NIOSH HEALTH HAZARD EVALUATION REPORT

HETA #2006-0055-3027
Savory Spice Shop, Inc.
Denver, Colorado

November 2006

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

PREFACE

The Hazard Evaluation and Technical Assistance Branch (HETAB) of the National Institute for Occupational Safety and Health (NIOSH) conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health (OSHA) Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employers or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

HETAB also provides, upon request, technical and consultative assistance to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Eric J. Esswein, MSPH, CIH of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and Michael G. Gressel, Ph.D, CSP of the Division of Applied Research and Technology (DART). Analytical support and analysis for capsaicinoids and gravimetric particulate sampling was provided by Samuel P. Tucker, Ph.D, NIOSH, DART and DataChem Laboratories, Salt Lake City, Utah. Desktop publishing was performed by Robin Smith and Isaiah Ransom of HETAB. Editorial assistance was provided by Ellen Galloway, HETAB.

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Highlights of the NIOSH Health Hazard Evaluation

NIOSH received a management request to investigate spice dust exposures at the Savory Spice Shop (SSS) in Denver, Colorado. Management at the SSS reported that employees experienced cough, sneezing and skin irritation during grinding, blending and packaging of a variety of spices including but not limited to: cinnamon, peppercorns, chilies (hot peppers), ginger, and cumin.

What NIOSH Did

- We took air samples for spice dusts, including capsaicin and dihydrocapsaicin, the active ingredients in hot peppers.
- We evaluated the effectiveness of the exhaust system in the blending room.
- We observed employee work practices.
- We asked employees about any work-related health symptoms when working with spices.
- We developed control recommendations to limit spice dusts exposures in the workplace.

What NIOSH Found

- Hand blending, grinding and mixing spices results in high dust concentrations for the worker in the blending and grinding rooms.
- Lower spice dust concentrations were present on the shop floor; the lowest concentrations were at the cash register.
- Capsaicin and dihydrocapsaicin was in the air when Thai green chili powder was being made.
- The exhaust system in the blending room is not effective at reducing spice dusts during hand blending operations.
- Employees reported rash and upper respiratory symptoms when working with spices.
- Work practices such as hand blending and cleaning the grinder with forced air creates significant dust in the workplace.

What SSS Managers Can Do

- Install local exhaust ventilation systems that are effective in controlling spice dust generation in the grinding room and the blending room.
- Use a drum tumbler instead of hand blending whenever possible to reduce dust exposures.
- Do not use forced air to clean the grinder .
- Use work practices which reduce dust when cleaning pans and sieves.
- Do not exhaust spice dusts near the evaporative cooler in back of the shop.
- Create and start a respiratory protection program. Fit test, train and offer medical examinations for employees who use respirators at work.

What SSS Employees Can Do

- Wear a NIOSH approved N95 (or greater efficiency) respirator when mixing, blending and grinding spices. A respirator with both a filter and an organic vapor cartridge may be needed if working with hot peppers.
- Use gloves to protect your skin when handling spices.
- Do not use forced air to clean the grinder.
- Use work practices that minimize spice dust generation for your job tasks.
- Wash your face, hands and arms thoroughly to remove spice dusts from your skin.
- Remove spice dust from your clothing using a high efficiency particulate air (HEPA) vacuum before you leave work.

CDC Workplace Safety and Health

What To Do For More Information:

We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513-841-4252 and ask for HETA Report #2006-0055-3027

NIOSH

Health Hazard Evaluation Report 2006-0055-3027
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a management request to evaluate employee exposures to spice dusts at the Savory Spice Shop (SSS) in Denver, Colorado. Management at the SSS reported that employees experienced cough, sneezing, and skin irritation during the grinding, blending, and packaging of a variety of spices including but not limited to cinnamon, peppercorns, chilies (hot peppers), ginger, and cumin.

Full-shift personal breathing zone (PBZ) and area air samples for the inhalable fraction of spice dust were collected during two workplace visits in December 2005 and February 2006. Air sampling during the second site visit was conducted to screen for the presence of capsaicin and dihydrocapsaicin (the active chemical ingredient in hot peppers). PBZ concentrations of spice dusts ranged from 0.31 milligrams per cubic meter (mg/m^3) to 2.7 mg/m^3 for retail employees working on the shop floor or when packaging spices into smaller containers. Area concentrations of spice dusts were 5.4 mg/m^3 and 4.6 mg/m^3 in the grinding room (when grinding spices) and 0.16 mg/m^3 and 0.10 mg/m^3 at the front of the store near the cash register. The two highest PBZ concentrations (24 mg/m^3 and 9.0 mg/m^3 for the full shift) were measured on the same employee who mixed and sieved spices by hand and operated a spice grinder. Capsaicin and dihydrocapsaicin were detected in area and PBZ samples in a range of 0.00035 – 0.0029 mg/m^3. There are no occupational exposure limits for spice dust exposures in the United States.

Exhaust ventilation in the blending and grinding rooms was evaluated. In the blending room, ventilation consisted of a ceiling-mounted vertical exhaust fan that was not effective or suitable for exhausting airborne dust generated during work processes. A standard window (box) fan provided some dilution ventilation to the grinding room, but also redistributed spice dusts in the basement. A 15-inch vane axial fan located in the basement exhausted air to a grille on the storefront. The vane axial fan enhanced natural ventilation in the basement but did not specifically control dusts in the workplace.

An occupational health hazard existed at the time of this evaluation due to employees' exposures to spice dusts and capsaicinoids. These exposures were primarily due to inadequate local exhaust ventilation. Recommendations are included to install local exhaust ventilation systems (sidedraft and enclosure hoods) in the blending and grinding rooms. Additional recommendations include changing work practices (such as not using compressed air for cleaning the grinder, not knocking dust from sieves and screens, and using enclosed dry product mixers equipped with tight fitting lids in place of hand blending) and using personal protective equipment.

Keywords: NAICS 445299 (all other specialty food stores), spices, spice dusts, inhalable dusts, spice grinding, spice shops, local exhaust ventilation, cough, dermatitis, capsaicin, dihydrocapsaicin, capsaicinoids

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INTRODUCTION

On November 15, 2005, the National Institute for Occupational Safety and Health (NIOSH) received a management request to evaluate employee exposures to spice dusts at the Savory Spice Shop (SSS), a small business in Denver, Colorado. Management at the SSS reported that employees were experiencing coughing, sneezing, and skin irritation during the grinding, blending, and packaging of a variety of spices, including (but not limited to) cinnamon, peppercorns, chilies (hot peppers), ginger, and cumin. The areas of concern in the shop were the spice blending room, the grinding room, and the main sales floor. Site visits were made to the SSS on December 20, 2005, and February 23, 2006, to observe work practices, interview employees, and conduct occupational exposure assessments to evaluate workplace exposures to spice dusts and capsaicinoids, the active chemical compounds in hot peppers.

BACKGROUND

The SSS is a small independently owned and operated retail spice store in the metropolitan Denver area. The shop receives a wide variety of bulk spices, which are ground and blended into an assortment of spice and spice/seasoning mixtures. Three full-time employees (including the two owners) and two part-time employees work at the SSS. However, before and during the busy Christmas season, the SSS may employ as many as eight full-time workers to cover increased seasonal work demands.

A wide assortment of spices and proprietary spice blend recipes are sold at the SSS. Employee work practices include customer service and retailing; "jarring" or containerizing spices and spice blends; repackaging dried spices from large containers into smaller, retail sized packets; and blending, grinding, and sieving spices. The workspace is configured as a long rectangle and consists of the ground level main shop floor with the cash register immediately to the left of the main store entrance. The retail area is configured with numerous shelves holding a variety of spices and spice blends displayed in large glass jars. A blending room on the shop floor includes a stainless steel work table, a large commercial sink for washing bowls and sieves, and cabinets for storage. The blending room is configured with a sliding glass door and a large window for customers to watch spice blending operations. Two small work areas are also on the main shop floor where weighing and bagging of dry (non-dusty) spices occurs. A door adjacent to blending room leads to the basement. The basement is configured with large sections of shelving for storing bulk ingredients. The spice grinder is located in a small room in the basement.

Ingredients to make the various spice blends are received in bulk and transferred into bags and/or bowls before mixing. Typically the spice blends are mixed manually in large stainless steel commercial kitchen bowls and, depending on the recipe and final desired consistency, these blends may receive additional grinding and mixing before being blended. During initial hand blending, some larger raw ingredients are often ground using a lidded commercial blender. Grinding of hand-mixed spice recipes or of individual spices (such as raw cinnamon bark) occurs in a small room in the basement of the shop using a 5-horsepower electric grinder. Some spice recipes may require several passes through the grinder to obtain the right consistency. Based on observations made during the initial site visit, work practices having the greatest potential for spice dust exposures were manually mixing or compounding ingredients in commercial kitchen stainless steel bowls (27 inch diameter, 8 inch height), manually sieving spices, and grinding spices and spice mixtures using the grinder.

Ventilation at the SSS consisted of a small ceiling-mounted residential kitchen exhaust fan installed in a corner of the ceiling in the blending room that exhausted to the back of the shop near an evaporative cooler and a standard window (box) fan located in the doorway of the grinding room. Additional ventilation consists of a 15-inch vane axial fan suspended from ceiling rafters in the basement that

exhausts upwards through a small section of round ductwork to an exhaust grille located at the sidewalk level at the storefront. The vane axial fan enhanced natural ventilation in the basement but due to its location it did not specifically control dust generation sources in the workplace.

Personal protective equipment (PPE) is used at the SSS for protection against spice dust exposures and consists of safety glasses for eye protection and disposable nitrile gloves (as needed) for skin protection. For respiratory protection, NIOSH-approved N-100 filtering facepiece respirators are available for voluntary use to reduce particulate exposures during manual mixing of ingredients in the blending room and when grinding spices with the grinder. During this HHE only the employee who manually blended spices and operated the grinder used respiratory protection. This employee wore a 3M Model 8233 N-100 filtering facepiece respirator most of the time when working in the blending or grinding rooms while spices were actively being mixed, ground, or sieved. This employee was observed removing the respirator shortly after any visible dusts were no longer being generated.

METHODS

Full-shift personal breathing zone (PBZ) and area air samples were collected for airborne inhalable dusts. To screen for possible exposures to capsaicin and dihydrocapsaicin, one PBZ and one area air sample were collected during the second site visit when Thai green chili powder was being prepared.

Inhalable dust samples were collected at a flow rate of 2 liters per minute using Institute of Medicine (IOM) samplers with tared 25-millimeter (mm) diameter 5-micron pore size polyvinyl chloride filters. The PBZ air samples were collected while employees performed normal job tasks. Area air samples were collected in static locations in the shop while work was performed. All sampling trains were calibrated on-site and in-line before and after the work shift using a Dry Cal® calibrator. Inhalable dust samples were analyzed gravimetrically for the total weight of dusts accumulated on the filters using NIOSH Manual of Analytical Methods (NMAM) Method 0500.[1] The limit of detection was 0.02 milligrams per filter. Air samples were also collected for capsaicin and dihydrocapsaicin according to NIOSH Method 5041 using Swinnex® filter holders containing 13-mm diameter glass fiber filters.[1] These samples were analyzed by a NIOSH analytical chemist using liquid chromatography and a fluorescence detector.

Effectiveness of the ceiling-mounted exhaust fan in the blending room was evaluated. Air velocity measurements were made in a section of ductwork using a TSI VelociCalc Plus (Model 8386A) thermal anemometer. Chemical smoke was also used to visually evaluate air movement in the blending room when the local exhaust ventilation (LEV) fan was operating.

Informal interviews were conducted with SSS employees to determine if they experienced health symptoms that might be related to exposures to spice dusts. Employees were asked to describe any symptoms they associated with working with spices.

EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity

(allergy). In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increases the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Recommended Exposure Limits (RELs),[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Spice Dusts

Spices, herbs, and seasonings are classified as food products and have been used to season food since at least medieval times. The active components in spices are complex chemical mixtures that impart distinctive flavors and aromas to food and can also be used to preserve certain foods. Spices are considered non-hazardous when ingested in reasonable quantities (a possible exception being allergic reactions in sensitized individuals); however, exposure to spice dusts has been reported to cause human health problems through inhalation and skin contact. Appendix A provides additional background information on health studies regarding workplace exposures to spice dusts.

The Control of Substances Hazardous to Health Regulations (COSHH) issued by the Health and Safety Executive of the United Kingdom (analogous to OSHA) specifically mention managing health risks arising from the use and handling of spices and seasonings. The COSHH regulations state that "most spices and herbs fall under the general dust category thus, 10 milligrams per cubic meter (mg/m^3) for total inhalable dusts as an 8-hour TWA and 4 mg/m^3 as an 8-hour TWA for the respirable fraction" (less than 10 microns in diameter). However, the regulation stipulates that the criteria are only appropriate provided that "no evidence exists that the product (e.g., spices and seasonings) can cause more serious health effects such as irritation or respiratory sensitization."[5] Therefore, neither criterion would be appropriate for irritant spice dusts (e.g., garlic, ground chilies, mustard, shallots, etc.) The COSHH regulations further state that a TWA of 3 mg/m^3 (total particulates) should be applied to irritant spice dusts unless health and safety data sheets indicate that a lower limit is more feasible. Exposures to spice dusts that are identified as respiratory sensitizers "should be reduced as low as reasonably practical."[5]

In the United States, exposure to spice dusts would be classified by OSHA as particulates not otherwise regulated (PNOR) or particulates not otherwise classified (PNOC), with exposure limits of 15 mg/m^3 for total dusts and 5 mg/m^3 for the respirable fraction.[6] However, because the literature has reported many of the common spice dusts as irritants, sensitizers, asthmagens (capable of causing asthma), and causing occupational dermatitis, classifying them as a nuisance dust is not appropriate (See Appendix A). NIOSH does not have an REL for PNOR and has concluded that the documentation cited by OSHA was inadequate to support a proposed 8-hour TWA PEL of 10 mg/m^3 for PNOR.[7]

Capsaicin and Dihydrocapsaicin

Capsaicin is a complex mixture of related chemicals called "capsaicinoids" that includes capsaicin and dihydrocapsaicin. Capsaicinoids are crystalline alkaloids that are the active chemical components found in chilies and are responsible for the hot or burning sensation that occurs after eating spicy foods that contain hot peppers. Capsaicin and dihydrocapsaicin (a chemical analogue) are mucous membrane and skin irritants in humans and mammals, can destroy certain sensory nerve cells, and are classified as mutagens.[8] Pure capsaicin is odorless, fat soluble and appears as a crystalline to waxy compound. The two most potent capsaicinoid compounds are reported to be capsaicin and dihydrocapsaicin, which produce a strong burning sensation in humans everywhere from the mid-tongue and palate down into the throat. All of the capsaicinoids can produce some type of pungency response in humans, but capsaicin is reported to be the most potent.[9] There are no occupational exposure criteria for capsaicinoids.

In 1994 NIOSH investigators evaluated occupational exposures to capsaicin and dihydrocapsaicin in pickle and pepper processing plants in Michigan. We found that workers reported eye, nose, and throat irritation; wheezing; chest tightness; shortness of breath; and incessant coughing and sneezing.[10] Capsaicin was detected in 11 of 70 air samples (16%) and dihydrocapsaicin was detected in 28 of 70 air samples (40%). Airborne concentrations of capsaicin ranged from 0.00007 to 0.00013 mg/m^3 and dihydrocapsaicin ranged from 0.00015 to 0.00033 mg/m^3, with workers on the brine filling line and pepper packing and preparation lines being the most highly exposed.

RESULTS

Spice Dust, Capsaicin, and Dihydrocapsaicin

Six PBZ and four area air samples were collected for inhalable dusts (See Table 1). All concentrations were above the limits of detection, ranging from 0.10 mg/m^3 for an area sample collected by the cash register, to 24 mg/m^3 for a sales associate working in the blending and grinding room. The highest inhalable dust concentrations were measured on the same employee while mixing bulk spices in the blending room (occasionally using the commercial blender) and also grinding spices using the grinder. These results were 24 mg/m^3 and 9.0 mg/m^3, respectively, for full shift PBZ samples collected during the December 2005 and February 2006 site visits. Concentrations of inhalable dusts measured on two sales associates working on the shop floor (who were neither mixing spices nor working in the grinding or blending rooms) were 0.31 mg/m^3 and 1.2 mg/m^3. Air concentrations measured on two sales associates packaging spice blends into small glass jars were 0.45 mg/m^3 at the bottom of the stairs in the basement and 2.7 mg/m^3 when packaging dry spices at a location near the door to the blending room.

In the grinding room, results from two area air samples collected separately on the December and February site visit dates were 5.4 mg/m^3 and 4.6 mg/m^3. Two area samples collected by the cash register near the front of the store were 0.16 mg/m^3 and 0.10 mg/m^3 for these dates.

Airborne concentrations of capsaicin ranged from 0.0006 mg/m^3 to 0.0029 mg/m^3, with the highest concentration obtained from a full shift PBZ sample while an employee was making Thai green chili powder (Table 2). Dihydrocapsaicin concentrations ranged from 0.00035 mg/m^3 to 0.00036 mg/m^3, for samples collected in the blending room while dried spice ingredients for Thai green chili powder were being weighed and mixed by hand in a large bowl and when grinding the ingredients using the grinder. Airborne concentrations of these two capsaicinoids were higher than the concentrations reported in the NIOSH study of worker exposures in pickle and pepper plants where employees reported eye, nose, and throat irritation; chest tightness; shortness of breath; and persistent cough.

Exhaust Ventilation in the Blending Room

The 7-inch round ceiling-mounted vertical exhaust fan (Nutone® model 8210) installed in the southwest corner of the blending room was inspected. The coarse filter for the fan was occluded with spice dusts. The fan had a manufacturer's exhaust rating of 210 cubic feet per minute (CFM) of air at 0.01 inches of water static pressure, and (according to the manufacturer) was designed for use in kitchens up to 105 square feet (ft^2) and other rooms up to 260 ft^2. While the fan may be appropriately sized considering the floor area of the blending room (measured at approximately 83 ft^2), it was not suitable for locally exhausting dust-laden air. The fan was connected to approximately 27 feet of 7-inch diameter light steel ductwork, with three elbows and an exterior weather hood (residential dryer vent cover). This length of ductwork, along with three elbows and a weather hood, adds considerable friction losses to this ventilation system. As a result, the fan's total exhaust volume was 90 CFM, less than one half the rating of the manufacturer. In addition, the duct velocity was measured at 350 feet per minute, much less than the appropriate transport velocity recommended for light dry dusts (e.g., spice dusts) of 2500–3000 feet per minute to prevent dust settling and loading in ductwork.[11] In addition, chemical smoke released above the stainless steel work table where spices are mixed indicated no obvious air movement toward the exhaust fan. Smoke was only captured if released within a 1 to 2 foot radius of the fan.

Employee Interviews

Five employees (one of whom worked full time) described a variety of upper respiratory and skin symptoms that they associated with working at the SSS. Work-related dermatological symptoms included skin rash, reddening of skin on the face, dry skin, and tight skin that employees associated with cinnamon, paprika, chilies, and turmeric. Upper respiratory symptoms included coughing, runny nose, sneezing, and congestion in the upper airway. Employees associated these symptoms with working with shallots, garlic, ground chilies, sage, cinnamon, black pepper, and especially Tabasco powder (coughing and sneezing). During the second site visit, several employees working retail on the shop floor were observed coughing when ingredients for Thai green chili powder were being mixed in the blending room and especially after the blend was ground in the grinder in the basement, suggesting that spice dusts are distributed to some degree throughout the store. Employees mentioned that when Tabasco powder was mixed into a blend, customers would vacate the store, presumably due to its extreme pungency.

DISCUSSION

Spice Dust Exposures

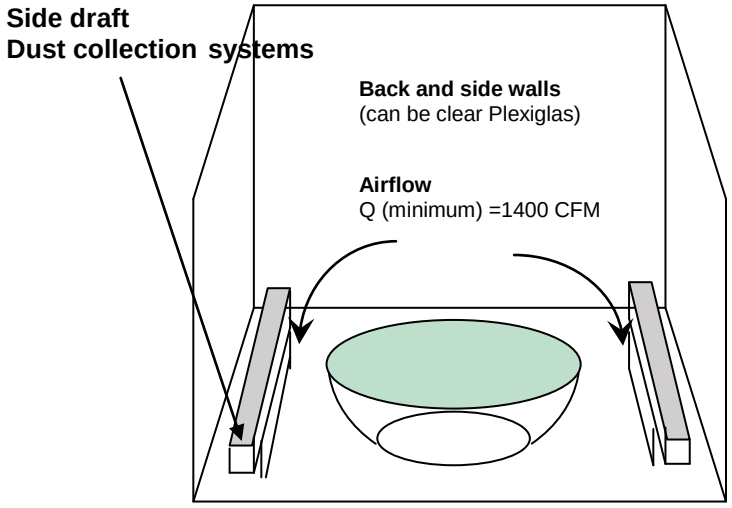
Spice dust concentrations were highest in the blending and grinding rooms where bulk spices are manually mixed and then mechanically ground. Manual mixing and mechanical grinding generate considerable concentrations of inhalable dusts close to the employee's breathing zone. Airborne spice dusts also are likely to settle and migrate on employees' clothing, and can also be distributed by local ventilation (e.g., the box fan used for ventilation in the grinding room) from the blending and grinding

rooms, possibly contributing to personal exposures throughout the rest of the shop. The lowest area air concentrations of spice dusts were at the cash register near the front of the store away from any spice dust generating operations. In contrast, in the grinding room, bulk spices and spice mixtures are ground serially (sometimes two or three times) into specific formulations and particle sizes using the grinder in a small, enclosed space. Spice grinding creates visible concentrations of dusts that accumulate on the worker and on any horizontal surface in the area. Depending on the recipe, highly irritating aerosols (capsaicinoids) can also be released into the workplace air. This was confirmed when Thai green chili powder was being ground and blended. The shop floor workers, the investigator, and the spice grinder experienced a strong cough reflex, eye irritation, lacrimation, and upper respiratory irritation as the raw ingredients were being mixed, and especially when the spices were being ground. A mechanical sieve shaker in the grinding room also generated some airborne dusts, but because the sieves were covered the dust amounts were judged to be much less than those generated by the grinder.

Local Exhaust Ventilation

A downdraft or side draft system would be an appropriate choice to control spice dusts in the blending room at the SSS. Commercially made or "off the shelf" downdraft LEV collection systems are available from commercial kitchen and bath ventilation distributors in the United States. Broan/Nutone produces one commercial system that would be appropriate (with minor modifications) for use in the blending room. The Broan Eclipse model 2800 series, designed for kitchens and available in stainless steel, uses a 7-inch elevated sidedraft slot hood that according to the manufacturer can be installed into any countertop. Mounting two of these hoods into a countertop (either a 30" or 36" length depending on the work surface), and with each hood facing inward, would allow spice mixing operations (using 27"-diameter bowls) to be performed between the two sidedraft hoods and allowing capture to occur from two sides simultaneously. Adding side walls and a back wall to the LEV system will further contain the dust and increase capture distance and hood effectiveness (see Figure 1). More information on LEV systems is provided in Appendix B of the report.

Figure 1. Example of LEV System for Spice Blending



According to the manufacturer, the system will work best with 10-inch round smooth steel ductwork. To prevent dust settling in the ductwork, a minimum transport velocity of 2500–3000 feet per minute will be needed. This will require a system volumetric flow rate of at least 1400 CFM. The Broan/Nutone

commercial downdraft system previously mentioned can be purchased with external blower fans, each with capacities of 500 CFM, 900 CFM, and 1100 CFM. For this system, a single separate external fan (or blower) and an exhaust stack that can achieve a volumetric flow rate (from both hoods) of at least 1400 CFM are recommended. The fan should also be capable of handling dust-laden air. A centrifugal fan with backward inclined blades or an axial fan is recommended because of the spice dust that will be present in the air stream. The off-the-shelf Broan/Nutone system uses a centrifugal fan with forward-facing blades. This blade design would hold dust more than backward inclined blades, and therefore may require more frequent maintenance and cleaning. A no-loss exhaust stack with a rooftop location is recommended. Also, the City of Denver may require an air discharge permit.

An enclosure LEV system is appropriate to control dusts generated at the grinder. Observation of the grinder suggests that most of the dust is generated at the metal discharge chute and at the feed hopper on top of the machine. An appropriate LEV system should include a hood that extends out from the wall to the right of the door entering this room so that the grinder can be slid (using its wheeled platform) into the opening of the enclosing hood, thereby enclosing the dust discharge points. The enclosure and fan should be configured with a hood face velocity ranging from 100 feet to 200 feet per minute. It may be possible to connect ductwork from this hood onto the existing 15" vane axial fan that is already located in the basement and which exhausts to the street level. However, this would depend on the final design of the LEV system and the fan static pressure capability when connected to the LEV system. Again, the City of Denver may require an air discharge permit.

CONCLUSIONS

Concentrations of inhalable spice dusts measured on workers at the SSS ranged from 0.31 mg/m^3 to 1.2 mg/m^3 for employees working on the shop floor, and 0.45 mg/m^3 to 2.7 mg/m^3 for workers who packaged spices and spice blends either in the basement or at a small desk area on the shop floor near the door to the blending room. Exposures to the inhalable fraction of spices were highest (9.0 mg/m^3 and 24 mg/m^3) for the single worker who hand blends, sieves, and grinds spices and works most of the shift time in the grinding and blending rooms. Workplace airborne concentrations of capsaicinoids measured in this study exceeded those in a NIOSH study where workers reported multiple upper respiratory symptoms, persistent coughing, and shortness of breath.[11]

Spice dusts and capsaicinoids aerosols have no occupational exposure criteria in the United States. The OSHA PEL for general (nuisance) dust exposures of 15 mg/m^3 as a TWA over an 8-hour work day would not be an appropriate criterion for this workplace because spice dust exposures (either alone or in combination with capsaicinoids) are reported to be sensitizers, asthmagens, and capable of causing occupational dermatitis (allergic skin rashes). Because occupational exposure limits do not exist for either spice dusts or capsaicinoids aerosols, the most appropriate strategy for controlling these materials is installing LEV and improving work practices and material handling techniques to limit, to the greatest degree possible, dust and aerosol generation, thus reducing employee workplace exposures. Limiting airborne exposures to the lowest feasible limits (which for practical purposes may be the threshold of upper respiratory irritation for employees) is in the best interest of both management and employees because employees who become sensitized or who develop occupational asthma or allergic contact dermatitis would be at risk for subsequent reactions and might not be able be able to work in the culinary arts fields or other jobs where spice dusts are an exposure risk.

Although appropriate particulate respiratory protection was worn during most of the work shift by the most highly exposed worker, LEV engineering controls, changes to work practices and changes in materials handling are still needed, in concert, to reduce spice dust generation throughout the shop. Obviously, until appropriate LEV is installed in the workplace, workers who blend and grind spices are

encouraged to wear appropriate respiratory and dermal protection (i.e., gloves). In addition, employees should use work practices and equipment that minimize spice dust generation and reduce exposures as outlined in the following recommendations.

RECOMMENDATIONS

The following recommendations are provided to the SSS in the interest of reducing occupational exposures to spice dusts (through both inhalation and dermal routes of exposure) and improving occupational health and safety conditions for all employees working at the shop.

1. Install LEV systems (sidedraft and enclosure hoods) in the blending and grinding rooms to control the release of spice dusts at the point of generation.

2. Use a drum tumbler (or another suitable type of dry product mixer) configured with a tight-fitting lid as an alternative to hand blending to reduce spice dust emissions into the workplace.

3. Replace the jet stream nozzle on the suspended faucet over the sink in the blending room with a multi-stream spray head. Workplace observation suggests that spice dusts are generated when the single, strong jet of water is directed on sieves, mixing bowls and other kitchen products that are cleaned in the sink. Another possible option includes simply immersing the sieves and bowls in a sink full of water and detergent to dislodge accumulated spice dusts before using the sprayer on the items.

4. Do not use forced air from the exhaust side of the vacuum cleaner to blow spice dusts out of the grinder during cleaning operations. This practice simply resuspends spice dusts into the workplace environment and increases the potential for inhalation exposures. Using a bottle brush and/or a thin vacuum nozzle attachment is recommended to vacuum clean the interior of the grinder. Any shop vacuums that are used in these areas should be fitted with a high efficiency particulate air (HEPA) filter.

5. Refrain from hitting sieves and bowls on the sink in the blending room and the wooden table in the grinding rooms. While this practice effectively dislodges dusts from the sieves and bowls, it also contributes to airborne dust levels in workplace air.

6. Encourage workers to vacuum their clothing (if grossly contaminated with spice dusts) using a vacuum equipped with a HEPA filter before leaving work.

7. Familiarize workers with the potential respiratory and dermal hazards of spice dusts exposures and insure they understand workplace controls and PPE requirements that are designed to prevent spice dust release and workplace exposures.

8. Until LEV can be installed, or engineering or administrative controls are implemented to reduce worker exposures to spice dusts, employees who blend, mix, or grind spices should use NIOSH-approved respirators (N95 or greater) while working with spices. When working with chilies the use of a NIOSH-approved half-mask respirator with a combination cartridge (N95 or greater filtration and organic vapor removal) may reduce worker exposures to capsaicinoid vapors along with spice dust particulates.

9. Develop a respiratory protection program that includes medical screening of workers who wear respirators, proper fit testing, and employee training in the proper selection and use of respirators. Workplace respirator programs should comply with OSHA standard 1910.134(a).[12]

10. Encourage workers to continue using nitrile gloves to avoid direct skin contact with spices. This is especially important for spices that are skin irritants or known or suspected to cause skin rash such as thyme, turmeric, cinnamon, garlic powder, or chilies although other spices may also cause occupational dermatitis.

11. Do not discharge LEV exhaust air near the evaporative cooler at the back of the building. This practice adds organic materials (spice dusts) and bacteria and fungi (which can be naturally present on spices) into the evaporative cooler sump, which could create a reservoir for microbial growth. Instead, the LEV from the blending room should be exhausted vertically through the roof using a no-loss stack.

12. Trim the top of the door leading to the grinding room in the basement to allow this door to swing open completely without hitting the overhead water pipes. This will reduce the hazard of limited or partially blocked egress from this small room.

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Table 1
HETA 2006-0055-3027
The Savory Spice Shop, Denver, Colorado
December 2005 and February 2006
Inhalable Dust Concentrations

Sample No.	Date	Job Title/Location	Sample Volume (Liters)	Concentration (mg/m^3)
BO5-1	12/20/2005	Field Blank	0	N/A
BO5-3	12/20/2005	Field Blank	0	N/A
BO5-4	12/20/2005	Media Blank	0	N/A
BO5-5§	12/20/2005	Sales Associate	236	0.31
BO5-6 and 9 *	12/20/2005	Sales Associate (hand mixing, blending, and grinding spices)	972	24
BO5-7	12/20/2005	Part-time help (packaging spices)	662	0.45
BO5-8	12/20/2005	Area sample (by cash register)	1070	0.16
BO5-10 ‡	12/20/2005	Area sample (in grinding room)	784	5.4
BO6-21 and 22 *	2/23/2006	Sales Associate (hand mixing, blending, and grinding spices)	764	9.0
BO6-23	2/23/2006	Area sample (cash register	720	0.10
BO6-24	2/23/2006	Sales Associate	732	1.2
BO6-25 †	2/23/2006	Area sample (in grinding room while grinding and sieving spices)	262	4.6
BO6-26	2/23/2006	Field Blank	0	N/A
BO6-27	2/23/2006	Field Blank	0	N/A
BO6-28	2/23/2006	Media Blank	0	N/A
BO6-29	2/23/2006	Sales Associate (packaging dry spices)	555	2.7

Notes
Analytical limit of detection = 0.02 mg per sample
§ sample collected from 09:45 – 11:43 am, pump faulted
* combined results from two samples collected serially to prevent filter overloading
‡ pump faulted at 392 minutes
† pump faulted at 131 minutes
N/A = not applicable (since no air volume was obtained, a concentration was not calculated)

Table 2
HETA 2006-0055-3027
The Savory Spice Shop, Denver, Colorado
February 23, 2006
Capsaicin and Dihydrocapsaicin Concentrations

Sample No.	Date	Type/Location of sample	Sample Volume (Liters)	Concentration, mg/m^3	
				Capsaicin	Dihydrocapsaicin
SS1a + SS1b	2/23/2006	Area sample while mixing raw ingredients for Thai green chili powder	265	0.0006	0.00036
SS2a + SS2b	2/23/2006	PBZ sample while mixing and also grinding Thai green chili raw ingredients	460	0.0029	0.00035
MB 1	2/23/2006	Media blank	0	N/A	
MB 2	2/23/2006	Media blank	0	N/A	
MB 3	2/23/2006	Media blank	0	N/A	
FB 1	2/23/2006	Field blank	0	N/A	
FB 2	2/23/2006	Field blank	0	N/A	

Notes
MB = media blank
FB = field blank
+ = combined results from two samples collected serially to prevent filter overloading
Limit of detection for capsaicin = 0.007 micrograms per sample
Limit of detection for dihydrocapsaicin = 0.01 micrograms per sample
N/A = not applicable (since no air volume was obtained, a concentration was not calculated)

Appendix A: Summary of Workplace Exposures to Spice Dust

In a relatively recent study of 61 male spice grinders working in 14 factories in Singapore, symptoms of upper respiratory tract irritation (sneezing and runny nose) was reported in 49% of the workers.[1] The study reported that the symptoms were greatest in the first few weeks of employment and did not recur in half of the affected workers. None of the spice grinders had symptoms of allergic skin disease or asthma. Total dust area concentrations ranged from 0.03 to 0.82 milligrams per cubic meter of air (mg/m^3) with a mean value of 0.15 mg/m^3. PBZ sampling was not conducted.

In another study investigating thyme farmers in Poland, occupational dermatitis was reported in 4 of 46 farmers who threshed dried thyme plants.[2] The symptomatic workers were all female and reported a history of work-related rash that began within 5 to 30 minutes of threshing the dried thyme (separating seeds and stems from the leaves). This activity created a course powder which was reportedly associated with high exposures to thyme dust. Skin itching, erythema (reddening of the skin), and swelling were found on the uncovered skin of the face neck and hands of the symptomatic workers. Rhinitis (runny nose) was reported in two of the thyme farmers, and conjunctivitis (pinkeye) was reported in one worker. Thyme-specific immunoglobulin E (IgE, an antibody produced by the immune system that is instrumental in mediating allergic reactions) was found in one worker who was symptomatic and in two asymptomatic workers. Exposure to bacteria, bacterial endotoxins, and fungal allergens were also reported, the source of which was epiphytic (naturally occurring on the plant) organisms on the thyme plants (and presumably on other spice plants as well). The study concluded that thyme dust is capable of causing occupational airborne contact dermatitis and suggested an irritant mechanism but also indicated that exposures to fungal allergens and bacteria may aggravate or enhance the effects of exposure to thyme dust alone.

In another study of 45 spice factory workers in Yugoslavia (matched with a control group of workers of the same sex, age, and smoking status) intradermal skin prick testing with mixed spice dust allergen showed positive skin reactions in 73.3% of the of the exposed workers and only 33.3% of the controls.[3] The study showed a statistically significant difference ($P < 0.001$) for both allergic skin reactions (skin prick testing) chronic respiratory symptoms ($P < 0.01$), and increased IgE serum levels *($P < 0.01$)* of spice dust antigens. The symptomatic workers reported a high prevalence of acute respiratory symptoms during the work shift, and the prevalence of chronic respiratory conditions was significantly higher in the exposed workers compared to the control population ($P < 0.01$). The study suggested that immunologic reactions are frequent in spice workers and may be related to acute symptoms and lung function changes but not chronic pulmonary changes.

In a 2002 letter to the editor of the Journal of Environmental Medicine, a case of bronchiolitis obliterans organizing pneumonia (BOOP) was reported in a 43-year-old African-American spice process technician working at a potato chip manufacturer.[4] BOOP, a restrictive lung disease, can be reversible with medical treatment (use of oral steroids) but if left untreated can be irreversible and disabling. The employee worked at the plant for 7 years and frequently complained of sneezing, nasal and eye irritation, and sinus congestion. The work included filling a misting device that sprayed spices onto potato chips. The work required manually pouring the dried spice mixtures into the feed hopper of the misting machine, then cleaning the machine with a brush and using compressed air. Dust masks apparently were available but were never used by the worker. Many different types of seasoning and spices were used in the machine including salt, pepper, onion, garlic, and paprika. The list of spice ingredients was not given and results of quantitative exposure assessments were not mentioned. The report concluded that there was an occupational association between BOOP and exposures to spice dusts in this case patient. The authors reported that to their knowledge no other cases of BOOP in spice workers have yet been identified.

The International Labour Organization (ILO) has reported that occupational dermatitis has been associated with exposures in the spice processing industry to mint, laurel, parsley, rosemary, and thyme as well as cinnamon, chicory, cloves garlic, nutmeg, and vanilla. The ILO Encyclopedia reports that respiratory symptoms including occupational asthma have been associated with dust exposures from Brazilian ginseng, parsley, black pepper, as well as cinnamon, cloves, coriander, garlic, paprika, chilies (presumably from capsaicinoid exposures) along with the bacteria and endotoxins in dusts from grains and herbs.[5]

Occupational exposure to paprika dust (and an occupational disease known as paprika-splitters lung) has long been known to cause hypersensitivity pneumonitis, which is a respiratory disease that causes inflammation of the lung tissues from exposure to organic dusts and allergens in exposed workers.[6] Inhalation of a chemical called substance P and capsaicin (the active ingredient in hot peppers and paprika) has been reported to cause a dose-dependant contraction of human bronchi in experimental studies. Inhalation of capsaicin in human volunteers caused dose-dependant coughing in subjects with mild asthma.

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Appendix B: Summary and Explanation of Local Exhaust Ventilation Systems

Local exhaust ventilation (LEV) systems typically consist of five components: a fan to produce negative pressure, ductwork to connect the system together, an air cleaner, a hood for collection of the emission at the point of generation, and a stack for discharge of the exhausted air. Two types of LEV systems are needed at the SSS. One system is needed to control dusts generated in the blending room and a separate system is needed to capture and control dusts generated by the grinder in the blending room. The types of systems recommended for the SSS include a downdraft system for the blending room, and an enclosure hood for the grinder in the grinding room.

Many types of industrial LEV systems are available; most include some type of "hood" or capture device that are generally classified by type including: enclosure hoods, capture hoods, or receiving hoods. LEV systems and hoods can be fabricated and installed by LEV designers and sheet metal shops or can be purchased commercially as a complete unit (hood, fan, ductwork, etc.). Traditional LEV hood designs include canopy (or receiving) hoods that are similar in shape and function to a standard kitchen range hood. This type of hood is normally only recommended for hot processes where thermal buoyancy (the tendency for hot gases or vapors to rise upwards) aids in capture of emissions at the face of the hood. Canopy hoods are specifically not recommended for situations where a worker's head can enter under the hood or come between where the air contaminant is generated (the source) and where the contaminated air enters the hood.

Enclosure hoods are designed and intended to enclose the process as much as possible, and using the negative (or static) pressure generated by the fan, contain process emissions from being released into the workroom air. These systems are often simply "boxes" consisting of sidewalls and a top that are engineered and configured to best fit the work process and the area where the emissions are being generated. Negative pressure generated from a fan keeps contaminants from leaving the enclosure hood.

Downdraft or sidedraft systems are capture hoods designed to pull contaminants away from the worker at the point of contaminant generation. Emissions are pulled downward, or to the side into a slot (duct) before they can be released into the workroom air. Downdraft/sidedraft systems typically are best suited for particulates released with a low velocity and that have some density. The advantages of downdraft or sidedraft systems are that the pollutant is pulled away from the worker's breathing zone and capture occurs as close to the point of generation as possible.

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