C&O€	370	**11.4**	18.7	< 15.8
Area	9/28	1	---	Line 11 Fill Room	Salmon, Plain, C&O€	368	3.4	11.9	< 15.9
Area	9/28	1	---	Line 11 Packaging Room	Salmon, Plain, C&O€	367	0.3	1.2	< 16.0
Area	9/27	1	---	Outside	----	190	< 0.3	< 0.1	< 15.4
Personal	9/26	1	Packager	Line 10 Packaging Room	Free Plain	397	0.4	1.7	
Personal	9/26	1	Fill operator	703 Fill Room	Free Plain	379	**5.2**	21.8	
Personal	9/26	1	Free cook	Free Cook Room	Free Plain	400	3.6	8.5	
Personal	9/26	2	Free cook	Free Cook Room	Free Strawberry	361	**8.3**	34.3	< 16.2
Personal	9/26	2	Free condiment cook	Free Ingredients Room	Free Strawberry	362	**6.7**	19.6	< 16.2
Personal	9/26	2	Packager	Line 10 Packaging Room	Free Strawberry	361	0.9	3.2	< 16.2
Personal	9/26	2	Fill operator	703 Fill Room	Free Strawberry	180	**6.3**	20.9	VOID
Personal	9/27	1	Packager	Line 7 Packaging Room	Strawberry	386	1.0	4.2	
Personal	9/27	1	Fill operator	Line 7 Fill Room	Strawberry	364	1.4	9.0	
Personal	9/27	1	Fill operator	Line 11 Fill Room	Strawberry	390	3.3	12.9	
Personal	9/27	1	Soft cook	Cook Room-Soft	Strawberry	370	**8.3**	23.5	
Personal	9/28	1	Packager	Line 11 Packaging Room	Salmon, Plain, C&O€	362	0.7	1.5	< 16.2
Personal	9/28	1	Fill operator	Line 11 Fill Room	Salmon, Plain, C&O€	386	2.2	6.8	< 15.7
Personal	9/28	1	Soft cook	Cook Room-Soft	Salmon, Plain, C&O€	391	**5.5**	12.2	< 15.0
Personal	9/26	1	Free cook	Free Cook Room	Free Plain	16	4.4	11.3	
Personal	9/26	2	Free cook	Free Cook Room	Free Strawberry	15	15.1	85.1	< 48.8
Personal	9/26	2	Fill operator	703 Fill Room	Free Strawberry	15	8.5	25.9	< 48.8
Personal	9/27	1	Condiment cook	Cook Room-Soft (Cond.)	Strawberry	16	10.7	28.6	
Personalß	9/28	1	Condiment cook	Cook Room-Soft (Cond.)	Salmon, Plain, C&O€	43	11.6	20.0	< 17.0
Personal	9/28	1	Condiment cook	Cook Room-Soft (Cond.)	Salmon, Plain, C&O€	43	10.9	25.5	< 17.0

*OSHA Sampling Method 1012; NIOSH Draft Recommended Exposure Limit (REL) 5 ppb 8-hour time-weighted average (TWA) (above REL in BOLD); NIOSH Draft Short-Term Exposure Limit (STEL) 25 ppb for 15 minutes. †OSHA Sampling Method 1012; no NIOSH Draft REL or STEL. ‡OSHA Sampling Method 1016, NIOSH Draft Sampling Procedure SMP2 [in brackets]; NIOSH Draft REL 9.3 ppb 8-hour TWA, NIOSH Draft STEL 31 ppb for 15 minutes. §Used shortly as personal sample and finished as area sample (adjacent to other area sample). ßNIOSH investigator carried sampler and shadowed condiment cook. €Plain and chive & onion (C&O) cream cheeses, which did not use alpha-diketone-containing ingredients, also being made in the room. VOID = sample results void because of sampling pump failure. Cond. = condiments area. ppb = parts contaminant per billion parts air. < = not detected; value is limit of detection.

Table 2. Air sampling results† for diacetyl, 2,3-pentanedione, and 2,3-hexanedione using evacuated canisters at cleaning operations, NIOSH survey, Sept. 2011.

Sample Type	Date	Shift	Job Title	Work Area	Cream Cheese Product Being Made in Room	Sampling Duration (minutes)	Diacetyl Concentration (ppb)*	2,3-Pentanedione Concentration (ppb)	2,3-Hexanedione Concentration (ppb)
Area	9/26	1	---	Cook Room-at COP	Plain‡§	Instant	20*	< 1.2	< 1.5
Area	9/26	1	---	Cook Room-at COP	Plain‡§	279	25*	< 2.1	< 2.6
Area	9/26	2	---	Cook Room-at COP	Plain‡§	Instant	23*	< 1.2	< 1.5
Area	9/26	2	---	Cook Room-at COP	Plain‡§	239	19*	< 2.9	< 3.6
Area	9/27	1	---	Free Ingredients Room-at CIP/COP	None (free strawberry)ß	Instant	5.1*	< 1.2	< 1.5
Area	9/27	1	---	Free Ingredients Room-at CIP/COP	None (free strawberry)ß	155	4.8*	6.2	9.0
Area	9/27	1	---	Outside	----	279	< 3.0*	< 3.4	< 4.3

†No recovery correction was performed. *Reliable diacetyl results not available because of co-eluting interference with another compound (2-methylpentane); thus, measurement could be overestimation. ‡Plain cream cheese did not use alpha-diketone-containing ingredients. §Free plain cream cheese being made in adjacent free cook room during 1st shift; free strawberry cream cheese being made in adjacent free cook room during 2nd shift. ßNo product was being made in the room, but remnants of free strawberry cream cheese ingredients from previous shift were being cleaned from equipment, and strawberry cream cheese was being made in the cook room. COP = clean-out-of-place. CIP = clean-in-place. ppb = parts contaminant per billion parts air. < = not detected; value is limit of detection

Table 3. Air sampling results for inorganic acids using sorbent tubes at cleaning operations, NIOSH survey, September 2011.

Sample Type	Date	Shift	Job Title	Work Area	Sampling Duration (minutes)	Nitric Acid Concentration (mg/m^3)*
Area	9/26	1	---	Cook Room-at COP	280	< 0.004
Area	9/26	1	---	Cook Room-at COP	142	< 0.003
Area	9/26	2	---	Cook Room-at COP	379	< 0.003
Area	9/27	1	---	Free Ingredients Room-at CIP/COP	155	0.007
Area	9/28	1	---	Cook Room-at COP (CIP)†	160	0.008
Area	9/26	2	---	Cook Room-at COP	19	< 0.021
Area	9/27	1	---	Free Ingredients Room-at CIP/COP	17	0.038
Area	9/28	1	---	Cook Room-at COP (CIP)†	15	< 0.027

*Nitric acid measured with NIOSH Sampling Method 7903; no other acids were detected. †A CIP also took place nearby in the room
COP = clean-out-of-place. CIP = clean-in-place. mg/m3 = milligrams nitric acid per cubic meter air. < = not detected; value is limit of detection.

Table 4. Microbial agents cultured from cardboard dust mixture collected by NIOSH investigators, July 7, 2011.

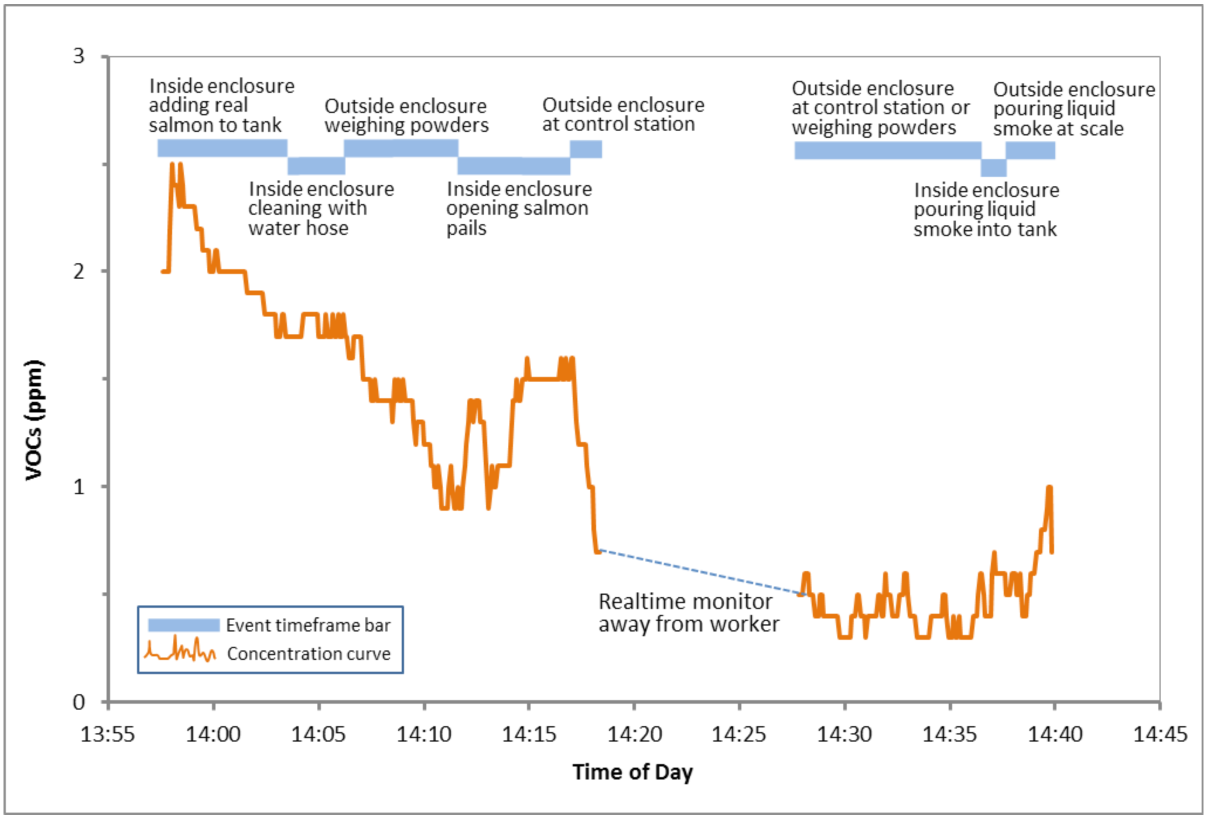
Sample location	Fungi		Bacteria	
	Identification	cfu/g†	Identification	cfu/g†
Under conveyor on mezzanine level in large packaging room	*Cladosporium sphaerospermum*	5,000	*Bacillus*	500
	Mucor plumbeus	1,000	Gram negative rods	200
	Penicillium brevicompactum	3,000	Total bacteria	700
	Penicillium chrysogenum	2,000		
	Penicillium glaborum	1,000	Thermophilic actinomycetes	0
	Penicillium species	1,000		
	Total fungi	13,000		
On and around conveyor on ground level of packaging line 9 in the large packaging room	*Cladosporium sphaerospermum*	1,400	*Bacillus*	2,200
	Mucor plumbeus	200	Gram negative rods	3,800
	Penicillium brevicompactum	100	Gram positive cocci	100
	Penicillium crustosum	700	Total bacteria	6,100
	Penicillium glabrum	200		
	Penicillium species	600	Thermophilic actinomycetes	0
	Yeast	100		
	Total fungi	3,300		

†cfu/g = colony forming units per gram.

Figures

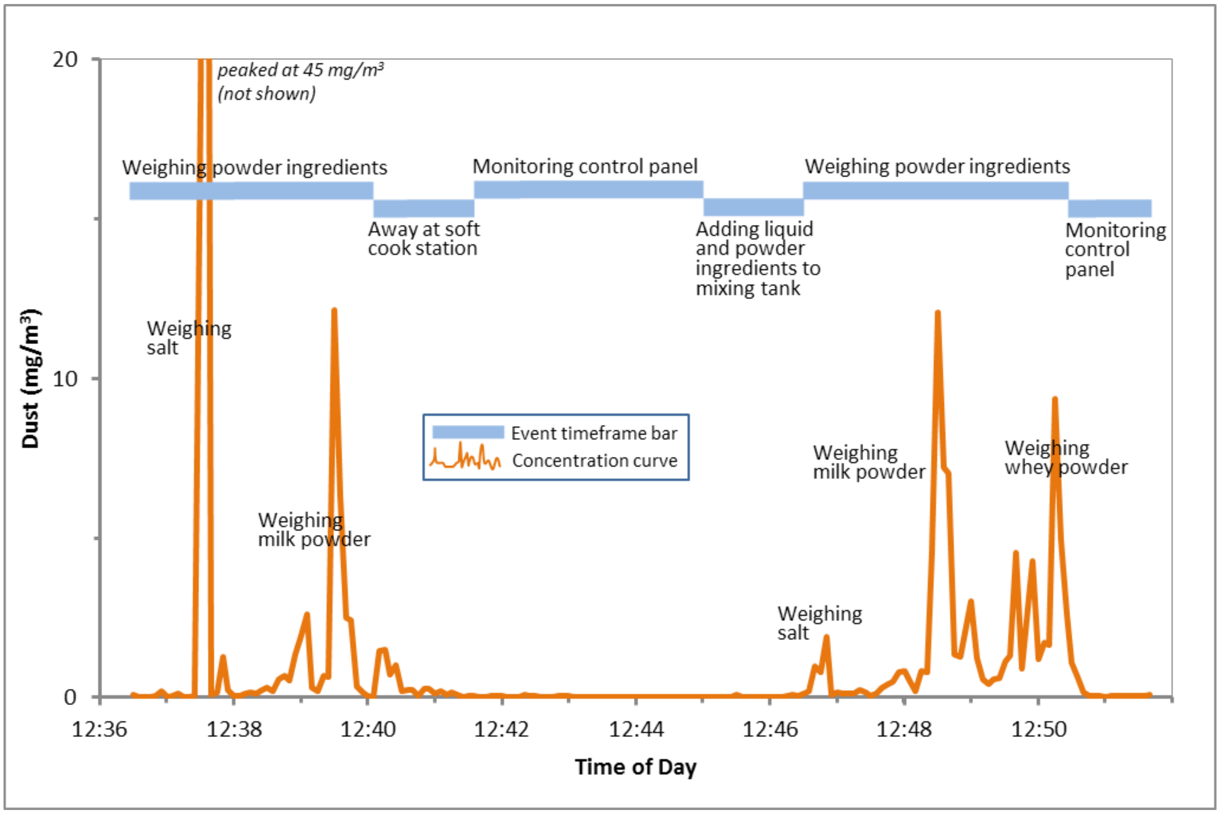
Figure 1. Puddle formed after release of cleaning solution onto floor during clean-in-place operation, NIOSH survey, Sept. 28, 2011.

Figure 2. Real-time total volatile organic compound measurements near worker at condiment cooking station, NIOSH survey, Sept. 28, 2011.



Note. VOCs: volatile organic compounds; ppm: parts per million.

Figure 3. Personal real-time dust measurements at whip cooking station, NIOSH survey, September 27, 2011.



Note. mg/m^3: milligram per cubic meter.

Figure 4. Worker disposing of empty powder ingredient bag into waste can in free cook room, NIOSH survey, Sept. 26, 2011.

Keywords: NAICS 311513 (Cheese Manufacturing), flavorings, diacetyl, 2,3-pentanedione, respiratory symptoms, ventilation

This page left intentionally blank

NIOSH Health Hazard Evaluation Program Description

The Health Hazard Evaluation Program investigates possible health hazards in the workplace under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) , or Section 501(a)(11) of the Federal Mine Safety and Health Act of 1977, U.S.C. 951(a)(11). The Health Hazard Evaluation Program also provides, upon request, technical assistance to federal, state, and local agencies to investigate occupational health hazards and to prevent occupational injury and disease. Regulations guiding the Program can be found in Title 42, Code of Federal Regulations, Part 85; Requests for Health Hazard Evaluations (42 CFR 85).

Acknowledgments

Analytical Support: Nicole Edwards
Desktop Publisher: Tia McClelland
Site Visit: Rachel Bailey, Mike Beaty, Randy Boylstein, Chris Piacitelli, and Christine Schuler.

Availability of Report

Copies of this report have been sent to the employer and employee representative at the facility. The New York State Department of Health and the Occupational Safety and Health Administration Regional Office have also received a copy. This report is not copyrighted and may be freely reproduced.

This report is available at http://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0102-3194.pdf.

All other HHE Reports may be found at http://www2a.cdc.gov/hhe/search.asp

Recommended citation for this report:
NIOSH [2013]. Health hazard evaluation report: Evaluation of respiratory concerns at a cream cheese manufacturing facility—New York. By Bailey RL, Piacitelli CA. Morgantown, WV: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2011-0102-3194.

Delivering on the Nation's promise:
Safety and health at work for all people through research and prevention

To receive documents or other information about occupational safety and health topics, contact NIOSH

Telephone: 1-800-CDC-INFO (1-800-232-4636)
TTY: 1-888-232-6348
email: cdcinfo@cdc.gov
or visit the NIOSH website at http://www.cdc.gov/niosh

SAFER • HEALTHIER • PEOPLE™