Evaluating Viscosity of Surimi Paste at Different Moisture Contents

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Abstract:
The steady and dynamic shear viscosity of fish muscle protein paste obtained from Alaska pollock surimi at 95%, 90%, 85%, 80%, and 75% of moisture contents were measured in the temperature range of 5°C to 20°C. To estimate the steady shear viscosity at high shear rate from dynamic shear viscosity, the modified Cox-Merz rule was applied by introducing a frequency shift factor. The concentration dependence of zero-shear viscosity showed power-law dependence with an exponent of 3.5, and the universal behavior of viscosity at different protein concentrations was observed by a introducing reduced variables. The Carreau model was applied to describe the shear- thinning behavior of the surimi paste, and the model parameters estimated empirically showed moisture content dependence. The viscous flow behavior was independent of temperature (5°C to 20°C), and addition of starch decreased the flow index and viscosity of the paste, compared to the pure surimi paste.

Zusammenfassung:
Die stationäre und dynamische Scherviskositäten von Surimi-Pasten, welche von Alaska Seelachs stammen, wurden bei einem Feuchtigkeitsgehalt von 95, 90, 85, 80 und 75% in einem Temperaturbereich von 5 bis 20°C vermessen. Um die stationäre Scherviskosität bei hohen Scherraten, aus der dynamischen Scherviskositatet abzuschätzen, wurde eine modifizierte Cox-Merz Regel angewandt, wobei ein Frequenz-Verschiebefaktor eingeführt wurde. Die Konzentratrionsabhängigkeit der Nullviskosität zeigte ein Potenzverhalten, und das universelle Verhalten der Konzentrationsabhängigkeit der Viskosität konnte mittels reduzierter Variablen beschrieben werden. Das Carreau-Modell wurde herangezogen, um das scherverdünnende Verhalten der Surimi-Pasten zu beschreiben. Die empirisch bestimmten Modellparameter zeigten eine Abhängigkeit vom Feuchtigkeitsgehalt. Das viskose Fliessverhalten war unabhängig von der Temperatur (5 bis 20°C) und die Zugabe von Stärke verminderte den Fliessindex und die Viskosität der Paste, verglichen mit der reinen Paste.

Résumé:
Les viscosités de cisaillement en régime établi et en régime dynamique de pâte de protéine musculaire de poisson d'Alaska "Pollock Surimi" avec des taux d'humidité de 95, 90, 85, 80 et 75% ont été mesurées dans une gamme de température allant de 5 à 20°C. Pour estimer la viscosité de cisaillement en régime établi à grande vitesse de cisaillement, à partir de la viscosité de cisaillement dynamique, la loi modifiée de Cox-Merz a été appliquée en introduisant un facteur de glissement en fréquence. La dépendance de la viscosité à cisaillement nul en fonction de la concentration a présenté une loi de puissance avec un exposant de 3,5 et le comportement universel de la viscosité à différentes concentrations en proteine a été observé au moyen de l'introduction de variables réduites. Le modèle de carreau a été employé pour décrire le comportement rhéo-fluidifiant de la pâte de Surimi et les paramètres du modèle, estimés empiriquement, ont présenté une dépendance en fonction du taux d'humidité. Le comportement d'écoulement visqueux était indépendant de la température (entre et 20°C) et l'addition de pulpe a pour effet la diminution de l'index d'écoulement et de la viscosité de la pâte, en comparaison avec la pâte pure de Surimi.

Key words: Carreau model, Cox-Merz,dynamic viscosity, surimi, zero shear viscosity

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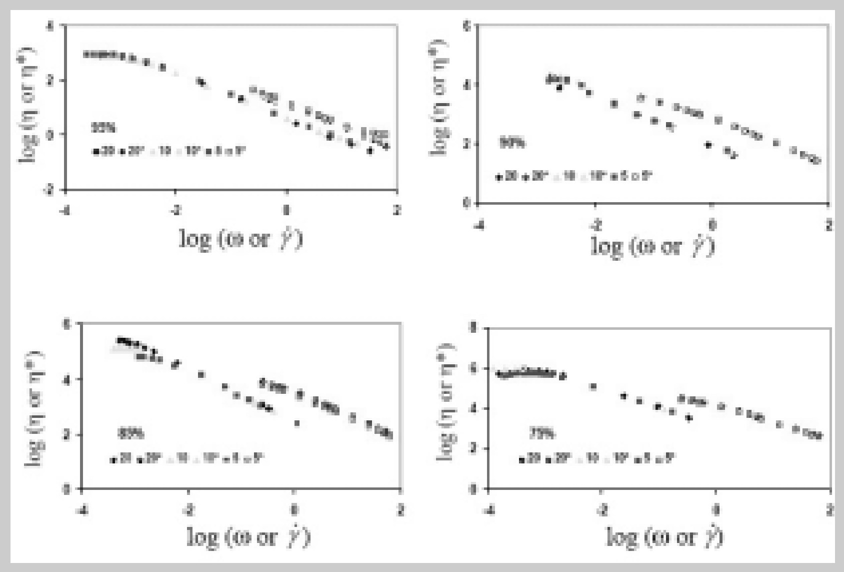

Figure 8: Temperature dependence of the steady and dynamic viscosity of surimi paste at 95%, 90%, 85% and 75% of moisture contents. (the '' and numbers in legends indicate the dynamic viscosity and temperature at measurement, respectively).*

op a master curve indicates the existence of an inherent simplicity hidden behind the apparent complexity of the structure of biopolymer systems.

5 TEMPERATURE DEPENDENCE OF VISCOSITY OF SURIMI PASTE

During processing surimi paste is maintained under 25°C to prevent a possible protein denaturation and moisture loss. The η and η^* of surimi paste at different moisture contents (95%, 90%, 85%, 75%) each at different temperatures (20°C, 10°C, 5°C) are presented in Fig. 8. At all moisture contents, the viscosity curves at all three temperatures overlapped well, albeit some minor deviations at low and high shear rate regions, suggesting that η or η_0 are independent of temperature within 5°C to 20°C range. Moreover, the horizontal shift factor, *A* for the modified Cox-Merz rule also remained unaffected by temperature remaining the same as those reported previously (Tab. 1). Thus, we conclude that fish myofibrillar protein is fairly stable in the 5 to 20°C temperature region, because any protein denaturation would have significantly changed the viscosity profiles.

CONCLUSION

Steady shear and dynamic viscosity of fish muscle protein paste (Alaska pollock surimi seafood) were measured as a function of moisture content and temperature. A modified Cox-Merz rule was used to estimate the steady shear at high shear rates by introducing a frequency shift factor. The dependence of the shift factor on moisture content > 85% indicated some possible structural changes in the myofibrillar protein aggregates at high moisture content. The reduced viscosity versus reduced shear rate plot yielded a master curve exhibiting a universal behavior for moisture content up to 85%. The power-law dependence of the zero-shear viscosity on protein concentration indicated the fish muscle protein is in the semi-dilute regime and the molecules are in highly interacting state. The strong shear-thinning behavior observed for fish muscle protein paste is due to the entanglement of fish muscle protein molecules, mainly composed of flexible actomyosin. In addition, the viscosity parameters were a function of concentration. The shear-thinning behavior of surimi paste was well described by the Carreau model. Viscous behavior of surimi paste was thermally stable between 5 to 20°C.

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