

Chemical and thermal characterization of a Portuguese traditional fermented meat sausage

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Introduction

In the North of Portugal several traditional fermented meat products are produced. One of these is *alheira* (Figure 1) that is a smoked sausage, made from the meat of pig, regional wheat bread and olive oil, seasoned with salt, garlic and paprika. This product must be subjected to a thermal process before consumption in order to guarantee its safety and reducing the occurrence of foodborne diseases.



Figure 1 – Alheiras.

Results and Discussion

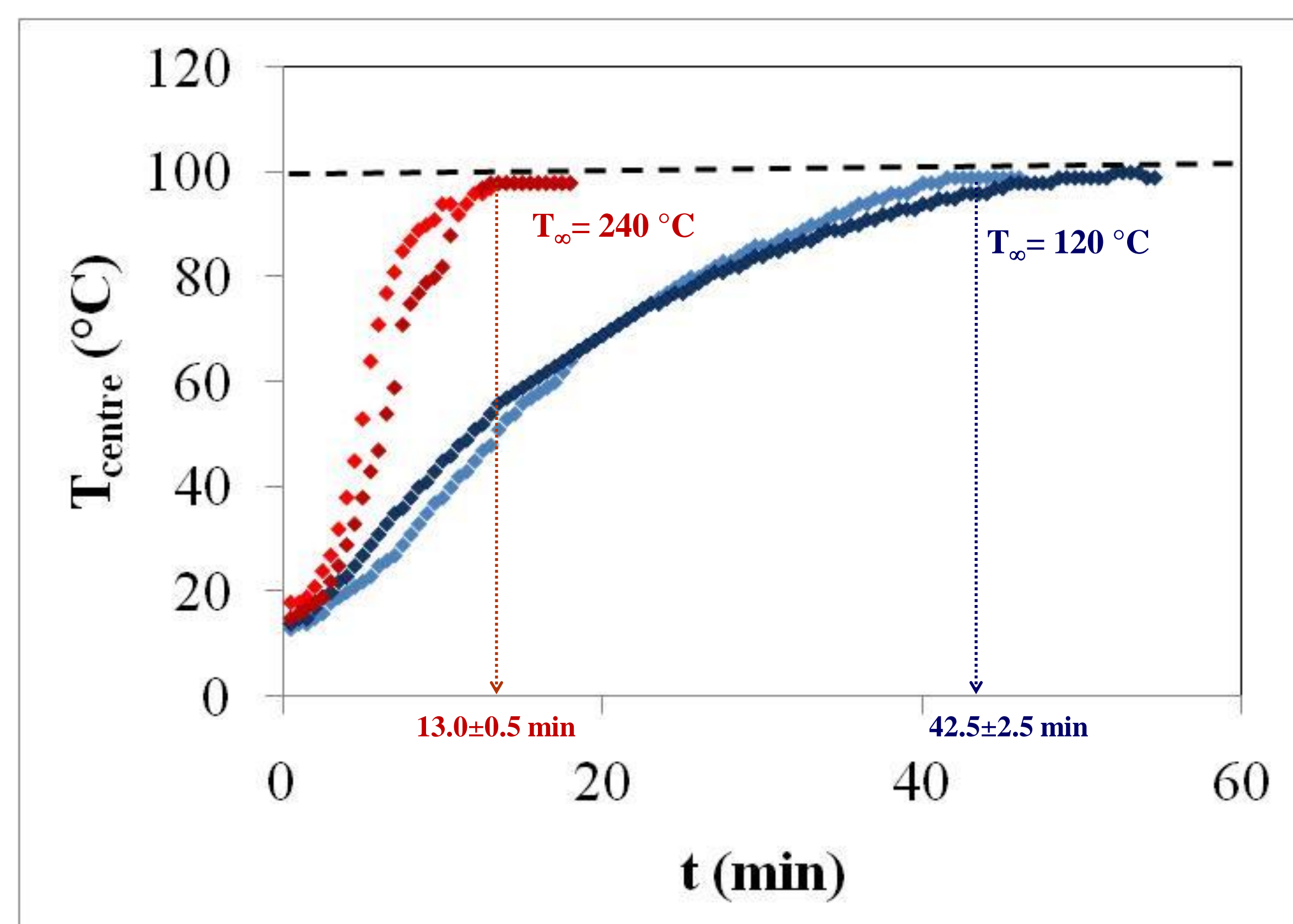
I) Alheira's composition

Table 1: Values of pH, water activity, fat and protein (minimum, maximum, mean and standard deviation) of *Alheiras*.

	Min.	Max	Mean	SD
pH	5,29	6,32	6.07	0.26
Water activity	0.90	0.93	0.92	0.01
Fat (%)	5.44	7.37	6.60	0.68
Protein (%)	8.94	12.06	9.78	0.9

pH and $a_w \uparrow \Rightarrow$ It is important to subject *alheiras* to a correct thermal treatment

II) Alheira's heating - Temperature profiles



- ✓ After a certain period of time, the temperature at the center of the product remained almost constant, around 100 °C, even though higher heating temperatures were used;
- ✓ At 240 °C the heating process was around three times faster than at 120 °C;
- ✓ For reaching 100 °C, 13.0 ± 0.5 min were necessary at 240 °C instead 42.5 ± 2.5 min at 120 °C.

Objective

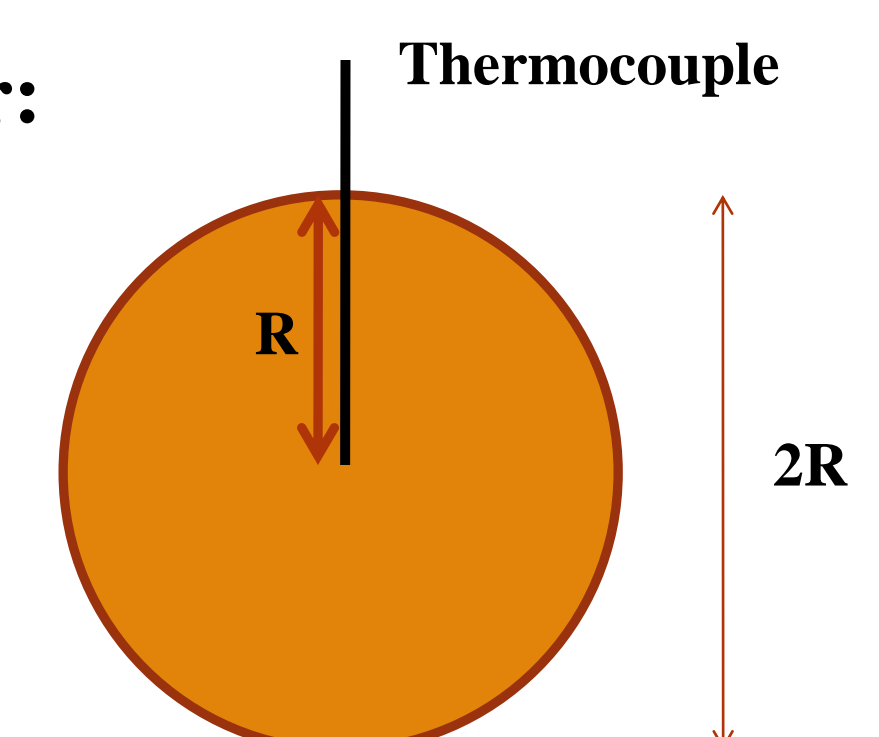
- ✓ Characterize *alheiras* in relation to the chemical composition and thermal behavior.

Materials and Methods

- ✓ *Alheiras* were bought to local producers.
- ✓ pH, water activity, fat and protein contents were determined:
- ✓ In order to obtain the heating curves, *alheiras* were roasted at different temperatures, ranging from 120 to 240 °C, in a forced convection oven: $T_\infty = 119 \pm 4$ °C and $T_\infty = 243 \pm 5$ °C, respectively.
- ✓ The center temperature, as well as the temperature of the surrounding medium, were monitored at 30 s intervals.

Approximating Alheiras to an Infinite Cylinder:

$$\frac{\partial T}{\partial t} = \alpha \left[\frac{1}{r} \times \frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial r^2} \right]$$



$$t = 0, \forall r, T = T_0$$

$$\text{Boundary conditions } t > 0, r = R, T = T_\infty$$

$$t > 0, r = 0, \frac{\partial T}{\partial r} = 0$$

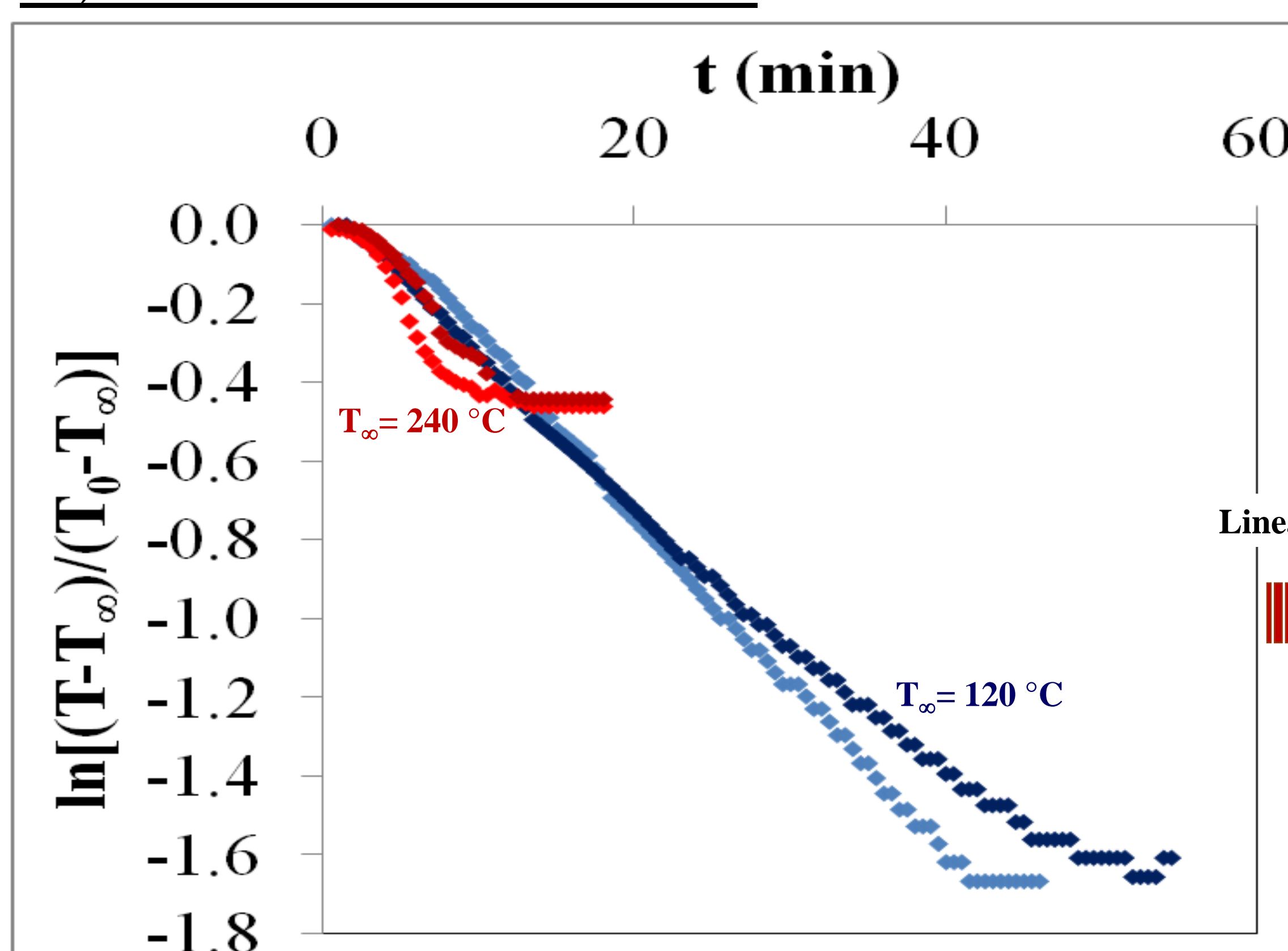
$$\frac{T - T_\infty}{T_0 - T_\infty} = 2 \times \sum_{n=1}^{\infty} \frac{J_0[R(n) \times r / R]}{R(n) \times J_1[R(n)]} \times e^{-\frac{\alpha t}{R^2} \times R(n)^2}$$

where: $J_0(x)$ – Bessel function of order 0;
 $J_1(x)$ – Bessel function of order 1;
 $R(n)$ - Positive solutions of the equation $J_0(x) = 0$
 α - Thermal diffusivity

After a long period of time \Rightarrow 1st Term of the Serie + Applying logarithms

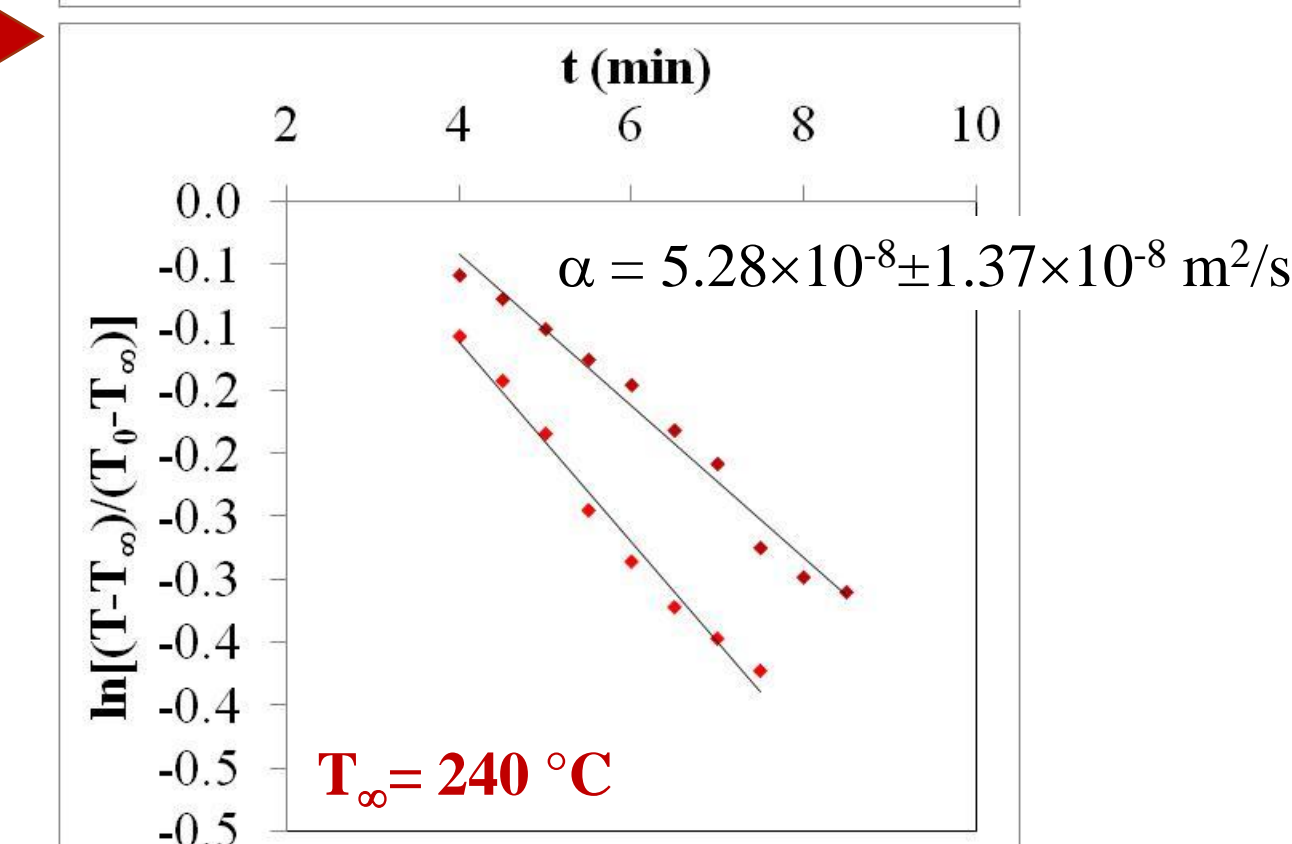
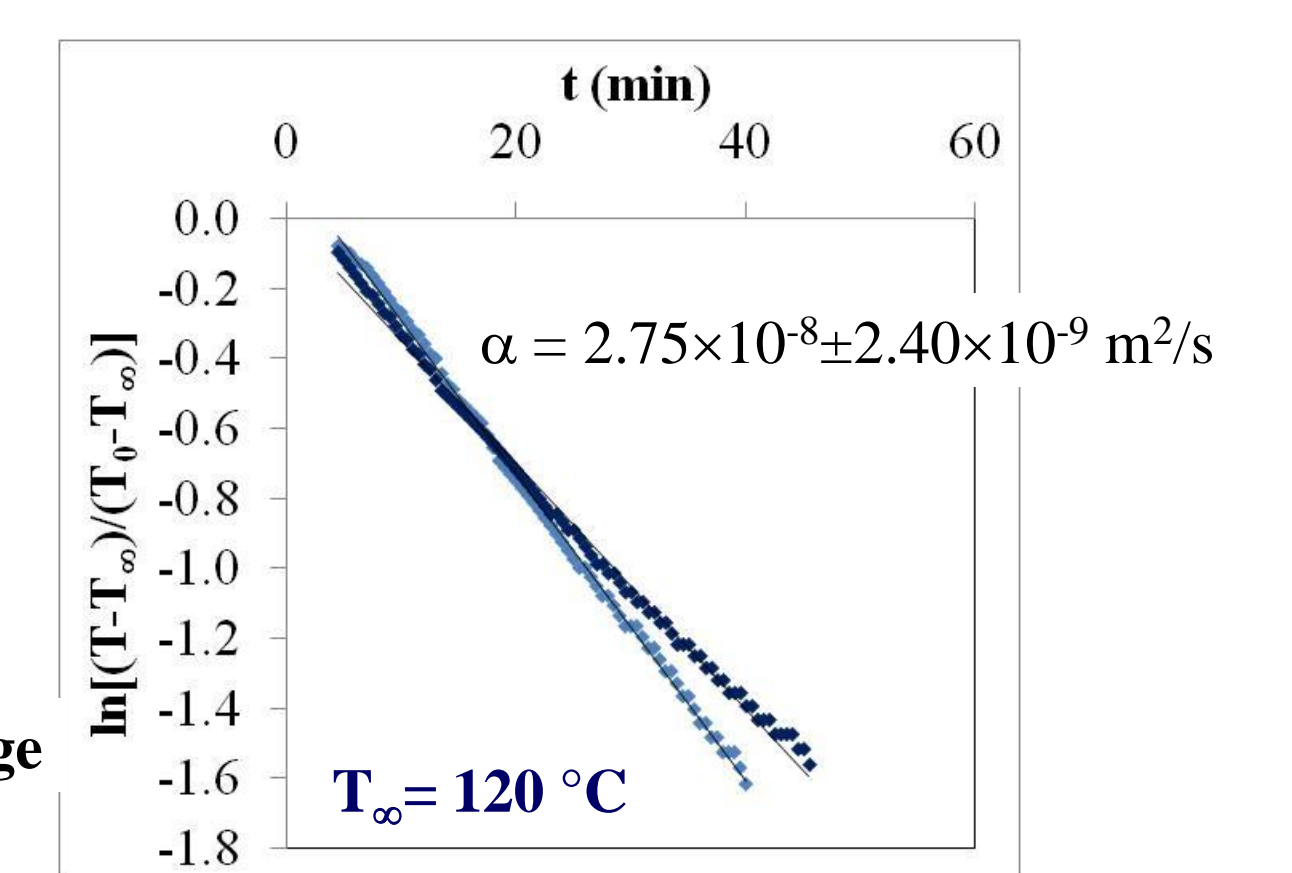
$$\ln \left[\frac{T - T_\infty}{T_0 - T_\infty} \right] = \ln \left[2 \times \frac{J_0[R(1) \times r / R]}{R(1) \times J_1[R(1)]} \right] - \frac{\alpha}{R^2} \times R(1)^2 \times t$$

III) Thermal Diffusivities of Alheira



$$R_{Alheiras} (120 \text{ }^\circ\text{C}) = 15.63 \pm 1.72 \text{ mm}$$

$$R_{Alheiras} (240 \text{ }^\circ\text{C}) = 16.17 \pm 0.84 \text{ mm}$$



Conclusions

- Due to their composition, *alheiras* must be subjected to a correct thermal treatment;
- A two-fold increase of temperature, decreases the time of heating in 1/3.
- Thermal diffusivities of *alheiras* at 120-240 °C are around 10^{-8} m²/s.