CATÓLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

Influence of solar processing on broccoli (*Brassica oleracea L. Ssp. Italica*) florets properties

Giorgia Carrieri, Carlotta Gilli, Bárbara Ramos & ***Cristina L.M. Silva***

University of Milan & University of Bologna, ITALY

Universidade Católica Portuguesa, CBQF, PORTUGAL

Third International Conference **CONSOLFOOD**2020
Advances in Solar Thermal Food Processing
22-23-24 January 2020
INSTITUTE OF ENGINEERING; UNIVERSITY OF ALGARVE; CAMPUS DA PENHA;
FARO-PORTUGAL

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

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

- Superfood
- High nutritional value
- Source of phytochemical compounds with health-promoting properties
- Usually consumed after cooking procedures

Effect of cooking

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

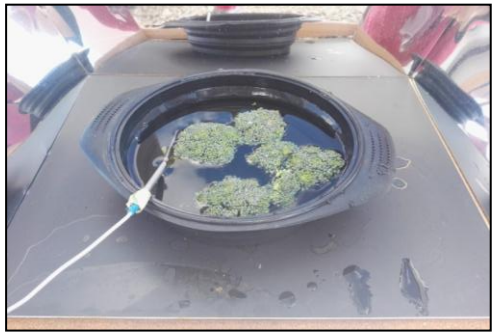
Thermal treatment affects:

- Cellular structure
- Texture
- Colour
- Phytochemical composition
- Organoleptic properties

Solar cooking

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

Is solar cooking similar to other conventional cooking methods?



Box

Parabolic

Objectives

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

- Investigate the phytochemical, physical and sensorial properties of broccoli (*Brassica oleracea* L*. ssp. Italica*) florets as affected by **water cooking process** at five different temperatures

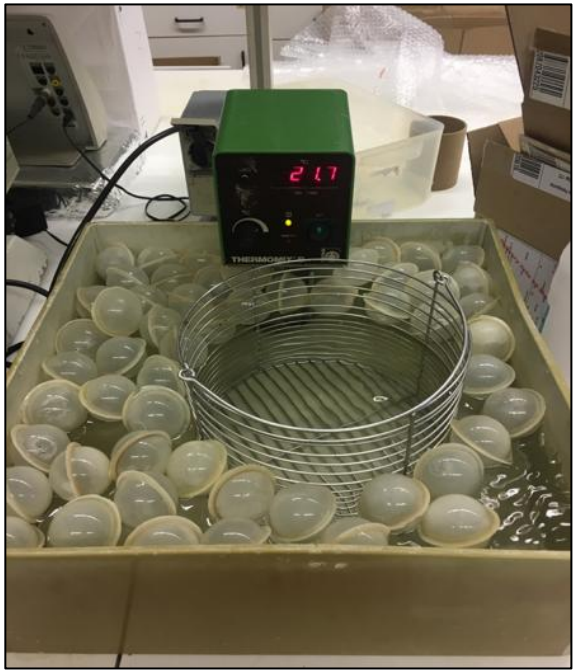
- **Model the change kinetics** of total phenolic content (TPC), total antioxidant activity (TAA), colour, texture and sensory quality along water cooking under isothermal conditions

- **Evaluate the impact of solar cooking** on broccoli quality and **compare with estimated values**

Materials & Methods

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

- Thermal bath system
- Isothermal cooking conditions
- Five different cooking temperatures (70, 75, 83, 90, 95 °C)
- Evaluation of quality along time

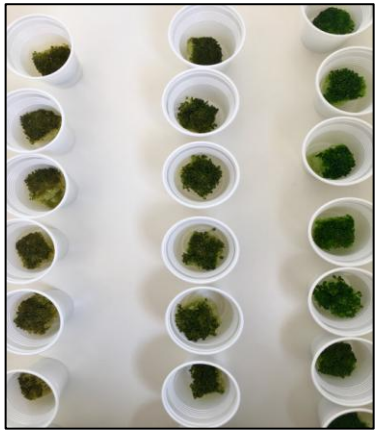


Materials & Methods

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

Analysis:

- Total phenolic compounds
- Total antioxidant activity
- Colour
- Texture
- Sensory analysis (*colour, flavour and texture*)



Materials & Methods

CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

Modeling:

$$\frac{C}{C_0} = exp\ (-kt)$$

$$\frac{C - Ceq}{C0 - Ceq} = \exp\left[-k\ t\right]$$

$$TCD = K\ [\ 1 - \exp(-kt)]$$

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

$$S = \alpha\ exp\left\{-exp\left[\frac{k_{max} e}{\alpha}\ (\lambda - t) + 1\right]\right\}$$

$$\alpha = (\mathrm{a} + \mathrm{b})\ \mathrm{T}$$

$$k_{max} = (\mathrm{k}_1 + \mathrm{k}_2)\ \mathrm{T}$$

Materials & Methods

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

Solar cooking:

Box

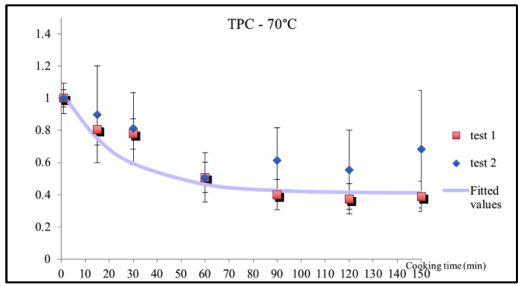
Parabolic

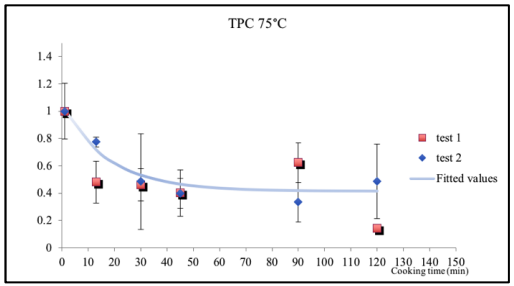
- Several experiments
- Quality evaluation
- Predict quality

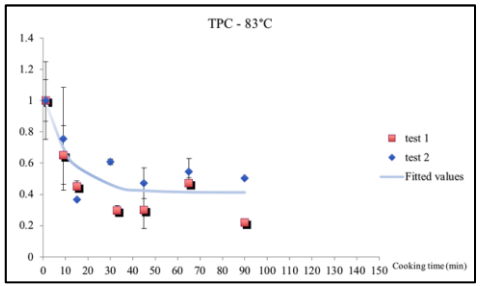
Results & Discussion

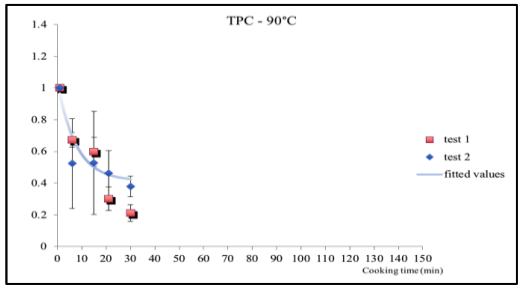
CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

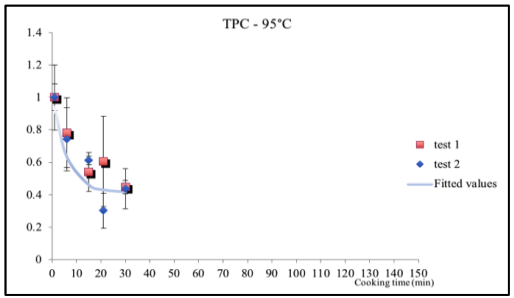
Total Phenolic Compounds:











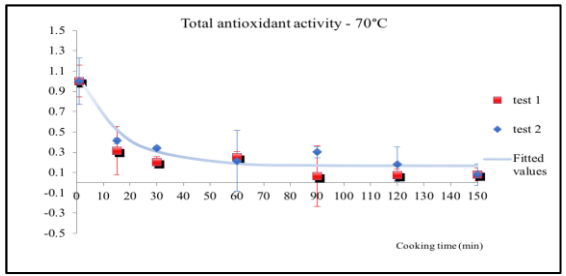
$$\frac{C - Ceq}{C0 - Ceq} = \exp\left[-k\,t\right]$$

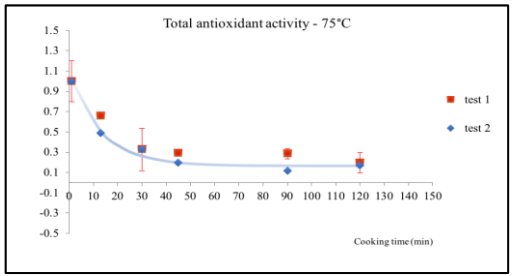
$$k = k_{ref} \exp\left[-\frac{\mathrm{Ea}}{\mathrm{R}}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

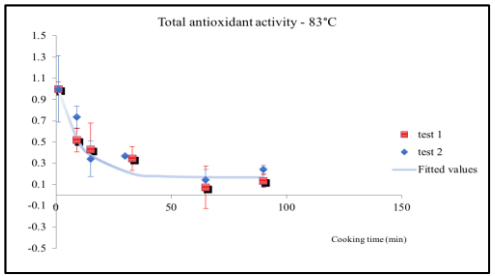
Results & Discussion

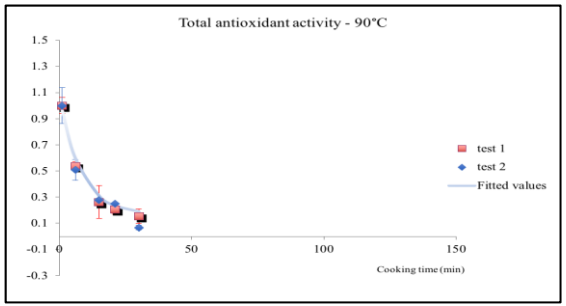
CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

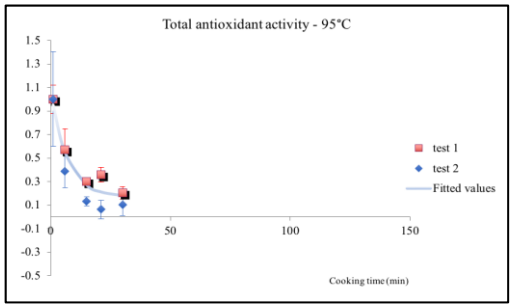
Total Antioxidant Activity:











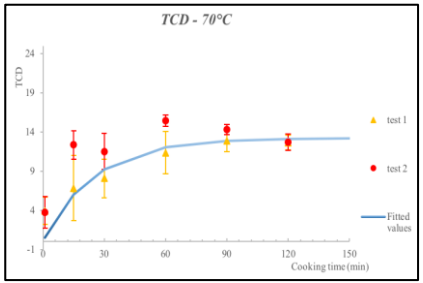
$$\frac{C - Ceq}{C0 - Ceq} = \exp\left[-k\,t\right]$$

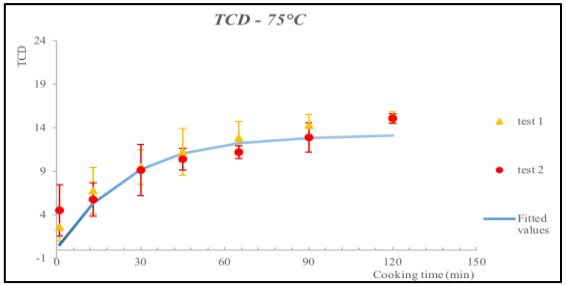
$$k = k_{ref} \exp\left[-\frac{\mathrm{Ea}}{\mathrm{R}}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

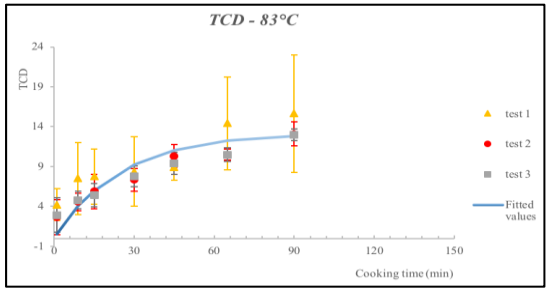
Results & Discussion

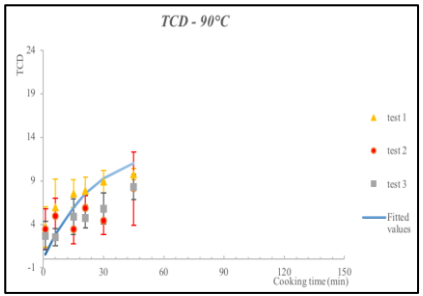
CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

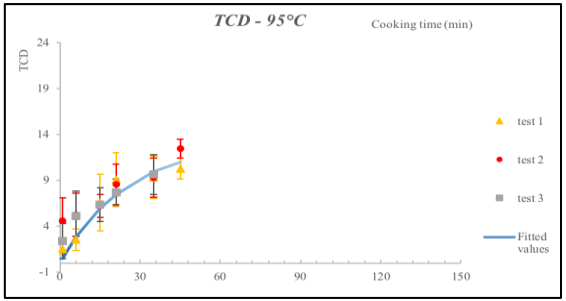
Total Colour Difference:











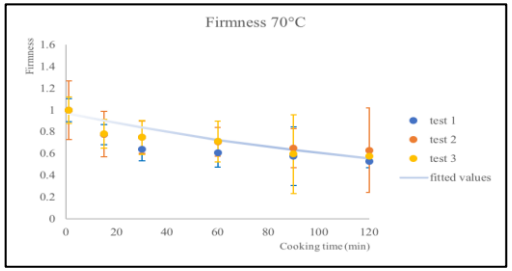
$$TCD = K\,[\,1 - \exp(-kt)]$$

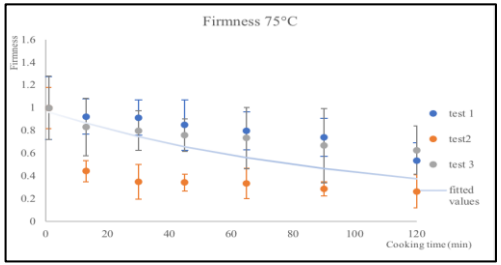
$$k = k_{ref}\exp\left[-\frac{\mathrm{Ea}}{\mathrm{R}}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

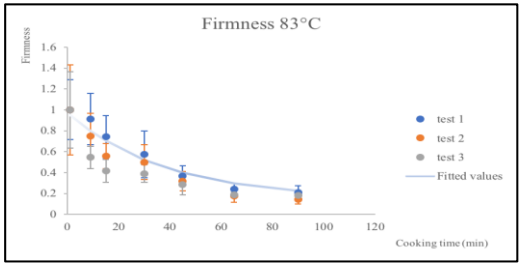
Results & Discussion

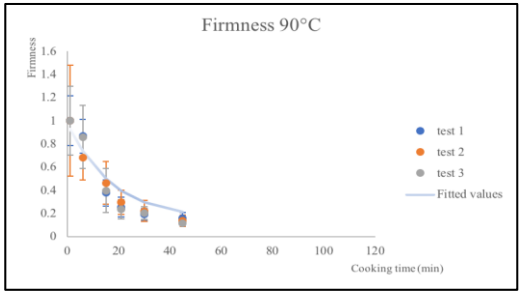
CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

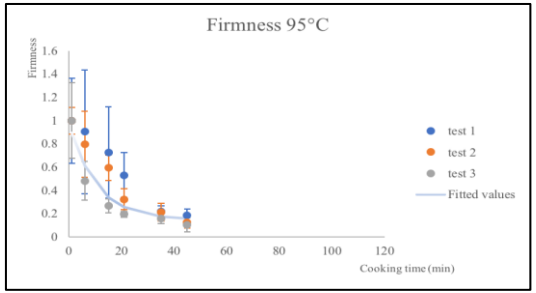
Firmess:











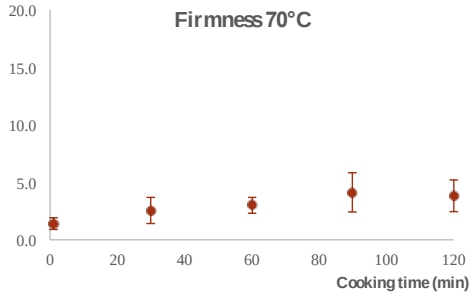
$$\frac{C - Ceq}{C0 - Ceq} = \exp\left[-k\,t\right]$$

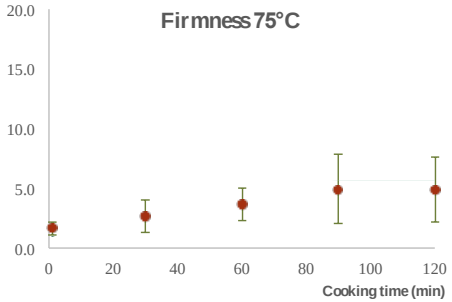
$$k = k_{ref} \exp\left[-\frac{\mathrm{Ea}}{\mathrm{R}}\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)\right]$$

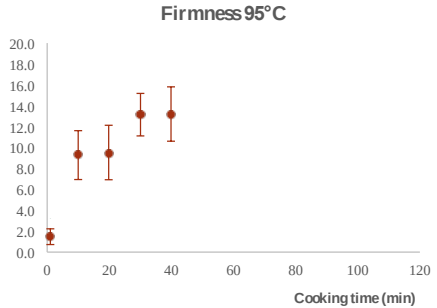
Results & Discussion

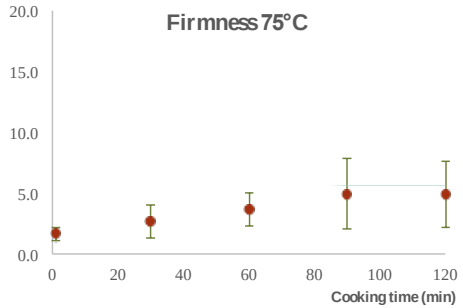
CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

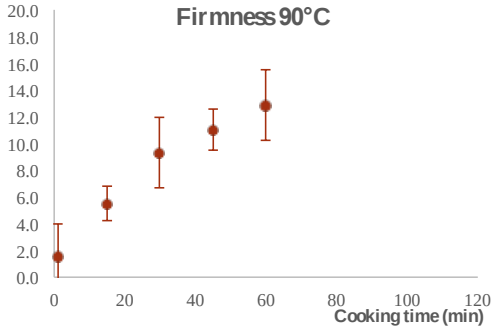
Firmess by a trained panel:











$$S = \alpha \, exp\left\{-exp\left[\frac{k_{max} e}{\alpha}(\lambda - t) + 1\right]\right\}$$

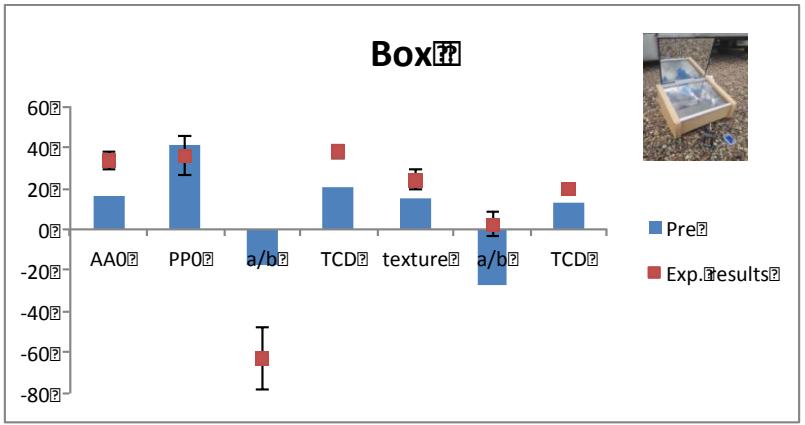
$$\alpha = (a + b)\ T$$

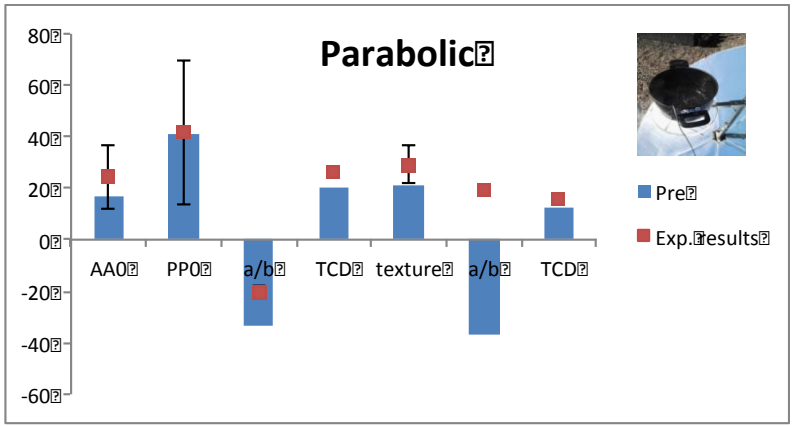
$$k_{max} = (k_1 + k_2)\ T$$

Results & Discussion

CATOLICA FACULTY OF BIOTECHNOLOGY PORTO

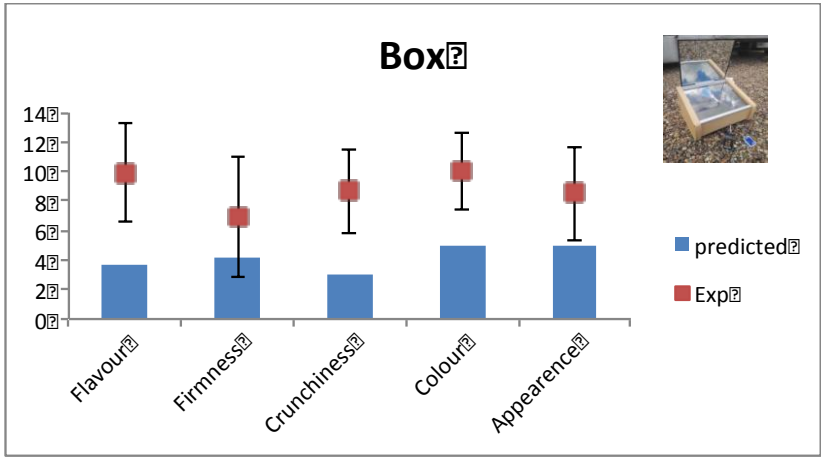
→ **Impact of solar cooking**

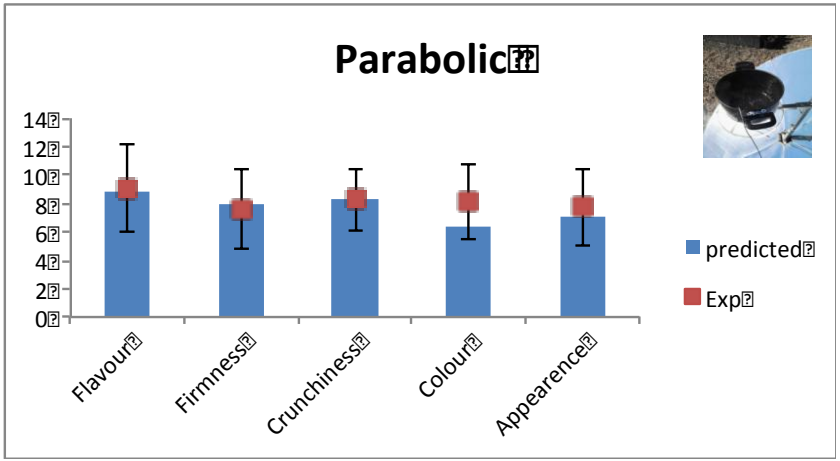




Results & Discussion

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO





Conclusions

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

- ✓ Different models were able to describe broccoli florets quality changes due to water cooking
- ✓ Quality evaluated by analytical methods predicted in a similar way the behavior under solar conditions. Only total phenolic compounds could be well estimated
- ✓ For sensory parameters evaluated by a trained panel it was possible to estimate well only for parabolic cooking
- ✓ For box type cooking, panelist identified very different characteristics

Contact

CATOLICA
FACULTY
OF BIOTECHNOLOGY
PORTO

Cristina L.M. Silva

Faculty of Biotecnology
Universidade Católica Portuguesa | Porto
Biotechnology Building
Rua de Diogo Botelho, 1327
4169-005 Porto, Portugal

Email: clsilva@porto.ucp.pt