Thermal and non-thermal orange juice pasteurization: The impact of ultrasound, thermosonication and heat treatment on *S. aureus* kinetic inactivation behaviour

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Introduction

S. aureus survival is a serious issue in the food field, which has pushed researchers to develop safe inactivation processes and, at the same time, not affect the food product's nutritional value. All of this to meet the increasing consumer demand for safe and quality food. One of the non-thermal preservation methods that is used as a powerful disinfection technology is sonication. It is considered an efficient process since it satisfies the Food and Drug Administration requirements for a 5-log reduction of microbial cells in fruit juices.

Objectives

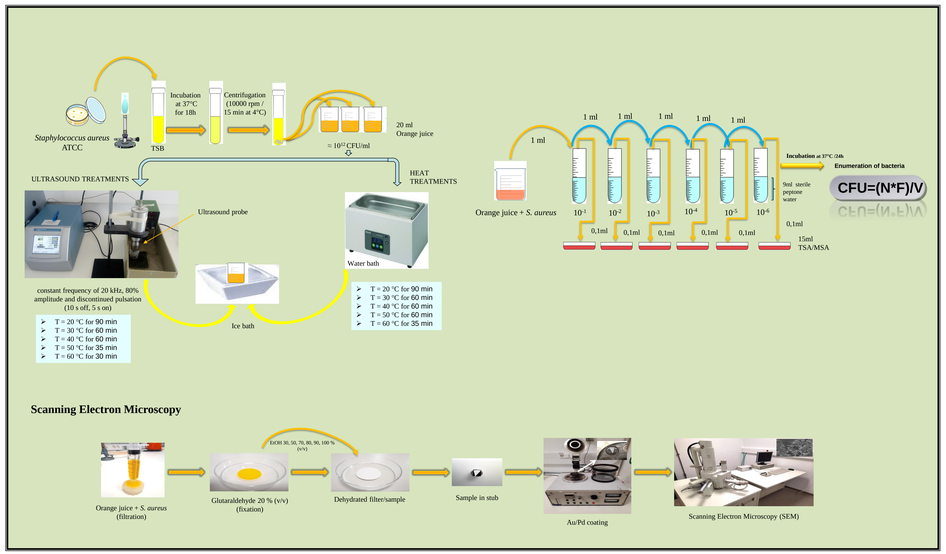
The main goals of this study were to evaluate:

- *S. aureus*'s kinetic inactivation behaviour in orange juice at different temperatures and after ultrasound, thermosonication and heat treatments;

and

- *S. aureus* cell viability and damage using two different platting media and SEM analyses.

Methodology



Results

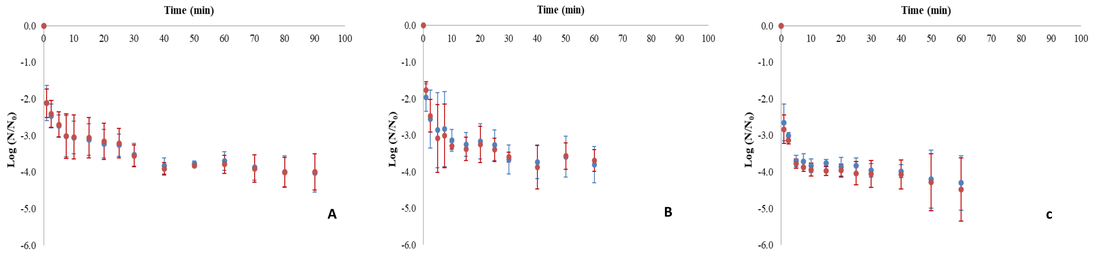


Fig. 1. Inactivation of *S. aureus* during ultrasound treatment at 20 °C (A), 30 °C (B), and 40 °C (C) in two media (Blue: MSA; Red: TSA).

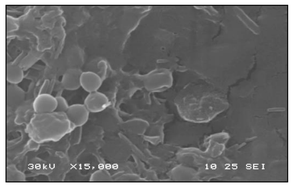


Fig. 2. Scanning electron microscope (SEM) images of *S. aureus* treated by ultrasound at 40 °C for 60 min

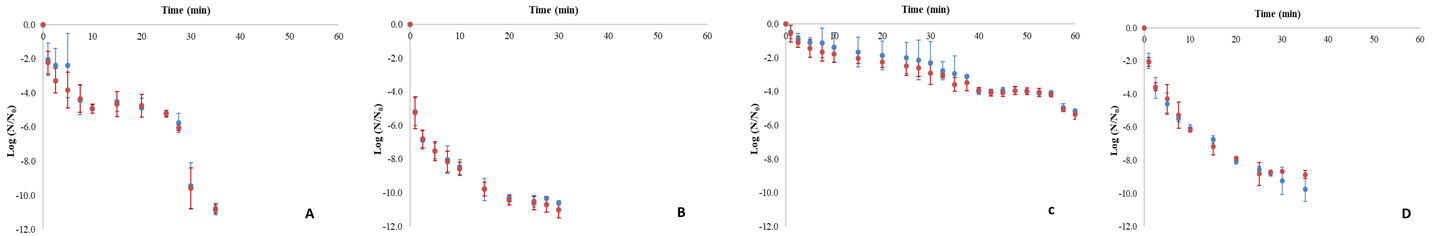


Fig. 3. Inactivation curves of *S. aureus* in orange juice during thermosonication at 50°C (A) and 60°C (B), and during heat treatment at 50°C (C) and 60°C (D) in two media (Blue: MSA; Red: TSA).

Ultrasounds at lower temperatures allowed a reduction of 4 log cycles on *S. aureus* viable cells.

Without ultrasounds, sublethal temperatures did not affect *S. aureus* survival.

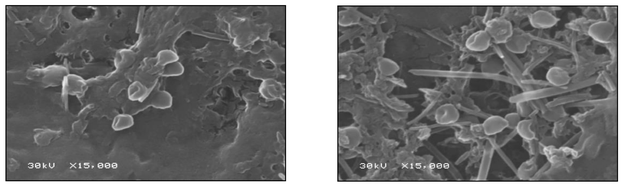


Fig. 4. Scanning electron microscope (SEM) images of *S. aureus* treated by thermosonication at 50 °C for 35 min (A: x 15000) and at 60 °C for 30 min (B: x 15000).

Thermosonication treatments at 50 and 60 °C allowed higher *S. aureus* inactivation rates and lesser treatment times than the heat treatments alone.

Damaged *S. aureus* cells are ruptured by ultrasound, proved by the presence of single-pore and flatted cells in thermosonicated samples, which cause cell lyses with fragmentized walls and membranes.

Conclusions

- Thermosonication treatment was more effective than sonication and heat treatment alone.
- The 5-log reductions for *S. aureus* were achieved with thermosonication at 50°C and 60°C within 25 min and 1 min, respectively.
- A synergistic effect was observed between thermal and ultrasound treatments, noted by increased cells susceptibility to cavitation effects.

This work was supported by National Funds from FCT - Fundação para a Ciência e a Tecnologia through project UID/Multi/50016/2020