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# OPTIMAL PROCESSING OF KUMARA

A thesis presented in patial fulfilment of the requirements for the degree of
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*...para mi padre...*

*...ese error consiste en creer que describir mas explicar, es igual a comprender...*
*...comprender es algo mas profundo, y no tiene que ver con la ciencia...*
*...sino mas bien con la percepción, osea con la capacidad de iluminación...*
*...este mundo necesita ser comprendido, mas que conocido, pero insistimos an acumular mas conocimiento de él...*
*M. MaxNeef*

# ABSTRACT

The colour and texture change of kumara (*Ipomoea batatas L.*) during the cooking process has been studied. A model was developed as a tool to understand how of these characteristics could be optimised in terms of cooking temperature and time.

After cooking, kumara undergoes an intensive darkening discolouration due to a reaction between iron and phenolic compounds. The discoloration mechanism was separated into three consecutive steps. Cell modification occurs during cooking allowing iron and/or phenolic compounds (principally chlorogenic acid) to leave the cell. Once free, both elements combine to form a colourless iron-phenolic complex. In the presence of oxygen this complex oxidises to form a blue-black $Fe^{3+}$ complex that is responsible for the dark colour. This mechanism was confirmed experimentally on roots of Owairaka Red and Toka Toka Gold kumara by measuring the colour parameters (a, b, L) over a range of cooking and storage conditions using a Minolta colorimeter.

Kinetics parameters for cellular modification during cooking and colour formation upon exposure to oxygen were determined. The results showed that the cell modification reaction followed first order kinetics with an activation energy and Arrhenius constant of $101 kJmol^{-1}$ and $4.56 mim^{-1}$ respectively. Upon exposure of cooked kumara to oxygen, colour formation occurs at a rate dependent on diffusion of oxygen into the kumara flesh. By chelation of iron through the use additives such as sodium pyrophosphate (SAPP) it is possible to prevent post cooking darkening in kumara.

Textural change was also studied and the mechanism was found to be a result of two main reactions, starch gelatinisation and cell wall disruption. Experiments were carried out to confirm this textural mechanism.

Experiments were carried out to measure the kinetics of textural change (fracture force) using Owairaka Red and Toka Toka Gold kumara. The results showed that texture kinetics were temperature dependent and followed first order kinetics and the Arrhenius Law with activation energies of 162 and 125kJ/mol, and Arrhenius constants of 5.59E22 and 2.54E17min$^{-1}$ for red and gold kumara respectively.

Attempts to measure cell wall disruption kinetics from changes in alcohol insoluble solids and total reducing sugars were not successful but literature data for pectin losses in potatoes showed close agreement with overall texture loss in kumara, suggesting that breakdown of the middle lamella is the primary cause of softening during cooking.

Using the kinetics data a model was formulated to predict temperature, texture and colour profiles through the product during cooking. Good comparisons were found between experimental data predictions from the model, for large kumara samples providing a partial validation of the model. The model was used to demonstrate the sensitivity of kumara quality and consistency to processing conditions. The use of the model was demonstrated with two industrially focussed case studies.

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