

PM 2.5 particles produced by cooking eggs in three types of oil

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Question

Which oil produces the least amount of PM 2.5 particles when cooking an egg on a stovetop?

Background Information

Cooking indoors is a major source of harmful PM 2.5 particles. Exposure to high levels of PM 2.5 has been linked to cause nonfatal heart attacks, aggravated asthma, and premature death in people that have heart or lung problems. The average household exceeds the health standards for PM 2.5 exposure due to cooking, candles, and smoke. The higher the temperature when cooking, the higher emissions of PM 2.5. Studies have shown that olive oil has the largest average cooking emissions of PM 2.5. Pan size and cooking surface area also affect the emissions from different oils.

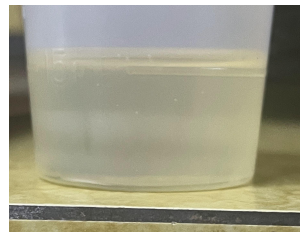
Hypothesis

Our group predicts that the oil with the least amount of PM 2.5 will be butter due to research done on the topic.

Method

Our first action was to gather all of the necessary materials

- 30ml of olive oil, liquid butter, and vegetable oil
 - A square, non-stick, copper pan. 9 3/4 by 9 3/4 inches
 - A stovetop
 - 6 free range chicken eggs
 - Constant temperature at 65 degrees Fahrenheit
 - Timer
 - WYND Air Quality Sensor
- Our Procedure
- Put 15ml of olive oil in the pan at half heat (150-170 degrees)
 - Record PM 2.5 levels at intervals of 30 seconds
 - Heat oil for four minutes
 - After four minutes is over put egg in pan on same heat for another four minutes
 - Two minutes in to timer, flip egg once
 - After four minutes is over turn heat off and let egg sit for another four minutes
 - As soon as heat is turned off, flip egg one last time
 - Repeat procedure with all types of oils for a total of two tests per oil
 - Add data collected to graphs that show overall experiment
- Control Variables
- Temperature
 - Pan
 - Cooking Temperature
 - Egg type
 - Time for experiment
 - Amount of cooking substance
- Dependent Variables
- PM 2.5 concentration
- Independent Variables
- Olive oil
 - Vegetable Oil
 - Butter



Conclusions

During this project our group made many discoveries and conclusions about household cooking and the oils used while doing so. The biggest one was that people should start using butter instead of olive oil and vegetable oil when cooking eggs in the kitchen. According to Statista.com, over 95 percent of the U.S. population eats eggs. If everyone of those people switched to using butter instead of olive oil or vegetable oil then the amount of PM 2.5 pollution would be greatly decreased within households. This would then decrease the intensity and amount of side effects.

References

1. "U.S.: Consumption of Eggs 2020." *Statista*, www.statista.com/statistics/280958/us-households-consumption-of-eggs/?msclkid=0f40a48ecf0811eca09d5e682f98c8e9. Accessed 8 May 2022.
2. US EPA, OAR. "Health and Environmental Effects of Particulate Matter (PM)." *Www.epa.gov*, 26 Apr. 2016, www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm?msclkid=ff148764cefb11ec9bbcc9db7f15c781. Accessed 8 May 2022.
3. Hu, Tianchao, et al. "Compilation of Published PM2.5 Emission Rates for Cooking, Candles and Incense for Use in Modeling of Exposures in Residences." *Www.osti.gov*, 1 Aug. 2012, www.osti.gov/servlets/purl/1172959.

Results

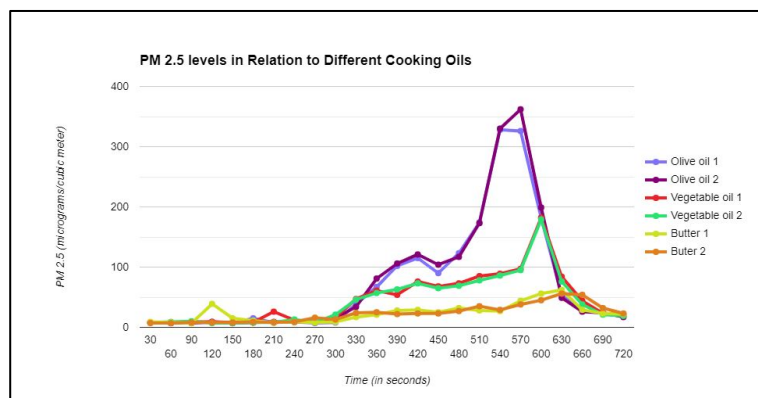
After the experiment the results showed that butter even though not the healthiest to consume, produced the least amount of PM 2.5 particles. Olive oil produced the largest amount and vegetable oil sat in the middle. All of the substances seemed to climb significantly in PM 2.5 production after the second flip of the egg. Every oil also had at least one small spike in the heating stage. We believe this to be because of the small bubbles in the oil popping, releasing PM 2.5. Butter stayed relatively low the entire time unlike the olive oil and vegetable oil tests. This discovery could be due to the fact butter is considered a dairy product. These revelations within the experiment showed us that butter is the safest cooking substance to use while frying an egg.

- Potential Errors in Experiment
- potential oil spillage
 - the amount of time it took to flip the egg

- Ways to Improve Our Experiment
- Run more tests
 - Change controls to see if it has any effect on experiment
 - Run tests on different types of stovetops



Graphs



At 240 seconds, the egg was put in the pan.

At 480 seconds, the heat was turned off the pan.

The Y-axis was changed based on the highs and lows of the tests.

Each graph, with the exception of graph one, contains the data for two tests of the same oil.

Since each test was twelve minutes long, the 720 seconds represents that number.

The data was recorded at intervals of 30 seconds.

