Lab: Determination of Citric Acid in Bubble Gum

Introduction

Bubble gum is a mixture of several chemicals, but rubber is the most important. A good bubble gum must be strong enough to stretch to a thin film without breaking, but still be soft enough to chew easily. That's a tall order. The other chemicals in bubble gum - resins, waxes, fillers, flavors, sugar, humectants, and emulsifiers - are all there either to provide flavor or to modify when and by how much the rubber stretches. Rubber molecules are polymers, which are long chain-like molecules formed when many smaller molecules bond together end to end. A natural polymer called latex, which is from trees, used to provide the stretchy part of bubble gum. Now many gum companies use a synthetic, food-grade version of the same rubber that goes into truck tires! This polymer is a mixture of styrene and butadiene and is abbreviated SBR.

Of the 20 or so chemicals in bubble gum, some dissolve in water and some do not. Most of the water-insoluble portion of bubble gum is called "gum base". That's where the rubber is. Some of the additives in the gum base actually restrict the size to which the bubbles can be blown on purpose, so as not to completely alienate parents! The most intense fragrances and flavorings in fruits are often essential oils like limonene (which is from orange and lemon rinds). They are well suited to gums because they are not water soluble and do not dissolve out of gum in your mouth. Gum does seem to lose flavor after a while, but that is usually because the sugar, which intensifies the fruit flavor, has dissolved after about 20 minutes.

Chemists must think of not only how the gum tastes and how big the bubbles get, but also how it feels in the mouth. It must soften without getting gooey, take up water without dissolving, and keep its flavor for as long as possible. On top of all that, it must not dry out on store shelves, should not stick to the wrapper, and be easy to work with in the factory. Chemists know how to tweak all the ingredients to make a formulation that is just right; who knew a simple thing like gum could be so complicated!

Reference: Gail Marsella, ChemMatters, October 1994 (American Chemical Society, 1155 16th St., N.W.; Washington, DC 20036).

Citric acid (as its monohydrate) is added to food products to give them a sharp, acidic taste. It is a food additive that is used to impart a sharp flavour in many types of gum such as BUBBLICIOUS. Bubblicious is Canada's #1 selling Bubble Gum.

Gum Base + Softener + Sweetener (sucrose) + Flavour + Colour —> BUBBLE GUM

The determination is based on an acid/base reaction between the citric acid in the bubble gum and standard sodium hydroxide. The percentage of citric acid in the bubble gum can be calculated from the titration results.

Materials

0.100 mol /L sodium hydroxide solution (IRRITANT)
Phenolphthalein indicator solution (0.2% in ethanol) (HIGHLY FLAMMABLE).
2 x pieces of Bubble gum

Apparatus

2 x 250 mL graduated flasks
Magnetic stirrer
50 mL burette reading to nearest 0.05 cm^3 with clamp, stand

Procedure

1. Take one piece of flavoured Bubblicious bubble gum, unwrap it and place on the bench.
2. Roll the gum into a very thin strip approximately 160 x 30 x 0.5 mm. Cut the thin strip into small pieces about the size of long grain rice.
3. Mass out two 1.00 g samples of gum bits and add to two separate 250 mL flask.
4. Pour 100 mL of distilled water into each flask. Add a magnetic stirrer to both and stopper. Stir vigorously for 30 minutes making sure the bubble gum bits do not stick together.
5. Add a few drops of phenolphthalein indicator solution and titrate with 0.1 mol/L sodium hydroxide contained in a 50 mL burette. The end-point is when a pink colour appears and remains after 15 seconds. Record the volume of titrant.
6. Repeat once more and average the results.

Data Table

Titration	1	2
Initial Volume of titrant (± 0.05 cm^3)		
Final Volume of titrant (± 0.05 cm^3)		
Volume of titrant used (± 0.10 cm^3)		

Data Processing

1. Average volume of titrant (0.1 mol/L NaOH) used = mL = L
2. Calculate the number of moles of NaOH used =
3. Citric acid monohydrate, $C_6H_8O_7 . H_2O$, reacts with sodium hydroxide, $NaOH_{(aq)}$, in a mole ratio of 1:3 for this neutralization reaction, [$C_6H_8O_7 . H_2O$: NaOH = 1:3]. Thus, from the number of moles of NaOH used by you in (2) above, calculate the number of moles of citric acid monohydrate consumed in the neutralization reaction.
4. Knowing the number of moles of citric acid monohydrate, you made a solution of 100 mL, hence calculate the concentration of citric acid monohydrate in the 100 mL sample, (assume that all citric acid monohydrate is dissolved in the water).
5. The formula of citric acid is $C_6H_8O_7 . H_2O$, using the number of moles of citric acid monohydrate determined in (3) above, calculate the mass of citric acid. This is the mass of citric acid in the 1.00 g sample of the bubble gum prepare by you.
6. Determine the citric acid content as a percentage by mass (m/m: grams per 100 grams).

Conclusion

Write a conclusion, and state 2-3 sources of error.