Morphogenesis of cheese flowers through scraping

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The "Tête de moine" Swiss cheese is generally served by scraping the surface of a cylindrical loaf with a sharp tool (Fig. 1). This produces thin sheets of cheese that are strongly wrinkled at the edge, resembling frilly flowers and enhancing the tasting experience. In this work we unveil the physical mechanisms at play in this scraping-induced morphogenesis. We measure the deformation of the cheese during scraping and show that plastic deformation occurs everywhere, but find a larger plastic contraction in the inner part of the flower, causing its buckling into shape. We show that it surprisingly derives from the lower friction coefficient evidenced on the cheese close to its crust.

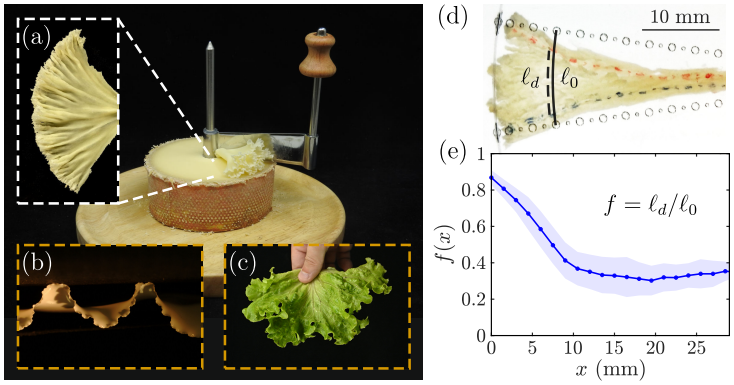

Figure 1. (a) Layer of the cheese *Tête de moine* with wrinkly edge, after being scraped using the cheese slicer "*la Girolle*". (b) Edge wrinkling of a torn plastic sheet ; (c) Wavy edge of a Blue Star Fern leaf. (d) Picture of a flattened cheese flower chip and (e) the associated metrics $f(x) = \ell_d/\ell_0$ as a function of the radial distance x from the edge periphery.

Our analysis [1] provides the tools for a better control of chip morphogenesis through plasticity in the shaping of other delicacies, but also in metal cutting. The new shaping mechanism evidenced here (inhomogeneous plastic shrinking induced by scraping) is described in its generality. It can be of interest for other materials such as in metal cutting or for polymer materials, when presenting inhomogeneous properties either by formulation, aging or mechanical processing. Even for homogeneous materials, the fact that friction properties control the metric change is also particularly interesting for material shaping : starting from a simple homogeneous material, but with a blade designed with spatially varying frictional properties [2], these results open the possibility of programming complex shaping from a simple scraping process.

Références

1. Zhang, J., Ibarra, A., Roman, B. & Ciccotti, M. Morphogenesis of cheese flowers through scraping. *ArXiv Preprint ArXiv :2501.00797*. (2025)
2. Aymard, A., Delplanque, E., Dalmas, D. & Scheibert, J. Designing metainterfaces with specified friction laws. *Science*. **383**, 200-204 (2024)