# KINETIC PARAMETERS FOR THERMAL INACTIVATION OF CUT GREEN BEANS LIPOXYGENASE USING UNSTEADY-STATE METHODS

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***Abstract-*** **Most raw vegetables can be stored for only a short time even at -20ºC. Blanching is the primary pre-freezing means of inactivating undesirable enzymes present in the vegetable. Lipoxygenase is widely distributed in vegetables and evidence is mounting to support its involvement in off-flavour development and colour loss. In order to optimize the blanching process of vegetables, it is essential to establish a kinetic model of the inactivation of the indicator enzyme. Isothermal and dynamic thermal approaches have been used to determine kinetic parameters. The unsteady-state procedure is more flexible and can be applied to uniform and non-uniform heating situations and generally a food medium, rather than an aqueous buffer solution, is always used for determining kinetic parameters. Kinetic parameters describing lipoxygenase inactivation during heating of cut green beans were determined using two unsteady-state procedures. The model used an analytical solution for heat conduction in a finite cylinder to predict time-temperature profiles, and a trial and error and a nonlinear regression of experimental lipoxygenase retentions to estimate kinetic parameters, rate constant, k and activations energy, $E_a$. Thermal diffusivity, $\alpha$, and convective heat transfer coefficient, h, were experimentally determined, but thermal conductivity, $\lambda$, was estimated. Mean values obtained, with standard deviations between parenthesis, were $k_{76ºC}$ = 27.2 (9.4) $s^{-1}$, $k_{82ºC}$ = 92.9 (7.5) $s^{-1}$; $k_{88ºC}$ = 212.1 (52.7) $s^{-1}$; $k_{94ºC}$ = 407.8 (56.7) $s^{-1}$; $E_a$ = 160.7 (8.1) KJ/mol using the trial and error procedure; $k_{85ºC}$ = 150 (26.3) $s^{-1}$ and $E_a$ = 164 (4.7) KJ/mol using the nonlinear regression method. Predicted and observed lipoxygenase retentions showed good agreement.**

***Keywords-*** **Blanching index, Heating treatment and Enzymatic activity.**

## I. INTRODUCTION

The blanching process involves exposing plant tissue to some form of heat, usually steam or hot water, for a prescribed time at a specified temperature. As a pre-freezing operation, blanching is the primary means of inactivating undesirable enzymes present in the vegetable (Barrett and Theerakulkait, 1995). The temperature-time combination used in the blanching process will generally be determined by the thermal stability of enzymes involved in quality deterioration of the processed product (Svensson and Ericksson, 1974b). Williams *et al*. (1986) evaluated the sensory character of blanched vegetable purées to which isolated enzymes had been added and found that lipoxygenase was the enzyme most active in aroma deterioration in English green peas and green beans. Lipoxygenase is widely distributed in vegetables and evidence is mounting to support its involvement in off-flavour development and colour loss (Barrett and Theerakulkait, 1995). In order to optimize the blanching process of vegetables, it is essential to establish the kinetic model of the inactivation of the indicator enzyme. Isothermal and dynamic thermal approaches have been used to determine kinetic parameters (Lenz and Lund, 1980). In unsteady-state procedures the inactivation reaction occurs at a variable temperature and the data required are the concentration of the degraded enzyme and the temperature profile of the sample during the heating-cooling process (Rodrigo *et al*., 1998). The unsteady-state procedure is more flexible and can be applied to uniform and non-uniform heating situations; besides, a food medium, rather than an aqueous buffer solution, is always used for determining kinetic parameters (Welt *et al*., 1997). Svensson and Ericksson (1974b) studied the thermal inactivation of lipoxygenase in peas, but using kinetic parameters previously determined in pea press juice (Svensson and Ericksson, 1974a). Luna *et al*. (1986) studied the thermal destruction of peroxidase in the blanching of corn-on-the cob, considering the corn cob as a finite homogeneous cylinder. There is no information about kinetic parameters of thermal inactivation of lipoxygenase in foods using the unsteady-state procedure.

The objective of this work was to determine the kinetic parameters for thermal inactivation of lipoxygenase in cut green beans using unsteady-state methods.

## II. MATERIALS AND METHODS

<u>*Green beans*</u>: green beans, variety Blue Lake, were obtained from a field close to Santa Fe city (Argentina); harvest was controlled by a member of the working group; once in the laboratory green beans were sized