THESIS

MASTERS IN TECHNOLOGY

(BIOTECHNOLOGY & BIOPROCESS ENGINEERING)

OPTIMISATION

OF

TOMATO PASTE PRODUCTION, STORAGE AND USE

BY CLAIRE FRANCES CAMPBELL

SUPERVISORS: Dr J E Bronlund

& Dr L V Chong

ABSTRACT

The manufacture of tomato products is one of the key activities of Heinz-Watties. The optimisation of tomato paste in terms of it's production, storage and use is important to understand as it is the base ingredient to many of the 21 major food brands Heinz-Watties supply in New Zealand. This thesis describes the work carried out to characterise tomato paste products in terms of the quality and quantity, correlations that exist between variables, the process variability at Heinz-Watties Hastings and formulation using tomato paste.

This thesis has identified that tomato paste needs to be accurately characterised in terms of both quality and quantity. Characteristics which influence the quality of tomato paste are factors such as the flavour, sweetness and viscosity to which the °Brix, total solids and insoluble or soluble solids must be known. °Brix measurement is affected by insoluble solids (which scatter light) resulting in an inaccurate reading when employing the refractometer °Brix method. To solve this, the tomato paste must be centrifuged in order to separate the insoluble from soluble portion within the tomato paste.

Colour, acidity and microbial stability are also important quality characteristics of tomato paste. These are measured by specific tomato paste colorimetric methods, pH and Howard mould count methodologies respectively. The quantity of tomato paste produced or the amount to use within recipes has been identified in this thesis to be accurately measured by measuring the tomato solids, insoluble and soluble solids and °Brix. This is due to the tomato paste being made up of total tomato solids and water which can be further broken down into solids which are insoluble (fibrous) & solids which are soluble.

Several different methods were identified within the thesis for measuring total solids. The best method in terms of repeatability was identified to be the vacuum oven method, however due to the twelve hour wait prior to obtaining results coupled with the large amount of equipment needed this would be restricted to a lab environment. Within the factory processing environment the best total solids method to employ would be that of the microwave oven method. Further testing beyond the scope of this thesis would need to be completed to perfect the methodology.

Correlations between variables were also explored within this thesis, to save time and equipment usage within the processing environment or to give an indication of variables during production. For example specific gravity can be measured instead of total solids (as long as the insoluble solids portion is known) and with the use of correlations the other parameters can be predicted. Further experimental validation beyond this thesis, using Heinz-Watties tomato paste does need to occur prior to use.

Other correlations investigations were that of the variables during dilution. The °Brix levels and viscosity were found to not change linearly during dilution. Therefore, by constructing simple mechanistic models on the interactions of the °Brix levels and viscosity on the proportions of insoluble and soluble solids simple equations have been devised within this thesis to allow the prediction of these parameters after dilution.

The current process of producing tomato paste at Heinz-Watties was characterised to identify the extent and cause of process variability. This work showed that although total solids levels are well controlled, the ratio of insoluble solids to total solids is not. The cause of this was most likely due to poor control over the break process and the extent of enzymatic pectin hydrolysis that occurs. Some suggestions on online measurement options to enable better control of this were explored within this thesis, such as, measuring specific gravity using an online densitometer (Coriolis mass flow meter) and to use previously mentioned correlations to determine total solids. Or alternatively online viscosity by the use of a tubular viscometer or refractive index meter.

Further work should be carried out beyond this thesis to investigate how tomato ripeness and break processing conditions could be controlled to ensure reduced variability in the ratio of insoluble solids to total solids. This is the key to good control of tomato paste and diluted tomato paste viscosity.

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1.0 PROJECT OVERVIEW

Tomato paste is used as a base ingredient to many of the 21 major food brands Heinz-Watties supply and it is estimated at having an input value of $4.8 million per annum in factories around New Zealand. At the Hastings site of Heinz-Watties, tomato paste is produced during the months of November to March (depending on harvesting of the tomatoes) and used all year round for products such as spaghetti, baked beans, soups, meat and pasta sauces. During the time tomato paste is not being used, it is stored aseptically in 200L drums outside, within the factory premises.

The optimal utilisation of the tomato paste is reliant on the following issues:

i) The adequate control of the paste quality during paste manufacture.

ii) The accurate recording of stock levels in terms of quantity and quality of the stored product

iii) The appropriate calculation of the amount of paste used during the formulation of the final products.

Each of the aspects listed above are dependent on the accurate characterisation of the tomato paste that is produced. This requires appropriate measurement methods which are being used that are repeatable, have the accuracy needed and are also suitable for use in an industrial environment. If such methods are available then the stock levels would accurately reflect the amount of tomato paste ingredient is in storage and the manufacturing process could be better controlled to produce more consistent paste quality. In addition to this the most appropriate measure of the paste composition could be used to calculate the amount of paste needed to achieve the required formulated product functionality (in terms of such aspects as flavour and colour).

The specific aims of this project were to firstly determine the most appropriate measurement methods for complete tomato paste characterisation. These methods were then used to assess the degree of variability of tomato paste production during the 2000 season at Heinz-Watties Australasia, King Street, Hastings. The project also investigated how physical and compositional properties of tomato paste are correlated and how they can be related to the functionality of formulated products.