MODELLING PEROXIDASE INACTIVATION KINETICS IN BROCCOLI (*Brassica oleracea* L.) AND PUMPKIN (*Cucurbita maxima* L.) USING BLANCHING AND THERMOSONICATION

Elsa M. Gonçalves, Joaquina Pinheiro, Marta Abreu, Teresa R.S. Brandão and Cristina L.M. Silva
Escola Superior de Biotecnologia, Universidade Católica Portuguesa, Rua Dr. António Bernardino de Almeida, 4200-072 Porto, Portugal, +351 225090351, clsilva@esb.ucp.pt

Keywords: Peroxidase inactivation, blanching, thermosonication.

Introduction. Peroxidase enzyme (POD) appears to be one of the most heat stable enzymes present in vegetables. It has been generally accepted that if POD is destroyed, it is quite improbable that other enzymes will have survived [1]. For such reason, POD has been suggested as indicator of heat treatments' adequacy. Blanching is a thermal treatment, used prior to freezing processes, to inactivate enzymes responsible to undesirable changes during process and storage of vegetables under frozen conditions. However, the severity of blanching processes should be controlled in order to maintain physical and nutritional quality of the food products. The application of ultrasonic waves that generate cavitation in suspensions that contain microorganisms and/or enzymes, has a lethal result and deactivating action [2]. The combined effect of ultrasonic waves and heat treatments applied simultaneously (thermosonication), appears more effective [3], being a possible good alternative to traditional heat blanching processes. The objective of this work was to determine inactivation kinetic parameters of peroxidase in broccoli and pumpkin, to design further efficient heat and thermosonication treatments.

Materials and Methods. Broccoli (*Brassica oleracea* L.), provided by an orchard near Lisbon, were cut into florets, carefully separated from heads. Samples were divided into two groups: one was submitted to a blanching treatment using five isothermal conditions (70, 75, 80, 85 and 90ºC), and the other to thermosonication using the same temperature range. Pumpkins (*Cucurbita maxima* L.) were acquired in a local market in Lisbon. At arrival to the laboratory, pumpkins were cut in cylinders of 10mm diameter and 1cm height). Cylinders from the same fruit were randomised and divided into two groups. One group of samples was submitted to five isothermal conditions within the temperature range of 75-95ºC, and the other was thermosonicated in the range 65-85ºC. After blanching and thermosonication, all samples were immediately cooled in iced water for 2 min, and dried. Ultrasonic equipment (Branson 3510) at 42 kHz and input power of 355 W was used for thermosonication treatments. The activity of POD was determined according to a spectrophotometric method described in the literature [4]. All experiments were replicated twice, and duplicates of each analysis were carried out.
A kinetic first order model was used to describe POD inactivation. The temperature dependence of the rate constant was expressed by the Arrhenius equation, for both treatments. A one step non-linear regression was performed to all experimental data, using STATA 6.0 software.

Results and Discussion. Fresh broccoli and pumpkin showed an initial specific peroxidase activity of 115.1±24.8 $Abs.min.ml^{-1}$ and 4.0±1.0 $Abs.min.ml^{-1}$, respectively. Estimated kinetic parameters for both vegetables and treatments are included in Table 1 (i.e. initial relative specific activities, C_0, inactivation rates at a reference temperature, k_{Tref}, and activation energies, E_a). The first order kinetic model and the Arrhenius dependence of the inactivation rate to process temperature, described the results adequately. The quality of the regression was evaluated by normality and randomness of residuals, and by coefficient of determination R^2, which was satisfactorily high in all cases (averaging 0.87).

Table 1. Kinetic parameters of POD inactivation in broccoli and pumpkin, using blanching and thermosonication treatments

	Blanching		Thermosonication	
Broccoli	C_0	108.3±4.5 $Abs.min.ml^{-1}$	C_0	104.6±4.5 $Abs.min.ml^{-1}$
	$k_{80ºC}$	1.6±0.07 min^{-1}	$k_{80ºC}$	1.6±0.08 min^{-1}
	E_a	159.0±3.6 $kJ.mol^{-1}$	E_a	139.1±3.5 $kJ.mol^{-1}$
Pumpkin	C_0	2.6±0.2 $Abs.min.ml^{-1}$	C_0	3.2±0.1 $Abs.min.ml^{-1}$
	$k_{85ºC}$	0.10±0.02 min^{-1}	$k_{75ºC}$	0.4±0.03 min^{-1}
	E_a	191.7±18.5 $kJ.mol^{-1}$	E_a	149.4±8.3 $kJ.mol^{-1}$

Results show that peroxidase in pumpkin was more heat sensitive than in broccoli, for both treatments. An effect of treatment on enzyme inactivation was not evident.

Conclusion. This study will help to design blanching and thermosonication optimal conditions, prior to frozen storage of vegetables.

Acknowledgments. Projecto Agro 822 "Novas Tecnologias de Processamento de Hortofrutícolas Congelados".

References.

1. Halpin, B.E and Lee, A. (1993). Effect of blanching on enzyme activity and quality changes in green peas. *J. Fd Sci.* 52(4): 1002-1005.
2. De Gennaro, I. Cavella, S. Romano, R. and Masi, P. (1999). The use of ultrasound in food technology I: inactivation of peroxidase by thermosonication. *J. Fd Eng.* 39: 401-407.
3. Ciccolini, L. Tailandier, P. Wilhem, A.M. Delmas, H. and Strehaiano, P. (1997). Low frequency thermosonication of *saccoromices cerevisiae* suspensions: Effect of temperature and ultrasonic power. *Che Eng J.* 62: 145-149.
4. Bifani, V., Inostroza, J., Cabezas, M.J. and Ihl, M. (2002). Determinacion de parametros cinéticos de peroxidasa y clorofila a en judias verdes (*Phaseolus vulgaris* cv. *Win*) y estabilidad del producto congelado. *Rev Quim. Teor. y Apli.* 2(467): 57-64.