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

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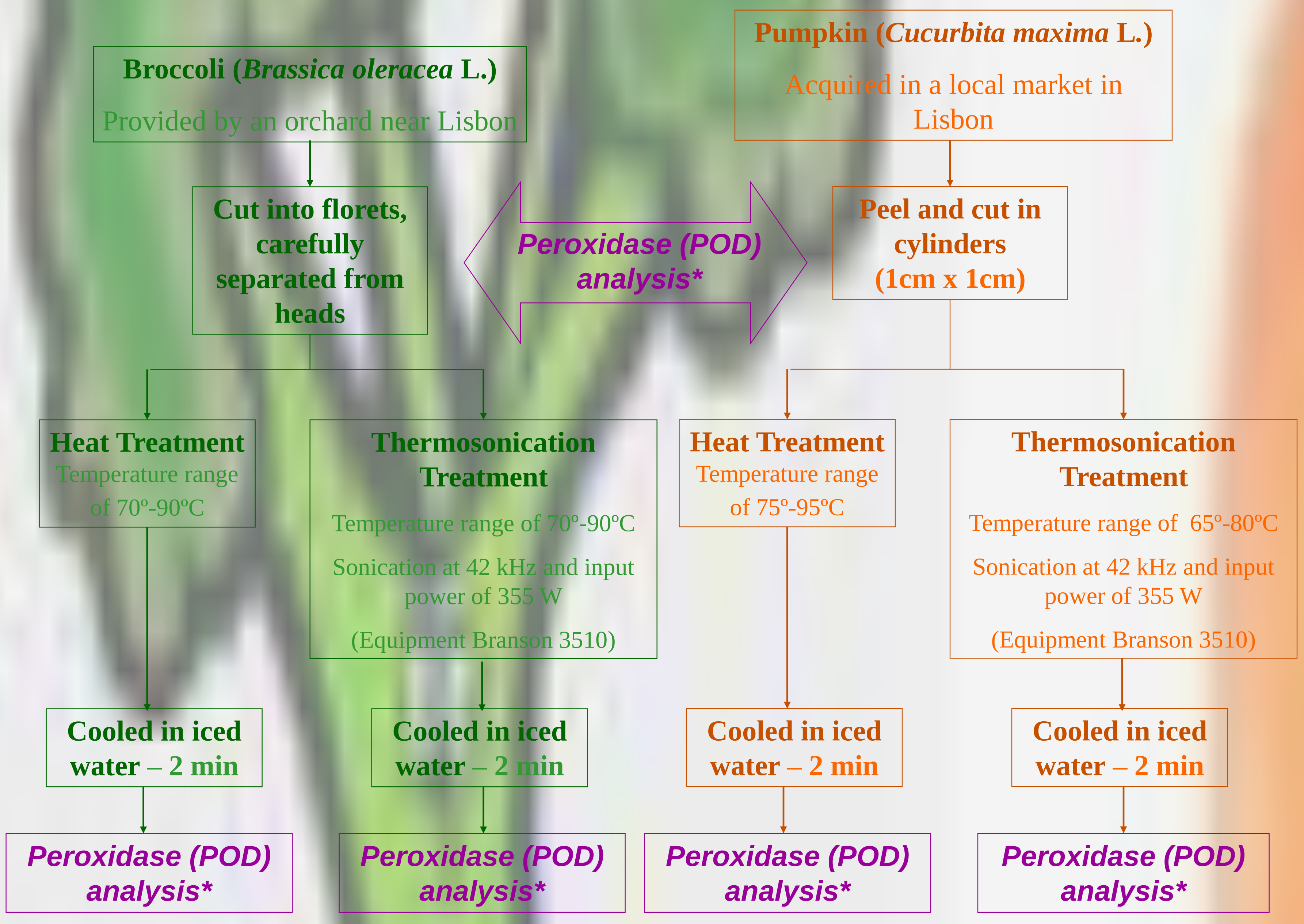
## *Objective*

The objective of this work was to determine inactivation kinetic parameters of peroxidase in broccoli and pumpkin, to design further efficient heat and thermosonication blanching treatments.

## *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 for 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.

## *Materials and Methods*



**Broccoli (*Brassica oleracea* L.)**

Provided by an orchard near Lisbon

**Cut into florets, carefully separated from heads**

**Pumpkin (*Cucurbita maxima* L.)**

Acquired in a local market in Lisbon

**Peel and cut in cylinders (1cm x 1cm)**

***Peroxidase (POD) analysis****

**Heat Treatment**

Temperature range of 70º-90ºC

**Thermosonication Treatment**

Temperature range of 70º-90ºC

Sonication at 42 kHz and input power of 355 W

(Equipment Branson 3510)

**Heat Treatment**

Temperature range of 75º-95ºC

**Thermosonication Treatment**

Temperature range of 65º-80ºC

Sonication at 42 kHz and input power of 355 W

(Equipment Branson 3510)

**Cooled in iced water – 2 min**

**Cooled in iced water – 2 min**

**Cooled in iced water – 2 min**

**Cooled in iced water – 2 min**

***Peroxidase (POD) analysis****

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***Peroxidase (POD) analysis****

### *POD Analysis method**

- 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.

### *Data Analysis*

- A kinetic first order model was used to describe POD inactivation (Eq 1).

$$C = C_0 - kt \qquad \text{(Eq 1)}$$

- The temperature dependence of the rate constant was expressed by the Arrhenius equation (Eq 2), for both treatments.

$$k = k_{ref} \exp\left[-\frac{Ea}{R}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right] \qquad \text{(Eq 2)}$$

- 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) and 5.6±1.3 Abs/(min.ml), respectively.

The effect of heat and thermosonication blanching treatments on broccoli POD activity is presented in Fig 1 and 2, respectively.

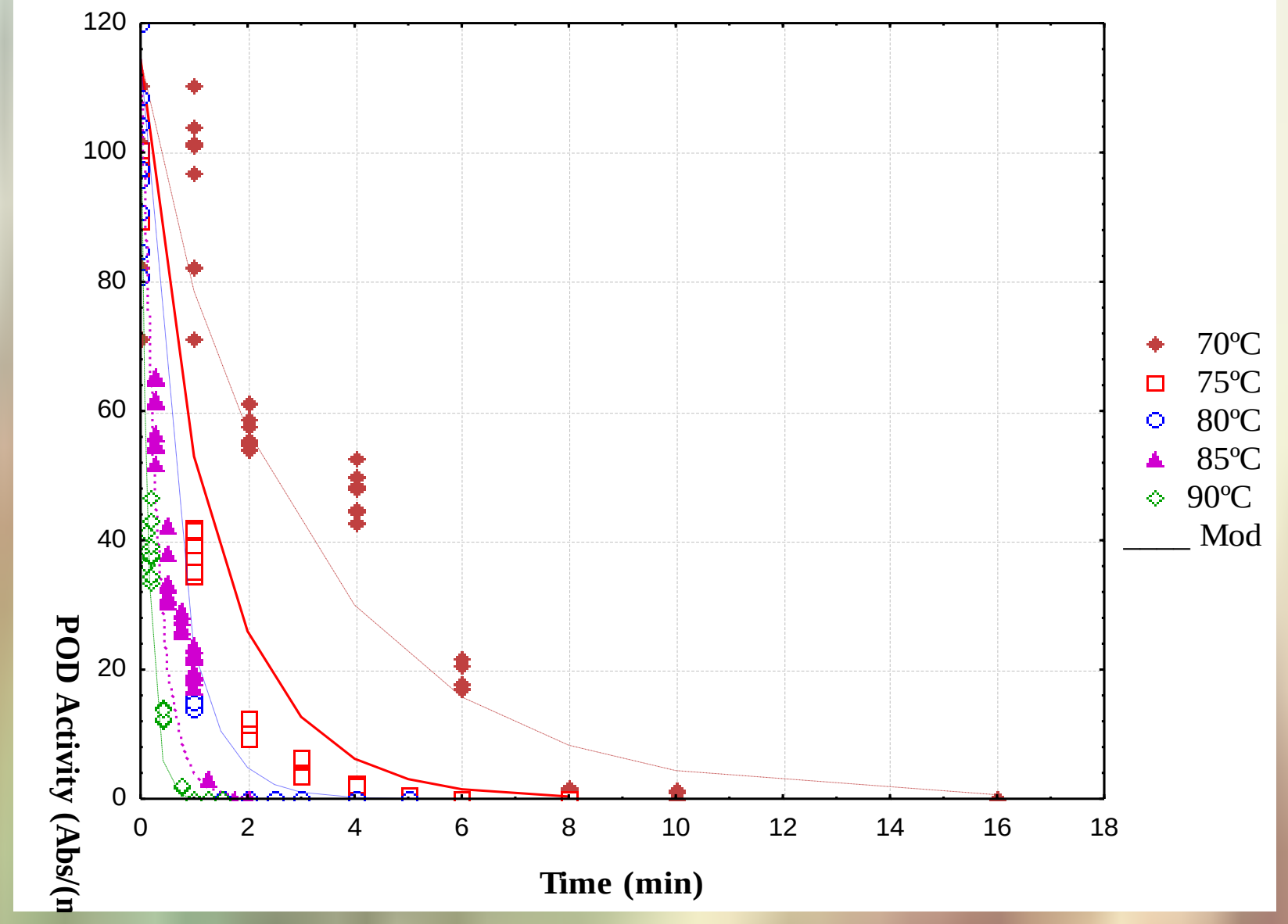

**FIGURE 1.** Effect of heat treatment on POD activity of broccoli, modelled using a first order kinetics.

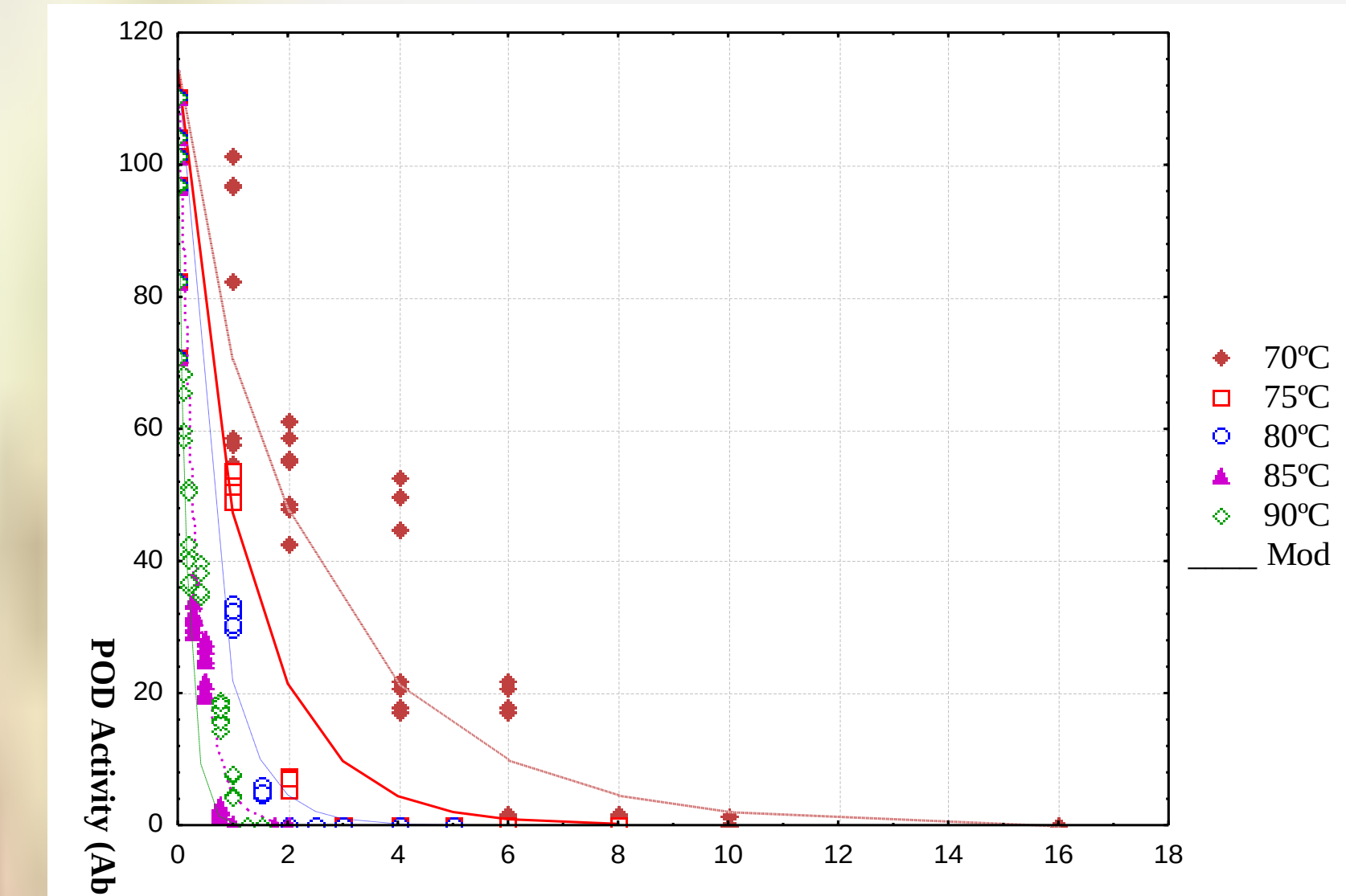

**FIGURE 2.** Effect of thermosonication treatment on POD activity of broccoli, modelled using a first order kinetics.

Both treatments applied (heat and thermosonication blanching) affected also the POD activity in pumpkin as process intensity increased (Fig 3 and 4, respectively).

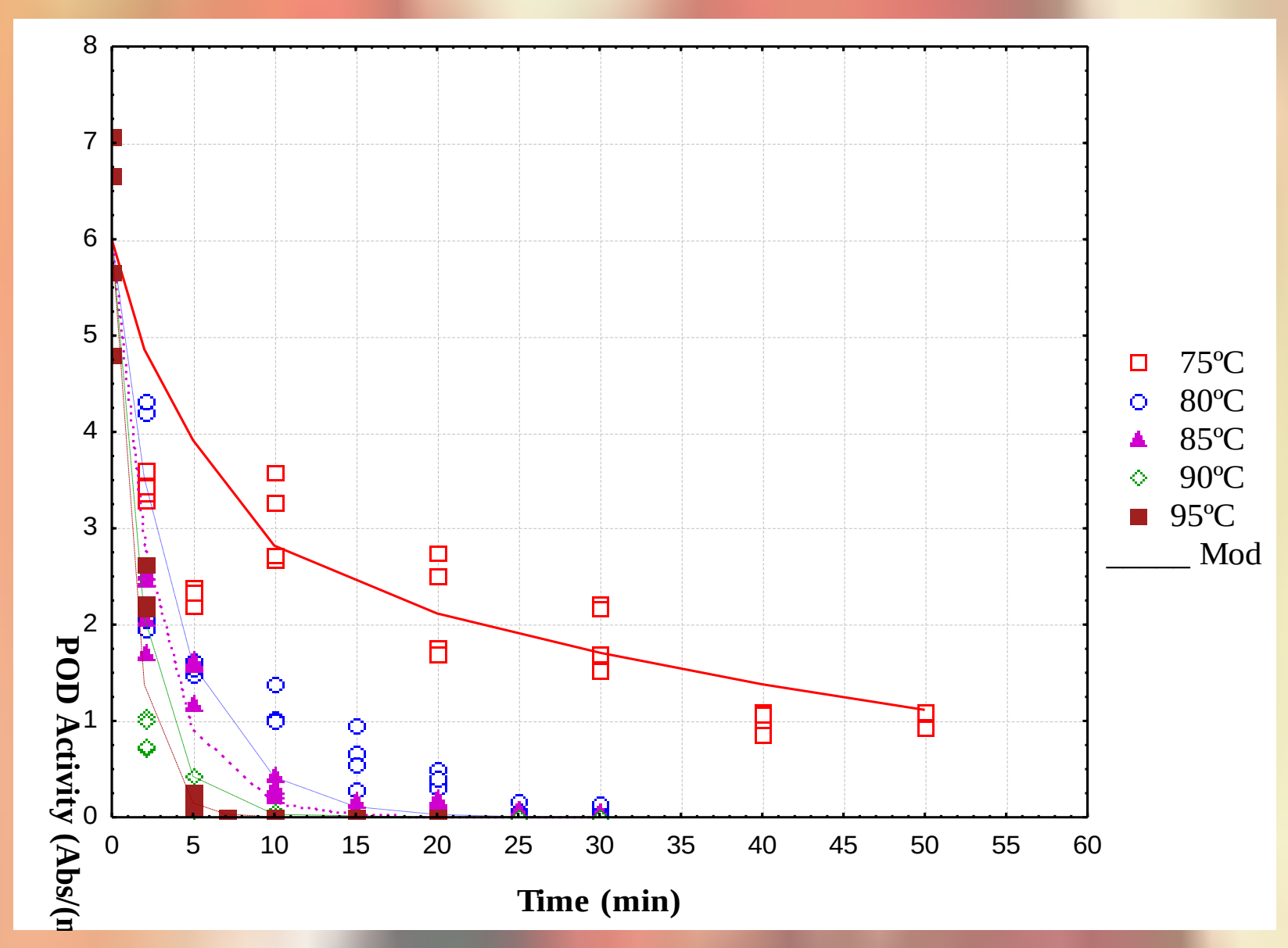

**FIGURE 3.** Effect of heat treatment on POD activity of pumpkin, modelled using a first order kinetics.

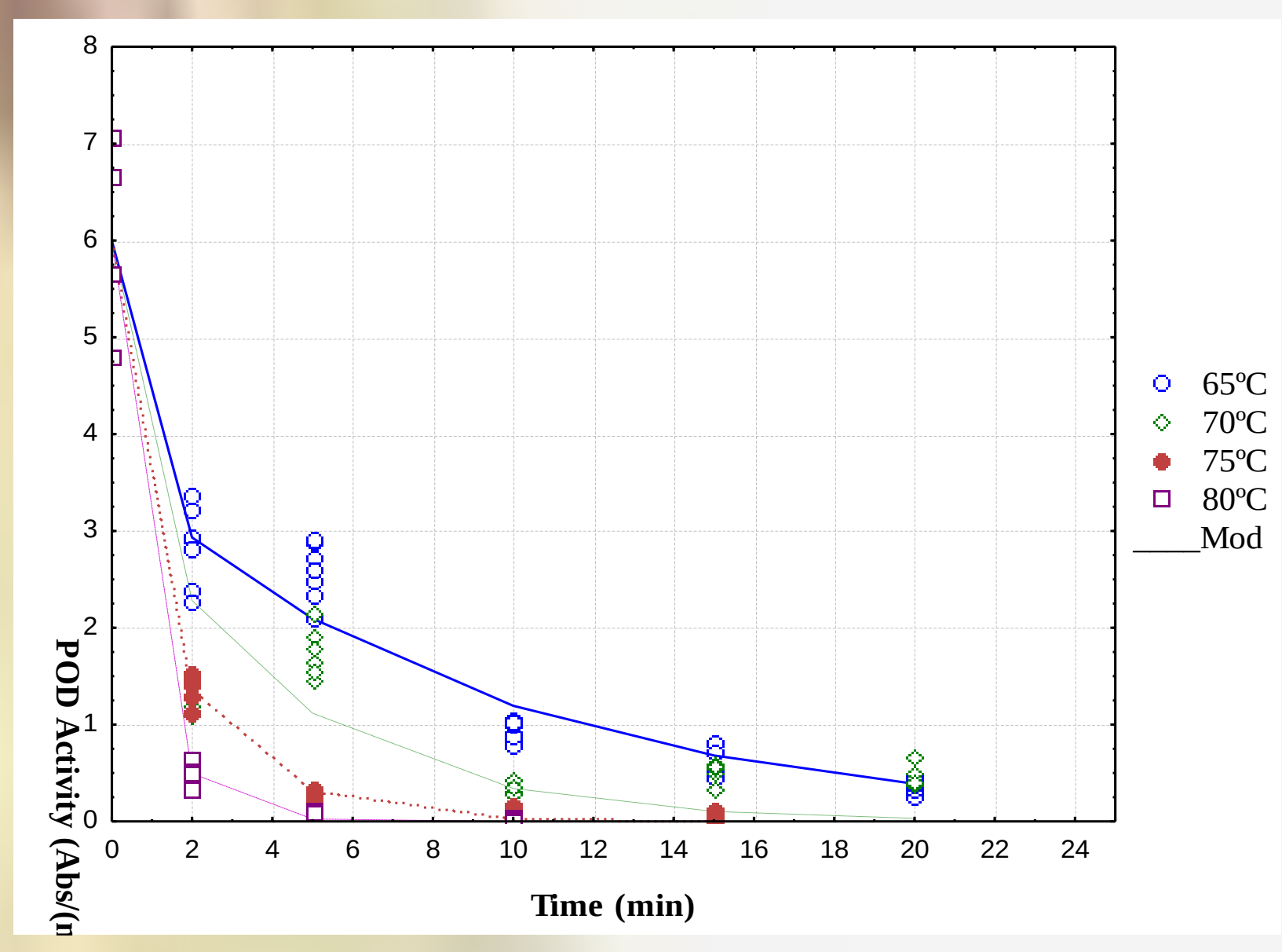

**FIGURE 4.** Effect of thermosonication treatment on POD activity of pumpkin, modelled using a first order kinetics.

The first order kinetic model, and the Arrhenius dependence of the inactivation rate on process temperature, described the results adequately. The quality of the regression was evaluated by normality and randomness of residuals, and by the coefficient of determination $R^2$, which was satisfactory high in all cases (averaging 0.87).

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, $E_a$).

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

| | ***Blanching*** | | ***Thermosonication*** | |
|---|---|---|---|---|
| ***Broccoli*** | $C_0$<br>$k_{80ºC}$<br>$E_a$ | 114.5±1.9 Abs/(min.ml)<br>1.6±0.07 $min^{-1}$<br>159.0±3.6 $kJ.mol^{-1}$ | $C_0$<br>$k_{80ºC}$<br>$E_a$ | 114.4±1.4Abs/(min.ml)<br>1.6±0.08 $min^{-1}$<br>139.1±3.5 $kJ.mol^{-1}$ |
| ***Pumpkin*** | $C_0$<br>$k_{85ºC}$<br>$E_a$ | 5.5±0.2 Abs/(min.ml)<br>0.10±0.02 $min^{-1}$<br>191.7±18.5 $kJ.mol^{-1}$ | $C_0$<br>$k_{75ºC}$<br>$E_a$ | 5.8±0.1 Abs/(min.ml)<br>0.4±0.03 $min^{-1}$<br>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.

## *Conclusions*

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

**•References**

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