Development of a functional model for tomato paste rheology

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Abstract

Tomato paste is a seasonal product, processed for retail or packed aseptically in bulk to use as a raw ingredient for manufacturing many other tomato based products such as sauces, ketchup, and soups. Paste is added to formulated food products to provide flavour, tomato solids, and viscosity. Viscosity is mostly imparted by the insoluble solids but there is a contribution from the soluble solids in the tomato paste. Because the composition and physical nature of tomato solids varies with processing methods, tomato variety and maturity, the functional properties of tomato pastes can also be highly variable. The objective of this study was to develop methodologies that could be used to characterise tomato paste batches in such a way that the functionality of the paste is predictable. Ideally rheological functionality should be predictable from compositional information and characterisation should require a minimum of measurement effort.

This work explored how paste composition impacted on paste rheology and found that much of the variation in flow properties of tomato concentrates can be explained by appropriate characterisation of the water insoluble and soluble solids levels in the paste. Serum contributes to the flow behaviour of tomato paste due to the presence of soluble solids in the serum. In particular, it was found that it was primarily sugars that cause this effect, potentially by enhancing the pectin-pectin interactions in the WIS components of the paste. In this work it was found that there were measurable differences in serum viscosity between pastes, however good overall model predictions could be achieved without considering the serum phase beyond the soluble solids concentration.

The Herschel-Bulkley model was found to be the most appropriate model to describe the flow behaviour of tomato paste. Herschel Bulkley parameters could then be linked to the insoluble and soluble solids levels in the paste. For some pastes the model could be fitted with just one paste specific parameter plus four other generally fitted constants (which apply to any paste). When applied to other pastes however, at least one of the other parameters was also required to be paste specific. These parameters relate the yield stress and the flow behaviour index to the water insoluble solids content. Because these two parameters need to be fitted for individual pastes, it is thought that they are influenced by the particle size and shape and/or their composition of the WIS fraction. For example elongated particles will orientate within a flow field with varying shear rates, thereby influencing the flow behaviour index.

There is potential to fit the two key paste specific parameters for a paste from a single flow curve. This could provide an industry implementable method to characterise tomato paste batches. Such a characterisation method would be useful for predicting flow behaviour under different processing conditions and how dilution during product formulation will affect viscosity. Future work should be carried out to extend this work to those aims.

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