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Press Release

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Riddle of Hole Formation in Cheese Solved

The holes in cheese are an eyecatcher and a constant source of fascination for children and adults alike. Many traditional Swiss cheeses such as Emmental and Appenzell place great importance on this signature 'eye formation'. But how and where exactly are these holes produced in cheese, and how do cheesemakers manage to steer the process of eye formation day after day, so that the cheese varieties match their ideal image? A new study by Agroscope and EMPA shows that hole formation in cheese is anything but a random process, and solves the riddle of how the holes get in cheese.

Hole formation in cheese: already a subject of investigation in 1917

Scientists have always been fascinated by the phenomenon of hole formation in cheese. Back in 1917, an American named William Clark published a detailed survey article on hole formation in Emmental, summarising the state of the latest research aimed at cracking this riddle. At the time, the notion that hole formation was caused by carbon dioxide produced by bacteria (e.g. propionic acid and lactic acid bacteria) was viewed as a hypothesis rather than an established fact – especially since it was not yet known which bacteria and fermentation processes contributed to gas formation in Emmental. This makes it all the more surprising that scientists were already puzzling over whether or not the holes arose in purely random places in the cheese.

Too-clean milk contributed to 'hole shortage'

The past few decades have also seen repeated efforts to solve this mystery scientifically. Whereas, for example, Swiss Emmental cheese previously tended to have too many holes in winter, over the past 10-15 years cheeses have increasingly been characterised by excessively sparse hole formation, resulting in a mysterious 'hole shortage'. This phenomenon was put down to improved milking technology and the ensuing 'ever cleaner' milk. Agroscope researchers harboured the suspicion that hay particles might be the microparticles triggering eye formation in cheese. To enable the study of the formation of the holes and their number, size and distribution in the cheese over the course of the 130-day ripening period, Agroscope and EMPA (Swiss research centre for material sciences) developed a new method for recording hole formation via X-ray computed tomography. The results of the series of experiments astounded even the researchers: The number of eyes in the cheeses could be controlled almost at will, depending on the amount of hay particles added.

Tiny hay particles form ‘eye starting points’ in cheese
Thanks to this discovery, the mystery of the vanishing holes can now also be explained scientifically. Over the last few decades, traditional milking in barns with open pails has been replaced by modern closed milking systems. At the same time as these improvements in milking technology have lessened the risk of undesirable microbiological contamination, however, they have also reduced the number of microscopic hay particles that find their way into the milk. This also means that fewer ‘eye starting points’ are present in the cheese. The fact that making traditional cheeses requires a pinch of hay dust in addition to milk, rennet and bacterial cultures is a nice example of how the production of raw milk and its processing into cheese are still closely linked activities. It also highlights just how natural traditional raw-milk cheeses are.

The study was peer-reviewed by international scientific experts and published in the International Dairy Journal. Detailed technological information on the use of hay particles can be found at www.sciencedirect.com.

PRESS RELEASE SUPPLEMENT

Subsequent to publication of the Agroscope media release ‘Riddle of Hole Formation in Cheese Solved’, the odd article has appeared erroneously reporting that hay particles are exclusively responsible for eye formation in cheese. Below, a brief clarification of the release:

Hole formation in cheese is chiefly triggered by two factors:

1. Plant particles functioning as ‘eye starting points’ (e.g. hay particles);
2. Bacteria which produce carbon dioxide (CO_2) in cheese (e.g. propionic acid or lactic acid bacteria).

The microscopic hay particles contain tiny air bubbles. These air bubbles are enlarged by the carbon dioxide (CO_2) created by the bacteria, leading to the formation of visible cheese holes or ‘eyes’. The hay particles only determine where and how many holes are formed in the cheese. In the absence of hay particles hardly any holes are formed, since the CO_2 created by the bacteria largely escapes from the cheese. Some lactic acid bacteria form very little CO_2, so that no holes are formed despite the presence of hay particles. This is the reason that various types of cheese such as Gruyère PDO or Sbrinz PDO contain no holes.

In a few of the reports the hay particles were misleadingly termed ‘dirt’. This is a false oversimplification, since premium cheeses can only be made from hygienically clean milk. Hay particles are effective in the smallest doses. As little as approx. 5-10 milligrams of hay particles per 1000 kilograms of milk are sufficient to achieve typical eye formation. At this very low dosage, hay particles have no effect on the hygienic quality of the milk.

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