pH v.s. Painkillers

The effect of pH on the solubility of Advil.

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Abstract

One of the most popular pain medications in the US today is the pain reliever, Advil. Advil is a nonsteroidal anti-inflammatory drug that can help with health issues such as mild pain, fevers and inflammation. Although Advil is meant to help you, it does have a few side effects that you should look out for, that are listed on the sides of the packaging. Most people when looking for a pain medication will want what works the longest and the fastest in the safest way possible. I'm going to be testing just that with one commonly used medication Advil. My hypothesis was if Advil, gel-capsules, and tablets are left at the different pH levels Acidic and neutral, then the Advil tablet painkiller will dissolve the fastest in the glass with the most acidic pH level. My data suggests that the tablet pain reliever dissolves the fastest in all tests at all pH levels. The pH level of 1 dissolved the fastest with an overall average of 3 minutes and 42 seconds.

Introduction

One of the most common painkillers used today is Advil. Before using this painkiller there's some things you should think about: what's in the medication and what do you need from it.

Advil, the nonsteroidal anti-inflammatory drug, is used to treat fevers, mild pain, and inflammation. Advil is a form of ibuprofen. Too much ibuprofen, like Advil, can cause serious issues such as damage to your stomach, intestines and other organs. This could result in serious side effects such as stomach pain and gastrointestinal bleeding. In certain cases, an ibuprofen overdose can be fatal, leading to heart attacks or kidney failure (HERO, Medication management).

When taking Advil there are a few different types you can consider. There are hard shell capsules, soft-gel capsules, and tablets. The most common form of painkillers used today are tablets because they are inexpensive, safe and an effective way to deliver oral medicine. But they also often offer a higher dosage of medication and it's easier to give yourself too much if you're not careful (Christine Case-Lo, 2019). Another thing you have to be cautious of when using tablet medication over gel caps is children's access to them. Many of these tablets come with a tasty outside layer making it more desirable to children, but it can be especially dangerous if your child has access to the drug, really likes the taste and wants more. To reduce the risk you can use capsule medications that don't have a sweet outside. When thinking about switching to capsule medications you also have to think about how these medications often do not offer as high of a dosage. They also are more expensive and don't give you the ability to cut the pill into smaller pieces like the tablets do (Christine Case-Lo, 2019).

The amount of time for a drug or painkiller to get into your bloodstream is a wide range depending on type of drug, age, weight, gender, pH level, and physical activity. Most opioids or painkillers take about thirty minutes to set into the bloodstream (OCRC, 2016). The pH level in the stomach is acidic and has a pH level of around three. But some people all across the world struggle with diseases such as ulcers, cancer and more that can cause the pH level in the stomach to change or have to take medication for these diseases that can cause the pH level in the stomach to change.

Ibuprofen and Naproxen are some of the most efficient pain relievers to make it into your bloodstream and the fastest and best at providing pain relief. They also reduce inflammation or swelling, and help fight fevers. Ibuprofen usually takes around 20-25 minutes to fully dissolve into your bloodstream, and Naproxen takes around an hour to

fully make it into the bloodstream but is one of the best long lasting pain relievers you can take (Very Well Health).

Even though Ibuprofen and Naproxen are some of the most efficient at making it into your bloodstream, Aspirin has been proven to be one of the fastest dissolving pain killers. They dissolve in your stomach after you swallow them. Among those tested, Aspirin was 80% more dissolved after 6 minutes (National Library of medicine, 2016).

If we could figure out how much time painkillers take to dissolve, it could help solve many of the problems they cause. We could help tell exactly when to take another medicine and help prevent the risk of overdosing on medications. We could also determine what is the best amount or type of medication for the pain you are experiencing, just overall making people much happier.

Hypothesis

If Advil gel-capsules and tablets are left at the different pH levels; a highly acidic level of 1, a less acidic level of 3 which is the pH level off the stomach and a neutral level of 7, then the Advil tablet painkiller will dissolve the fastest in the glass with the Acidic pH level.

Methods

When I perform my experiment I will collect my data by testing two different forms of Advil pain relievers in their gel capsules and tablet forms, in water with different pH levels of highly acidic (1), less acidic (3) and neutral (7). It will have added agitation by having a mechanical device held in the middle of the beaker stirring the liquid while the pill is in it. The breakers will be heated by a hot plate at a temperature of 36-37 degrees celsius so it approximates a body temperature of 98.6. To make the water different pH levels I will put 50 milliliters of distilled bottled water in two different glasses to make the neutral test. Then to make the Acidic tests I will make a mixture of distilled water and for the very acidic level I will add 1 milliliter of 0.5M Hydrochloric acid. To make the test less acidic I will add 0.5 milliliters of 0.5M Hydrochloric acid. To make sure the pH levels of the glasses are correct, I will use pH test strips. To get my results I will then add one of the same Advil painkillers to the two glasses with the same pH level and set a timer to see when the drug is fully dissolved and at what times. I will know when the painkillers are fully dissolved when the pills are no longer in a visible pill shape. Then I will repeat this for the rest of the Advil painkillers but instead adding Hydrochloric Acid to make the distilled water Acidic. In the end my results should show what painkiller dissolves fastest at the different pH levels.

Results

After receiving my results of the times it took for each pill to dissolve at the different pH levels, it was clear what pill dissolved the fastest at all pH levels.

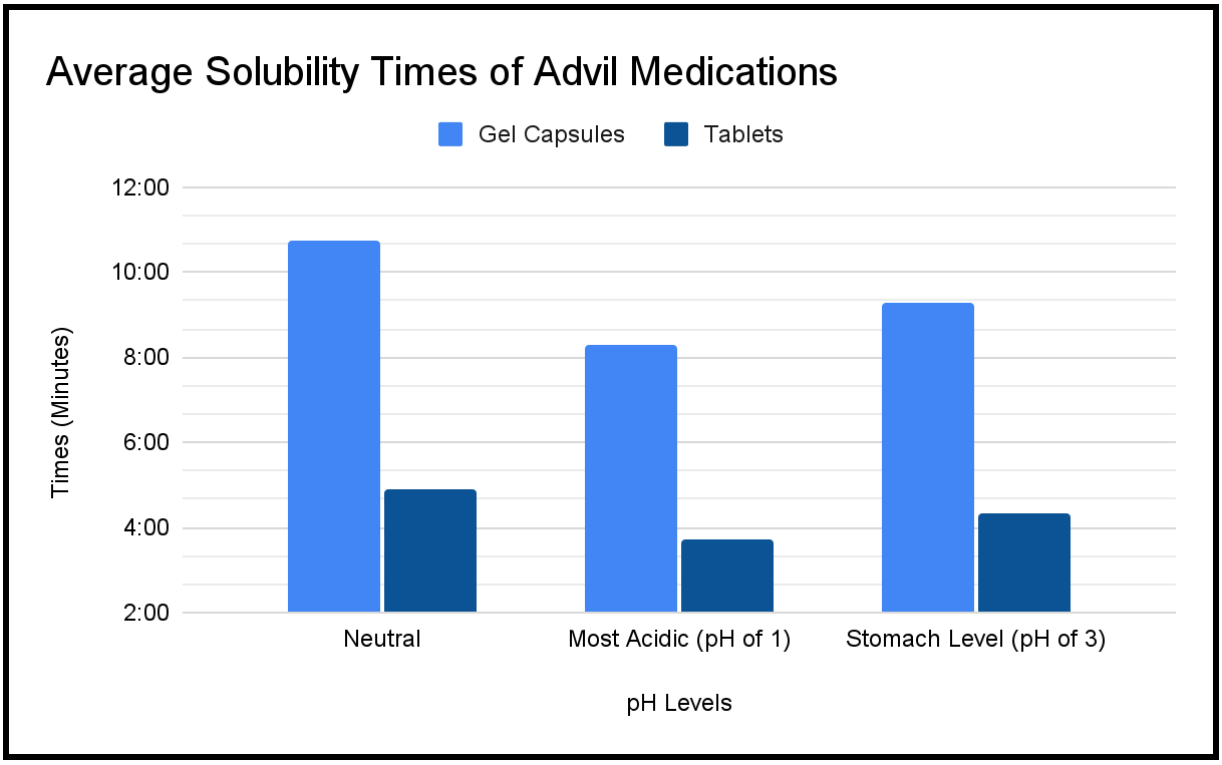
	pH Levels					
Advil Pill Type	**Neutral pH (Distilled Water pH 7)**		**Most Acidic (pH of 1)**		**Normal Stomach pH (pH of 3)**	
Gel Capsules	10:36	10:52	7:25	9:08	9:06	9:31
Tablets	4:06	5:42	3:28	3:56	4:15	4:25

These are the time for my two tests of all the pH levels (Neutral, Acidic, and Stomach pH levels). This table is showing how in all my tests it seems to be that the tablet Advil medication dissolved the fastest at every pH level, but dissolved the fastest at the lowest pH level of 1, with times both under four minutes.

Here is all my data averaged per section to show the overall averaged times I'll be using in my graph.

	pH Levels		
Advil Pill Type	**Neutral pH (Distilled Water pH 7)**	**Most Acidic (pH of 1)**	**Normal Stomach pH Level (pH of 3)**
Gel Capsules	10:44	8:16	9:18
Tablets	4:54	3:42	4:20

To accurately show what Advil medication dissolves the fastest, I averaged all the times to show in a graph what pill took the longest to dissolve and shortest to dissolve.



The light blue bars are the gel capsule medication and the dark blue bars are the tablet medication. The Advil tablets took much less time than any of the gel capsules in all of the pH levels. All of the tablet painkillers dissolved in the different pH levels in under 5 minutes with the average times of 4:20, 4:54 and 3:42. The gel capsules took much longer to dissolve with all their average times over 8 minutes.

Discussion

Altogether in all my tests the common result was that the Advil gel capsules dissolved much slower in all the pH levels than the Advil tablet painkillers did.

The tablet medications dissolved much faster in all the pH levels. In the neutral pH level the two times were 4:06 and 5:42 which made the average time of 4 minutes and 54 seconds. Then in the Most Acidic level that had a pH level of one, the two times were 3:28 and 3:56. These were my lowest two dissolution times which made for the lowest average time of 3:42. Then I tested the pH level that was about the stomach pH level which was 3. The times for these two tests were 4:15 and 4:45. The average for the stomach pH level was 4:20. So overall the tablet dissolution rate that took the longest was the tablets that were in the neutral pH level.

The gel capsule medications followed a similar pattern to the tablet medication where the times in the Most Acidic pH level (pH of 1) dissolved the pill much faster than

the other pH levels. The times for the most acidic test was 7:25 and 9:08 which had an overall dissolution time of 8:16. The neutral pH level dissolved the pills at 10:36 and 10:52 and had an average time of 10 minutes and 44 seconds. Then in the stomach pH level the dissolution times were 9:06 and 9:31 and had an average time of 9:18. Like the tablet medication times the mixture with the pH level of 1 dissolved the medications the quickest and the neutral pH level took the longest of the three tests with the gel capsules.

Overall the trends in my data show that the pills for both tablet and gel capsule medications that dissolved in the neutral pH level took the longest for all tests and had the highest averages in both the gel capsules and tablet data. Furthermore the pH level that had the lowest times was the mixture with the lowest pH level, that was the pH level of one. Both the tablet medications and gel capsules took the shortest time to dissolve in the pH level of one.

This means that the lower the pH level was, the less time it took for the pill to dissolve. This is because the pH levels that are the lowest have a higher concentration of hydrogen ions that cause a bigger reaction to take place in the stomach. Along with the thickness of the Advil medications we tested, the tablet medication has a thinner outer layer of sucrose sugar coating because it is less likely to be damaged when it is outside a container. This is because the tablet is small and compact, and has a solid pill inside of the sugar coating. Unlike the sucrose sugar coating of the tablet pill, the gel-capsules coatings are thicker and meant to protect the pill more because the medication is containing a liquid that is flexible and can be damaged easily if the pill was under a lot of pressure. So when the pills were placed in the different pH levels the gel-capsules took longer to dissolve because the pills had a thicker coating of the same sucrose sugar coating that both of the Advil tablet and gel-capsule medications have, therefore because it was thicker it took much longer to break down and dissolve.

Limitations

The limitation I faced while trying to perform my project, which could have affected my data, was that when adding the agitation to the tests, I couldn't always get the agitation to stand straight up in the middle of the beaker. At times it would fall over and I would have to quickly adjust it. This could have affected my results because if it bumped into the painkiller or mixed up the solution a little more than the others, it could have caused that pill to disintegrate faster or bump around the Advil pill I was testing, which could have damaged the outside of the pill and cause the medication to disintegrate faster.

Future Studies

In the future I could research different types of NSAIDs the pills have in them, for example in Advil it is a form of Ibuprofen, so I could use other pills that have other medications such as naproxen, diclofenac, celecoxib, mefenamic acid, etoricoxib, or indomethacin. I could also focus more on different temperatures that I test the pills at and more pH levels to see where the best temperature and pH level is to disintegrate the pills. This could also include testing these medications in various different control liquids other than distilled water to make it more like a stomach of a person that would be taking these medications to see if different substances affect the solubility of the different medications.

So I would be expanding the different types of tests I would do on these medications and the different types of medications, to truly see where the medications and painkillers dissolve the best and to determine what would be best to make the medications work the fastest and most efficiently for the best results.

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