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Influence of Oat Milk on the Rheological Properties and Compositional Properties of Basil-Enriched Functional Ice Cream

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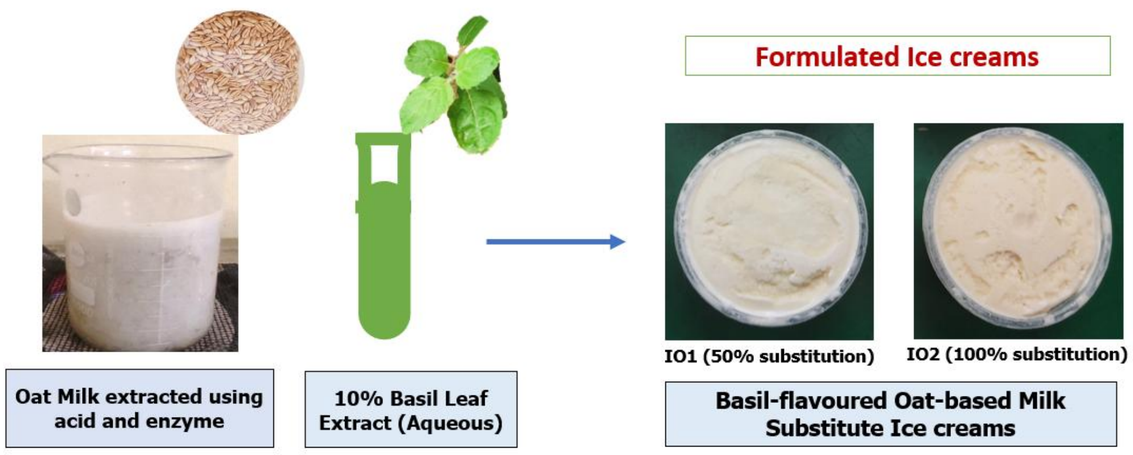
INTRODUCTION & AIM

Rheological properties such as viscosity, flow behaviour, meltdown resistance, and structural stability in frozen desserts are strongly influenced by β-glucans and soluble fibers present in oat milk. These polysaccharides enhance water-holding capacity, stabilize air cells, and inhibit ice crystal growth, producing a smoother texture and creamier mouthfeel similar to conventional dairy ice cream. Due to their linear molecular structure and high water-binding potential, oat β-glucans form a stable gel matrix that improves overrun and slows melting, enhancing the overall rheological integrity of the product. Research indicates that frozen desserts formulated with oat milk exhibit higher specific gravity, viscosity, and cohesiveness than dairy controls, showing greater textural stability and consumer acceptability. Compositional studies confirm that oat milk is rich in β-glucans, carbohydrates, and minerals, resulting in higher total solids and enhanced nutritional quality. When combined with basil, the formulation exhibits increased antioxidant potential and total phenolic content. Synergistic interactions between oat avenanthramides and basil polyphenols enhance viscosity and oxidative stability. The presence of these bioactive compounds maintains desirable pH and acidity, supporting product freshness. Overall, oat milk serves as a functional dairy substitute that enriches the rheological strength, compositional balance, and nutritional quality of plant-based ice cream formulations.

This study aims to systematically evaluate how substituting dairy milk with oat milk at 50% and 100% levels influences both the rheological characteristics (such as viscosity, flow behaviour, consistency) and the compositional properties (total solids, carbohydrate, fat, and mineral content) of basil-enriched functional ice cream. The findings will support innovation in sustainable, clean-label frozen desserts tailored for modern dietary preferences.

DEVELOPMENT Of BASIL-ENRICHED FUNCTIONAL ICE CREAM



Oat-based milk substitute was produced using a consecutive acid and enzymatic extraction method followed by blending with varying proportions of full cream dairy milk to formulate Basil-Enriched Functional Ice Cream. Fresh basil leaves were extracted by blanching at 50˚C for 3 minutes, grinding, and filtering. The formulated oat-based milk substitute sample (50% or 100% oat-based milk substitution) was heated to 50°C and combined with spray-dried skimmed milk powder, cream, powdered sugar, glycerol monostearate (emulsifier), and sodium alginate (stabilizer) step by step. The mix was then pasteurized, homogenized, and aged for 12 hours at 4°C. Then the aged mix was flavoured with 10% basil extract, frozen, and stored at -18°C for further compositional, rheological and sensory analyses. The same procedure was used for the control, except that the flavour used was 0.25% vanilla instead of basil leaf extract.

METHODS

Dairy milk was substituted with oat milk at two levels- partially (50%) and completely (100 %) for the development of functional ice cream. The experimental samples were flavoured with 10% basil leaf extract. These experimental samples were compared with the control sample with 100% full cream dairy milk ice cream for physicochemical properties (pH, titratable acidity, fat, protein, carbohydrate, ash, and total solids) using standard AOAC methods, rheological properties (viscosity measurements, Shear stress versus shear rate), overrun, melting properties, textural properties (hardness, adhesiveness, cohesiveness, gumminess, springiness, and chewiness), antioxidant potential (Total Polyphenol and DPPH inhibition activity) and overall acceptability using a modified ice cream scorecard from the American Dairy Science Association.

RESULTS & DISCUSSION

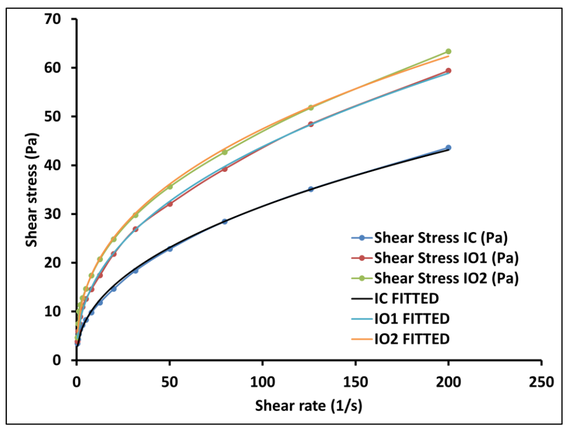
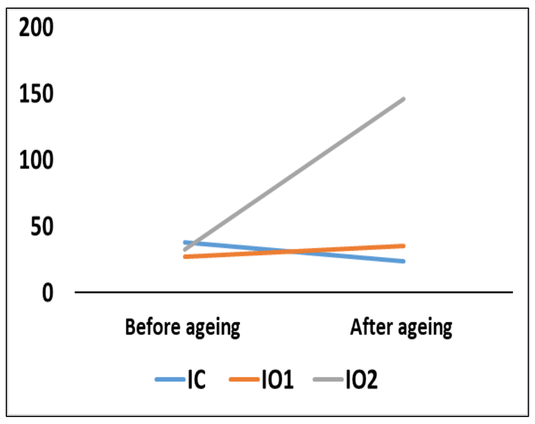


Fig: Shear stress versus shear rate curves for ice cream formulations: Control (IC, 100% full cream dairy milk), IO1 (50% dairy substitution by Oat-based Milk Substitute), and IO2 (100% dairy substitution by oat-based milk substitute).



Effect of ageing on viscosity (cP) of basil-enriched functional ice cream samples: IC (control, 0% oat milk), IO1 (50% oat milk substitution), and IO2 (100% oat milk substitution), measured before and after ageing

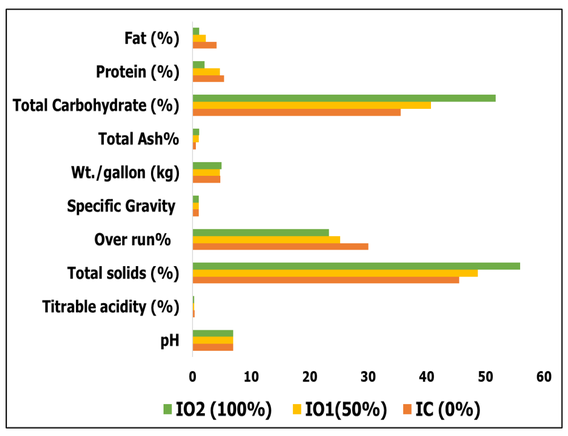


Fig: Physicochemical properties comparison of basil-enriched functional ice cream with varying levels of oat milk substitution: control (IC, 0% oat milk), partial substitution (IO1, 50% oat milk), and full substitution (IO2, 100% oat milk). Parameters include pH, titratable acidity, total solids, overrun, specific gravity, weight per gallon, total ash, total carbohydrate, protein, and fat content.

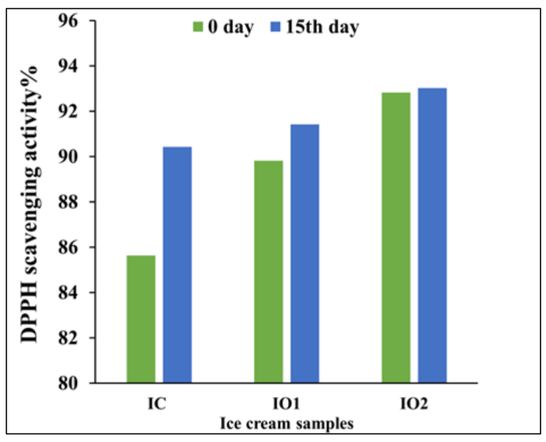


Fig. Effect of storage (0 and 15 days) on DPPH radical scavenging activity (%) of ice cream samples: IC (100% full-cream dairy milk, control), IO1 (50% substitution with Oat-based Milk Substitute), and IO2 (100% substitution with oat-based milk substitute). Different superscript letters indicate significant differences at $p < 0.05$ (DMRT).

Oat milk substitution led to significant rheological and compositional changes:

- **Viscosity and consistency increased markedly in basil-enriched functional ice cream samples (ranging from 35.13 to 146 cP), resulting in a stable, cohesive matrix that improved melting resistance, structural integrity, and produced a denser, smoother texture in the product. These improvements, observed in the oat-based ice creams compared to the control, are likely due to the high levels of β-glucans and soluble fibers present in oat milk, which enhance both the structural thickness and water-binding capacity of the mix.**
- **Compositional analysis showed higher total solids, carbohydrates, and ash comparatively, which supported the observed textural improvements. Total phenolic content increased substantially in the oat milk samples, with 100% oat milk substituted ice cream sample recording the highest antioxidant activity (Polyphenol content- 45.44 to 46.68mg GAE/100g and DPPH inhibition activity-89.85 to 92.81%).**
- **Sensory evaluation indicated that basil-enriched functional ice cream formulated with oat-based milk substitutes achieved high overall acceptability among panellists.**

CONCLUSION

Oat milk significantly enhances the rheological properties and compositional quality of Basil-Enriched Functional Ice cream formulations. Its inclusion improves viscosity, structural stability, melting property and antioxidant capacity, making it a promising dairy substitute for developing plant-based frozen desserts tailored to health-conscious and lactose-intolerant consumers.

FUTURE WORK / REFERENCES

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