Rheological Evaluation of the Structure of Ice Cream Mixes Varying Fat Base

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Abstract:
This paper discusses the influence of fat type in the structure of ice cream, during its production by means of rheo-optical analysis. Fat plays an important part in the ice cream structure formation. It's responsible for the air stabilization, flavor release, texture and melting properties. The objective of this study was to use a rheological method to predict the fat network formation in ice cream with three types of fats (hydrogenated, low trans and palm fat). The three formulations were produced using the same methodology and ratio of ingredients. Rheo-optical measurements were taken before and after the ageing process, and the maximum compression force, overrun and melting profile were calculated in the finished product. The rheological analysis showed a better response from the ageing process from the hydrogenated fat, followed by the low trans fat. The formulation with palm fat showed greater differences between the three, where through the rheological tests a weaker destabilization of the fat globule membrane by the emulsifier was suggested. The overrun, texture measurements and meltdown profile has shown the distinction on the structure formation by the hydrogenated fat from the other fats.

Zusammenfassung:
In diesem Artikel wird der Einfluss eines Fett-Typs in der Struktur von Eiscreme während der Herstellung mit rheo-optischen Methoden untersucht. Fett spielt eine wichtige Rolle bei der Bildung der Struktur von Eiscreme. Es ist verantwortlich für die Stabilisierung an Luft, die Geschmacksabgabe, die Textur und die Schmelzeigenschaften. Das Ziel dieser Untersuchung war, eine rheologische Methode anzuwenden, um die Bildung von Fettnetzwerken in Eiscreme anhand drei unterschiedlicher Fett-Typen zu erforschen (hydrogeniert, Magertransfette und Palmenfett). Diese drei Formulierungen wurden mit derselben Methode und derselben Zusammensetzung hergestellt. Rheo-optische Untersuchungen wurden vor und nach der Alterung durchgeführt. Die maximale Druckkraft, das Überlaufen und das Schmelzprofil bei dem hergestellten Produkt wurden bestimmt. Die rheologische Analyse wies eine bessere Antwort bzgl. des Alterungsprozesses des hydrogenierten Fettes auf, gefolgt von dem Magertransfett. Die Formulierung mit dem Palmenfett wies größere Unterschiede zwischen den drei auf. Durch die rheologischen Messungen wurde eine schwächere Destabilisierung der Fettglobul-Membran durch den Emulgator angedeutet. Das Überlaufen, die Texturmessungen und das Aufschmelzprofil zeigten die Unterschiede der Strukturbildung der hydrogenierten Fette im Vergleich zu den anderen beiden Fetten.

Résumé:
Cet article discute l'influence du type de graisse sur la structure de la crème glacée, lors de sa production, au moyen d'une analyse rhéo-optique. La graisse joue un rôle important dans la formation de la structure de la crème glacée. Elle est responsable de la stabilisation de l'air, de la libération de l'arôme, et des propriétés de texture et de fondant. L'objectif de cette étude est d'utiliser une méthode rhéologique afin de prévoir la formation du réseau de graisse dans la crème glacée pour trois types de graisse (graisse hydrogénée, de palme et de trans bas). Les trois formulations ont été produites en utilisant la même méthodologie et le même ratio d'ingrédients. Les mesures rhéo-optiques ont été effectuées avant et après le processus de vieillissement, et la force de compression maximum et les profils de fusion ont été calculés pour les produits finis. L'analyse rhéologique présente une meilleure réponse pour le processus de vieillissement associé à la graisse hydrogénée, suivi de la graisse trans bas. La formulation avec la graisse de palme présente la plus grande différence entre les trois types, et les tests rhéologiques suggèrent pour cette graisse une déstabilisation plus faible de la membrane globulaire de la graisse par l'émulsifiant. Les mesures montrent une distinction de la graisse hydrogénée par rapport aux autres à propos de la formation de la structure.

Key words: food rheology, structure, ice cream, palm fat, low trans fat

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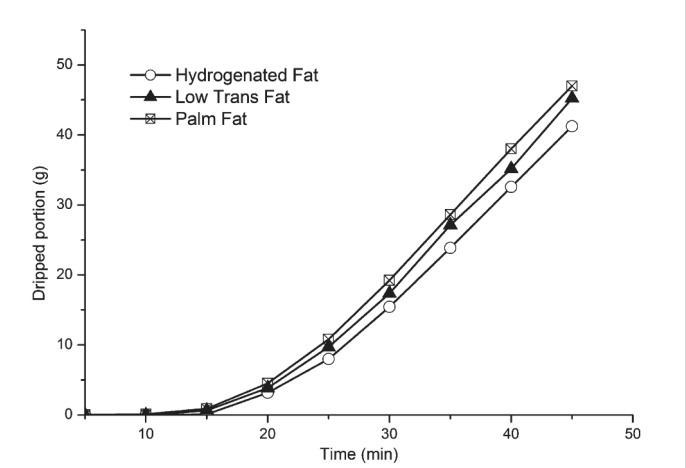

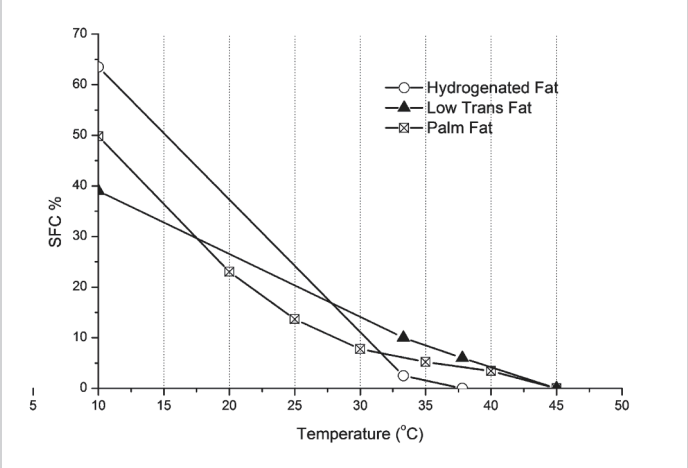

Figure 6 (left): Meltdown curves of ice creams with different fats.

Figure 7: Solid fat content of the tested fats.

bilization. The low trans fat used in this experiment had a lower solid fat content at 5° C than the palm fat, which could explain the lower overrun observed.

3.4 MELTING TEST

The melting profile allows us to evaluate the fat network formation since the fat globule aggregation by partial coalescence seems to be the largest contributor to the ice cream melting resistance. [23]. As the ice crystals melt and the ice cream structure starts collapsing, it's expected the fat network to keep its form during the meltdown [24]. The melting curves of each formulation can be observed in Figure 6, in which the hydrogenated fat showed the slowest melting rate and palm fat the fastest melting rate. As it was seen in the rheological results, the hydrogenated fat presented the best results to the ageing process, which would allow the formation of a better fat network through partial coalescence. The presence of small crystals is also responsible for a better fat network formation since it causes a higher emulsification which is related to a higher partial coalescence [11, 24]. The meltdown is also influenced by the solid fat content of each fat. Palm fat has the lowest solid fat content at the room temperature tested (25 ± 0.5° C) as can be seen in Figure 7.

4 CONCLUSION

All data obtained from the rheological analysis with images suggested that palm fat suffers a lower destabilization of fat globules by the emulsifiers during ageing, with hydrogenated vegetable fat presenting the best results to this parameter. The hydrogenated fat shows less firmness and greater overrun on ice cream formulations when compared to formulations with low trans fat and palm fat. In this experiment, palm fat and commercial low trans fat could not substitute with the same pattern the hydrogenated fat in ice cream manufacture while maintaining its beneficial properties to the product. Further studies must be done to achieve an ideal substitution, in particular the interaction between palm fat and the emulsifier. The rheological analysis during the ice cream production proved to be useful to predict the final characteristics of the ice cream since the results from the overrun, melting test and textural measurements agreed with the findings of the rheological analysis.

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