THE EFFECTS OF CEREMONIAL SMUDGING ON INDOOR AIR QUALITY

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Abstract

Last year the researcher experimented to see if smudging (burning) the four sacred medicines (sage, sweetgrass, cedar, and tobacco) emitted carcinogens. Sage is the most commonly smudged of the sacred medicines and used traditionally to clean the air. The researcher wanted to determine if indoor air quality was negatively affected by smudging sage. It was hypothesized that the smudging of sage would negatively affect the indoor air quality, but not be over EPA standards, and that sage from different locations would have different results. Sage for smudging was obtained from individuals--all sage was to have been smudged if it wasn't used in this research. Samples came from South Dakota, Minnesota, and California. The sage was burned in a box with an air sampling pump.

The hypothesis was rejected on both parts Except for one result that was likely an error, Sulfur dioxide, Lead, Nitrogen dioxide, and total oxidants for all samples came out essentially as zero. Carbon dioxide and Selenium were at safe levels according to EPA standards. For Particulates every single test was above the EPA's 35 µg/m3 standard. The National Ambient Air Quality Standards (NAAQS) are standards established by the US EPA to protect the public health from the 6 criteria pollutants (US EPA, 2006). Sage from different locations all yielded similar results.

These particles could cause all kinds of health concerns as they enter into the blood stream and lungs such as difficulty breathing, asthma, lung and heart diseases, and even death for those with preexisting heart problems. People who follow the traditional Native American ceremonies should be aware of the risks associated with smudging indoors.

Purpose

Last year the researcher did a project on carcinogens produced through smudging (burning) the four sacred Native American medicines, which includes sage. The year the researcher wanted to look more into how sage specifically affects indoor air quality.

Question

- How will smudging sage affect the indoor air quality?

Hypothesis

- The smudging of sage will negatively affect the indoor air quality, but will still be within safe levels established by the EPA.
- Sage from different sources will have different results.

Background Research

According to the EPA there are six common air pollutants: ozone, particulate matter, carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. Ozone is a respiratory irritant produced by equipment that uses high voltage electricity smudging sage won't emit ozone so this was not tested. Smoke from smudging sage won't emit carbon monoxide because carbon monoxide is a normal constituent of exhaust gases from incomplete combustion. Smoke from smudging sage was tested for the most common air pollutants that it could give off.

These are the standards established by the EPA. Image from: epa.gov

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 FR 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 μg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 FR 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	$PM_{2.5}$	primary	Annual	12 μg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Smudging

Smudging is the Native American practice of purifying yourself and/or your surroundings. You do this by balling up the sage, placing it inside a conch shell, lighting the sage on fire then blowing it out so that only smoke remains, and then pushing the smoke towards someone or something using a eagle feather or your hands. In our school we smudge at least three times per week in rooms that are approximately 20’x20’x10’. In Minnesota we are more likely to smudge indoors than outside.

Methods/Testing

The first step was to make a container to trap and keep the smoke. This container was made with a plastic crate wrapped with cling wrap. The container measures two feet cubed (226.53 Liters). Only five sides were wrapped with the wrap, the bottom was not.

The sage, Bashkodejllbik (White Sage: *Artemisia ludoviciana*), was obtained from people and schools. All of the sage would otherwise have been smudged in ceremony indoors. Measure 5 g of each of the sage samples twice. Each sample was placed into a fire safe container. An air-sampling pump was also placed into the container, filled with 75 mL of the specific absorbing solution and turned on. Testing was begun with one ball of sage (5 g sample). A portion was lit on fire, put out by blowing on, an allowed to begin smoldering. At this point the sage was put in the fire safe container in the box and into a fume hood. The sage was left in the container for one hour and allowed to smolder. When one hour had ended, all testing materials were removed and the smell dissipated. The absorbing solution was removed from the air-sampling pump and divided into the parts needed for testing.

During these tests goggles and gloves were worn and testing was done under a fume hood in the science lab.

Smoke was tested for particulates, nitrogen dioxide, carbon dioxide, total oxidants, sulfur dioxide, lead, and selenium using a particulate filter, spectrophotometer, and titration testing. Results were converted into the amount in a classroom 10’x20’x20’.


Vince South High
Center S
Northland Visions
Vince South High

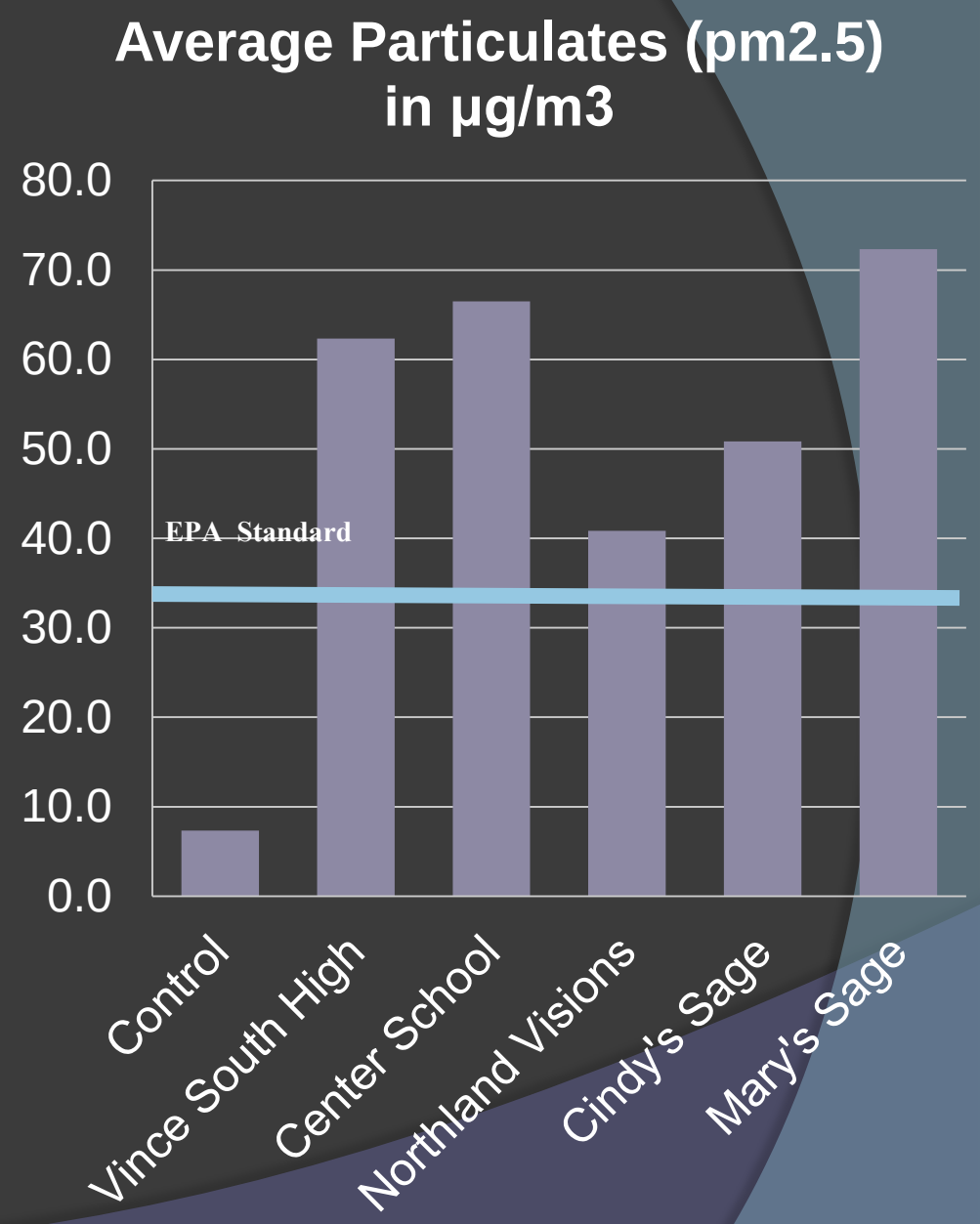
Results

The test results were converted to be for a 10’x20’x20’ room (a typical classroom at Center School

	Lead (in ppm)	Nitrogen dioxide (ppm)	Sulfur dioxide (in ppm)	Particulates (pm 2.5) in µg/m3			Selenium in mg/L			Total Oxidants (in ppm)	Carbon dioxide (in ppm)
	Trial 1	Trial 1	Trial 1	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 1
Control	0	0	0	7	7	8	0.01	0.01	0	0	600
Vince South High 1	0	0	0	58	59	65	0.01	0.01	0.01	0	700
Vince South High 2	0	0	0	62	63	67	0.01	0.01	0.01	0	900
Center School 1	0	0	0	62	65	68	0.01	0.01	0.01	0	500
Center School 2	0	0	0.03	71	68	65	0.01	0.01	0.01	0	400
Northland Visions 1	0	0	0	42	40	46	0.01	0.02	0.01	0	300
Northland Visions 2	0	0	0	35	40	42	0.02	0.02	0.02	0	800
Cindy's Sage 1	0	0	0	52	51	47	0.01	0.01	0.02	0	500
Cindy's Sage 2	0	0	0	52	53	50	0.02	0.03	0.01	0	400
Mary's Sage 1	0	0	0	72	71	76	0.02	0.01	0.02	0	500
Mary's Sage 2	0	0	0	69	72	74	0.01	0.01	0.01	0	600
Average for Sage	0	0	0.00	57.5	58.2	60.0	0.01	0.01	0.01	0.00	560
Standard Deviation	0	0	0.01	12.3	11.8	12.5	0.00	0.01	0.00	0.00	190

Results cont. Particulates

Average Particulates (pm2.5) in µg/m3	
Control	7.3
Vince South High	62.3
Center School	66.5
Northland Visions	40.8
Cindy's Sage	50.8
Mary's Sage	72.3



ANOVA Results—to see if there was a significant difference between the different samples of sage.

ANOVA

Particulates

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3845.533	4	961.383	106.426	.000
Within Groups	225.833	25	9.033		
Total	4071.367	29			

ANOVA

Carbondioxide

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	163750.000	3	54583.333	6.238	.055
Within Groups	35000.000	4	8750.000		
Total	198750.000	7			

ANOVA Results Cont.

To be a statistically significant difference the Sig needs to be over 1.0 in an ANOVA. Lead, Nitrogen dioxide, Sulfur dioxide, Selenium, and total oxidants were essentially the same so no statistical analysis was done. The ANOVA revealed that there was no statistically significant difference between the sage samples for Carbon dioxide or particulates. Thus the second hypothesis, that there would be difference between different samples of sage, is rejected.

Impact

All of the particulate levels were above the EPA recommended. Everyone who practices Native American traditional ways should be aware of health risks involved in smudging indoors. This way they can inform people who participate in smudging and not risk their health to participate in their traditions.

Everyone should understand these risks so that no one finds it disrespectful for someone to leave during indoor smudging and so that people can advise others. Smudging could also take place out doors or in rooms with better ventilation. The current way in which we smudge at school is placing our students at risk.

Conclusion

The two hypotheses were that the smudging of sage would negatively affect the indoor air quality, but that it would still be within EPA guidelines, and that different types of sage would have different results. Both hypotheses were disproven.

Lead, Nitrogen dioxide, and total oxidants for all samples came out essentially as zero. For Sulfur dioxide, one sample test came out 0.03 ppm, but that could just have been an error during the test as the other trial of the same sage came out 0, as did the others. Carbon dioxide and Selenium were at safe levels according to EPA standards.

Conclusion Continued-- Particulates

- For Particulates every single test was above the EPA's 35 µg/m3 standard. The National Ambient Air Quality Standards (NAAQS) are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). The US EPA established a more protective standard for fine airborne particles. The EPA's standard for small sized particulates, the size produced by burning sage, (PM2.5) standard requires air particle levels be maintained below 35 µg/m3 over a 24-hour average (US EPA 2006).

- According to the EPA:

  Particle pollution - especially fine particles - contains microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. Numerous scientific studies have linked particle pollution exposure to a variety of problems, including:

  - premature death in people with heart or lung disease,
  - nonfatal heart attacks,
  - irregular heartbeat,
  - aggravated asthma,
  - decreased lung function, and
  - increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

  People with heart or lung diseases, children and older adults are the most likely to be affected by particle pollution exposure. However, even if you are healthy, you may experience temporary symptoms from exposure to elevated levels of particle pollution.

Sources

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