

ANALGESIC DRUGS: HOW DO THEY DIFFER?

Introduction

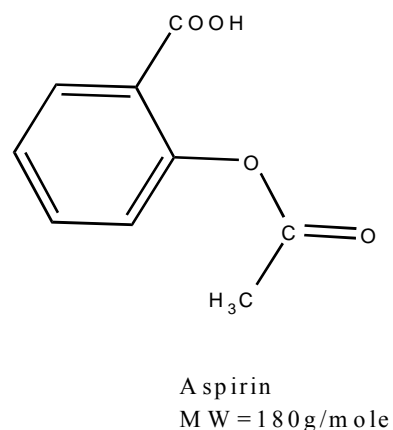
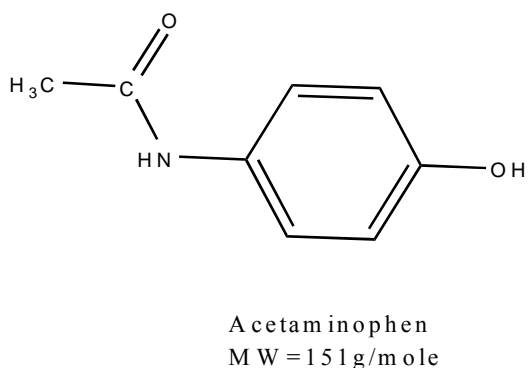
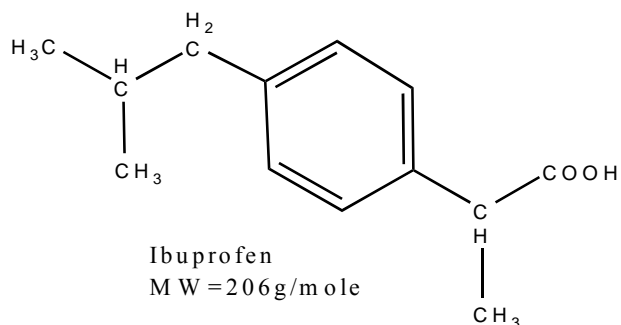
Today on the market, there are a variety of over the counter drugs that can be used to combat the aches and pains encountered in everyday living. Whether it is a headache or muscular pain, three of the major pain relievers are aspirin, acetaminophen, and ibuprofen. Aspirin, acetaminophen, and ibuprofen are the generic name given to each of these chemical compounds. The structures of each are given below to show the difference in chemical structure. Familiar name brands are Excedrin® (aspirin), Tylenol® (acetaminophen), and Advil® (ibuprofen).

There are countless formulations of these three available for the population to choose from. Each pain reliever can be combined with a variety of other chemicals to combat specific symptoms that the consumer is interested in treating. For example many cold remedies will contain an antihistamine and/or a decongestant along with one of these pain relievers to help relieve cold symptoms. Specific examples would be Dimetapp®, Pseudophed®, and Actifed®. Also each retailer often offers its store brand variety of the pain reliever or cold medicine. Consumers should read the active ingredients listed on the container to know which ones each medication contains. There is a variety in choice as well as cost to the consumer. Check out the labels the next time you are in a store purchasing one of these products.

The consumer needs to consider the side effects as well as the indications of different pain relievers. All three claim to relieve pain and are anti-pyretics (will reduce fevers). Aspirin and ibuprofen also have anti-inflammatory properties. Noted adverse side effects include stomach upset from aspirin use. Long term use of acetaminophen has been linked to liver problems. Aspirin and ibuprofen are blood thinners, which can create problems during surgery. When choosing a pain reliever each consumer should consider his or her own health and situation to determine the best choice.

Besides the active ingredients, over the counter medications also contain inactive or filler ingredients. These are also often listed on the packaging. These inactives or fillers are added so the drug is available in a form that can be used by the body. The fillers are used for a variety of purpose two of which are: 1) to promote absorption of the active ingredients and 2) to provide a convenient form that can be ingested by the consumer.

With experience each consumer can determine which combination of active ingredients and which brands best meet his or her needs.



Background Information

Methanol will be used to isolate the active pain relievers (aspirin, acetaminophen, and ibuprofen) from the fillers in the tablets since most inactive ingredients are not soluble in methanol. Tests for pH and solubility in polar and nonpolar solvents are important properties when considering the physiological action of drugs in the human body.

Experimental Procedure

Note: Flammable solvents will be used during these experiments. Therefore no open flames will be permitted in the lab during this experiment!!

1. Dissolution of the active ingredient

- A. Obtain one aspirin tablet. If the tablet is coated, scrape off the coating using a spatula. Once the coating is removed, use a mortar and pestle to grind the tablet to powder form.
- B. In a test tube, dissolve the powder in 3ml of methanol. Cork and shake the tube vigorously in order to dissolve the active ingredient.

Repeat the procedure above in step A and B with the acetaminophen and ibuprofen tablets. Label each test tube.

2. Removal of filler

Prepare three filter funnels using beral pipets.

- A. Cut off the top round end of each pipet.
- B. Place a small cotton plug into the tip of each pipet, followed by a piece of tissue paper (chem. wipe will work.). Use a small diameter rod (a straightened paper clip works well) to loosely pack down the cotton and tissue plug. DO NOT PACK TOO TIGHTLY or your samples will not filter.
- C. Using a clamp, stabilize each pipet over a clean test tube.
- D. Pour the methanol solutions from part 1 into the prepared filter. Use a different filter for each of your three pain reliever samples. Collect the methanol solution of each into a separate labeled test tube as it drips from the tip of the filter. If the solution does not filter, place your thumb over the top open end of the funnel and gently squeeze the bulb portion of the filter to help push through the methanol solution.
- E. If a solution is still cloudy, consider using a centrifuge to clarify the solution. Consult with your TA or SuperChem Lab on the use of a centrifuge.

These three filtered solutions of pain relievers will be used in the remaining tests.

3. Quantitative comparison of solubility in methanol

Perform the following procedure on each of the three pain reliever samples.

- A. Label a clean small test tube. Add a small boiling stone and then accurately weigh the test tube.
- B. Using a small pipet, place 30 drops of the methanol solution (from Part 2 above) into the weighed test tube. After this step, you should have three test tubes.
- C. Place the three test tubes into a beaker of hot water in the student hood at your workstation. Gently heat the beaker of water so the methanol boils off. Continue heating until no more bubbling is evident and all condensation on the sides of the inside of each test tube has evaporated. At this point there may be a liquid in the bottom of the tube due to the sample now being in liquid form. Let bubbling cessation indicate when all the methanol has evaporated.
- D. Carefully remove each test tube (using a test tube holder) and let the test tubes cool.
- E. Dry the outside of each test tube and reweigh.
- F. For each pain reliever take the difference between the initial and final weight of the test tube. This is the weight of pain reliever that dissolves in 30 drops of methanol.
- G. Use the test tubes in the next test.

4. pH of water solutions

- A. To each test tube obtained in the above test, place 20 drops of water.
- B. Stopper and vigorously shake each test tube for several minutes.
- C. Test the pH of each test tube, using the pH paper provided.

5. Solubility in water (a polar solvent)

Perform the following procedure on each of the three pain reliever samples.

- A. Take a clean dry test tube and add 10 drops of water.
- B. Add 2 drops of the methanol solution (from Part 2 above).
- C. Mix gently by shaking and record your observations.

6. Solubility in diethyl ether (a nonpolar solvent)

NOTE: DIETHYL ETHER IS EXTREMELY FLAMMABLE. MAKE SURE THERE ARE NO OPEN FLAMES IN THE LAB!!!

Perform the following procedure on each of the three pain reliever samples

- A. Take a clean dry test tube and add 10 drops of diethyl ether.
- B. Add 2 drops of the methanol solution (from Part 2 above).
- C. Mix gently by shaking and record your observations.

7. Crystal comparison

Perform the following procedure on each of the three pain reliever samples.

- A. Place 5 drops of the methanol solution (from Part 2 above) on a clean dry watch glass.
- B. Let the methanol evaporate.
- C. Using a magnifying glass, observe the crystalline structure and sketch your observations.

ANALGESIC DRUGS: HOW DO THEY DIFFER? DATA SHEET

Quantitative comparison of solubility in methanol (Part 3)

WEIGHTS	ASPIRIN	ACETAMINOPHEN	IBUPROFEN
Empty test tube			
Test tube + drug			
Drug in 30 drops			
Drug (mg/drop)			

pH of water solutions (Part 4)

	ASPIRIN	ACETAMINOPHEN	IBUPROFEN
Color of pH paper			
pH in water			

Solubility (Parts 5 and 6)

SOLUBILITY	ASPIRIN	ACETAMINOPHEN	IBUPROFEN
Water			
Diethyl ether			

Crystal comparison (Part 7)

	ASPIRIN	ACETAMINOPHEN	IBUPROFEN

Observations			
Diagram			

QUESTIONS

1. Which pain reliever is most soluble in methanol based on weight?
2. Which pain reliever is most soluble in methanol on a mole-to-mole basis? (Convert weights to moles and then compare.)
3. Compare the answers in questions 1 and 2. Which do you think is more meaningful? Why?
4. Which pain reliever is most acidic in water? Is least acidic in water? Explain your reasoning. Using these results, what effect would you think each pain reliever would have on the body?
5. Look at the solubility results in water and diethyl ether. Can the results be related to their structure? (See first and second page of this experiment for structures.) Hint: water is polar and diethyl ether is nonpolar.