Influence and comparison of thermal, ultrasonic and thermosonic treatments on physicochemical quality of orange juice

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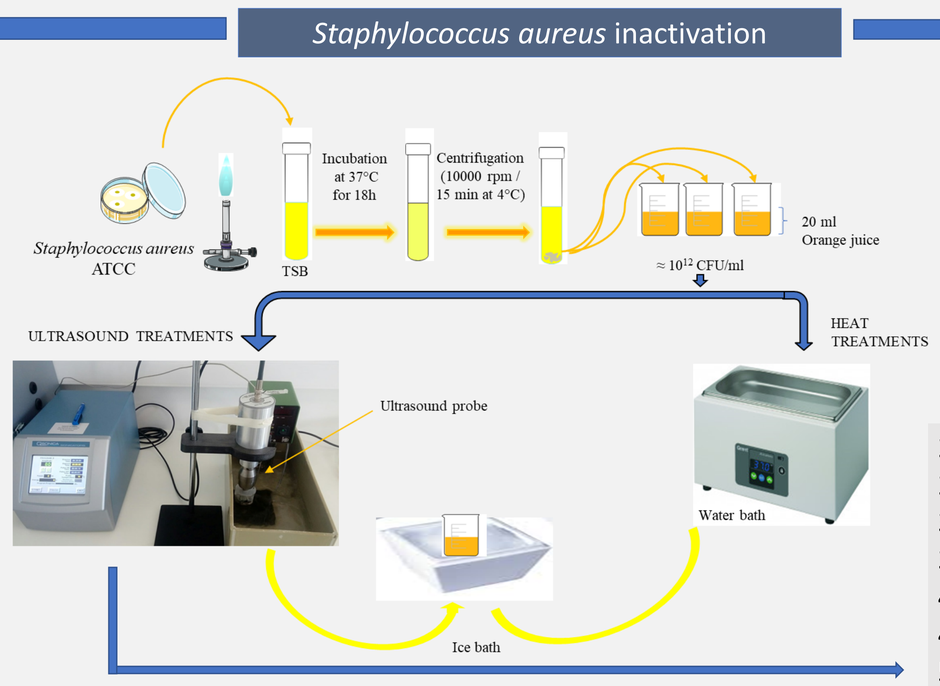
Introduction

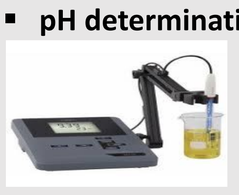
Orange juice is the most popular and consumed juice worldwide, associated with healthy eating habits. Thermal pasteurization treatments are used to preserve industrially produced juice. Unfortunately, this process removes many nutritious compounds. Therefore, other **milder treatments** are being studied to minimize the impact on the product's final quality.

The main **goal of this study** was to evaluate the effect of **thermosonication (TS)** treatment on the quality of orange juice in comparison with **heat (HT)** and **ultrasound (US)** treatments alone.

Methodology



- **pH determinations**



- **Total Soluble Solids (°Brix)**

- **Color**

Colorimeter Minolta CR-400

Hue angle (h^*) : $h^* = \tan^{-1}(b^*/a^*)$
Chroma (C^*): $C^* = \sqrt{(a^{*2} + b^{*2})}$

These treatment times were chosen to guarantee the *Staphylococcus aureus* inactivation.

Data analysis

All physicochemical parameters, and microbial cell counts, were evaluated in triplicate before and after treatments. Principal components analysis (PCA) was carried out to detect simple patterns and differences.

Results

Table 1. Effect of ultrasounds, thermosonication and heat on orange juice physicochemical parameters.
The values are mean ± margin of confidence interval at 95%.

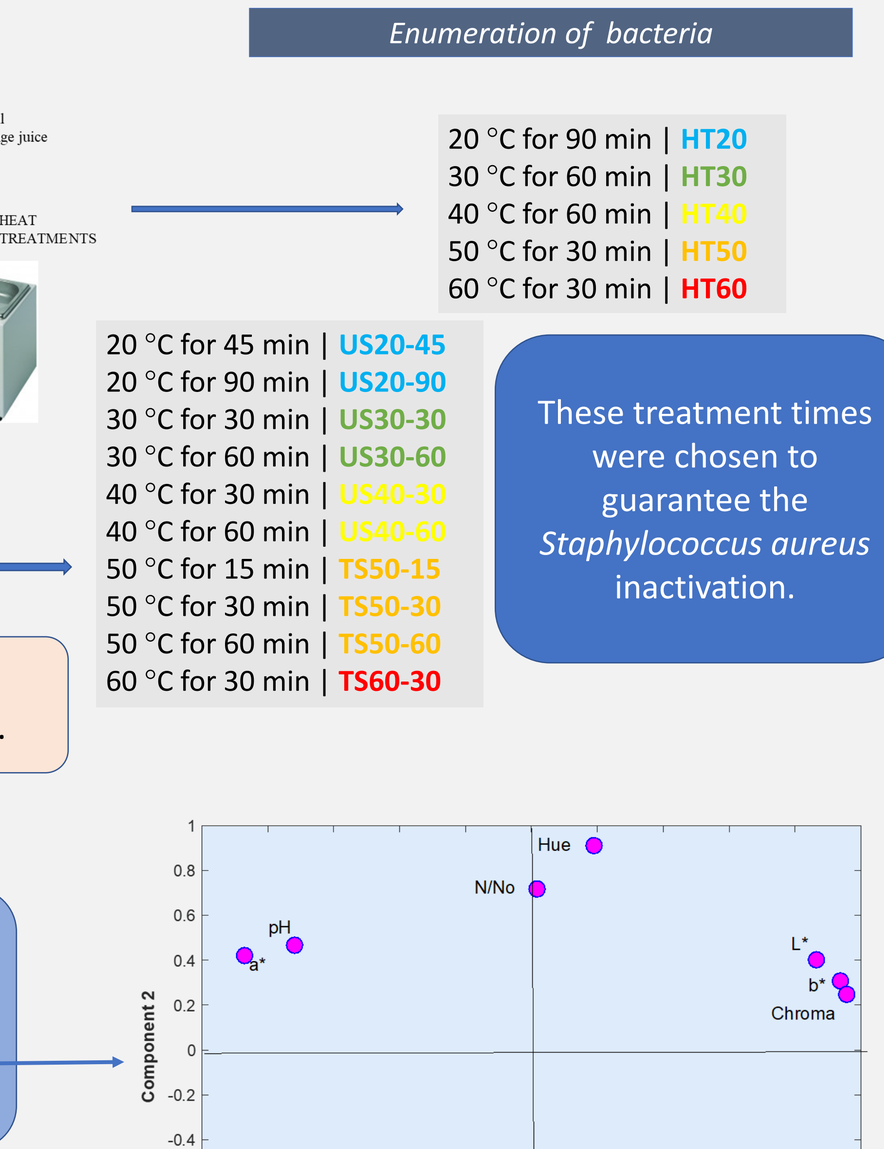
Treatment	*L**	*a**	*b**	Chroma	Hue	SSC	pH	Log (N/N_0)
Untreated	29.57±0.21	-4.02±0.05	12.43±0.24	13.06±0.25	2.83±0.003	11.22±0.02	3.79±0.01	0
US20-45	29.31±0.28	-4.34±0.10	12.38±0.14	13.12±0.13	2.80±0.01	11.20±0.15	3.75±0.02	- 3.77±0.07
US20-90	29.47±0.58	-4.47±0.18	13.27±0.79	14.00±0.80	2.82±0.01	11.34±0.06	3.76±0.02	-4.02±0.52
US30-30	29.40±0.87	-4.37±0.20	12.95±0.94	13.68±0.92	2.82±0.02	11.16±0.06	3.69±0.02	-3.66±0.40
US30-60	30.26±0.40	-4.57±0.10	14.03±0.73	14.76±0.68	2.83±0.02	11.29±0.07	3.71±0.01	-3.80±0.49
US40-30	29,52±0.54	-4.35±0.11	12.98±0.37	13.69±0.37	2.82±0.007	11.22±0.06	3.70±0.003	-3.95±0.18
US40-60	30.43±0.29	-4.55±0.13	13.26±0.35	14.34±0.48	2.82±0.003	11.18±0.26	3.67±0.03	-4.30±0.74
TS50-15	30.41±0.36	-4.62±0.17	13.67±0.32	14.43±0.26	2.82±0.02	11.14±0.23	3.65±0.06	-4.50±0.57
TS50-15	30.24±0.13	-4.64±0.14	13.71±0.23	14.48±0.19	2.81±0.01	11.43±0.20	3.67±0.02	-9.44±1.35
TS50-60	28.51±0.06	-3,81±0.04	11.37±0.04	12.00±0.04	2.82±0.003	11.06±0.13	3.90±0.02	< 12 log
TS60-30	29.40±0.11	-4.09±0.07	12.33±0.18	12.99 ±0.19	2.82±0.001	11.84±0.06	3.82±0.01	-10.60±0.13
HT20	30.08±0.40	-3.93±0.06	12.83±0.38	13.42±0.37	2.84±0.006	11.10±0.09	3.90±0.06	2.34±0.37
HT30	30.28±0.38	-4.07±0.05	13.37±0.33	13.97±0.31	2.85±0.008	11.00±0.21	3.80±0.02	12.33±1.09
HT40	30.43±0.29	-3.95±0.03	13.26±0.35	13.83 ±0.34	2.85±0.008	11.31±0.16	3.82±0.04	17.64±1.25
HT50	29.44±0.75	-3.91±0.14	12.40±0.91	13.01±0.91	2.83±0.01	11.14±0.23	3.82±0.03	-5.35±0.30
HT60	29.30±0.12	-3.88±0.09	12.22±0.24	12.83±0.25	2.83±0.002	11.29±0.05	3.83±0.04	-8.87±0.24

values surrounded by a red box are significantly different ($p<0.05$) from the untreated sample

PCA revealed two components with eigenvalues greater than one, which explained 56.1% and 28.4% of the total variance

The first component was mostly influenced by a*, pH, L*, b* and Chroma, while the second by Hue and microbial inactivation.

The second component allowed a clear distinction between types of treatment, while the first component allowed separation among the processing conditions of temperature/time.



Most of quality characteristics were not significantly affected by the applied treatments.
All treatments reduced the *S. aureus* presence in at least 3 log cycles, except the HT at 20, 30 and 40 °C, where an increase in microbial counts was attained.

Fig. 1. PCA loadings and score plots with all variables

Conclusions

- Thermosonication treatment was more effective than sonication and heat treatment alone.
- Since thermosonication treatment was effective on *S. aureus* inactivation and allowed a retention of most of quality parameters analyzed, this technology can be considered as a promising alternative to traditional pasteurization of orange juice.

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