



How Does the Cookie Crumble?

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2.671 Instrumentation and Measurement

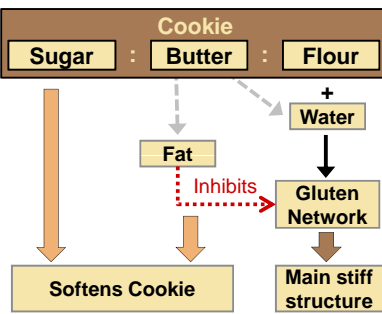


<https://thenourproject.com/search/?q=cookie&id=241899>

Abstract

In order to bake the most pleasing cookie, we need to understand how a cookie's ingredients affect its overall shape and taste. By varying the ratio of sugar to butter to flour in a cookie, we are able to change the material properties of the cookie. We use texture profile analysis and Weibull strength analysis to quantify taste factors and define what makes a "reasonable" cookies.

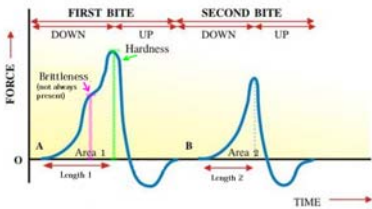
Chemistry of Cookies



Texture Profile Analysis (TPA)



- "Two Bite Test" - compress sample twice
- Quantify chewiness, hardness and brittleness
- Invalid if sample is destroyed early, sticks to probe or overloads sensor



$$\text{Springiness} = \frac{\text{Length2}}{\text{Length1}}$$

$$\text{Chewiness} = \frac{\text{Area2}}{\text{Area1}} \cdot \text{Hardness} \cdot \text{Springiness}$$

Since cookies are brittle materials, Weibull distribution was fitted to reported TPA values. Scale parameter was reported in bar graphs.

Acknowledgements

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Ratios – Sugar : Butter : Flour by Mass

9 batches of cookies made, 5 chosen as representative of cookie types

1:2:3 Cookies



Shortbread

1:1:1 Cookies



Halfway between Sugar Cookie and Shortbread

1:3:2 Cookies



Butter Cookies

2:1:1 Cookies

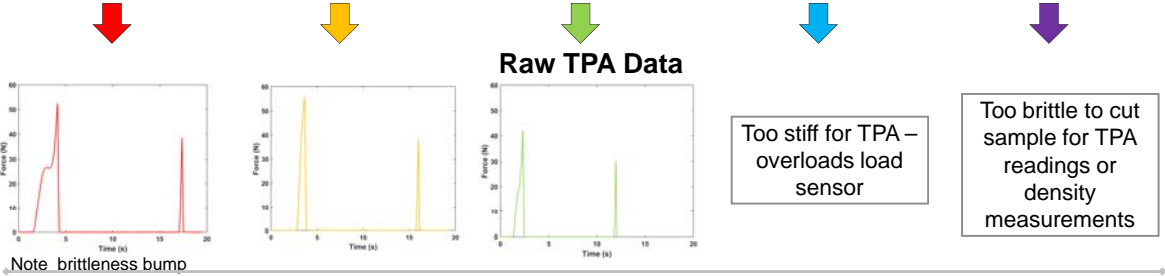


Sugar Cookies

1:1:2 Cookies



"Flour Cookies"



Note: brittleness bump

Too stiff for TPA – overloads load sensor

Too brittle to cut sample for TPA readings or density measurements

Statistical Analysis

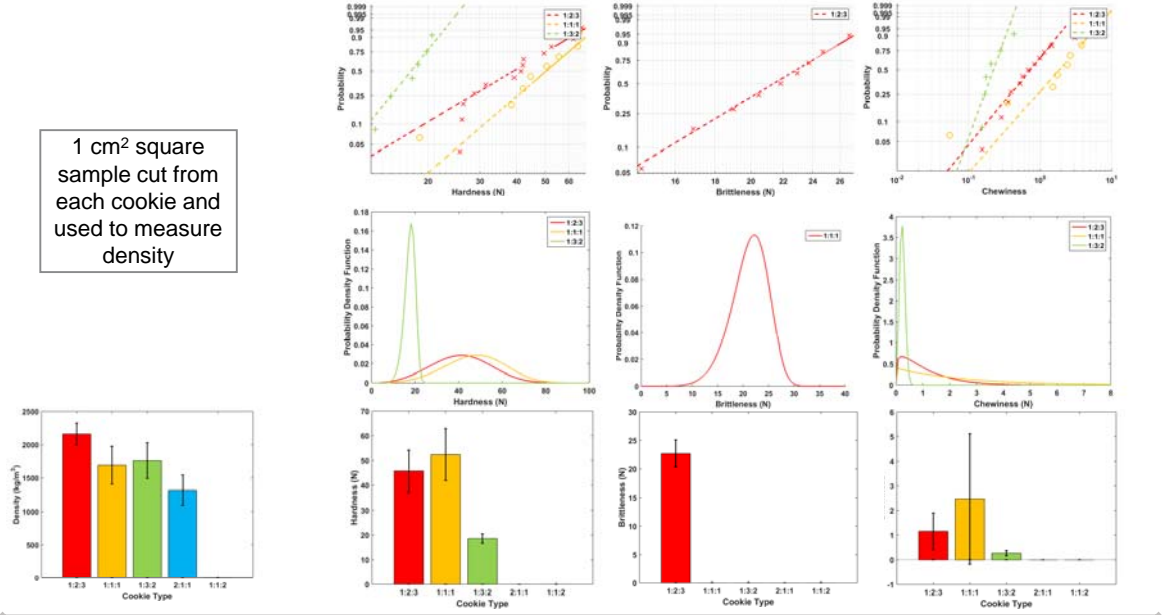
Density

Hardness

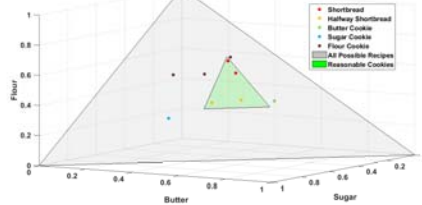
Brittleness

Chewiness

1 cm² square sample cut from each cookie and used to measure density



Cookie Space



- Reasonable cookie region determined by taste tests of cookies
- Not enough data to quantify what aspects of cookie make it reasonable nor enough data to interpolate from results

Conclusions

- Reasonable cookie space is surprisingly small
- TPA provides a reasonable quantification for hardness and brittleness, but not chewiness
- For more accuracy, larger load cell and larger compressive probe needed for TPA to get full range of stiffness and eliminate need to cut sample