Antacids

DIGESTION

The process of digestion involves the breakdown of food into molecules that can be utilized by individual cells in the body. The process starts in the mouth through the mechanical action of chewing and by the action of the digestive enzyme, amylase, present in saliva. Much of the digestive process, however, takes place in the stomach, a collapsible muscular bag which can hold between 2 and 4 litres of food.

The walls of the stomach are lined with a layer of cells which secrete mucus, pepsinogen (a precursor for the enzyme pepsin that breaks down proteins into peptides), and hydrochloric acid, collectively known as gastric juices. The hydrogen ion concentration of the hydrochloric acid normally lies between 3×10^{-2} mol dm^{-3} and 3×10^{-3} mol dm^{-3} giving a pH value between 1.5 and 2.5. The wall of the stomach is protected from the action of the acid by a lining of mucus. Problems can arise if the stomach lining is damaged or when too much acid is produced, which can eat away at the mucus lining.

TREATMENT OF INDIGESTION

The discomfort caused by excess acid is known as indigestion and may result from overeating, alcohol, smoking, anxiety, or in some people from eating certain types of food. Some drugs, such as aspirin, can also irritate the stomach lining and can result in ulceration of the stomach walls by the gastric acid. Antacids are used to combat excess stomach acid. They are most effective if taken between one and three hours after eating, as food typically remains in the stomach for up to four hours after a meal.

Antacids are essentially simple bases, such as metal oxides, hydroxides, carbonates, or hydrogencarbonates. They work by neutralizing the acid, preventing inflammation, relieving pain and discomfort, and allow the mucus layer and stomach lining to mend. When used in the treatment of ulcers they prevent acid from attacking the damaged stomach lining and so allow the ulcer to heal. Common examples include $Al(OH)_3$, $NaHCO_3$, $CaCO_3$, and 'milk of magnesia', which is a mixture of MgO and $Mg(OH)_2$. Typical neutralization reactions are:

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(l)$$

$$MgO(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l)$$

$$Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$$

SIDE EFFECTS

Although relatively harmless, antacids can have side effects. Magnesium compounds can cause diarrhoea, whereas aluminium compounds can cause constipation. Aluminium compounds can interfere with the absorption of phosphate from the diet causing possible bone damage if taken in high doses over a long period. Sodium hydrogen carbonate produces carbon dioxide gas, which may cause bloating and belching.

Antacids are commonly combined with alginates and anti-foaming agents. Alginates float on the contents of the stomach to produce a neutralizing layer. This prevents heartburn, which is caused when the stomach acid rises up the oesophagus. Anti-foaming agents are used to help prevent flatulence. The most usual anti-foaming agent is dimethicone.

WORKED EXAMPLE

Which would be the most effective in combating indigestion – a spoonful of liquid containing 1.00 g of magnesium hydroxide, or a spoonful of liquid containing 1.00 g of aluminium hydroxide?

M_r for $Mg(OH)_2 = 24.30 + (2 \times 17.01) = 58.33$

M_r for $Al(OH)_3 = 26.98 + (3 \times 17.01) = 78.01$

Amount of $Mg(OH)_2$ in 1.00 g $= \frac{1.00}{58.33} = 0.0171$ moles

Amount of $Al(OH)_3$ in 1.00 g $= \frac{1.00}{78.01} = 0.0128$ moles

$$Mg(OH)_2(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + 2H_2O(l)$$

Therefore amount of HCl neutralized by 1.00 g of $Mg(OH)_2$
$= 2 \times 0.0171 = 0.0342$ moles

$$Al(OH)_3(s) + 3HCl(aq) \rightarrow AlCl_3(aq) + 3H_2O(l)$$

Therefore amount of HCl neutralized by 1.00 g of $Al(OH)_3$
$= 3 \times 0.0128 = 0.0384$ moles

Therefore the aluminium hydroxide would be slightly more effective.