

Incense and Joss Stick Making in Small Household Factories, Thailand

S Siripanich^{1,2}, W Siriwong^{1,3}, P Keawrueang¹,
M Borjan^{4,5}, M Robson^{3,4,5}

Abstract

Background: Incense and joss stick are generally used in the world. Most products were made in small household factories. There are many environmental and occupational hazards in these factories.

Objective: To evaluate the workplace environmental and occupational hazards in small household incense and joss stick factories in Roi-Et, Thailand.

Methods: Nine small household factories in rural areas of Roi-Et, Thailand, were studied. Dust concentration and small aerosol particles were counted through real time exposure monitoring. The inductively coupled plasma optical emission spectrometry (ICP-OES) was used for quantitative measurement of heavy metal residue in incense products.

Results: Several heavy metals were found in dissolved dye and joss sticks. Those included barium, manganese, and lead. Rolling and shaking processes produced the highest concentration of dust and aerosols. Only 3.9 % of female workers used personal protection equipment.

Conclusion: Dust and chemicals were major threats in small household incense and joss stick factories in Thailand. Increasing awareness towards using personal protection equipment and emphasis on elimination of environmental workplace hazards should be considered to help the workers of this industry.

Keywords: Environment; Occupational exposure; Dust; Aerosols; Workplace; Risk assessment; Thailand; Incense; Joss stick

Introduction

Incense and joss stick have been used for various rituals throughout the world. The Egyptians and Babylonians started using incense for praying and religious ceremonies around 586–538 BC. Both the ancient Greeks and Romans used incense to drive away demons and to attract the gods. Then, Chinese and Japanese used incense sticks of various types at different occasions.¹ Nowadays, incense are made from a variety of perfumes and

chemicals, and extensively used for room deodorizers and repellents. Most of the incense products come from China, Vietnam, India, Cambodia, Bangladesh, and Thailand. The northern and northeastern parts of Thailand are among the largest centers for incense and joss stick production.

Incense sticks are normally made in small household factories; the process needs no advanced technology. In Thailand, many rural areas are suitable for incense making especially for incense dry-

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¹College of Public Health Science, Chulalongkorn University, Bangkok, Thailand

²Bureau of Epidemiology, Ministry of Public Health, Thailand

³Thai Fogarty ITREOH Center, Chulalongkorn University, Bangkok, Thailand

⁴School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ, USA

⁵UMDNJ School of Public Health, Piscataway, NJ, USA



Correspondence to
Wattasit Siriwong,
PhD, Assistant
Professor, College of
Public Health Science,
Chulalongkorn Uni-
versity, Phayathai Rd.
Pathumwan, Bang-
kok, 10330, Thailand
Tel: +66-2218-8231
Fax: +66-2251-7041
E-mail: wattasit.s@
chula.ac.th

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TAKE-HOME MESSAGE

- Incense and joss sticks are widely used in the world for praying and rituals. Most products are produced in Asia—China, Vietnam, India, Cambodia, Bangladesh, and Thailand.
- Raw materials used in incense and joss stick production process such as incense powder, saw dust and chemicals are harmful.
- Real time monitoring revealed high dust concentrations in all the production process. Many heavy metals were found in dissolved dye and incense products samples. Those included barium, manganese, lead, barium, cadmium, and nickel.
- The health hazards identified in the process included wood dust, mold, chemicals (heavy metals, aromatic compounds), unsafe machine and equipment, adopting awkward working postures, and low frequency of use of personal protective equipment.

ing.² The main ingredients used in making incense are wood powders including coarse sawdust, sandal wood, glutinous incense powder, fragrance powders, dye colors, and perfume oils. The small incense factories in the villages are usually operated in or near the house. Wood dust, the major hazard produced from the process, diffuses around the house and contaminates the environment. The dust may affect the health of workers and their family members residing in the house. Previous studies showed that chronic exposure to wood dust can affect the respiratory tract and cause asthma, and skin and eye irritation.³⁻⁷ Occupational exposure to wood is a well-established cause of various respiratory diseases and nasal cancer.⁸⁻¹² Moreover, numerous chemicals used in production of joss sticks—stains and perfumes—may affect the workers' health. For example dermal exposure to heavy metal residues such as lead, cadmium, chromium, manganese, *etc*, which is abundant in the chemical compounds has deleteri-

ous health effects.¹³ Long-term exposure to heavy metals has many multisystem effects such as headache, fatigue, arthralgia, abdominal discomfort, anemia, peripheral neuropathy, *etc*.^{20,21} Furthermore, perfumes used in the process are generally essential oils consisting of aromatics compounds that can cause asthmatic reactions, headache, dizziness, nausea, *etc*.²²⁻²⁴

Most of the previous studies devoted to the health effects of incense smoke. It was found that incense smoke inhalation is associated with lung cancer and asthma.^{14,26} It is also associated with an increased risk of leukemia in children whose parents had burned incense at home before pregnancy or during nursing period.¹⁵ There are only a few studies on the occupational health effects of incense and joss stick making.^{16,17} Liou, *et al*,¹⁸ found that the dust concentration in incense stick industries was as high as 42.7 mg/m³.

The present study was conducted to assess the environmental hazards in small household incense and joss stick factories in rural areas of Roi-Et, Thailand.

Materials and Methods

This cross-sectional study was conducted from October 2011 to March 2012 in Dong Deang village at Roi-Et province, Thailand. The village is the largest area for making incense and joss stick in northern Thailand. There were 21 factories in the region where incense and joss sticks were made manually, however, we only included small household factories with five or more workers and where all production steps, including mixing incense powders, rolling and shaking wood powders onto the sticks, staining sticks, spraying of aromatics, and packing were being done. From a primary survey, we found only nine small household factories that fulfilled the inclusion criteria.

The survey record form was adopted from the Canada Occupational Walk-

through survey form,²⁵ which consisted of a section on the main information such as the nature of process operation, material and quantities used, equipment and machinery, identified hazards, personal protective equipment (PPE) used, waste and environmental management, *etc.* Real time exposure monitoring by Dusttrak Aerosol Monitor 8520 (DustTrak™) was used to measure the concentration of aerosols and particles corresponding to PM10, according to the Division of Medical Engineering (DME), Ministry of Public Health (MoPH). Small particles and particles of chemical reaction were measured by Ultrafine Particle Counter 8525 (P-Trak™) for environmental assessment of the workplace. The measurements were made in four small household factories and a house from the same village for comparison where no incense making was taken place. The dust and small particles were measured at each production stage in all studied factories. The measurements were repeated for three times every 10 min for each stage. The microwave digestion method and analysis by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) was used for determination of heavy metals in dyes used in the process. The measurements were made for 10 dye samples and 10 incense products.¹³

Results

From the walk-through survey in the nine small household incense factories, we found that two types of incense sticks were made in the village—“*Toop Saad*” (ธูปศักดิ์) and “*Toop Fun*” (ธูปฟื้น); however, the most popular product was *Toop Saad*. The raw material for incense and joss stick making consist of bamboo stick, glutinous incense power that Thai people call “*Goow bowa*,” incenses wood powders, fragrances incense powder (sandal wood), color powder and perfume oil. This study has focused on

the process of manufacturing *Toop Saad* incense stick.

The process of joss stick making includes 1) bamboo cores preparation; 2) mixing various incense powders in a correct proportion; 3) rolling and shaking wood powders onto the sticks. In this step, a bundle of bamboo stick is immersed into water. The sticks are then rolled into incense wood powders. The layered sticks are then shaken so that the loose powders are removed. This step is repeated so that incense wood powders are firmly rolled on the sticks layer by layer to the desirable size. The sticks are left under the sun to dry. 4) The sticks are then dipped into an incense stain. Red and yellow paints are popular colors. The dyed sticks are then spread out once again and left under the sun to dry. 5) The last step is spraying aromatic perfume on the sticks and packing them (Fig 1).

Environmental Workplace Assessment

Out of the nine factories studied, six small incense and joss stick factories were located in a place where people live; three factories were only 10–50 m far away from residence place. Dust was the major hazard from the incense making process and spread around the house—even into bedroom and kitchen. Moreover, raw materials including chemical substances, incense colors, incense wood powder and aromatic oils were stored in the house, near bedroom or kitchen. None of the nine factories used waste management system. The quality of most of the materials used in the process, especially incense colors and aromatic perfumes, were low. Most of them were also unsafe so that they could spread into the environment and contaminate food and water.

There were 51 workers in the nine studied factories; 41 (80%) were male and 10 (20%) were female. Most of the male workers were involved in mixing the ingre-



Preparing bamboo cores for incense stick



Mixing different incense powders



Rolling/shaking wood powders onto the sticks



Drying



Dipping into incense colors and staining sticks



Spraying aromatic perfume



Packing

Figure 1: The process of incense making—“*Toop Saad*” method

dients, rolling and shaking the sticks, and dyeing and drying the incense, whereas most of female workers worked in wrapping and packing joss sticks. Personal protective equipment (PPE) was not used by all workers (Table 1). Some of the workers (especially those in packing section) took care of their children while working. Therefore, children may inhale the hazardous chemicals and particulate matters.

Dust and Particles Concentration Measurement

Real time exposure monitoring results are shown in Table 2. The dust concentration was high in all production stages, especially in rolling and shaking wood powders onto the sticks, packing and mixing process, where the mean±SD dust concentrations were 0.54±0.27, 0.48±0.16, and 0.31±0.18 mg/m³, respectively.

The mean concentration of small aerosol particles was the highest in aromatics spraying and packing units. There were 9018 particles/mL in aromatics spraying unit and 8603 particles/mL in the packing unit. The mean±SD dust concentration measured in four spots of the comparison house was 0.02±0.25 mg/m³; the mean±SD small particle count was 1465±21 particles/mL. The measured dust concentration and small particles count measured in small household factories were significantly (*p*<0.05) higher than the comparison house.

Assessing the Concentrations of Chemicals in Incense Products and Dissolved Dyes

Several heavy metals were detected in 10 dissolved dyes and 10 incense samples (Table 3).

Environmental Management and Waste Disposal

Assessment of environmental workplace and waste management in the nine fac-

Table 1: Personal protective equipment (PPE) used by the studied workers

PPE using	n (%)		
	Men (n=41)	Women (n=10)	Total (n=51)
Proper clothing (long sleeve shirt and trousers)	28 (68)	10 (100)	38 (75)
Gloves (cotton gloves)	1 (2)	2 (20)	3 (6)
Mask (cotton mask)	0 (0)	2 (20)	2 (4)
Hand washing before eat or drink	31 (76)	10 (100)	41 (80)
Bathing before lunch or dinner	16 (39)	4 (40)	20 (39)

ories by walk-through survey showed a large amount of waste and residual water, which remain from the incense making process. Most of the wastes and residual water originated from incense stick dipping stages, dyeing and dust or incense powders left on the floor. The waste water would be left around the house or used for watering of plants. Dyes were also stored in a container without covering and could be spread around the house or on the ground. All these put children at high risk of being exposed to various chemicals including heavy metals. Normally, the residual dust spreading on the floor and wall were not swept away or cleansed. The products were usually stored in the residence before distribution.

Identification of Hazardous Agents and Health Risk Factors

Wood dust and chemical substances were the major hazard that directly affected the workers, especially those who worked in the mixing process, rolling and shaking unit, and dyeing section. However, incense workers who worked in dyeing unit and aromatics spraying were at risk of being exposed to various chemicals, such as heavy metals and volatile organic compounds. Furthermore, working in an

Table 2: Results of the real time measurement for dust (PM10) concentration in four small household incense and joss stick factories and a house without such activities for comparison, Roi-Et, Thailand

Process	Dust (PM10) concentration (mg/m ³)		Small aerosol particle count (particles/mL)		Temp (°C)	Humidity (%)	Time
	Mean (min–max)	Mean±SD of means	Mean (min–max)	Mean±SD of means			
Mixing different incense powder (n=12)							
Factory 1 (n=3)	0.14 (0.04–0.33)	0.31±0.17	1900 (1750–2030)	2960±47	30	53	10:00
Factory 2 (n=3)	0.23 (0.060–0.35)		4930 (4870–4980)		32	44	10:00
Factory 3 (n=3)	0.33 (0.05–0.48)		2350 (2150–2480)		32	45	11:00
Factory 4 (n=3)	0.55 (0.15–0.84)		3050 (2880–3320)		33	49	11:00
Rolling and shaking (n=12)							
Factory 1 (n=3)	0.93 (0.04–2.51)	0.54±0.26	2380 (2290–2480)	2483±34	30	51	10:30
Factory 2 (n=3)	0.43 (0.410–0.45)		2740 (2670–2840)		32	43	10:30
Factory 3 (n=3)	0.46 (0.40–0.51)		2370 (2320–2440)		33	49	11:30
Factory 4 (n=3)	0.35 (0.30–0.41)		2460 (2380–2550)		33	50	11:30
Aromatics spraying (n=12)							
Factory 1 (n=3)	0.04 (0.03–0.04)	0.22±0.11	4170 (4060–4270)	9018±68	31	47	11:00
Factory 2 (n=3)	0.17 (0.09–0.15)		19 600 (18 980–20 040)		32	44	11:00
Factory 3 (n=3)	0.18 (0.05–0.26)		4900 (4720–5140)		32	49	12:00
Factory 4 (n=3)	0.14 (0.04–0.16)		7400 (7320–7500)		33	51	12:00
Packing and wrapping (n=12)							
Factory 1 (n=3)	0.53 (0.04–1.45)	0.48±0.16	4170 (4130–4220)	8603±54	31	53	11:30
Factory 2 (n=3)	0.63 (0.08–1.12)		16 520 (16 380–16 760)		32	44	11:30
Factory 3 (n=3)	0.40 (0.30–0.50)		5070 (4910–5220)		33	45	12:30
Factory 4 (n=3)	0.29 (0.04–0.42)		8650 (8300–9110)		33	49	12:30
Household without incense making factory (comparison, n=4)							
	0.02 (0.00–0.05)	0.02±0.02	1465 (1250–1750)	1465±21	28	54	09:50

Note: The ambient air quality standards for particulate matter (PM10) according to Pollution control Department, Ministry of Natural Resources and Environment, Thailand, is 0.12 mg/m³ (average in 24 hrs) and 0.05 mg/m³ (average in 1 year).

awkward working posture, and repetitive movements may lead to musculoskeletal disorders such as back and muscle pain. Moreover, working without PPE, eating while working or eating at contaminated workplace area, and smoking were other important factors that would cause health problems. Working with low information of good practise and good hygiene may cause occupational injuries, skin diseases, respiratory symptoms and others illnesses (Table 4).

Discussion

Occupational exposure to hazardous agents is important in causing illness among workers. In this study, we evaluated the environmental hazards in nine small household incense and joss sticks factories in *Dong Deang* village, Roi-Et province, Thailand. The results showed that in the studied household factories the process was substandard; the working environment was unsafe; there were nu-

Table 3: Concentration of chemicals in dissolved dyes and incense sticks, in the studied small household factories, Roi-Et, Thailand. The measurements were made by inductively coupled plasma optical emission spectrometry (ICP-OES).

Heavy metals	Mean±SD concentration	
	Dissolved dye (mg/L) (n=10)	Incense sticks products (mg/kg) (n=10)
Barium	1.60±0.15	1.30±0.29
Cadmium	0.17±0.10	0.08±0.03
Chromium	1.34±0.13	0.89±0.10
Manganese	1.12±0.01	0.87±0.13
Nickel	0.64±0.08	0.99±0.19
Lead	0.90±0.05	0.95±0.03

merous environmental hazards; workers as well as non-workers (*eg*, children) who lived in the same place, were exposed to various types of dusts, different chemicals, heavy metals, residual water and wastes. Real time exposure monitoring revealed

Table 4: Health hazards identified in the studied small household factories, Roi-Et, Thailand

Unit	Hazard	Risks and health effects
Preparing bamboo cores for incense stick	Machine and equipment Working posture	Wound/Muscle and back pain
Mixing incense powders	Wood dust	Respiratory disorders such as nasal congestion, runny nose, asthma, eye irritation, and skin disorders (rash, itching, dermatitis)
Rolling and shaking wood powders onto the sticks	Wood dust, mold Working posture	Respiratory disorders such as nasal congestion, runny nose, asthma, eye irritation, skin disorders (rash, itching, dermatitis), and muscle, back, and wrist pain
Dipping sticks into an incense dye and drying them	Wood dust, mold, working posture, chemicals (heavy metals), heat	Respiratory disorders such as nasal congestion, runny nose, asthma, eye irritation, skin disorders (rash, itching, dermatitis), and muscle, back, and wrist pain Neurological signs (dizziness, faint, headache) Heat stroke
Spraying aromatic perfumes and packing the joss sticks	Wood dust, mold, Working posture, chemicals (heavy metals, aromatic compounds)	Respiratory disorders such as nasal congestion, runny nose, asthma, eye irritation, skin disorders (rash, itching, dermatitis), and muscle, back, and wrist pain Neurological signs (dizziness, faint, headache)

that the dust (PM₁₀) concentrations were high in all stages of the production. This was consistent with previous studies conducted in Taiwan that showed the concentration of total dust in a large incense stick factory was very high, particularly in the mixing and rolling stage of sticks (9.9–42.7 mg/m³). The total dust concentration in mixing unit in Japanese incense and coil incense factory was 9.9–31.1 mg/m³.^{16,18} The mean concentration of dust (PM₁₀) in recorded in our study (Table 2) was higher than the mean dust concentration reported in real time monitoring in a tobacco factory, Bangkok, Thailand (0.37 mg/m³).¹⁹

Health hazards associated with wood dust exposure have been described in previous studies. Occupational exposure to wood dust has been shown to cause respiratory diseases, asthma, nasal cancer and skin irritation.³⁻⁷ Heavy metals, which were detected in the process of incense production, have various deleterious health effects. In particular, long-term exposure to lead has serious health effects on developing a children.^{20,21} Many perfumes used in incense production is a mixture of fragrances such as essential oils and aromatic compounds. It is shown that some fragrances can cause asthmatic reactions in some individuals, especially in those with severe or atopic asthma, and can cause headache, dizziness, nausea, *etc.*²²⁻²⁴

Inappropriate working behavior and adopting awkward working posture are other factors influencing the health of incense makers.^{10,18} In spite of the presence of a high concentration of dust and other pollutants in the environment, only few workers used PPE (Table 1).

We found that incense production process in small household factories in Thailand is running under unstandardized and unsafe conditions. Waste from the process was not suitably controlled and managed. We should increase the awareness of workers working in such industries of en-

vironmental hazards and encourage them to use PPE. Further studies are needed to shed more light over health of workers and children who live in household factories.

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