Design and Analysis of Novel 3D Printed Foods with Re-purposed Animal and Plant Proteins

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Introduction

3D food printing is a novel technology with design freedom to create complex structures with functional and nutritional benefits[1].

There has been growing interest towards utilising plant- and animal-based proteins to develop 3D printed foods[2].

Texture and rheology determine 3D food printing success, depending on the structure and physiochemical properties[3].

Objectives

Assess the Rheological Properties of Plant and Animal-based food inks

- Determine the viscoelastic properties of Plant, Animal and Hybrid (plant + animal) food inks for printability

Assess the Textural Properties of cooked 3D printed foods

- Measure the hardness (Force, *N*) of cooked 3D printed samples

Methods

Sample Preparation

Food Ink Formulation: Paste of protein powders and water.

Plant	Pea protein (22.7%) w/w
Animal	Chicken breast (21%) w/w
Hybrid	Pea protein (11.4%) + Chicken breast (10.5%) w/w

3D Food Printing and Cooking: *Foodini* printing cartridges (4 mm nozzle) were filled with food ink (80 ml) to print '5-layered square', custom designed in *Foodini Creator;* and oven baked at 200 ºC for 20 minutes.

Sample Analysis

Rheological Analysis: Storage *G'* and loss *G"* moduli were measured using a *MCR 302 Rheometer* on food ink samples with an angular frequency range of 0.1 to 100 rad/s.

Texture Analysis: Hardness (Force, *N*) of cooked 3D printed samples were measured using *TA.XTplus Texture Analyser*, with test speed 2.00 mm/sec, 5 kg load cell, and WBS blade.

Foodini (Natural Machines) 3D Food Printer

Results

Rheological Analysis

- *G'* and *G"* of all samples progressively increased during the frequency sweeps, indicating food ink elasticity and stability (Fig 1).

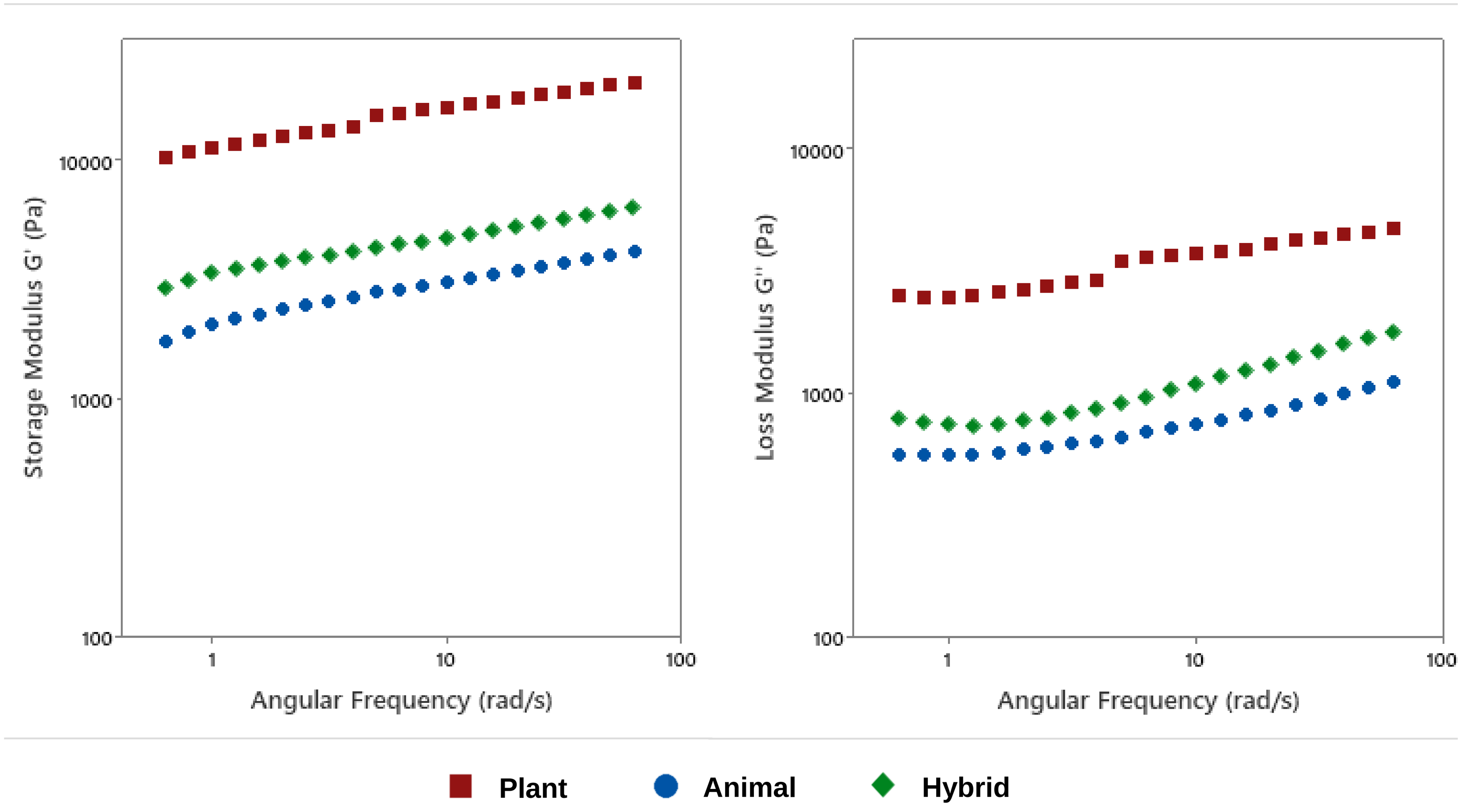

Figure 1. *Viscoelastic parameters: (a) Storage and (b) Loss Moduli of Plant, Animal and Hybrid food inks*

3D Food Printing

3D printed '5-layered square': *Plant, Hybrid, Animal and close-up 3D view of Plant (left to right); uncooked (top) and cooked (bottom)*

Texture Analysis: Hardness

- Force (*N*) of cooked 3D printed samples were not significantly different ($P > 0.05$, Fig 2).

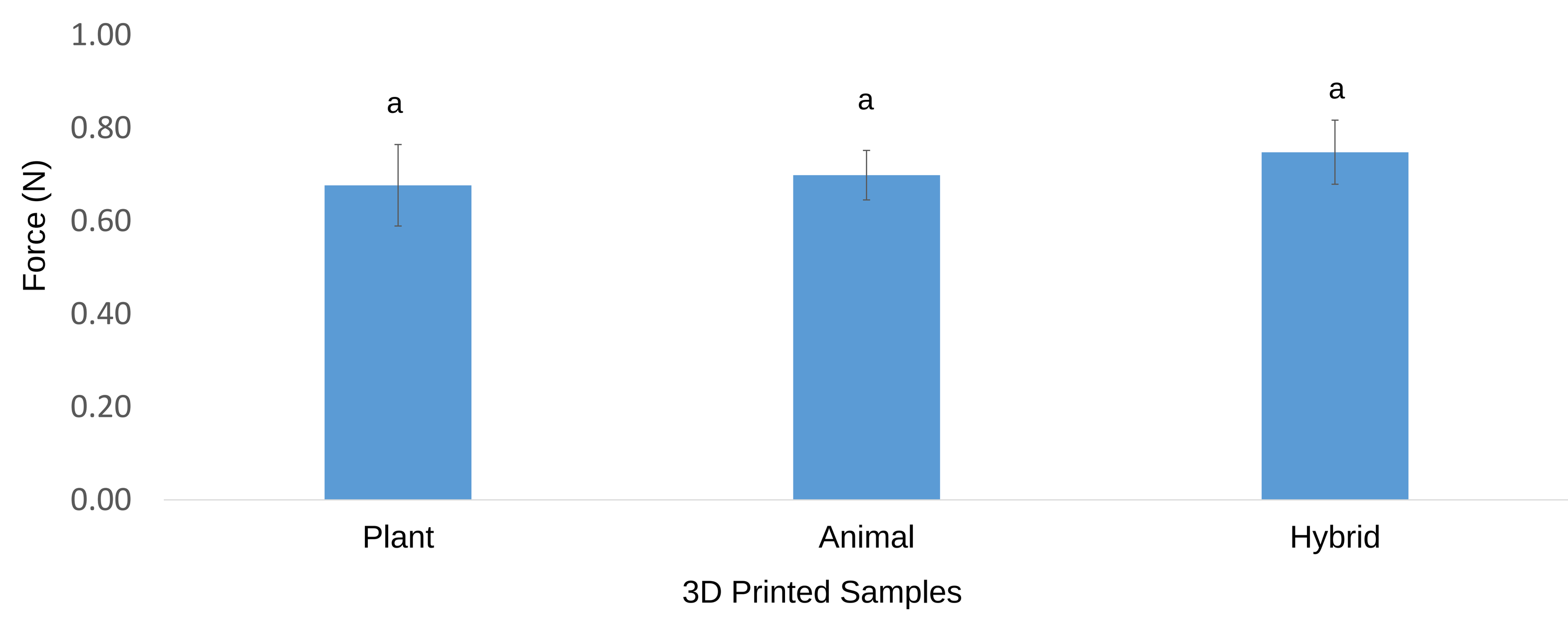

Figure 2. *Mean ± StDev of Force (N) of cooked 3D printed samples. Superscript letter indicates significant difference (ANOVA and Tukey's post hoc testing (P > 0.05))*

Conclusions

- Rheological analysis showed that Plant, Animal and Hybrid food inks exhibit suitable flow behaviour for printability.
- Texture of cooked 3D prints composed of Plant-based ink result in softer products, compared to Animal or Hybrid food inks.
- This study suggests the future potential of developing sustainable food inks using plant and animal proteins for 3D printing purposes.

References

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Acknowledgements

This research project is funded by the Massey-Lincoln and the Agricultural Industry Trust Capability Development and Research Fund (MLAIT CDR). The Faculty of Agriculture and Life Sciences at Lincoln University has also supported the work via a summer scholarship project and with on-going research assistance funds. We thank Michelle Tamehana (Massey University) for assisting with laboratory work, and Adrian Russell (Plant Research (NZ) LTD) for supporting the pathway of the current work with the plant resource developed and grown in Canterbury, New Zealand.