How to Reduce Oil in French Fries: A Student Experiment

Hervé This vo Kientza1,2
1 Université Paris-Saclay, INRAE, AgroParisTech, UMR 0782 SayFood, 75005, Paris, France
2 Group of Molecular Gastronomy, INRAE-AgroParisTech International Centre for Molecular Gastronomy, F-75005, Paris, France

It appears that the rise in obesity worldwide is linked to overconsumption of energy-dense nutrients, as well as reduced physical exercise, especially in cities. In particular, consuming too much fried food can be unhealthy, not only because of the richness of such products in saccharides but also because of oil consumption. Moreover, poorly fried food can result in the consumption of dangerous compounds such as acrylamide (see the chapter on frying by Pedreschi).

Here, we propose a simple demonstrative experiment (This, 1999) that can both show how a good frying technique can avoid oil consumption and also indicate that, in contrast to what has been published for a long time, the roughness of fried products is less important for oil uptake during frying than water condensation.

Protocol
The experiment is simple, cheap, and easy to implement: only a balance is needed in addition to the usual culinary tools. Here it is:

1. Peel a potato.
2. Cut it into parallelepipeds about 10 × 1 × 1 cm.
3. Heat oil (e.g., in a pan, or in a special frying system, or in a beaker on lab heating equipment).
4. When the temperature is about 180 °C, select two potato parallelepipeds, and weigh them; cut the heaviest so that the masses are about the same (a precision of 0.1 g is enough, as we shall see), and record the final measurements.
5. Prepare a large quantity (about 20 sheets) of absorbing paper.
6. At the same time, put the two parallelepipeds into the hot oil and record the phenomena: bubbles flowing out of the potato tissue; this steam condensing on the wall of a cold glass that you put over the oil bath; potato parallelepipeds first sinking, then floating; progressive disappearance of the many jets of bubbles; with bubbles flowing only from one to ten places.
7. When the two French fries are golden in colour, take them out of the oil at exactly the same time and immediately sponge the first one carefully, while you put the other on a plate.
8. After 2 minutes, sponge the second French fry as carefully as the first.
9. Measure the mass of the two French fries.
10. Repeat the experiments for other parallelepipeds, and calculate the standard deviation for all recorded masses.

Results
The last step is included for best practice, but indeed, the result does not need it; for a 10 g initial mass of potato, there is between 0.5 and 1 g difference in mass between the two potato sticks, with a lower mass for the French fry that is carefully sponged immediately after frying. As the two French fries are otherwise submitted to the same process, it means that this is a difference in oil absorption, and indeed, another experiment, measuring the pressure inside the potato parallelepipeds, shows that the pressure increases with time inside the French fries, which explains the flow of steam during frying, preventing oil from getting inside.

In order to make such measurements, ready-to-use equipment is available, certainly, but a good idea of the pressure increase can be obtained by connecting a Pasteur pipette to a U-tube filled with oil. The difference in levels can lead to the determination of pressure. Using such equipment, it can be observed (Figure 99.1) that the pressure increases regularly at the centre of the French fries, but after the potato sample is out of the bath, the pressure stops increasing and decreases after about 2 minutes. This can be correlated with the recording of the temperature of the inside tissue of potatoes, which can be made by inserting a thermocouple into the parallelepipeds at various places; in this way, it can be observed that the temperature inside the potatoes remains below 100 °C except at the limit of the crust (Figure 99.2).

The interpretation of all these phenomena is clear: with the potato tissue (80% water) in the oil at a temperature higher than 100 °C, its water boils, and this creates a large volume of steam (assuming that 18 g of water generates 24 L of steam, it can be calculated from the mass variation of French fries that about 30 L of steam is produced for one parallelepiped: this prevents oil from coming inside the fries).
For the fry that is not sponged immediately, the condensation of the steam inside the fried system (cutting a French fry transversely shows a lot of space filled with gas) sucks the oil inside, and this can be very important for public health. Now, one should also know that a triangle test organized during one of the monthly seminars on molecular gastronomy in Paris showed that the jury were able to recognize the French fries that had been sponged, but preferred the more oily fries!

REFERENCES