"Toll House" Recipe Cookies Do Not Maintain Their Morphology Under Heat Stress Conditions

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We investigated the morphological behavior of chocolate chip cookies as reported by previous investigators.

A hallmark of the male-dominated scientific establishment is the disbelief in or marginalization of the outsider or other. Two children undertook to prove their hypothesis that the popular drop-cookie recipe[1] for chocolate chip cookies (known as "Toll House cookies") would not yield preshaped cookies or that preshaped batter would not maintain its morphology through a trial of heat shock (a.k.a. "baking").[2] Because their results were exclusively qualitative, i.e. based on exclusively descriptive data drawn from repeated experimentation and because the experimenters were mere children, we sought to disprove the results via quantitative computer analysis of batter under heat stress conditions.

We were unable to effectively challenge their results.

Methods

To challenge the results, we prepared the Toll House formulation in its standard form.[1,2]

To assess area and shape continuity or flux over a ten-minute heat stress condition, we employed an endpoint assay. Morphology and area, measured from a vantage normal to the plane of plating, were quantified before and after baking conditions using the powerful image analysis package ImageJ.[3] Index of roundness is measured as a ratio of perimeter to the square root of area with an adjustment by a constant based on 4 * pi to yield 1 for a perfect circle.

Results

We confirm the qualitative analysis that dough both spreads and loses integrity of hard corners due to heat shock (see Figures 1a and 1b).

The dough is a suspension of starch, sucrose and lipid-based chips in butterfat, which is subjected to pretreatment and post-treatment by heat. Application of heat appears to alter morphology of the suspension, resulting in more spread and smoother-edged objects.

In addition, quantification of changes in absolute area and circularity confirm that dough loses its morphometric integrity when heated to 375 degrees F. Absolute area change is an index of spreading. All specimens spread typically by more than 100 percent each. Circularity is an index of variation from a perfect circle where 1 = perfect circle and, for our uses as it is known that area increases over time, 0 = perimeter approaching infinity. Circularity increases by approximately 25 percent which indicates the smoothing and loss of detailed edge features. Unfortunately, we were unable to establish a 1:1 correlation between area change and increase of circularity in individual specimens; however, the population study of each parameter isolated from the other is compelling (see Figures 2a and 2b).

Discussion

The de facto final arbiter on all things cooking in the United States, the Culinary Institute of America, says nothing in its popular press regarding the chemistry or stability of drop-cookie dough under heat stress conditions.[4] Therefore, we established definitively that drop-cookie dough loses its morphometric integrity when subjected to heat.

However, the mechanisms of action have not been identified. Yet to be determined is the cascade of chemical events leading to collapse, spreading and subsequent cessation of flux. What roles do sugar and starch suspended in lipid play to slow the spread of the fat, which loses viscosity when heated? Do chocolate chips play a significant role as physical barriers to heat and gravity induced flow? Does protein in flour crosslink to provide stability and at what point does protein in egg crosslink due to heat? Cookies develop crisp outer shells which may be involved in the cessation of flux. The relative roles dehydration or other chemical reactions contribute to this exoskeleton have yet to be investigated.

Our investigation lays a firm foundation for further study. It should also be especially noted that cookies are three-dimensional constructs and, therefore, need more rigorous study as objects in space.

Acknowledgements

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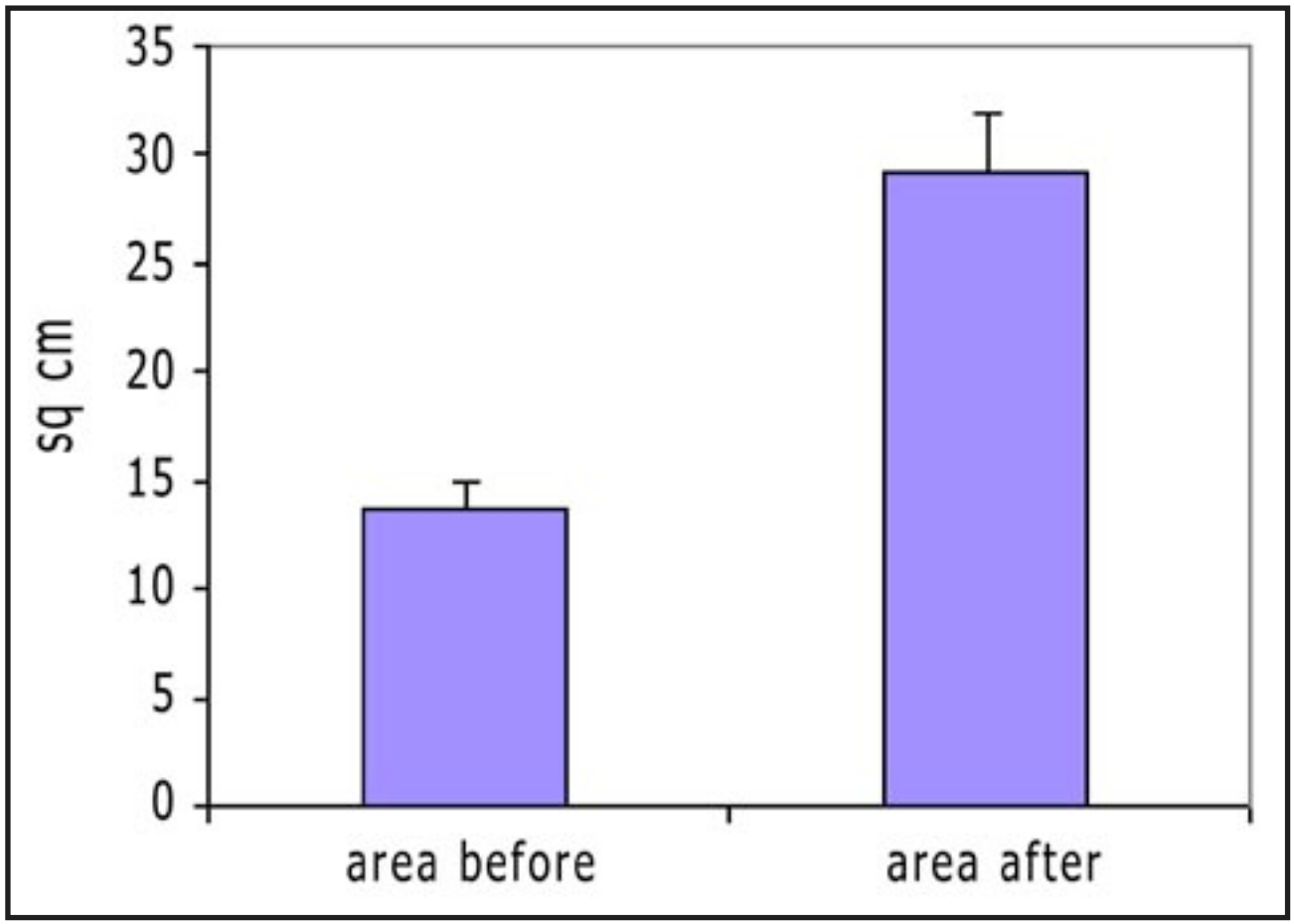
Area as measured by 2D projection from directly above. The thick colloid increases by 2X due to treatment by heat in standard convection oven.



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3. Image J 1.34g, W.S. Rasband, National Institutes of Health, Bethesda, Md., http://rsb.info.nih.gov/ij/, 1997-2005.

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Approximate 25 percent loss of unique edge variation of features as measured by circularity of 2D projection from directly above due to treatment by heat in standard convection oven.