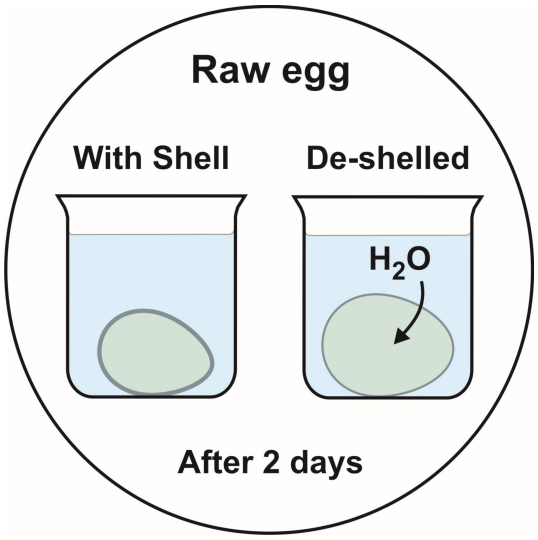
Swelling of a decalcified egg in water



Equipment:

3 beakers (400 mL)

"Chemicals":

2 raw chicken eggs (as equal as possible in size)
white vinegar
[acetic acid (w = 10 %) in water]
deionized water

Safety:

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Procedure:

Preparation: One of the raw eggs is placed in a beaker filled with approx. 200 mL of white vinegar. When the hard shell has completely dissolved after one or two days, the egg is very carefully removed from the beaker and rinsed with water.
Procedure: The de-shelled egg is then put in a beaker filled with deionized water. The same is done with the raw egg. Both beakers are allowed to sit for a day or two.

Observation:

After placing the egg in vinegar, bubbles starts to form around the egg, i.e. a gas is produced. Over time, foamy residues settle on the surface of the vinegar. Finally, the entire shell has dissolved and the inside of the egg is only surrounded by the translucent shell membrane. After removing the egg from the vinegar bath, one notices that it has already increased a bit in size compared to the untreated raw egg. After the treatment in deionized water, this effect is even much more pronounced.

Explanation:

The eggshell consists of more than 90% calcium carbonate, which dissolves in acetic acid, thereby releasing carbon dioxide:

$$CaCO_3|s + 2\ CH_3COOH|w \rightarrow Ca2+|w + 2\ CH_3COO^-|w + H_2O|l + CO_2|g.$$

The remaining 10% of components of the shell–including the pigment of brown eggs–aggregate as a more or less liquid residue on the surface of the vinegar.

The shell membrane, which still surrounds the egg after it has been decalcified, is semi-permeable, i.e. only small molecules such as water molecules can pass through the membrane. There exists a concentration gradient between the deionized water and the egg lying in it, since the inside of the egg contains proteins etc. in addition to water. This means that the concentration of the water and therefore the corresponding chemical potential is smaller in the egg than outside. Consequently, water penetrates into the interior of the egg and the resulting osmotic pressure "inflates" the egg.

Disposal:

The liquid can be added to the wastewater; the solid residues can be disposed of with household waste or organic waste.