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THE KINETICS OF QUALITY DETERIORATION
IN LEMON JUICES AND CONCENTRATES
DURING STORAGE

A THESIS PRESENTED IN PARTIAL FULFILMENT
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ABSTRACT

The effects of initial dissolved oxygen content, temperature and total soluble solids content on the kinetics of the quality deterioration in lemon juices (9 °Brix) and concentrates (20-50 °Brix) during storage were determined.

The parameters used to measure quality loss were ascorbic acid retention, nonenzymic browning, and sensory quality. The suitability of furfural and hydroxymethylfurfural (HMF) as indices of quality deterioration was also investigated.

Ascorbic acid degradation and HMF formation were observed to follow a first-order reaction model while browning and furfural formation followed a zero-order model. Temperature dependence of the different reactions could be described by the linear and Arrhenius expressions over the temperature range of 10 to 36°C.

The initial dissolved oxygen content (0.41, 1.44 and 3.74 mg/L) did not significantly affect the rate of ascorbic acid degradation and furfural formation in single-strength lemon juice stored at 36°C. However, browning and HMF formation were significantly higher in the juice with 3.74 mg/L dissolved oxygen content than in the samples with the other two oxygen contents.

The total soluble solids concentration affected the rates of the different reactions but not to such a significant extent as the temperature effect. Ascorbic acid retention was observed to increase with an increase in soluble solids content.

The rate of the browning reaction generally increased with increases in soluble solids content for the 20 to 50 °Brix juice samples. The rate of furfural formation consistently increased with increases in soluble solids level at 36°C, but was not as consistent at 10 and 20°C.

The rate constants and activation energy values of the different reactions for the 9 °Brix juice were considerably higher than those for the 20 °Brix concentrate. These observations and the poor correlation obtained between ascorbic acid retention and browning, and between ascorbic acid retention and furfural formation for the higher Brix concentrates, suggested that different reactions or reaction mechanisms predominated in single-strength juice compared with concentrates.

Furfural could serve as an index of quality deterioration in single-strength lemon juice but not in concentrates (20-50 °Brix) due to its simultaneous formation and decomposition at these high soluble solids levels.

The sensory panel perceived significant changes in colour in the juices prior to changes in flavour. The browning reaction should thus be the main criterion in the determination of storage life.

Low temperature storage is essential for optimum storage stability. Over a 16-week storage period at 10°C, it is suggested that lemon juice be stored as a 50 °Brix concentrate. Some advantages of storing lemon juice at such high soluble solids levels are high retention of ascorbic acid and flavour properties, and reduction in storage and distribution costs. To extend the storage life of lemon juice concentrates beyond four months, storage temperatures lower than 10°C would be necessary so that the extent of browning would not reach unacceptable levels.

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