The Antacid Effect

Chicken Biryani: Stimulating stomach acid production has never been more delicious!

Introduction

You certainly know what an acid is, and can no doubt give examples. Many of the foods we eat routinely are acidic, we know that our car batteries contain acid, and many popular face creams contain mild acids which allegedly renew and restore our youthful complexions. There are an equal number of common household chemicals that are basic: bleach, drain cleaner, baking soda, most soaps and detergents. While we tend to associate acids with corrosion, very strong bases are also corrosive (think of oven cleaner, and what it does).

Concentration of hydrogen ions compared to distilled water		Examples of solutions at this pH
10,000,000	pH = 0	battery acid, strong hydrofluoric acid
1,000,000	pH = 1	hydrochloric acid secreted by stomach lining
100,000	pH = 2	lemon juice, gastric acid, vinegar
10,000	pH = 3	grapefruit, orange juice, soda
1,000	pH = 4	tomato juice, acid rain
100	pH = 5	soft drinking water, black coffee
10	pH = 6	urine, saliva
1	pH = 7	"pure" water
1/10	pH = 8	sea water
1/100	pH = 9	baking soda
1/1,000	pH = 10	Great Salt Lake, milk of magnesia
1/10,000	pH = 11	ammonia solution
1/100,000	pH = 12	soapy water
1/1,000,000	pH = 13	bleaches, oven cleaner
1/10,000,000	pH = 14	liquid drain cleaner

Look closely. Is this a linear scale?

Chemically, acids and bases neutralize each other.

Ordinary water, for example, is neutral: neither acidic nor basic. Adding base to an acid makes it less acidic, more neutral. Adding acid to a base does the same in reverse: makes it less basic, more neutral. The degree to which a substance is an acid or base can be quantified using the pH scale. A neutral substance has a pH of 7. The more acidic, the lower the pH. The more basic, the higher the pH. The pH scale shown below gives you the idea.

You may never have said to yourself, "I need to increase the pH in my stomach to alleviate this uncomfortable hyperacidity!" However, you may well have taken a Tums™ after an especially spicy meal (spicy food isn't necessarily very acidic, but it stimulates the production of stomach acid). The antacid tablet is basic, and neutralizes some of the stomach acid, relieving your heartburn. While every tablet's ads claim its superiority, how do you know for sure which brand works the best? Let's find out.

Objectives

- Identify the differences between acids and bases
- Explore the pH scale qualitatively
- Show quantitatively how acids are neutralized by bases
- Compare commercially available antacid tablets to determine their efficacy
- Present experimental results in a graphical format

Equipment

- Five 500ml flasks (artificial stomachs)
- 100 ml graduated cylinder
- Syringe, funnel
- Phenolphthalein solution
- Hydrochloric acid (HCl, artificial stomach acid)
- Sodium hydroxide (NaOH, a base)
- Assorted antacid tablets
- Mortar and pestle

Experimental Procedure

- Label each of the five flasks. Flask 1 is Control. This flask will not have any antacid added to it. Flasks 2 through 5 should be labeled with the brand name of the antacid to be tested. Make sure to follow through with your labels—do not add antacid Brand X to any flask except the flask labeled Brand X.
- Add 100ml of HCl to each of the five flasks. To this, add 10 drops of the phenolphthalein solution. The phenolphthalein is an indicator: it is colorless in acid, but turns pink in a base.
- Crush one antacid tablet using the mortar and pestle. Record its brand, and add it to the appropriate flask.
- Rinse and dry the mortar and pestle to remove any residue before crushing the next tablet. Proceed to crush one tablet at a time, adding it to the correctly labeled flask.
- Stir the flasks if necessary to help dissolve the tablets. Allow at least five minutes for the tablets to dissolve before proceeding. If any of the tablets cause the solution to effervesce (bubble), note this.

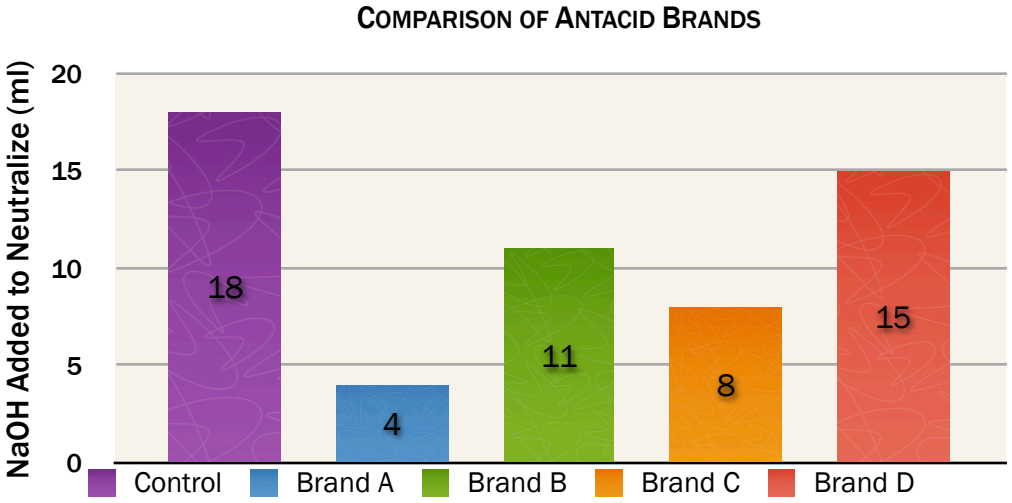
- Titrate each flask with sodium hydroxide. Draw some solution into the syringe, and record the initial volume. Add this, one drop at a time, to the flask. Continue to titrate until the phenolphthalein maintains a faint pink color for at least 30 seconds. This indicates that the solution in the flask has been neutralized.
- Record the volume of NaOH remaining in the syringe. The difference (initial volume – final volume) is the volume added to the flask.

Data & Analysis

If you have not already, create a neat table and record your data in your lab notebook.

Flask	Antacid Brand	Effervescent? (yes or no)	Volume of Sodium Hydroxide		
			Initial Volume (ml)	Final Volume (ml)	Added to Flask (ml)
1	Control				
2					
3					
4					
5					

1. Using the example below as a guide, prepare a bar chart of your results. On the x–axis, label a column for each of your flasks. The y–axis should be scaled to record the total amount of NaOH required to neutralize the flask.



2. According to the example table, which flask required the most sodium hydroxide to neutralize? Does this match your results? Explain why it should.
3. Using your own, graph, compare the tablets. Does one brand clearly "win?" Using your graph, explain how you know which brand is the most effective and which brand is the least effective.
4. According to your data, does effervescence seem to correlate to effectiveness? That is, does a bubbly tablet necessarily work better?
5. Some brands advertise immediate relief, while others claim a long–lasting effect. Which perform better in this test? Recalling how spicy food affect stomach acid production, how could you modify this experiment to more accurately compare these two types of antacids?
6. Examine the pH scale, and estimate the pH of the stomach acid. Similarly estimate the pH of the antacid tablet (hint: milk of magnesia is a liquid antacid).
7. Again look at the pH scale. The pH numbers range from 0 to 14, but is this scale linear? For example, is a base with pH 12 twice as basic as an acid with pH 6? Look at the left column of hydrogen ion concentration to answer this question. If you have an acid with pH = 4, what would be the pH of an acid ten times stronger (more acidic)? What about 1/10 as strong?