Lipids act as a lubricant during the extrusion stage of pellet manufacturing, reducing agglomerate strength

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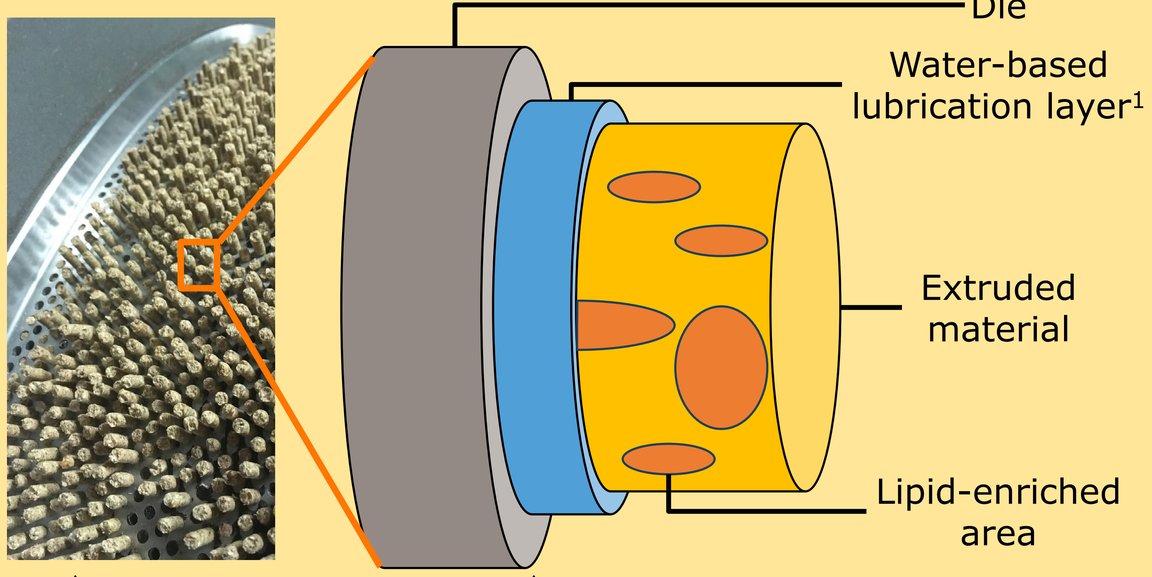
Background

- Increased inclusion of lipids reduces both energy consumption of cold extrusion processes (e.g. pellet manufacturing) and agglomerate strength.
- Behaviour of the lipids during cold extrusion and differences among lipids sources remain poorly understood.

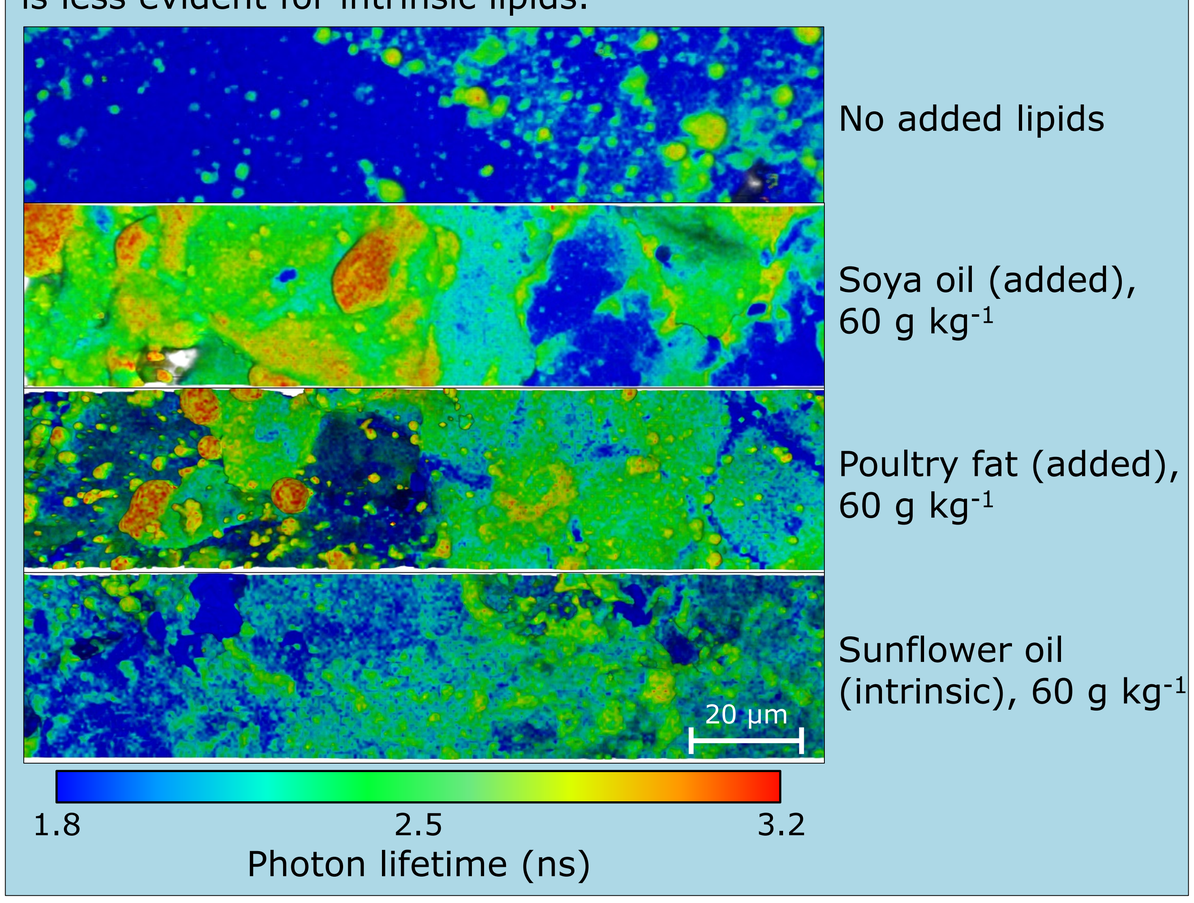
Hypothesis: lipids as a lubricant



1) ↑ Inclusion level lipids ⟶ ↑ Lipid-enriched areas on agglomerate surface ⟶ ↓ Friction material die wall ⟶ ↓ Agglomerate strength
2) ↑ Lipids part of a material ⟶ ↓ Capacity of lipids to migrate to die wall ⟶ ↓ Lipid-enriched areas on agglomerate surface ⟶ ↑ Agglomerate strength

Result 1: lipids on the agglomerate surface

Photon lifetime imaging illustrates dispersed lipid-enriched areas on agglomerate surface for added lipids, implying lipid emulsification in lubrication layer between material and die. This is less evident for intrinsic lipids.



Objectives

To understand how cold extrusion of pellets is impacted by:

1. Lipid inclusion level.
2. Lipid source, i.e. separately added (added) or as part of a material (intrinsic).

Conclusions

- Added lipids reside on agglomerate surface and seem to be emulsified in the water-based lubrication layer (Result 1).
- Increased added lipids inclusion reduces both energy costs and agglomerate strength in a dose response manner (Result 2).
- Inclusion of materials with intrinsic lipids allow for production of strong agglomerates containing high levels of lipids (Result 2).

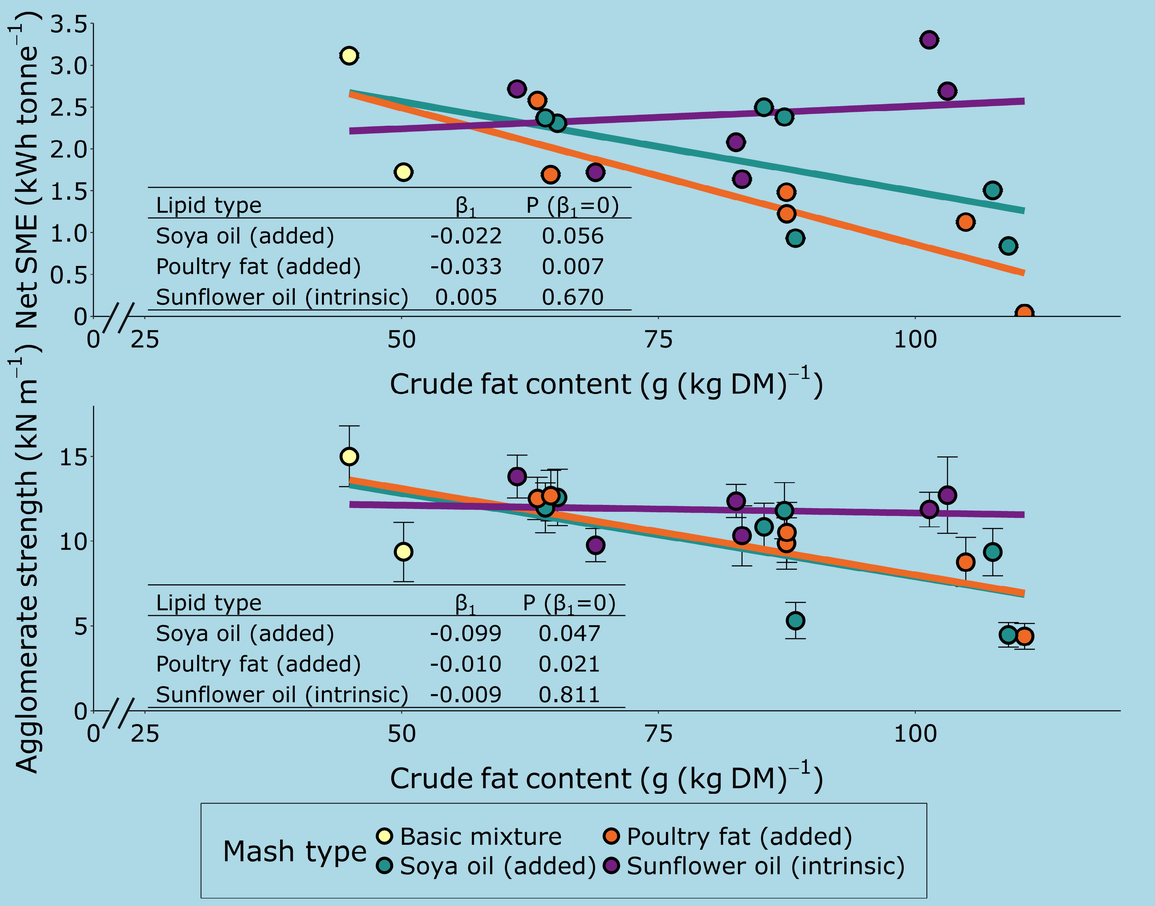
Experimental design

Mixture of dry ingredients mixed with 20, 40, or 60 g kg^{-1} of soya oil (added), poultry fat (added), or sunflower oil as part of sunflower expeller meal (intrinsic).

Cold extrusion was performed at pilot scale. Each mixture was prepared in batches of 400 kg and processed in duplicate.

Result 2: Lipid inclusion and source impact cold extrusion

Increased inclusion of added lipids reduced both energy costs of cold extrusion (net SME) and agglomerate strength. This is not the case when lipids are an intrinsic part of a feed material.



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[1]Benders, et al. (2024). Phase segregation lubricates paste extrusion, arXiv, 1-26.