



Inactivation of *Alicyclobacillus acidoterrestris* in apple juice under ultraviolet irradiation treatments



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Objectives

Study the influence of UV-C radiation treatments,

with seven different intensities

(0.32, 0.86, 2.59, 5.59, 8.45,

11.50 and 13.44 W/m²),


on *A. acidoterrestris* inactivation in apple juices

Relevance

Heat processing

 Microorganisms and enzymes inactivation

 Shelf life

 verse effects on sensory and nutritional characteristics of the foods

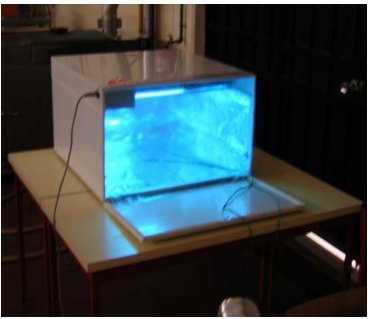
Relevance

Non-thermal technologies

- > increased attention
- > potential for inactivating spoilage and pathogenic microorganisms
- > minimize quality losses in terms of flavour, colour and nutritional compounds



Relevance



Ultraviolet-C

- Non-thermal strategy to control microorganisms in food products
- Microorganisms that are exposed to UV-C light are affected at the DNA (deoxyribonucleic acid) level, which compromises their survival



Relevance

A. acidoterrestris

- Thermo-acidophilic bacteria that produce spores --> can survive to pasteurization processes even under acidic environments and at room temperature
- This microorganism was suggested as the target for the design of adequate pasteurization processes



Relevance



Mathematical models

- Log-linear survivors --> has been fundamental to the food industry for establishing the concept of decimal reduction time (D)
- Some deviations to these linear tendencies frequently occur, depending on the microorganism and the contaminated food matrix
- Mathematical modelling of inactivation kinetics due to radiation effect is scarce and requires investigation

Materials & Methods

Spore suspension
(2×10^7 CFU/mL)



0.05 mL

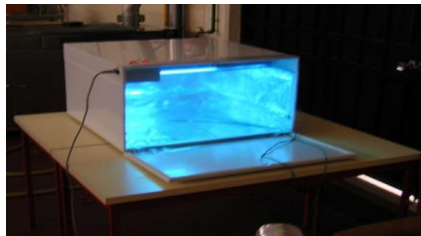


25 mL apple
juice



UV-C radiation

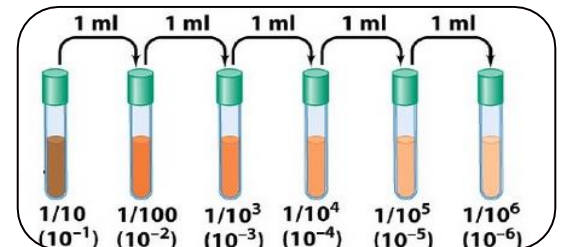
(0.32, 0.86, 2.59, 5.59, 8.45,
11.50 and 13.44 W/m²)



Incubation at
45 ° C for 2 days



1 mL



Materials & Methods

Data analysis

$$\log \left(\frac{N}{N_0} \right) = -\frac{1}{D} t \quad (1)$$

N_0 - initial microbial load of the juice (CFU/mL)

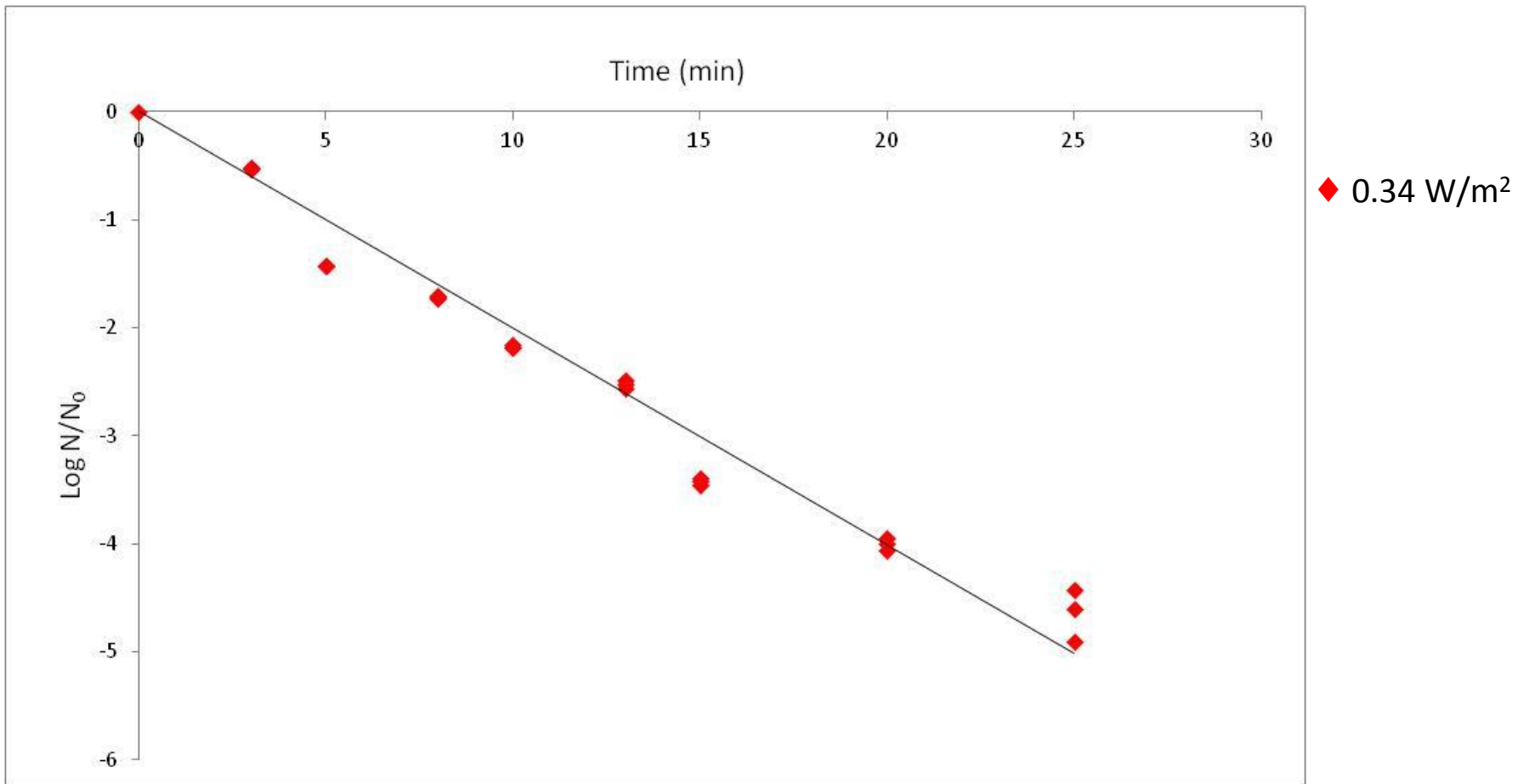
N - microbial load (CFU/mL) at a given treatment time t (min)

t - time (min)

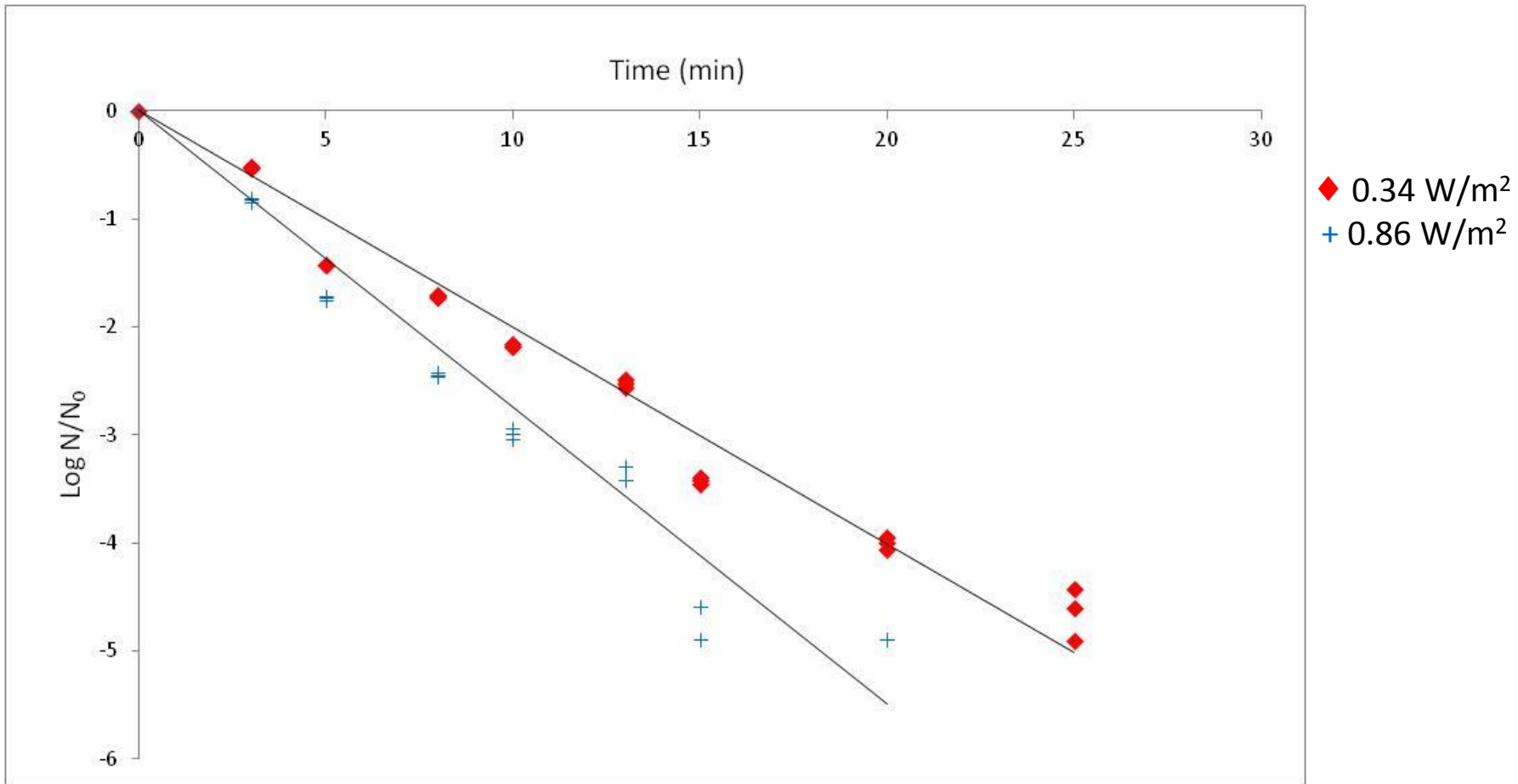
D - decimal reduction time, or D-value (min) required to inactivate 90% of the microorganisms at a constant UV-C dose

Results & Discussion

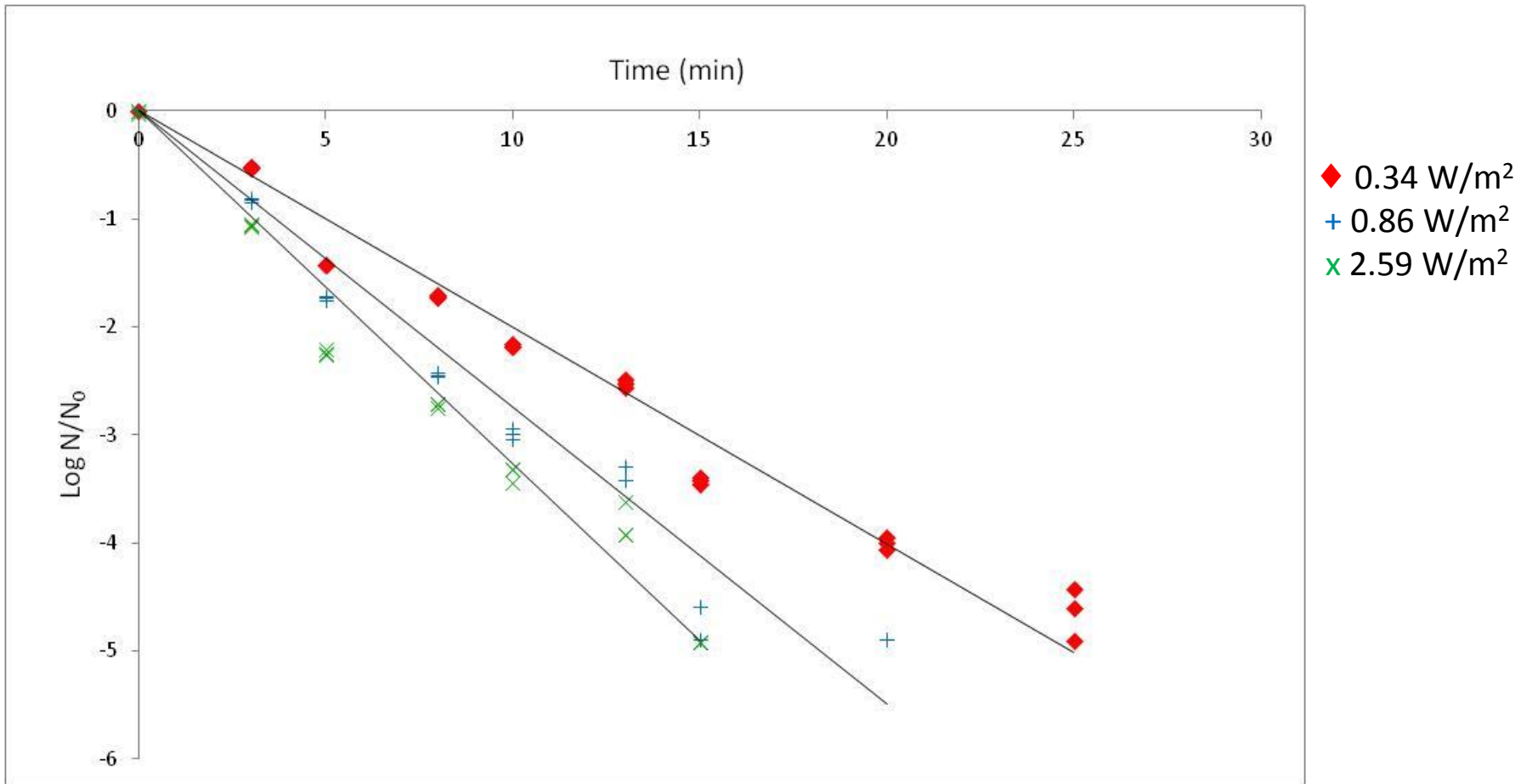
Results were expressed in terms of $\log(N/N_0)$ to avoid the influence of the initial microbial loads. The magnitude of N_0 around 10^5 CFU/mL.



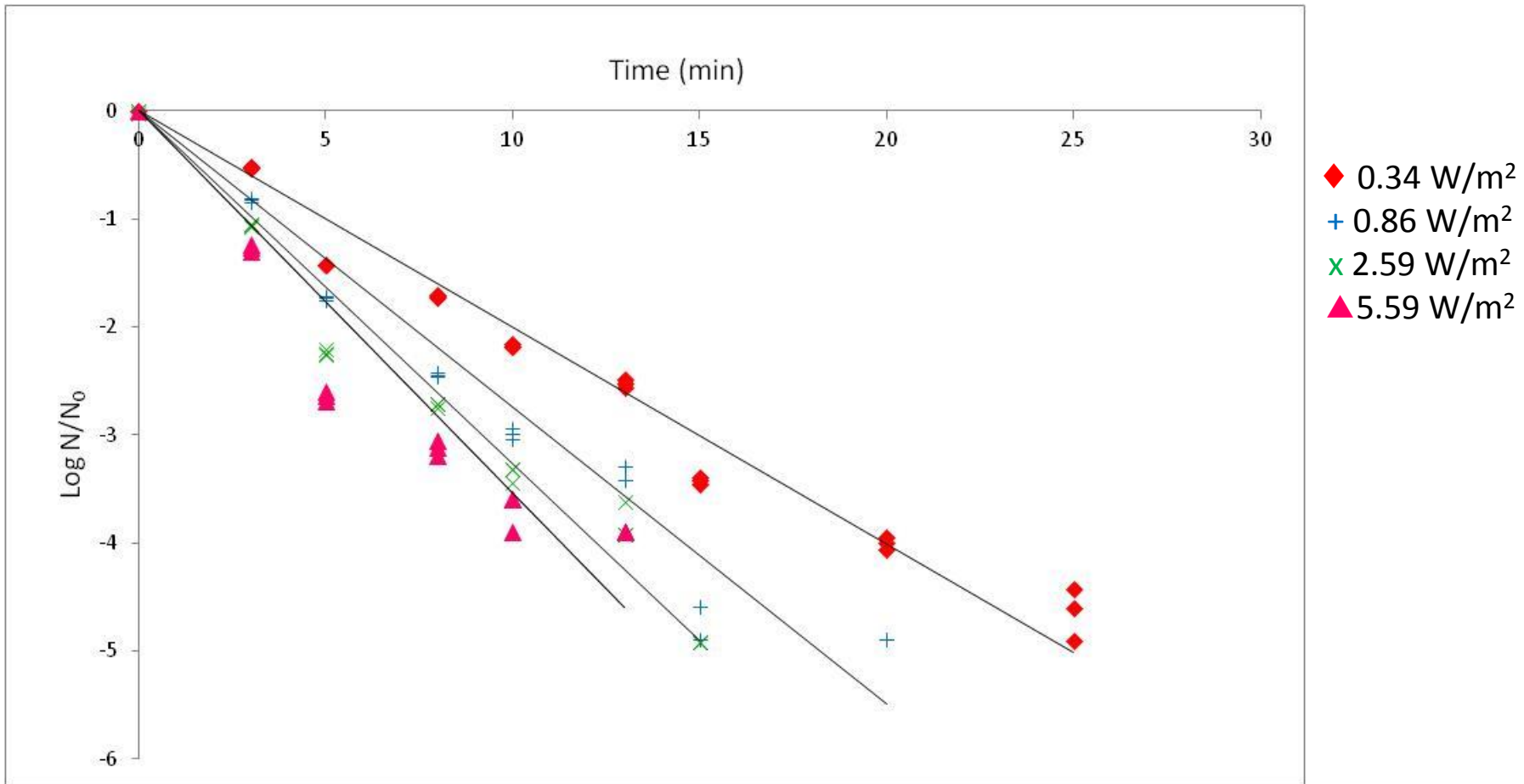
Results & Discussion



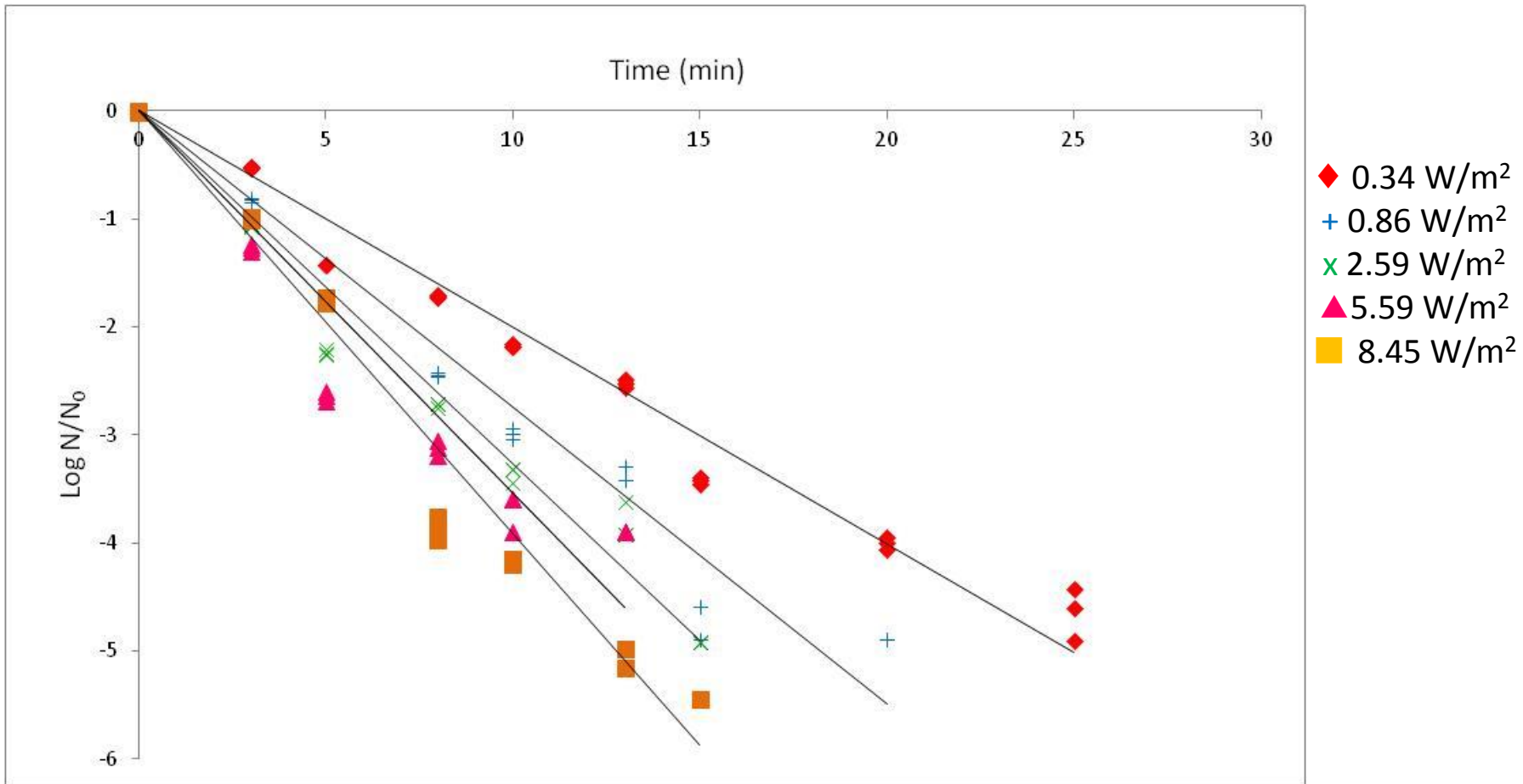
Results & Discussion



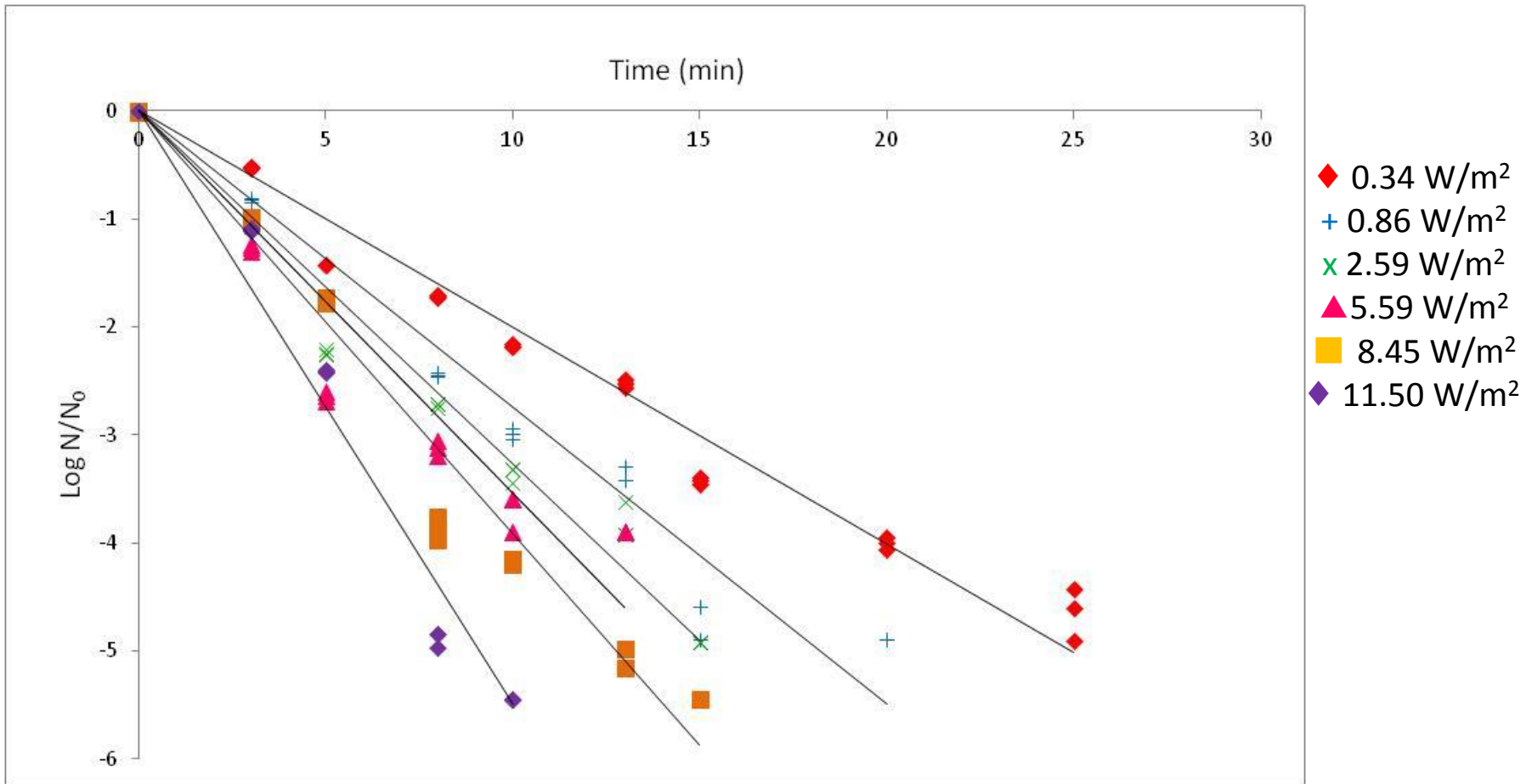
Results & Discussion



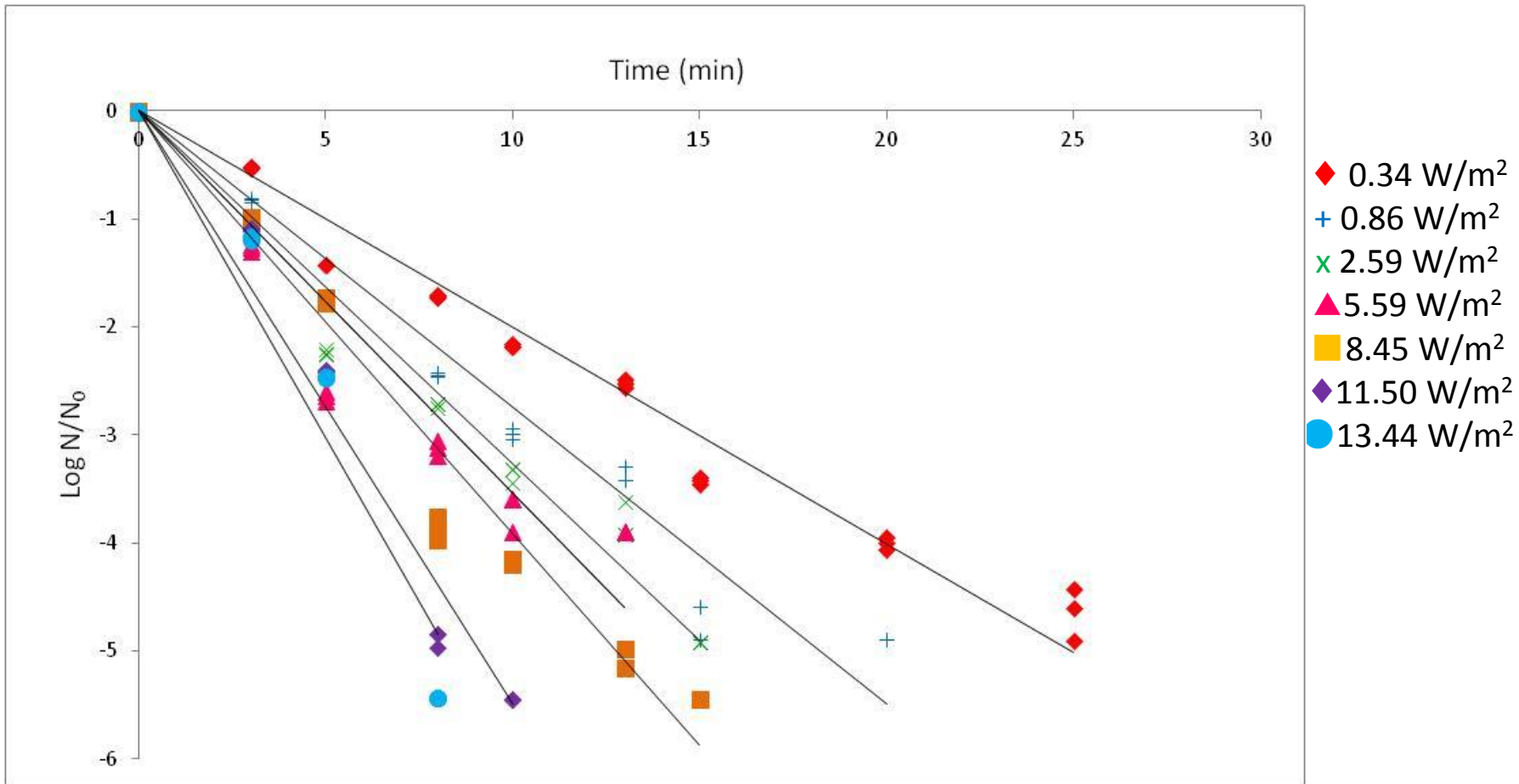
Results & Discussion



Results & Discussion



Results & Discussion



Results & Discussion



- At the highest intensity levels (11.50 and 13.44 W/m²) the UV-C treatment allowed reducing 5 log-cycles of initial contamination in approximately 8 minutes
- At the lowest doses (0.34 W/m²) it took around 25 minutes to attain a similar reduction
- For all tested intensities, microbial reductions attained FDA requirements, however for different treatment times
- When compared to a thermal treatment at 95 ° C, UV-C radiation was much more efficient in microbial reduction

Results & Discussion

- Baysal et al. (2013) studied UV-C on the inactivation of *A. acidoterrestris* in white grape and apple juices
- The effects of UV light intensity (3.8, 7.1 and 13.1 W/m²) and exposure time (0, 3, 5, 7, 10, 12 and 15 min) were evaluated
- The best reduction (5.5 log-cycles) was achieved in grape juice when the UV intensity was 13.1 W/m²
- For apple juice the maximum inactivation was approximately 2 log-cycles
- In our work, with a similar intensity (13.44 W/m²), a reduction of about 5 log-cycles was observed

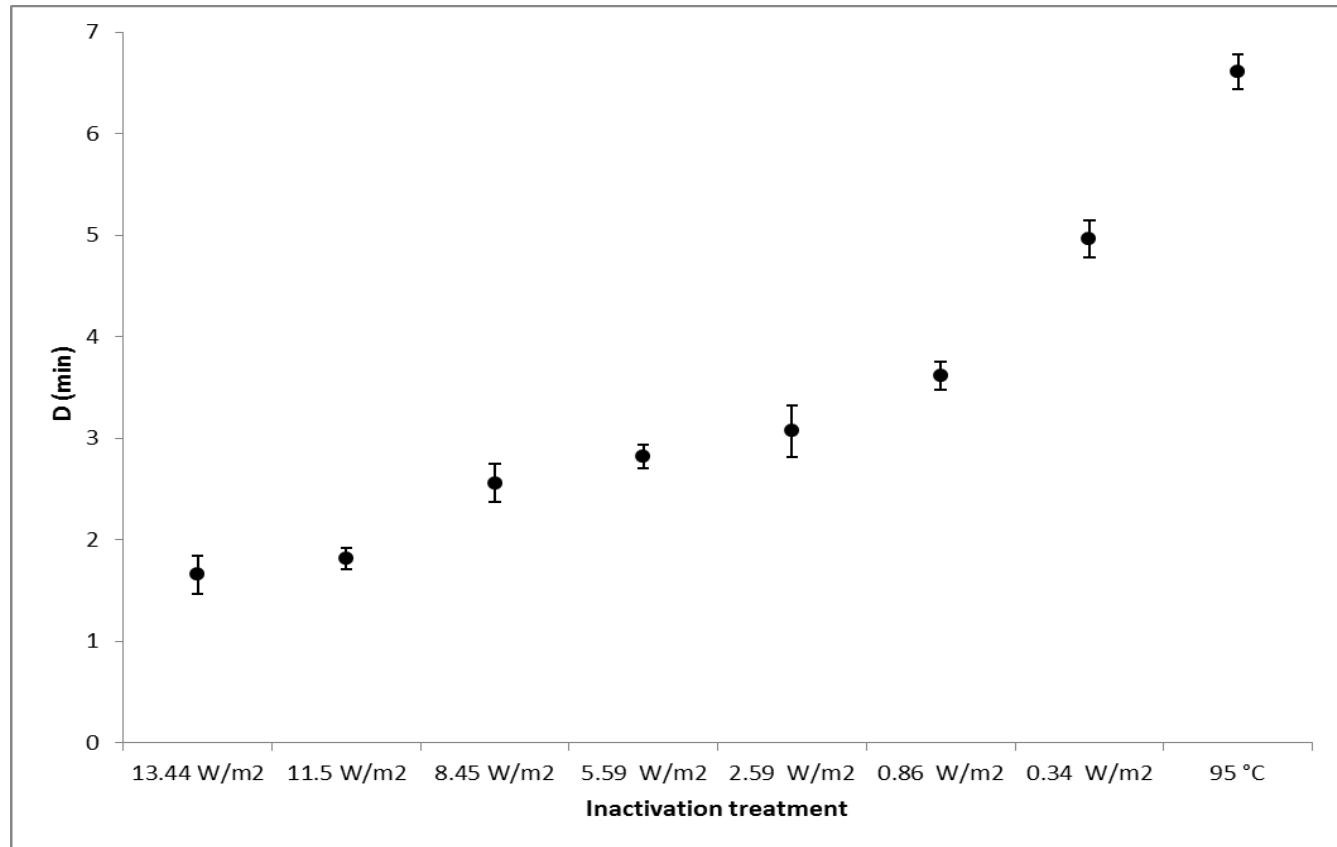
Results & Discussion

- Estimations of D-values were obtained at the different UV-C intensities
- The D-value is similar to the commonly used for thermal destruction of microorganisms



Results & Discussion

D-value of *A. acidoterrestris* estimated for each apple juice treatment. Bars are the limits of confidence intervals at 95%.



Results & Discussion

- Higher intensity of UV-C treatment → lower D-value
- *A. acidoterrestris* becomes more sensitive when radiation intensity increases
- Comparing to the highest intensity used (D-value of 1.6 ± 0.2 min), the D-value at 95° C is 4 times higher





Results & Discussion

- UV-C treatments are a promising process for fruit juices preservation
- These treatments avoid the detrimental effects of thermal processes, and can be considered more effective in the inactivation of spoilage and even pathogenic microorganisms
- From an industrial perspective, UV-C treatments can also be considered much more economic

Conclusions

- Ultraviolet-C radiation was effective on the inactivation of *A. acidoterrestris* spores in apple juices
- Even at the lowest intensities tested (0.34 W/m^2), the treatment impact on microbial reduction was higher than the one observed for a thermal process at 95° C
- Comparing these treatments in terms of decimal reduction times, D-value obtained at 95° C was 4 times higher than the one estimated at the lowest UV-C dose





Conclusions

- UV-C could be used as an alternative to thermal treatment for apple juices or combined with other pasteurization processes
- This research opens new opportunities of investigation that embrace studies on quality characteristics of the products and safety standards

Thank you!





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