

INTRODUCTION

Acrylamide (AA) is a potential carcinogenic compound that is found in significant amount in baked food products, AA content in baked goods such as cookies should be minimized while maintaining desirable characteristics (e.g., colour). AA formation is influenced by the non-uniform distribution of temperature and moisture during the baking process. Hence, a comprehensive model that couples heat and moisture transfer principles, as well as reaction kinetics of AA formation and degradation, and browning will advance the understanding, predicting and screening of baking conditions that attain low AA contents and acceptable colour.

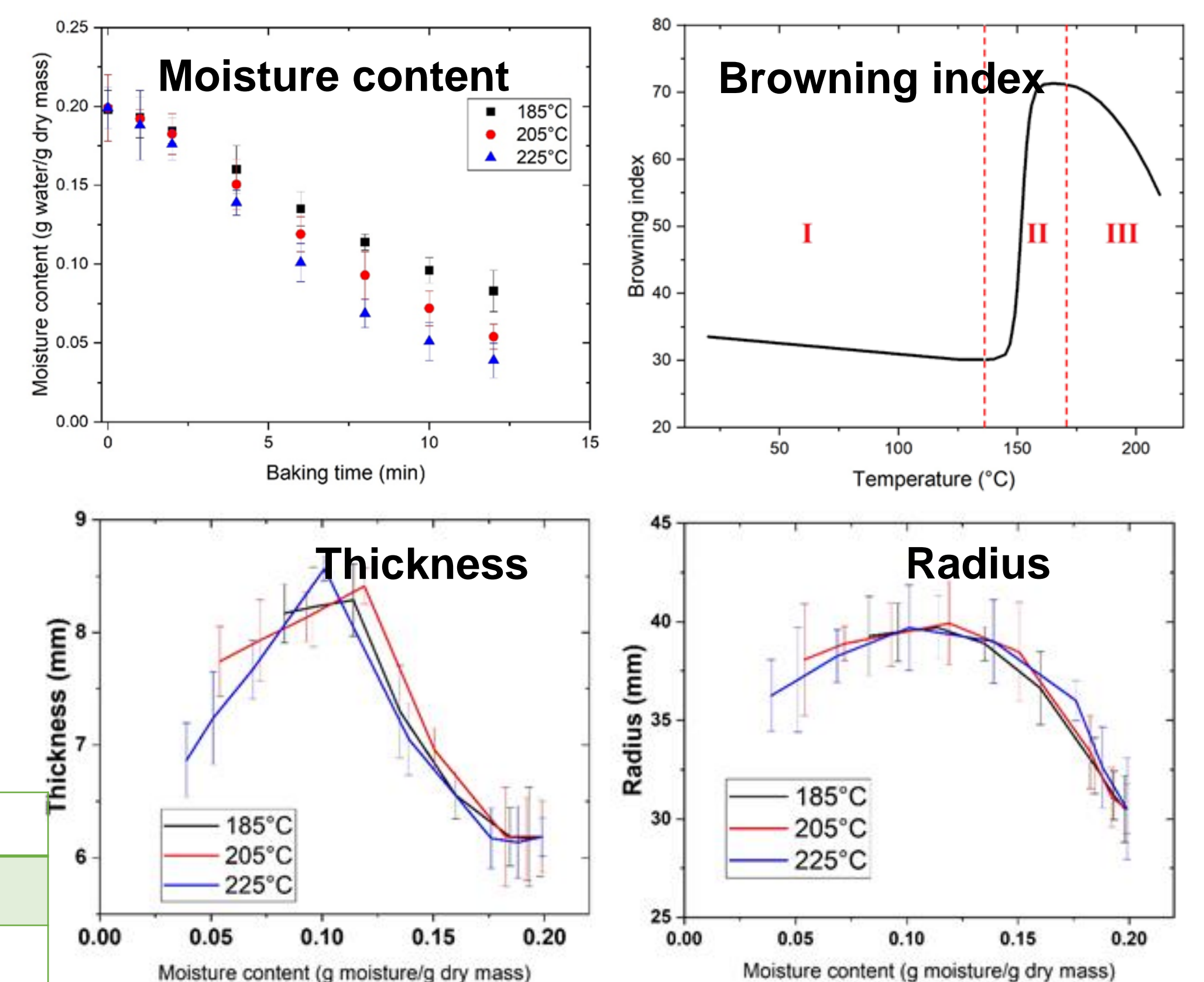
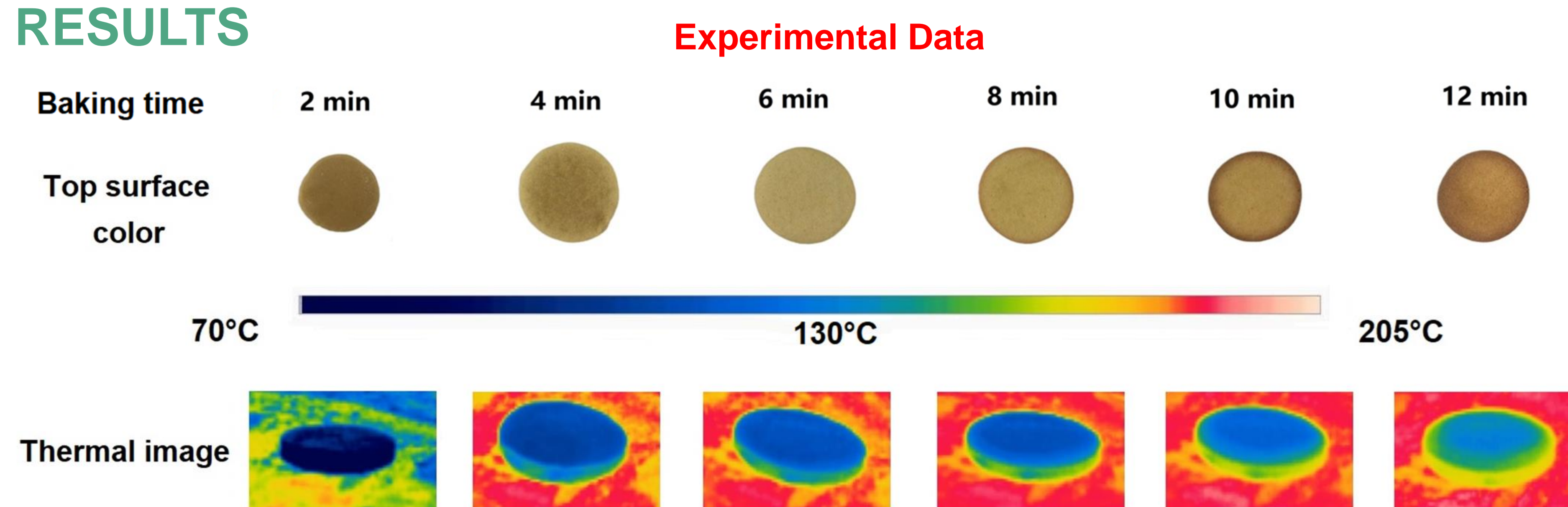
AIM

The objective of this study was to collect data to develop and validate such a comprehensive model and use it to simulate the temporal-spatial distributions of AA and colour during cookie baking.

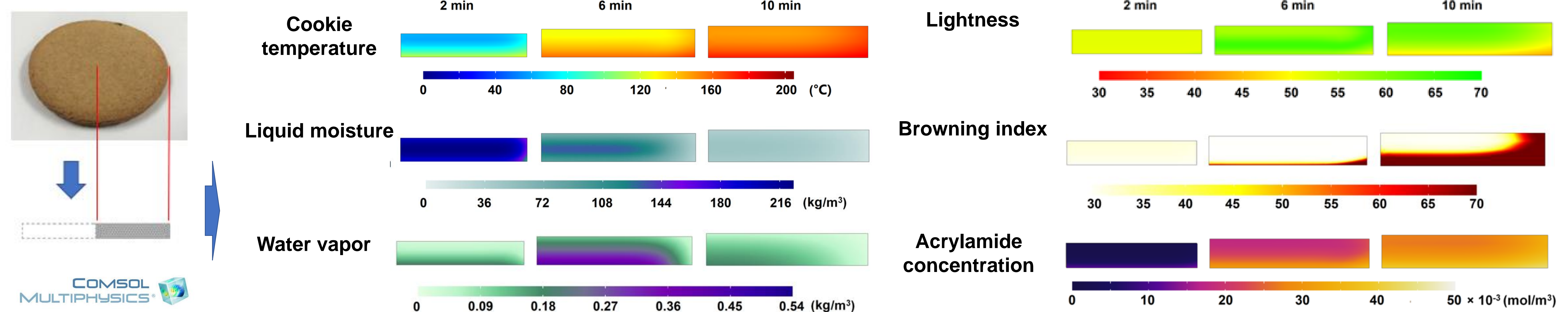
METHODS

- Dough preparation: AACC 10-53.01 standard protocol (Unbleached white flour)
- Cookie baking: 185, 205 and 225°C (natural gas oven)
- Sampling: shaving from different locations of cookies
- Colour development: L*, a*, b* indexes; Browning index; Imaging; Empirical kinetic modeling [1]
- Acrylamide content: Extraction: Liquid-solid phase extraction; Content determination: HPLC-DAD; Formation and degradation modeling: first-order kinetics [2]
- Shape characteristics: Thickness expansion; Diameter expansion; Empirical modeling
- Heat transfer: Temperatures (cookie, oven); Fourier's law of thermal conduction; Heat transfer coefficients [3]
- Moisture transfer: Moisture distribution; Fick's law of diffusion; Moisture transfer coefficients [3]

RESULTS



Validation	Modeling Results / RMSE		
Oven temperature	Overall moisture	Surface average temperature	Overall acrylamide content
185°C	0.997 / 244.536	0.995 / 3.247	0.994 / 1.463×10^{-4}
205°C	0.997 / 271.464	0.995 / 3.621	0.995 / 1.964×10^{-4}
225°C	0.994 / 372.139	0.993 / 4.870	0.995 / 2.462×10^{-4}



CONCLUSIONS

- Shape change, colour development and effective moisture diffusivity of the cookie during baking were modeled phenomenologically.
- The developed model accurately estimates temperature, moisture, colour and acrylamide content during baking.
- Non-uniform distribution of temperature and moisture within the cookie during baking resulted in non-uniform distribution of colour and acrylamide content.

ACKNOWLEDGEMENTS



REFERENCES

- [1] Peleg M, Corradini MG, Normand MD. Isothermal and non-isothermal kinetic models of chemical processes in foods governed by competing mechanisms. *Journal of agricultural and food chemistry*. 2009 Aug 26;57(16):7377-86.
- [2] Chan, D. S. (2020). Computer Simulation with a Temperature-Step Frying Approach to Mitigate Acrylamide Formation in French Fries. *Foods*, 9(2), 200.
- [3] Chen, C., Upadhyaya, S., Khir, R., & Pan, Z. (2020). Simulation of walnut drying under hot air heating using a nonequilibrium multiphase transfer model. *Drying Technology*, 1-15.