Comparative functional properties of kafirin and zein viscoelastic “doughs” formed by simple coacervation at different acetic acid and protein concentrations

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Problem statement

- Sorghum contains kafirin (sorghum prolamin storage protein), which does not by itself form a viscoelastic mass when hydrated in water. Until recently, it had been impossible to form a stable viscoelastic mass from kafirin. WHY?
- We have isolated the kafirin, releasing it from the protein bodies through coacervation. Coacervation involves dissolution of kafirin in glacial acetic acid, followed by addition of distilled water.
Objectives

- To determine the effects of different final acetic acid and protein concentrations on the morphological and rheological properties of kafirin and zein viscoelastic masses.

- To understand the rheological properties of kafirin, versus zein and gluten
Figure 1: Experimental design for determining the lowest final acetic acid and protein concentrations that will allow kafirin and zein viscoelastic mass formation.
Figure 2: Stereomicroscopy of kafirin and zein viscoelastic masses at different acetic acid concentrations.
Figure 3: Scanning electron microscopy of kafirin and zein visco-elastic masses at different acetic acid concentrations.
Above 5% acetic acid, Zein visco-elastic masses were too soft for analysis.

Figure 4: Percentage stress relaxation of kafirin and zein viscoelastic masses at different acetic acid concentrations.
Figure 5: Confocal laser scanning microscopy of kafirin and zein viscoelastic masses at different protein concentrations
Figure 6: Scanning electron microscopy of kafirin and zein viscoelastic masses at different protein concentrations.
Figure 7: Percentage stress relaxation of kafirin and zein viscoelastic masses at different protein concentrations and after storage at 4°C for 2, 8 and 16 days
Discussion

- As the final acid concentration decreased, there was a gradual reduction in percentage stress relaxation. The lower the final acid concentrations, the firmer the visco-elastic mass. The acetic acid might have acted as a plasticizer (Sly et al., 2014).

- Kafirin had higher stress recovery compared to zein. This could be attributed to highly polymerised kafirin protein compared to zein.

- Zein formed a taffy-like material or gel, unlike kafirin which formed a stable visco-elastic mass at high residual acid concentrations (above 5%). This shows that the functionality of kafirin is probably different from zein in terms of its ability to form “dough” under certain conditions.
Conclusions

• Both kafirin and zein preparations can form stable, food-compatible viscoelastic masses at 0.1-5% final acetic acid concentrations. However, kafirin can form visco-elastic masses even at higher acetic acid concentrations unlike zein which may only form handleable viscoelastic masses at or below 5% acetic acid concentration. This shows that formation of zein viscoelastic mass probably depends on the amounts of residual acetic acid unlike kafirin.

• Zein viscoelastic mass has more viscous flow characteristics, whereas kafirin is more elastic. Higher elasticity exhibited by kafirin over zein may be attributed to its higher degree of polymerisation.
Conclusions

- Viscoelastic masses may not be formed by kafirin or zein at 5% protein contents or below. This protein percentage may not be enough to enable a handleable viscoelastic mass by both zein and kafirin.

- This suggests that the coacervation process may not work with flour since the kafirin and zein content is only approx. 5% of total grain weight.
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