Sugar-Coat This!

University of Kentucky AIChE Student Chapter
University of Kentucky Interdisciplinary Outreach Organization
Dayaanand Anbazhagan

I. Objective	The main objective of Sugar-Coat This! is to understand the importance of enteric coating pills and tablets, in order to maintain the stability of the API (Active Pharmaceutical Ingredient) when exposed to the acidic conditions of the stomach. The experiment will allow one to create the ideal tablet coating by optimizing household supplies to grasp a better understanding of the commonly consumed oral medication. After conducting the experiment, students should be able to describe the differences between enteric coated tablets and non-coated tablets, as well as the significance of said tablets when placed under conditions mimicking the gastric milieu.
II. Materials	a) 10 pieces of Skittles (Represents the pill of this experiment) b) 10 medium sized clear plastic cups c) Bottled Water d) Diet 7-Up e) Corn Starch f) Vegetable oil g) Sugar h) Flour
III. Procedure	**Creating the Enteric Coating.** 1) Add the advised amount of sugar, flour, corn starch and vegetable oil in a bowl and begin mixing. 2) Pay attention to the ingredients being used - as each ingredient exhibit different properties for the final mixture (Vegetable oil aids in sticking the dry ingredients together, flour and corn starch are thickening agents, etc.). 3) Post mixing, prepare 10 pieces of candy ('pill') that will represent our pill/tablet for this experiment. 4) Prepare 8 different sized coatings, ranging from extra-thin to extra-large - and keep it aside. 5) Starting with the extra-thin coating, apply said coating to a piece of candy - make sure the coating fully covers the 'pill' where the end result of our coated pill should fully be covered by designed coating. **NOTE:** Repeat this step for the following - 2 pieces of candy with extra-thin coating, 2 pieces of candy of medium sized coating, 2 pieces of candy with large coating, and finally 2 pieces of candy with extra-large coating. 6) Have the finished coated pills arranged according to the size assigned.

	Dissolving the coated pills in Water & Diet 7-Up 7) Prepare 5 cups filled with Diet 7-Up to mimic the acidic conditions of the stomach and 5 cups containing water mimicking the neutral conditions of the small intestines. **NOTE:** Ensure the coated pills, water and Diet 7-Up are uncontaminated from other solutions and materials. 8) Place the first 4 coated pills (ranging from extra-thin coating to extra-large coating) into the cups containing the Diet 7-Up. Use an uncoated pill (plain candy) and place that into the 5th cup containing the Diet 7-Up. 9) Repeat step 8, with the cups containing water. 10) Set a timer for 10 minutes, observe and record every change occurring to the coated and uncoated pill from the start. 11) At the 5-minute mark, if the coatings do not look like they are dissolving - stir the coated candy in the cups until the 10-minute mark has been reached (This exemplifies the churning and agitating movement in the stomach). 12) After 10 minutes, remove all the pieces of coated/uncoated candy from their respective cups and compare how the various sized coatings and their effectiveness in manipulated environments (acidic and neutral).
IV. Theory	In this module, the principles of enteric coated pharmaceutical properties are explained and how different pH levels associated with the acidic conditions of the stomach as well as neutral conditions of the small intestine affect the dissolution of a consumed pill/tablet. For example, enteric-coated pills/tablets are primarily used to minimize the side effects (nausea, gastric irritation and bleeding) that can occur with APIs such as aspirin and certain nonsteroidal inflammatory compounds. Insufficient coating can result in ineffective gastric resistance. Besides that, too much coating can seriously delay the drug release when the dosage form passes into the small intestine. Designing the ideal coating is imperative, as the presence of imperfections in the coating (cracks, etc.) can also lead to reduced gastric resistance. In conclusion, polymers like enteric coatings serves as a barrier to prevent the gastric acids in the stomach from dissolving or degrading drugs after you swallow them. Without the full enteric protection, many drugs would fall apart rapidly in stomach acids, where their intended effects would be reduced or eliminated altogether.

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What is Enteric-Coating?

Enteric coating is a polymer applied to oral medication. It serves as a barrier to prevent the gastric acids in the stomach from dissolving or degrading drugs after you swallow them. Without full enteric protection, many drugs would fall apart rapidly in stomach acids. Their intended effect would be reduced or eliminated altogether. Different medications work in different ways, but several types of drugs need to reach the intestinal tract intact before they deliver their ingredients.

How does the Enteric Coating Process help?

The coating creates a delayed release for various dosage forms. Thanks to this process, pharmaceutical companies can ensure drugs make it through the stomach to the small intestine or other stages in digestion it needs to reach. Through the combination of enteric protection and rapid release ingredients, medical professionals can now accurately target when a medication springs into action. This coating does more than protect drugs, though. It also defends the stomach, and it's lining from the harm that certain medications can cause. The enteric-coated capsules or tablets keep the drug's ingredients from activating until they are safely beyond the stomach.

What are the ideal properties of enteric coating materials?

- Resistance to gastric fluids
- Ready susceptibility to intestinal fluids
- Ease of application without special equipment
- Ability to be printed or to allow film to be applied to engrave tablets
- Stable alone in coating solution

Commonly used medication that contain enteric coating:

- Antacids (Omeprazole - Prilosec)
- Pain Relievers (Motrin)

Safety Assessment Form

Basic Information:

AIChE Community Affiliation:	University of Kentucky AIChE Chapter University of Kentucky IEO (Interdisciplinary Outreach Organization)
Primary Contact Name:	Dayaanand Anbazhagan
Primary Contact Email Address:	nda236@g.uky.edu
Name of Module:	Sugar-Coat this!
Brief Description of Module:	The module walks the audience through the science behind the enteric coated pills or tablets that are designed to prevent cases related to stomach irritation. The presenters will describe the differences between enteric coated and non-coated pills when placed under pH conditions mimicking the stomach (acidic) and lower intestines (neutral). The coatings designed will aid in understanding the effectiveness of enteric coating in a simulated environment (mimicking the churning and agitating movement of the stomach).
Does your module have a demonstration or experiment component? *Indicate Yes or No*	Yes
Briefly describe any interactive portions of your module:	The audience will be able to use the design & experimentation concepts learned from protecting the pill by repeating the experiment whilst manipulating variables (pill size and shape ; coating size and shape).

Materials Used/Waste Generated:

If you need additional space, please insert additional rows and continue numbering sequence.

	Item *Include concentration where applicable*	**Chemical State** *Where applicable, specify solid, liquid, or gas. Otherwise write "N/A"*	**Estimated quantity used** *include units where applicable*	**Estimated amount of waste generated** *Include units where applicable*	**Waste Classification** *Where applicable, specify Acid, Base, Organic, Metal, Oxidizer, Other (include explanation if other), or Regular trash*
1	10 pieces of Candy (Skittles)	Solid	11 g	N/A	May be safely disposed in regular trash.
2	10 medium sized clear plastic cups	N/A			
3	Water	Liquid	500 mL	N/A	May be safely disposed down the drain.
4	Diet 7-Up	Liquid	500mL	N/A	May be safely disposed down the drain.
5	Six Clear Drinking Glasses	N/A			
6	Corn Starch	Solid/Liquid	2 tbsp	N/A	May be safely disposed of down the drain with water.
7	Flour	Solid	1.5 tbsp	N/A	May be safely disposed of down the drain with water.
8	Sugar	Solid	2 tbsp	N/A	May be safely disposed of down the drain with water.
9	Vegetable oil	Liquid	1.5 tbsp	N/A	May be safely disposed of down the drain with water.

Access to 120V power outlet:

Access required? *Respond Yes/No in the space provided*	**No**
If yes, specify reasoning/any equipment it will be used for: *Please note that outlets requested to plug in laptops/monitors will not be granted*	**N/A**

Hazard Identification & Mitigation:

Please ask yourself the following questions prior to completing the below table. ***1) What can go wrong?*** *(Identification of Hazards);* ***2) How bad can it be?*** *(Severity of Hazards);* ***3) How easily or often can it happen?*** *(Frequency or Likelihood);* ***4) How is the risk managed?*** *(Both preventive & mitigation safety measures)*

Hazards: *Describe any hazards associated with the above list of materials used and waste generated and any other hazards associated with the execution of the module*	**The are no hazards associated with this lab - most required materials are safe household items.**
Safety Measures: *Describe any safety measures that will be taken to mitigate hazards identified above*	**N/A**
Required PPE: *Specify required PPE, who is required to use it, and within what proximity*	**Anyone involved in the demo is required to have safety goggles and gloves although weak acids are being handled.**

Certification:

I certify that this module is safe for presentation to K-12 community members (including students, parents, and educators) and to AIChE volunteers and community members. I additionally certify that this module is safe for presentation by K-12 community members (such as parents & educators) and by AIChE volunteers and community members.

Dayaanand Anbazhagan		9/1/21
Primary Contact Name	**Primary Contact Signature**	**Date**