WCCTA 2016 <u>Miniworkshop: Molecular Cuisine to Make Science Palatable (Foams)</u>

Experiment 1A: Beating egg-whites – denaturation (physical force)

One egg white

(from fresh egg, preferably at ambient room temp; do not use packaged pasteurized egg white) Whisk in bowl

(without/with acid additive, lemon juice, vinegar, cream of tartar or in copper bowl)



In a simple example/ demonstration of beating egg whites there are many significant lessons: from composition - fats, cholesterol, proteins, to physical denaturation where the energy from whisking and collisions are transferred, breaking the bonds and unfolding the proteins, introducing air and an air-water interface that orients the protein parts (hydrophobic unfolded and hydrophilic) causing them to form a network trapping the air bubbles in a foam. This can be taught with more or less chemical sophistication depending on students' backgrounds. As the unfolded proteins bond to each other (ionic,

hydrogen bonding, hydrophobic and disulfide bonds), the sulfur atoms in the proteins can form disulfides but can be kept apart to stabilize the foam to maintain 'stiff peaks', by capping them with a free H+ ion ('reducing') - from tartaric acid (a dibasic acid) or cream of tartar (the monopotassium salt of tartaric acid) or even a little bit of lemon juice or vinegar (citric or acetic acids). Without the acids, the disulfide bonds may form between proteins leading to aggregation that leads to the protein matrix squeezing the water out – overbeaten egg whites (especially without acid) begin to 'weep'

Concepts can also be readily extended in their scientific detail (pKa, strong and weak acids, etc.) and extrapolations to other concepts and ideas for the science majors. Laboratory portion: make egg white foams by whisking with different acids (lemon juice, vinegar, cream of tartar) or in copper bowls and examine the difference(s).

Flavored egg white foam can be further heat denatured (cooked)

Experiment 1B: Vauquelin* (via Hervé This)

35g fresh egg white

45g powdered sugar

2g dry egg white

35g (flavored) liquid [or use a flavored syrup – rather than thin liquid, or whisk in at end, crushed/powdered (in blender) freeze dried-fruit powder]

Whip egg white first before adding sugar + dry white, in portions; add liquid – whip till 'stiff peaks'. This may require motorized whisk.

Spoon (some of) foam onto dish/bowl – heat in microwave (900w) for 15-20s (excessive microwaving will cause foam to collapse)

*named after Nicolas Vauquelin (1763–1829), one of Lavoisier's teachers

Experiment 2A: "Air" (with lecithin)

100 ml (or g): liquid 0.2 - 0.5 g soy lecithin (prinicipal component is phosphatidyl choline) [available at GNC or online] Equipment: battery powered frother (Ikea or online – about \$3 to \$6 each)

Whisk air into liquid with frother; square container works better. Lecithin (emulsifier) stabilizes foam that can be spooned off. Note: As most of the foam is 'air' – this works better with strongly flavored liquids

Experiment 2B: Chocolate Chantilly/Mousse [with flavor]

(via Hervé This)

100 g chocolate (chopped into small pieces) 95 mL or g liquid to flavor

Heat half the liquid and chocolate in microwave (~1min on full power), mix to ensure that all chocolate is melted. Place bowl with melted chocolate and liquid over ice-water bath. Whisk *vigorously* (careful: do not let ice-water get in and contaminate chocolate mix) - to incorporate air till chocolate starts to thicken. Remove bowl from ice-water, continue to whisk till consistency of heavy cream and soft 'peaks' form.

Should take 9 mins or so. Careful – will stiffen/harden quite fast after soft peaks stage – so remove from ice-water when (almost) at soft peaks and continue whipping.

How this works: The chocolate bar already has lecithin in it, which helps emulsify the chocolate fat and (flavored) aqueous phase along with some air incorporation.

This is *fail-proof*. If the consistency is too soft and mixture is too fluid, it needs more chocolate – add, melt and restart whisking. If the mixture is too hard, then add more liquid, melt, and re-whisk.

Some differences in consistency will arise due to differing acidity etc. of the liquid. Some liquids that work well: coffee, lemonade, ginger beer, cranberry and/or pomegranate juices (and related blends), watermelon.

When using juices, take care not to use already very sweet juices as the final product will be too sweet.

Alternatively, powders – such as chile* (chipotle, ancho or others including mixtures) or "curry" work too – just add powder to heated and melted chocolate+water.

*Do not use hot sauces. Tried that so you don't have to. Vinegar from sauce will assault you