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Effects of Alginate and Glycerol Concentrations Combined with Calcium Chloride as Edible Coatings on Mass Transfer During Osmotic Dehydration of Ginger Slices

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RESEARCH OVERVIEW

Osmotic Dehydration

Osmotic dehydration is a process of partial water removal that involves immersing food material in a hypertonic solution.

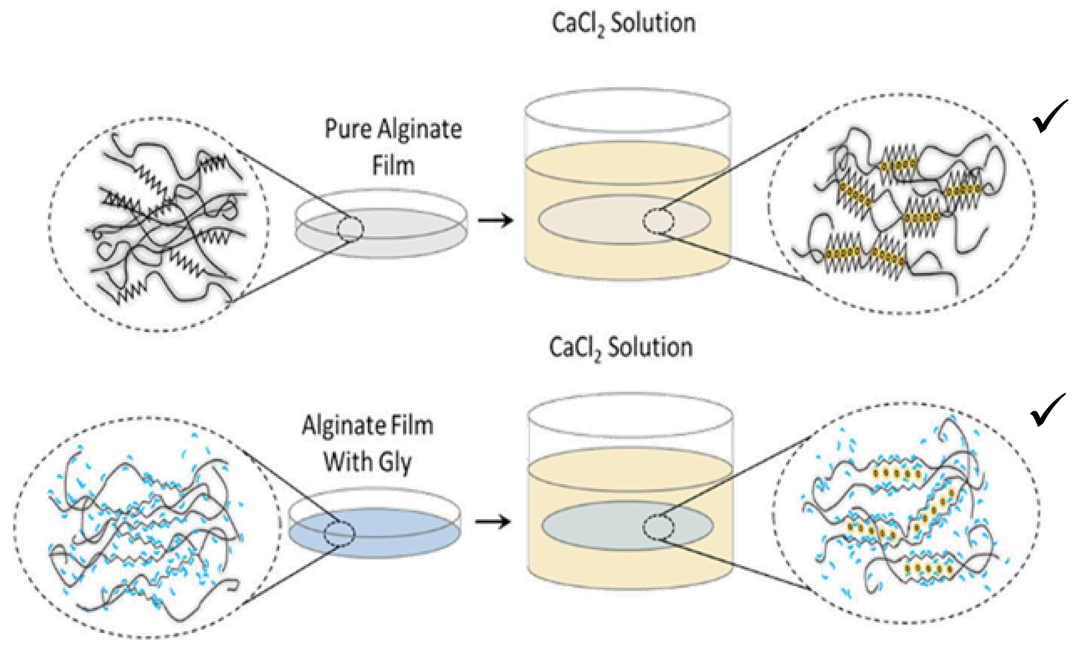
During the immersion, two major mass transfers occur: water outflow from the product to the solution (water loss, WL) and solute inflow from the solution to the product (solid gain, SG).

Challenges in the Osmotic Dehydration Process

- **Excessive Solute Uptake**: This may negatively impact the final product's quality *(Pan et al., 2023).*
- **Longer Drying Time**: The crystallized structure formed from the excessive solute can lead to longer drying times, which can increase energy consumption and processing time *(Pinto et al, 2023).*

Composite of Alginate, Glycerol and Calcium Chloride ($CaCl_2$) as Edible coating

- Act as a barrier for a solid gain
- Shelf-life extension and flavor preservation.



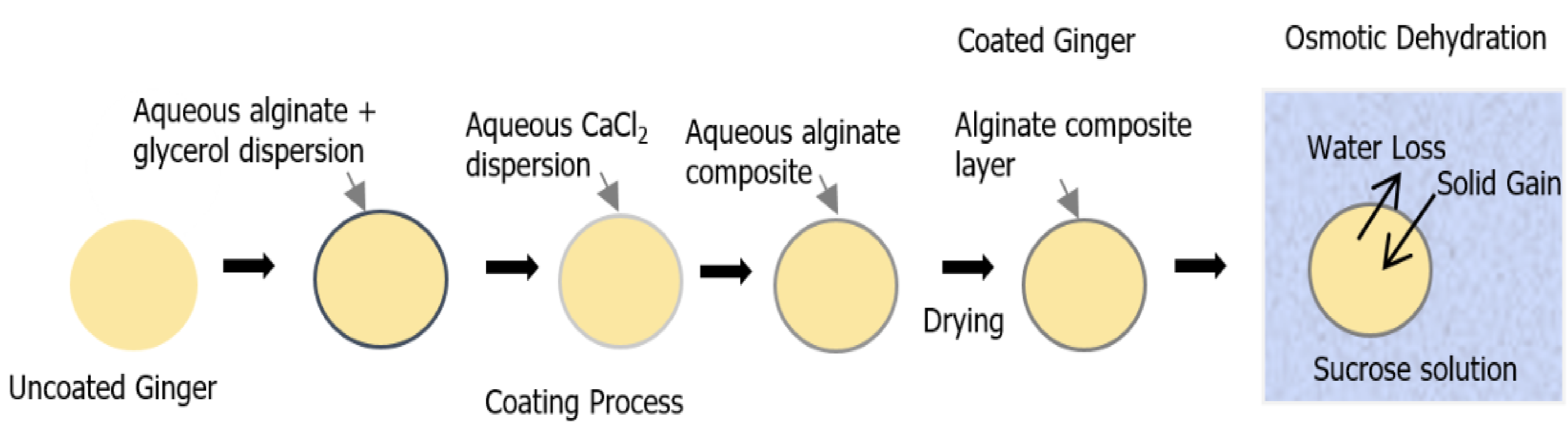
✓ Tightly packed gel network and more rigid gel structure.

✓ More flexible network with reduced rigidity and increased elasticity.

Source: Giz et al. (2020)

METHOD

Schematic representation of the process of alginate-based coating and osmotic dehydration of ginger slices



Mass transfer mathematical expressions

$$WL\ (\%) = \frac{w_{wo} - (w_t - w_{st})}{w_{wo} + w_{so}} \times 100 \qquad SG\ (\%) = \frac{w_{st} - w_{so}}{w_{wo} + w_{so}} \times 100$$

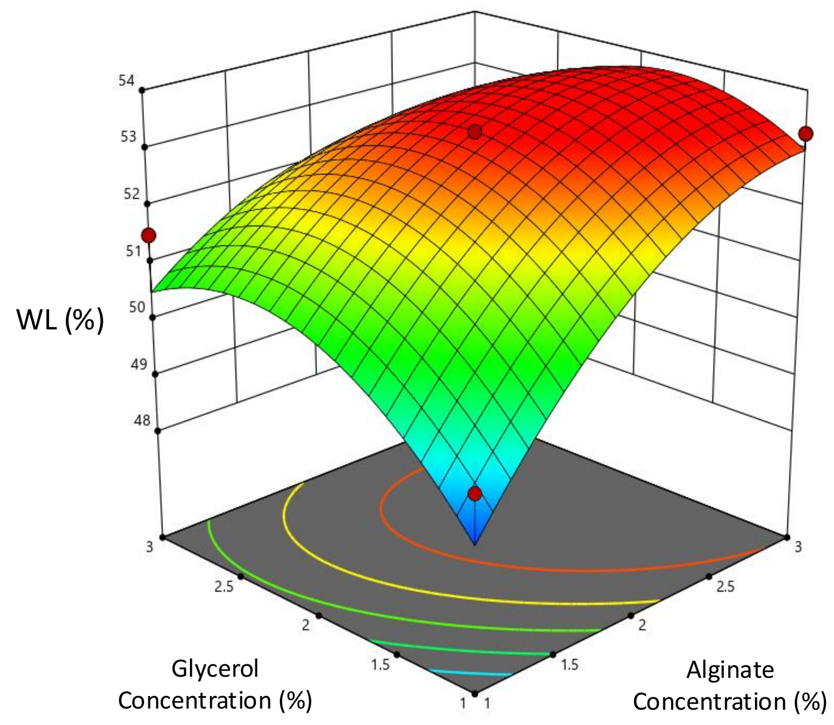
W_{wo} = mass of water in sample before dehydration (g),
W_t = mass of sample after dehydration (g),
W_{so} = mass of the solids in sample before dehydration (g),
W_{st} = mass of the solids in sample after dehydration (g).

Coded and uncoded values of the experimental variables using central composite design

Parameters	Coded Factor	Factor Level				
		− α	-1	0	+1	+ α
Alginate (%)	A	0.59	1	2	3	3.41
Glycerol (%)	B	0.59	1	2	3	3.41

RESULTS & DISCUSSION

Water loss (WL)

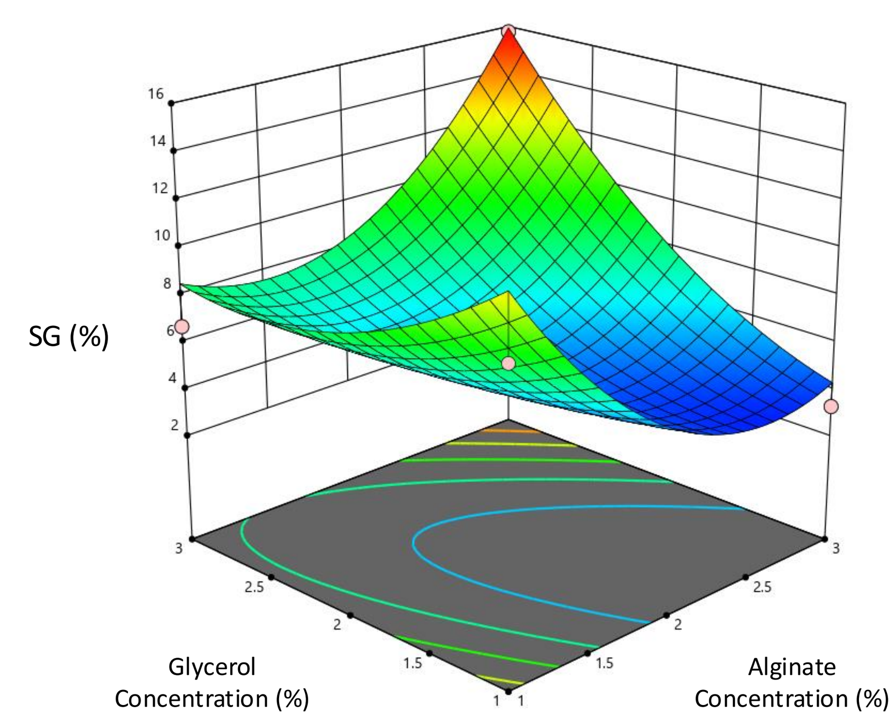


- Alginate and glycerol concentrations showing quadratic effects on WL.

- High alginate concentrations increased WL due to alginate's hydrophilic nature, which enhances water removal.
- At lower glycerol concentrations, $CaCl_2$ can more effectively cross-link with alginate, forming a more rigid structure. This stronger gel retains more water, leading to lower WL.
- In contrast, at higher glycerol concentrations, the glycerol interferes with the cross-linking process, making the film more flexible. This allows more water to escape, resulting in higher WL.

Solid gain (SG)

- An increase in alginate concentration decreases SG as higher alginate levels form a more structured gel network, which acts as a stronger barrier.
- An increase in glycerol concentration results in higher SG as higher glycerol levels create a more flexible and less structured gel network, allowing greater SG.



CONCLUSION

- The study demonstrates that alginate and glycerol concentrations significantly impact WL and SG during the osmotic dehydration process of ginger slices.
- Higher alginate concentrations increase WL while decreasing SG due to the formation of a more structured and rigid gel network. In contrast, higher glycerol concentrations increase SG by making the gel more flexible and permeable while also reducing WL.
- Therefore, optimizing the balance between alginate and glycerol concentrations is crucial for achieving the desired dehydration efficiency, maximizing WL, and minimizing SG.

References:

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