



Towards the definition of an objective criterion of the food printing quality

Valérie Guénard-Lampron, Giana Almeida, Charlotte Dumoulin, Cassandre Leverrier

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Valérie GUÉNARD-LAMPRON¹, Giana Almeida¹, Charlotte Dumoulin¹, Cassandre Leverrier¹

¹Université Paris-Saclay, INRAE, AgroParisTech, UMR SayFood, 91120, Palaiseau, France

✉ valerie.guenardlampron@agroparistech.fr

INTRODUCTION

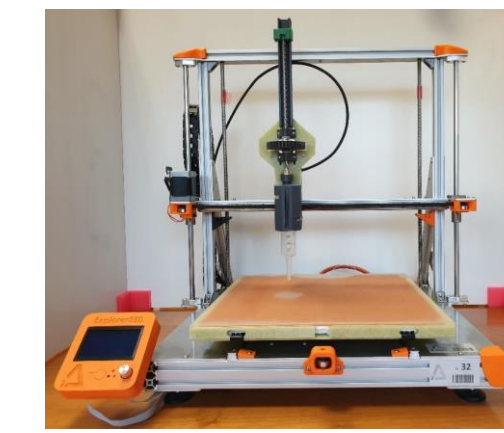
3D food printing is an interesting technology for offering personalized, healthy, good, appetizing and diversified food. However, it is still difficult to predict the print quality of the new printable recipes. A printable wheat flour based dough can be obtained by applying a thermomechanical treatment^{1,2}. In this work, a wide variety of food matrices for 3D printing were formulated from flours (wheat, rye, soy, lentil) and fruit and vegetable purees (potato, chestnut, broccoli) with the idea of generating a large range of printed products to study printing quality criteria.

OBJECTIVES

The objective of this work was to highlight **one or several criteria to evaluate and predict food printing quality** in an objective way.

Criteria under study covered the following properties of printed products:

- ❑ Visual (image analysis)
- ❑ Rheological (rheometer)
- ❑ Textural (texture analyser)



Food 3D printer prototype

METHODOLOGY

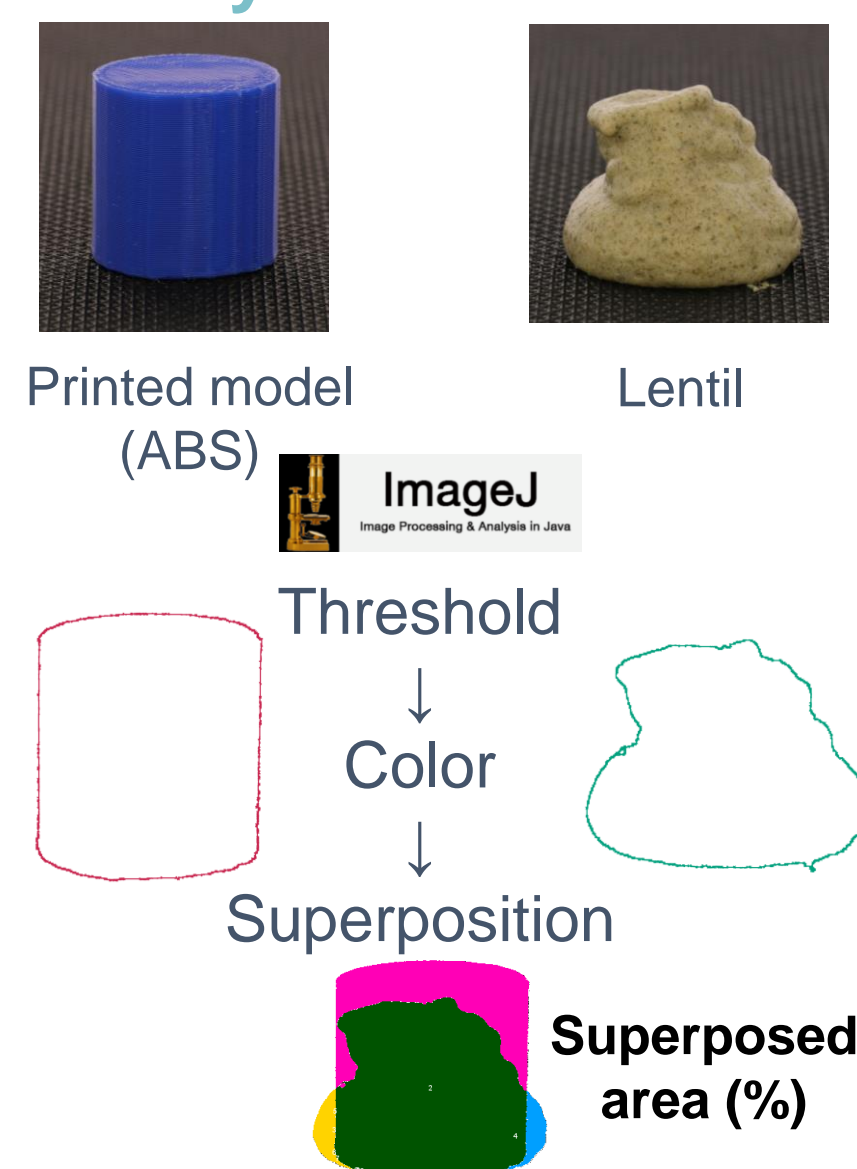
Printed products



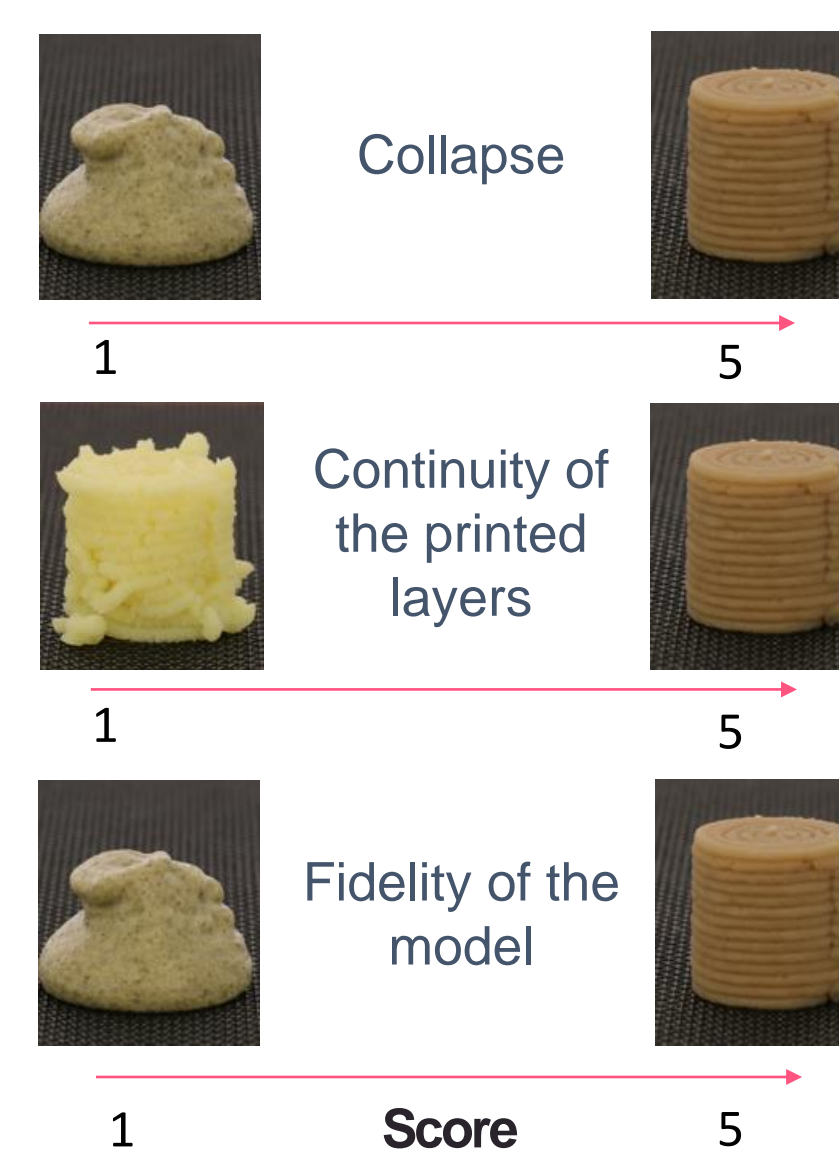
Image analysis

Pictures taken from multiples viewing angles

Image analysis by a software



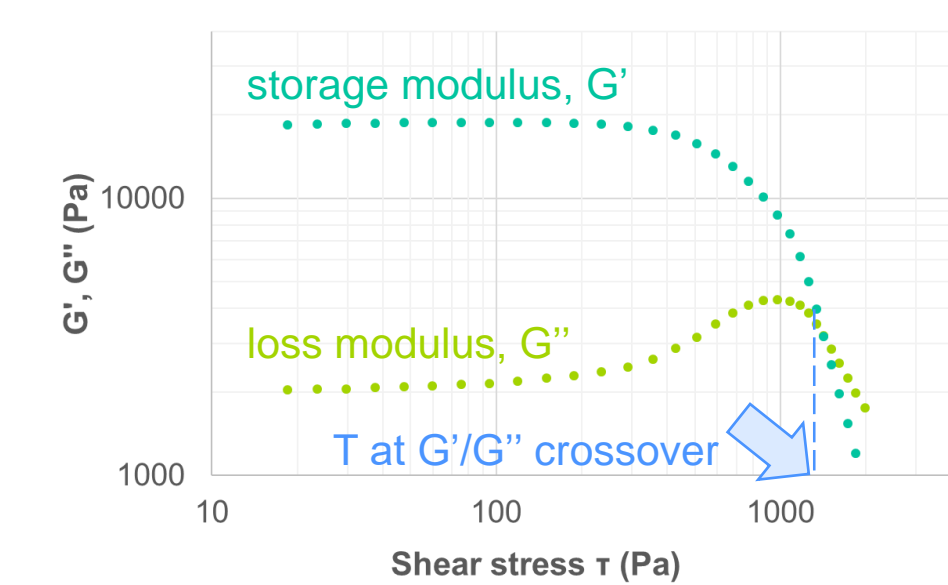
Visual evaluation by 12 judges



Rheological & textural properties

Rheology

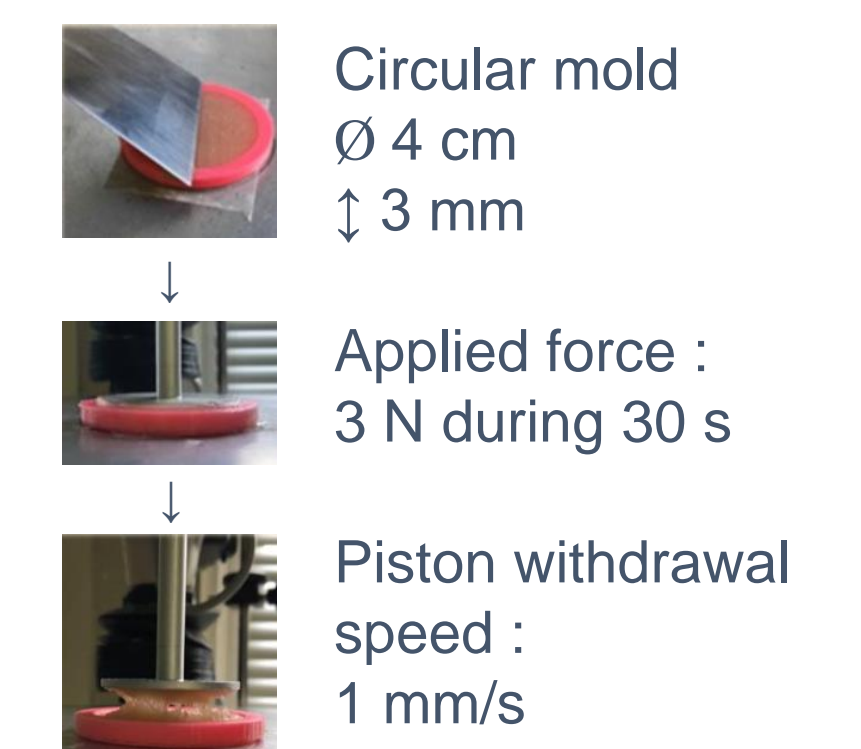
τ at G'/G'' crossover (Pa)
Amplitude sweep
Geometry: cone-plate (\varnothing 25 mm)
Temperature : 20 °C
 γ : 0,01% - 100%
 f : 1 Hz



Texturometry

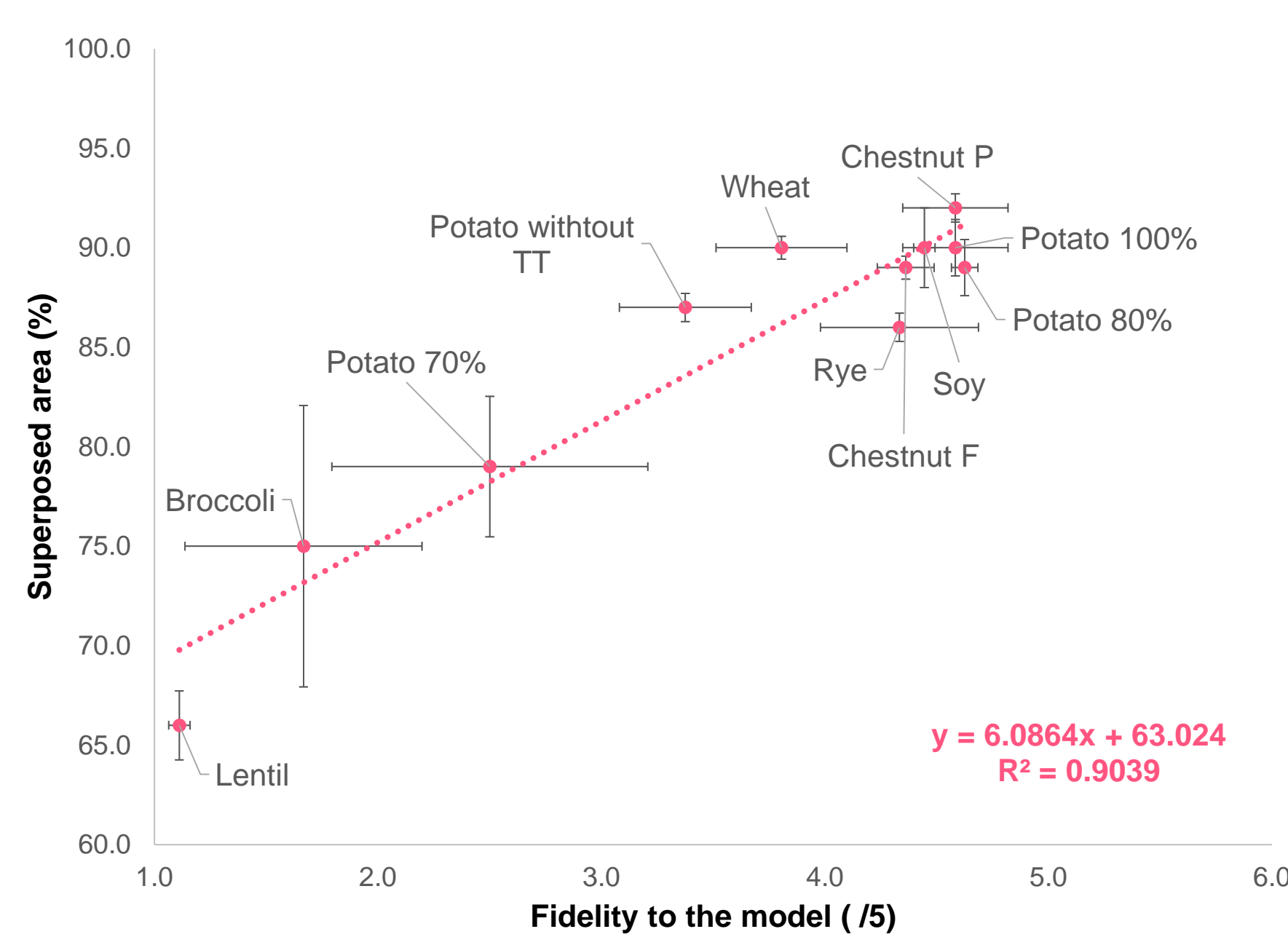
Firmness (N) : mean force at the plateau
Back-extrusion method
Probe : flat and circular (\varnothing 25 mm)
Speed : 1 mm/s, Depth : 30 mm

Stickiness (N) : maximum force required to remove the piston

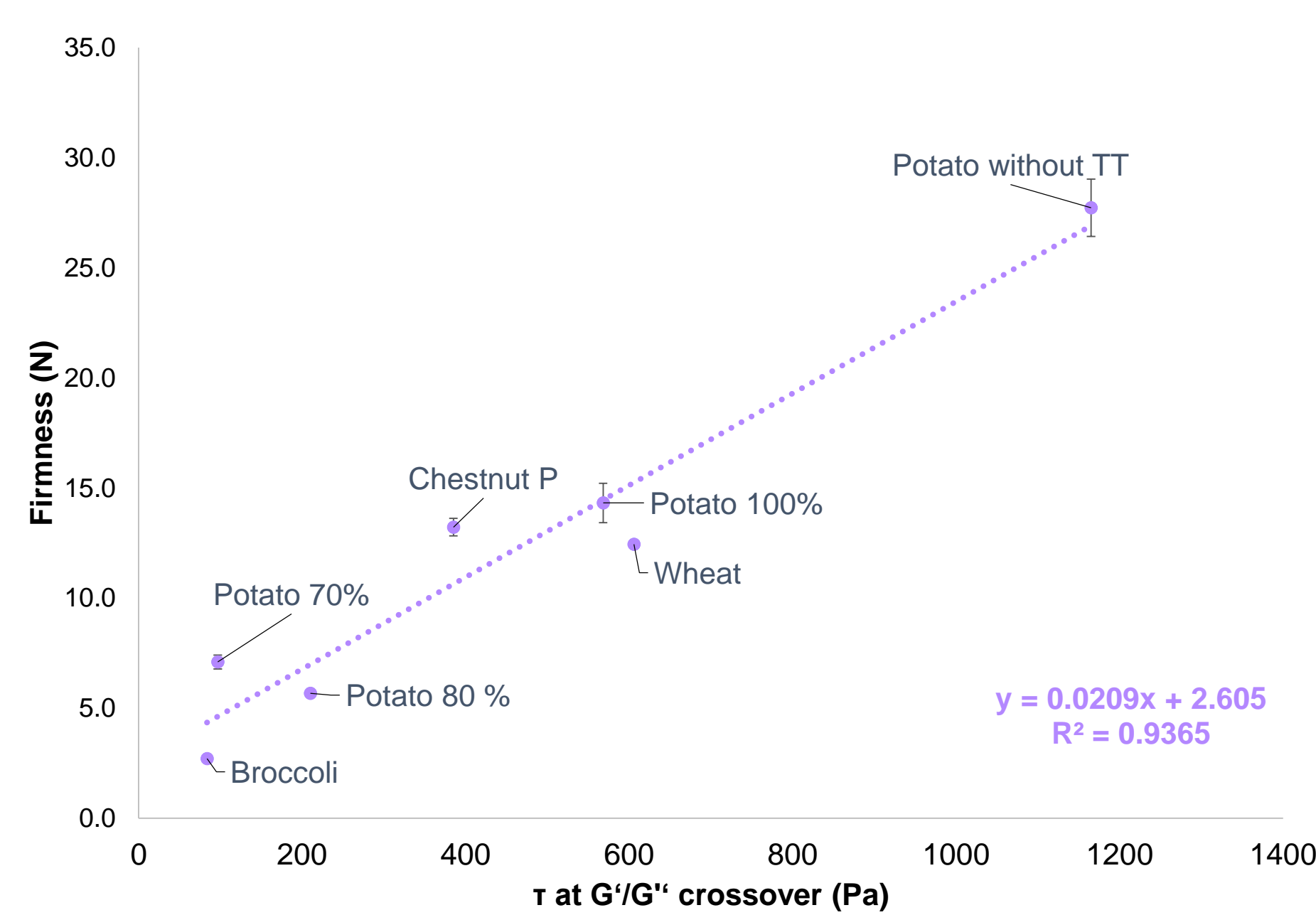


Results and discussion

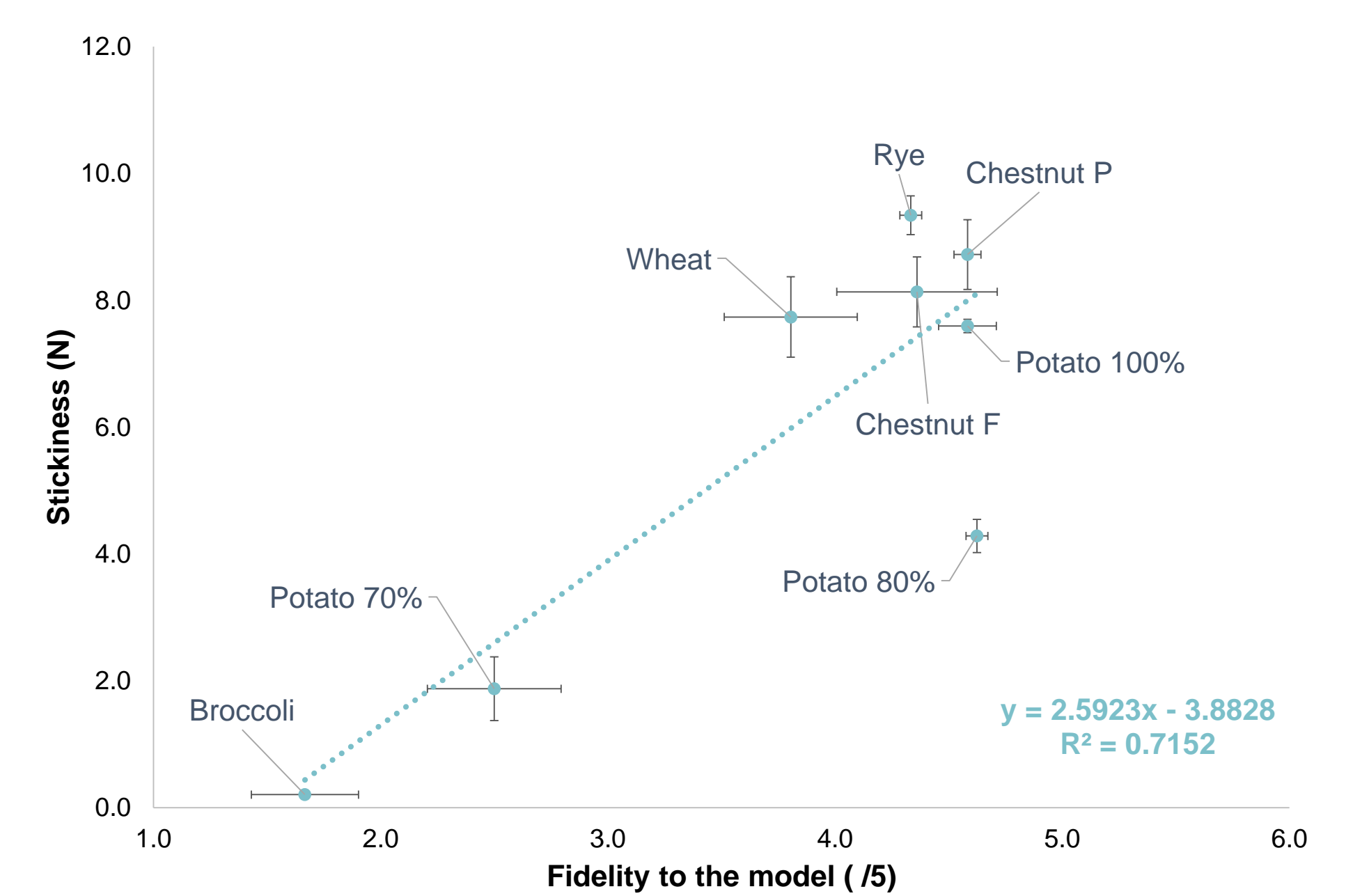
Image analysis as a representative tool ?



Textural and rheological properties impacting printing behavior and quality ?



Stickiness, a relevant criterion ?



The **image analysis** protocol developed allows to describe the print quality in a reliable and objective way, and is **representative of the scores given by the judges** :

A linear relationship ($R^2 = 0.90$) is observed between the superposed area (%) and the model fidelity score.

Same results are observed for the collapse ($R^2 = 0.90$), but the continuity of the printed layers is less representative of the printing quality ($R^2 = 0.54$).

The **back extrusion mean force (firmness, N)** of the printed products is **linked to stress at G'/G'' crossover (Pa)** ($R^2 = 0.94$) :

When the stress at G'/G'' crossover is higher, the back-extrusion mean force (firmness, N) increases which can result in an increase in the force required to extrude the product and impact the print quality.

A similar relationship was demonstrated for food matrices based on tomato purees³.

The **stickiness (N)** of the printed products seems to **partially explain the printing quality** ($R^2 = 0.72$) :

The model fidelity score is higher when the stickiness value increases.

However, the relation between the stickiness and the fidelity score is less obvious than between mean force (firmness, N) and stress at G'/G'' crossover (Pa).

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REFERENCES

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- Guénard-Lampron, V., Masson, M., Leichtnam, O., Blumenthal, D. (2021). Innovative Food Science & Emerging Technologies, 72, 102738.
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CONCLUSION

A single criterion is not sufficient to predict printing quality of food matrices

Food printing quality ...

- ❑ can be quantified by image analysis
- ❑ depends on rheological and textural properties which are linearly related
- ❑ is partially explained by the stickiness (N)