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ANALYTICAL CHALLENGE

Rubbery egg challenge

Hervé This[1]

We would like to invite you to participate in the Analytical Challenge, a series of puzzles to entertain and challenge our readers. This special feature of "Analytical and Bioanalytical Chemistry" has established itself as a truly unique quiz series, with a new scientific puzzle published every other month. Readers can access the complete collection of published problems with their solutions on the ABC homepage at http://www.springer.com/abc. *Test your knowledge and tease your wits in diverse areas of analytical and bioanalytical chemistry by viewing this collection.*

In the present challenge, coagulation is the topic. And please note that there is a prize to be won (a Springer book of your choice up to a value of €100). Please read on…

Meet the challenge

Food ingredients are very complex systems, containing a wealth of compounds organized in a very specific way which affects the bioactivity [1]. Even drinks are more complex than one could guess at first. For example, wine is certainly not a simple solution, because it has a complex colloidal structure [2]. Is the analysis of food and cooking impossible under such conditions? The proposal to consider phenomena, structures, and composition by successive orders of magnitude provides some hope [3]. Consider wine as an example. At first order (>100 g kg^{-1}) it is simply made of water and ethanol [4]; tartaric acid, glycerol, succinic acid, acetic acid, 2,3-butanediol, lactic acid, methanol, malic acid, and citric acid make up the second-order content (1–100 g kg^{-1}); and compounds of the third or higher orders (0.1–1 g kg^{-1}) include odorant molecules.

The same approach helps in understanding more complex food systems, particularly the eggs whose white (although this part is often greenish rather than white) is a wonderful educational tool for chemical physics because at first order it is a solution of proteins in water [5]. The yolk is more complex [6], also containing lipids of a variety of categories (triglycerides, phospholipids, and sterols). During thermal treatment in boiling water eggs "cook", which means that protein coagulates because disulfide bridges form between proteins [7]. This makes a coagulated protein network, with water trapped within (remember that 90 % of the egg white's mass is from water).

Of course, this phenomenon is not the only possible one, because shells are porous [8] and water can exchange between the boiling water and the protein solution. Also, it can be shown that heated proteins can dissociate: a filter paper soaked in lead acetate placed on top of a beaker where egg white is cooked turns black because of the release of hydrogen sulfide from sulfur-containing proteins. Some hydrogen sulfide odor is also apparent in hard-boiled eggs.

The challenge

Processing of food ingredients can result in changes of shape, consistency, odor, color, and taste, to name just a few properties, and the most obvious change that occurs when we cook eggs is the coagulation. Chefs say that

✉ Hervé This
herve.this@paris.inra.fr

[1] INRA/AgroParisTech UMR 1145 Ingénierie Procédés Aliments, Group of Molecular Gastronomy, 16 rue Claude Bernard, F-75005 Paris, France

we should boil eggs for less than 10 minutes, because otherwise they become rubbery.

Is it true that eggs become rubbery when cooked in boiling water for more than approximately 10 minutes? If so, why?

References

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We invite our readers to participate in the Analytical Challenge by solving the puzzle above. Please send the correct solution to abc-challenge@springer.com *by October 1, 2015. Make sure you enter "Rubbery egg challenge" in the subject line of your e-mail. The winner will be notified by e-mail and his/her name will be published on the "Analytical and Bioanalytical Chemistry" homepage at* http://www.springer.com/abc *and in the journal (volume 408/issue 1) where readers will find the solution and a short explanation.*

The next Analytical Challenge will be published in 407/27, November 2015. If you have enjoyed solving this Analytical Challenge you are invited to try the previous puzzles on the ABC homepage.