

**In the spirit of adventurous inquiry, pose your own question or choose one of our past prompts. Be original, creative, thought provoking. Draw on your best qualities as a writer, thinker, visionary, social critic, sage, citizen of the world, or future citizen of the University of Chicago; take a little risk, and have fun.**

## **Making Mustard the STEM Student Way**

Being a self-proclaimed chef, I am always trying to recreate my favorite store bought food items from scratch. Lately making mustard has been an obsession of mine, and strangely I find my STEM knowledge helping me tremendously in the process.

Like the procedure of every scientific lab, planning goes first. I took out my recipe book and proceeded to write the “pre-lab”. “Section 1.1: materials.” I googled my favorite mustard - Kosciusko’s Spicy Brown Mustard - and added all of its ingredients (except for the thickener and preservative) to my Amazon cart. The next step seemed unclear - how do I make smooth, spreadable, spicy yet mild mustard from these tough, grainy, bitter and unappetizing mustard seeds? Well, they sure need some form of deconstruction - I don’t have a blender, so a mortar and pestle will make do. But how do I cut the bitterness but preserve the spice? Could it be vinegar? Salt?

Water? In addition, I found two very different methods of masking mustard on the Internet, one telling me to grind the seeds dry, the other telling me to grind them after they were soaked in water. But what is the difference? Why is there a difference? I wrote down all my questions, excited to find out the answers later.

I started the lab with two trials, each with the same amount of water, seasonings (salt and vinegar), and dried mustard seeds. In trial one, I soaked the seeds overnight with part of the pre-measured water and grinded them while it was wet. The grinding process was such a hassle: wet seeds were so slippery in the mortar that my pestle rarely touches them. The rest of the water, as well as salt and vinegar, was then immediately added. The end product was a rough, grainy paste without much flavor. Trial two was no better: the grinding process was significantly easier so I had to grind the seeds into a thin powder, but its taste was unpleasant. It was way too bitter, and it left an unpleasant aftertaste no amount of water could chase down.

“What went wrong?” I wrote in my notebook’s comment section: “Trial one definitely had some of the spicy mustard flavor without the unpleasant bitterness. Since the only difference between trial one and two was soaking, the mustard seeds’ longer time in water definitely helped develop a better taste.” But what was special about water? What exactly did it do to the bitter mustard seeds so they become spicy and flavorful? Wanting to seek the answer, I went online, trying to research for any chemical reactions explaining that change.

Apparently, the extraction of the spicy, nasal clearing flavor from the mustard seed requires an activation of its secondary metabolite, glucosinolate, by the enzyme, myrosinase. The two molecules - glucosinolate and myrosinase - are typically stored in separate plant cells, so grinding the seeds finely is key to extracting them from the cells and mixing them together. The water is another key

reactant in the process: without it, the sinigrin (the type of glucosinolate in brown mustard seeds) would not become allyl isothiocyanate (the chemical compound giving mustard the “kick”). “The reason why trial two taste so bitter is that the water is added too late, not allowing the reaction to proceed completely”, I wrote, “So what I should do next time is to grind the seeds finely first, producing maximum surface area for higher reaction rate, then soak them in water for 40 minutes and only adding seasoning at last, ensuring the enzymes are not denatured by low pH and high salinity”.

With all this newly learnt knowledge, I conducted my second mustard lab. The result was amazing: I was able to create an amazing spicy brown mustard with perfect seasoning and just enough kick of spice. Reflecting back on the mustard lab in my notebook, I realized just how important a role my scientific knowledge played in the process: I learnt about factors influencing reaction rates in AP Chemistry - without this knowledge I wouldn't have known how to improve trial one's flavor; I learnt about the anatomy and functionality of enzymes in AP Biology - without this knowledge I wouldn't have known what made trial two so bitter... Most importantly, I learnt about the scientific methodology of conducting experiments - the most vital component contributing to the success of my mustard lab.

Now a self-proclaimed mustard master, I went on and created many more batches of mustard - honey yellow, french dijon, and even a wasabi K-BBQ flavored one. Mustard making not only provided me with unlimited amounts of delicious condiments, but also helped me see how I can apply my STEM knowledge to my day-to-day life.

I invite you to try making your own mustard too!



Figure 1: On the left stands the KBBQ inspired wasabi mustard (as labeled), and on the right stands a swirl of classic yellow mustard and spicy brown mustard.