Pharmaceutics
Antacids Lab Report

Introduction

'Antacid' is a common term used to describe substances, mainly bases, that are used to counteract excess stomach acid and relieve heartburn.
In this lab report I am going to investigate the neutralising behaviour of six different antacids on hydrochloric acid. Antacids are available in a variety of different formulations and are mainly available as over-the-counter (OTC) preparations.
Antacids work by neutralising excess stomach acid and by doing so they raise the pH of the stomach. The pain felt by the sufferer is commonly caused by peptic ulcers. The gastrointestinal mucosa houses nerves. When these nerves are exposed (for example those in ulcers) and hydrochloric acid reaches them, the nerves signal pain to the central nervous system. The effect of aluminium ions can also contribute to indigestion. The ions can inhibit the smooth muscle cells and delay the emptying of the stomach causing. This is turn means that there is a build up in stomach acid.
In this lab report I am going to investigate the neutralising behaviour of six different antacids on hydrochloric acid. Antacids are available in a variety of different formulations
The pH range of the stomach falls in the range between 1 and 4, depending on food intake and digestion. Usually the stomach has a pH that falls in between 1.5 and 2.5. This level can drop to 0.8 or even 0.4 in some cases when the stomach is not emptied. This build up in acid can also cause acid reflux up the oesophagus. This occurs when the lower oesophageal sphincter is abnormally relaxed, causing it to remain open. This leaves an open passage way for acid from the stomach to reflux up the oesophagus. This commonly causes heart burn.
The hydrochloric acid, that causes these conditions, is produced in the stomach by parietal cells. These cells are located in the gastric gland. These cells produce hydrochloric acid by the following equations:

$$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow HCO_3^- + H^+$$

At this point HCO_3^- ions are pumped out of the cell and at the same time Cl^- ions is being pumped in. This is known as counter-transport. The H^+ and Cl^- are then moved out of the parietal cells into the lumen of the gastric gland. The Cl^- is moved by facilitated diffusion and the H^+ is pumped out by active transport. The ions are then secreted into the stomach by the gastric gland.
When the gastric gland produces too much acid, antacids are required to bring up the pH in the stomach. There are many different types of antacids available. The most common types of antacids that can be found are: aluminium and magnesium-containing, sodium bicarbonate, bismuth-containing, alginates and simeticone.

Antacids have very few interactions. However they should preferably not be taken at the same time as any other drugs and it may affect absorption. In general the side effects from antacids are mainly constipation or diarrhoea. These can be prevented by the pairing of ingredients. Another more common side effect is flatulence; this is mainly due to the liberating of carbon dioxide.

Materials

pH buffer (pH 4), unknown antacids 1, 2, 3, 4, 5 and 6, hydrochloric acid (0.05M), pestle and mortar, pH meter, beakers (50ml and 500ml), magnetic stirrer, stopwatch, deionised water, measuring cylinders (50ml and 500ml).

Method

The pH meter was set up using a clamp and stand, so that it rested above the magnetic platform. The pH metre was able to be lowered in and out of the beaker to take readings.

The pH meter was standardised using a pH buffer (pH 4). The buffer was poured into a 50ml beaker and was placed on the platform. The pH meter was placed into the solution. The meter was altered until the meter read ‘pH 4’. The solution was then tipped back into its container and the beaker was washed and discarded of.

A table was constructed and labelled ready for readings to be recorded.

200ml of hydrochloric acid (0.05M) was measured using a 500ml measuring cylinder and was transferred into a 500ml glass beaker. The beaker was placed on the magnetic platform and the magnetic stirrer was allowed to stir the acid solution for 2 minutes, at a medium speed. A reading of the initial pH was read and recorded in the table. At this time the stopwatch was set for 30 minutes.

The recommended amount of antacid 1 was crushed in a pestle and mortar. The crushed antacid was then mixed in 25ml of deionised water. The mixture was added to the beaker containing the hydrochloric acid and the stopwatch was started. Readings of the pH were taken at 1, 2, 5, 10, 15, 20, 25 and 30 minutes and recorded in the table.

The following steps were repeated for unknown antacids 2 and 3. For antacids 4, 5 and 6 no addition of deionised water was required as the antacids were already in liquid form. Therefore the recommended doses of antacids 4, 5 and 6 were measured in a 50ml measuring cylinder and added straight to the hydrochloric acid. The experiment was carried out as outlined before.

Results
<u>Table One</u> - raw data collated whilst carrying out the experiment.

pH	Initial	1 minute	2 minutes	5 minutes	10 minutes	15 minutes	20 minutes	25 minutes	30 minutes
Antacid 1 (2 tablets)	1.6	1.7	1.7	1.8	1.9	2.0	2.0	2.1	2.1
Antacid 2 (2 tablets)	1.5	5.4	5.7	5.8	6.0	6.1	6.2	6.3	6.4
Antacid 3 (2 tablets)	1.6	2.2	2.3	2.4	2.4	2.4	2.4	2.4	2.4
Antacid 4 (20ml)	1.6	3.7	4.0	4.3	4.3	4.7	4.8	4.9	5.0
Antacid 5 (20ml)	1.5	2.3	3.5	4.0	4.0	4.2	4.2	4.3	4.5
Antacid 6 (10ml)	1.5	8.3	8.5	8.8	8.8	8.9	8.9	8.9	8.9

With this data I have used the following equations to obtain further information. This information is represented in Tables Two and Three:

- Overall change in pH = (final pH of solution) – (initial pH of solution)
- Speed = $\frac{\text{(Change in pH in the first minute)}}{\text{Time (1 minute)}}$

The antacids used the experiment were as followed:
Antacid 1 - Magnesium Thiosulphate
Antacid 2 - Rennie
Antacid 3 - Gaviscon (tablets)
Antacid 4 - Gaviscon (liquid)
Antacid 5 - Neucogel
Antacid 6 – Milpar

Discussion
<u>Table Two</u> - overall change in pH caused by the addition of the antacids.

Antacids	Overall change in pH
Antacid 1	0.5
Antacid 2	4.9
Antacid 3	0.8
Antacid 4	3.4
Antacid 5	3.0
Antacid 6	7.4

The figures shown above were calculated by using the following equation:
Overall Change in pH = (final pH of solution) – (initial pH of solution)

<u>Table Three:</u> Fastest Speed of Neutralisation

Antacids	Fastest speed of neutralisation
Antacid 1	0.1 pH units/min
Antacid 2	3.9 pH units/min
Antacid 3	0.6 pH units/min
Antacid 4	2.1 pH units/min
Antacid 5	0.8 pH units/min
Antacid 6	6.8 pH units/min

The figures shown above were calculated using the following equation:

$$\textbf{Speed} = \frac{\textbf{(Change in pH)}}{\textbf{Time}}$$

From the raw data above I can see that all of the antacids tested had a neutralising effect on the hydrochloric acid. The speed of the change in pH can be calculated by using the formula stated above and the raw data collected whilst performing the experiment. Table Three shows the greatest speed of change, in pH, produced by each antacid. From calculating this and by observing the graph (showing change in pH over time), I can conclude that the greatest change in all the antacids occurred in the first minute after introduction. From this I can also conclude that all the antacids used were 'fast acting'. However from Table Two ad from the speeds calculated in Table Three, it can be seen that the overall change in pH varies from one antacid to another. This means that even though all of the antacids are fast acting, their effectiveness varies, as they all cause a different overall change in pH.

The graph and table two show that Antacid 6 was by far the most effective antacid. This is as it caused the greatest change in pH in the shortest amount of time – a 7.4 change in pH occurred in 15 minutes. It also had the greatest speed of action at 6.8 pH units/min. This antacid's effect only lasts for a short period of time. From the graph and table one it can be seen that the pH begins to plateau 5 minutes after introduction and only changes by 0.1.

Antacid six was Milpar (this information was given to me once the experiment had been completed). Milpar is a magnesium based antacid. This gives the antacid properties ideal for treating excess stomach acid. The liquid is fairly insoluble in water and so is long lasting. This makes it a particularly effective antacid as it is very fast acting, which gives instants relief to the patient, causes a greater pH change, which means it can neutralise large amounts of excessive stomach acid, and is long lasting meaning that should there another be another build up in stomach acid, the antacid is still present to counteract the effects. However the magnesium in the antacid also gives it laxative properties and cause unwanted side-effects.

In comparison Antacid 1 was the least effective. It caused an overall change of 0.5 in pH and required 25 minutes to complete. It also produced the slowest speed of action at 0.1 pH units/min. This antacid is slow acting and causes very little change in pH. This therefore would be a very poor antacid as it would not

give instant relief as it takes a longer period of time to work and the acid would remain in the stomach as the antacid has very poor neutralising properties.
Antacid 1 was Magnesium Thiosulphate. The magnesium in this antacid would have the same properties as before. However the actual neutralising would be less effective. This antacid also has laxative properties and therefore would be a better laxative than an antacid.
Antacid 2 was Rennie. This antacid's active ingredients are calcium carbonate and heavy magnesium carbonate. This is antacid was fast acting and caused a relatively high change in pH. The calcium carbonate also counteracts the laxative effects of the magnesium. However it slows down bowel movement and so can cause constipation.
Most antacids that contain magnesium are paired with either aluminium or calcium carbonate so counteract its laxative properties.
Antacids 3 and 4 were Gaviscon in tablet and liquid form, respectively. They are both composed of sodium alginate, sodium bicarbonate and calcium carbonate. However the liquid form is highly more effective than the tablets. This down to the surface area of both antacids and this will effect how quickly they work.
Antacid 5 was Neucogel. This antacid, along with liquid Gaviscon, are probably the most ideal antacids. This is as they higher the stomach pH back into its normal range in a sufficient time. Therefore these are to two that I would recommend to a patient suffering from indigestion and heartburn.
Where as Antacid 6 is the most effective, it would cause the stomach to turn alkaline. This would mean that the stomach would be unable to carry out its functions. The stomach must be acidic to create ideal conditions for the protease enzymes to work and obtain amino acids. The acidic conditions are also required to kill any foreign bacteria and so prevent infection and illness.
To improve this experiment I would use a wider range of antacids that were available to the public. I would compare the data from the solid tablets and from the liquids separately and then compare them to each other. This would help to get a clearer idea for which type of antacid is better.
I would also carry out the experiment for a longer period of time. For example an hour. This is as the graphs for antacids such as Rennie, Neucogel and Gaviscon (liquid) had not plateau off and so there could have been a greater change in their overall change in pH than the ones stated in Table Two.
Further more to gain a clearer view on the actions of all the antacids I would run the experiment again but use a range of hydrochloric acid at different pH. From this I could gain an idea on how well the antacids would work in different conditions.

Conclusion

From this experiment I can conclude that all the antacids that were tested worked to neutralise the sample acid. Also that they all work in different ways. The mechanisms of action vary from one antacid to another, as their active ingredients differ. I can see from my results that some mechanisms of action have a greater effect than others. Furthermore I can say the majority of antacids action occurs in the first 2 minutes of use, making most of them fast acting.

However the effectiveness of the antacid depends on how quickly it can return the stomach back to its normal conditions. Some performed poorly and over performed. The antacids that can cause a change in pH by 2 – 3 are the most ideal.

Reference

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