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KINETICS OF VITAMIN A LOSS IN  
A FOOD SYSTEM DURING HEAT PROCESSING

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## ABSTRACT

Vitamin A is nutritionally significant and is used as an indicator for the performance of fat soluble vitamins in products and processes. There was a paucity of kinetic data relating to its loss in food systems during thermal processing and therefore it was important to develop kinetic models that described destruction rates, and their dependence on factors such as temperature and the microenvironment of the food.

A real food system, beef liver, was used to study the loss of vitamin A on thermal processing. Two different heating methods were employed to obtain kinetic data - a steady state and an unsteady state procedure. In the steady state method, liver puree was heated in glass capillary tubes. The order of reaction, rate constants and their dependence on temperature were determined. Using experimental design techniques, the effects of composition (fat, protein and moisture contents, pH and copper concentration) on vitamin A loss were determined. The ranges of compositional variables were those expected in manufactured meat products conforming to practical and New Zealand legal requirements. The unsteady state method was employed to see if the steady state reaction kinetic parameters were valid on scale-up, and if steady state results could be used to predict vitamin A losses in commercial thermal processing operations.

For natural beef liver puree, vitamin A loss on steady state heating (103 - 127°C) could be described by first order kinetics. The reference rate constant,  $k_{122}$ , had the value  $125.0 \times 10^{-5} \text{ s}^{-1}$  and the activation energy was  $112 \pm 9 \text{ kJmol}^{-1}$  at the 95% level of confidence.

Where fat, protein and moisture contents were studied at one level of copper and pH to determine their effect on vitamin A loss, it was found that either moisture content or fat content could explain most of the observed variation. However, moisture content was the preferred variable to model the effect of composition, as it explained a greater proportion of the variation. Moisture content increased the rate of vitamin A loss as it increased in value from 52 - 72%. The activation energies were very similar for the mixtures, and only when the copper level was changed did

$E_a$  change. The change in rate moving from 102°C to 122°C was less in runs where copper was present at high concentrations than when it was at a low level. This indicates that changing copper concentration probably brought about changes in the mechanism of vitamin A loss.

Under similar compositional and heating conditions to those used in steady state, pilot plant canning trials gave greater vitamin A losses than predicted from the steady state data. Part of the discrepancies was due to destabilisation of the system which led to some heat transfer by convection and to fat migration to the outer parts of the can. Neither of these effects was taken into account by the prediction method. The remaining differences were probably due to a change in the kinetics between the steady state and unsteady state experiments.

Kinetic parameters were calculated from the unsteady state data for comparison with the steady state values. The activation energies were the same but the reference rate constants were different. The difference was only slight with a liver mixture of 56% moisture content but was significant at 69% moisture content. Therefore it was not possible to relate  $k_{122}$  in the steady and unsteady state and so the steady state data did not scale up completely.

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