C4 pH value of beverages – How acidic is it in the stomach?

Note: This answer sheet will go into the analysis for the experiment only if experience shows that there could be particular difficulties.

5 Analysis

a) Compare the pH values of the beverages with one another. Arrange them in a small table in ascending order of pH value.

Note: The media package “Experimento | 10+: C4 pH value of beverages” includes additional information on the typical pH values of various beverages and foods.

6 Questions

a) In what way do beverages with a low pH value differ from those with a high pH value?

Answer: They differ in their content of hydrogen ions (H^+) or hydronium ions (H_3O^+). The lower the pH value, the higher the content of H^+ or H_3O^+.

b) Deduce the following from your test results: What properties must the stomach have in order to process beverages and food with extreme pH values without harm?

Answer: Because our test results for many beverages (e.g., cola) indicate extremely acidic pH values, we can deduce that the stomach’s surface must have an acid-fast protective mantle.

c) What pH value does gastric acid have? Explain why.

Answer: The pH value of gastric acid fluctuates between pH 0.8 (digestive state) and pH 2.0 (resting state). The main reason for the highly acidic pH value is that strong acids kill nearly all bacteria that reach the stomach. Furthermore, the low pH value aids in the preliminary digestion of proteins and to a certain degree also that of fats in the stomach.

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d) There are illnesses in which the gastric acid attacks the mucus membrane of the stomach. What would a doctor advise or prescribe to the patient in this case?

Answer: If bacteria (e.g., Helicobacter pylori) or circulatory disorders of the mucus membrane (e.g., due to stress) result in destruction of the protective mantle in places, gastric acid can attack the mucus membrane, and inflammations and ulcers may occur. In the past, mineral antacids (acid neutralization agents) such as calcium carbonate, magnesium carbonate, sodium hydrogen carbonate, or magnesium trisilicate were prescribed to treat this condition. The advantage is that these well-proven remedies generally do not have any side effects. The disadvantage is that these antacids have only a relatively short-term effect. Modern medicine uses remedies known as H2 receptor blockers or proton pump inhibitors, which slow down the release of H^+ ions, thus increase the pH value in the stomach. These medications are preventive and have a longer-lasting effect, but may produce certain side effects, depending on the brand.

e) What path do beverages take on their way through the digestive tract? Describe the path in your own words.

Answer: Beverages reach the stomach through the mouth and esophagus. If they contain nutrients (e.g., milk protein), digestion begins in the stomach. Then in the small intestine, digestion of nutrients (e.g., carbohydrates) contained in a beverage continues. Depending on the body's need, the salts and vitamins in the beverage are absorbed through the wall of the small intestine. The volume of water that is resorbed by the small intestine also depends on how acute the body's need for water is. The remaining volume of water is resorbed in the colon at any rate. Ingredients that are indigestible, not needed for the body, or even harmful are partially resorbed and excreted in urine via the kidneys or detoxified in the liver (e.g., alcohol). The rest are expelled in feces.

f) How and in what sections of the digestive tract are the energy-providing nutrients, proteins, carbohydrates, and fats broken down mechanically and chemically?

Answer:

Mouth: Food is decomposed mechanically – food is chewed and mixed with saliva – starch molecules are broken down into maltose by the enzyme amylase.

Stomach: Fats are mechanically emulsified into fine droplets – up to 30% of the fats are broken down into fatty acids and glycerol by fat-splitting enzymes (lipases) – proteins are partially digested through splitting into peptides by hydrochloric acid and by the enzyme pepsin.

Small intestine: The acidic bolus is neutralized.
Carbohydrate digestion in the small intestine: Maltose is broken down into glucose molecules by additional intestinal enzymes – other disaccharides (e.g., sucrose) are broken down into their monosaccharides by enzymes – glucose is absorbed into the intestinal cells and diffused into the blood of the portal veins. From there, glucose is transported to the cells where it is consumed (e.g., muscle cells).

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Protein digestion in the small intestine: Approx. 60% of proteins in food are already resorbed in the form of peptides in the duodenum. Proteins and peptides are broken down further by protein-splitting enzymes (proteases) from the pancreas – longer-chain peptides are split into dipeptides and free amino acids by enzymes of the intestine's brush border and absorbed into the intestinal cells – dipeptides are broken down into individual amino acids – the body builds its own proteins from the resorbed amino acids. Fat digestion in the small intestine: Fat droplets are finely emulsified and initially broken down by lipases and bile salts – micelles are formed from the first degradation products (fatty acids, mono- and diglycerides), bile salts, and other lipids – micelles attach to the intestinal cells' membrane – micelles are resorbed by the cells and reassembled into triglycerides – triglycerides are transported to the bloodstream via the lymph – short- and medium-chain fatty acids are absorbed directly into the portal blood via the brush border membrane.

Colon: Up to 20% of proteins are degraded bacterially in the colon – all indigestible food constituents are expelled as feces.

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