

Universidad Michoacana of San Nicolas Hidalgo

The use of ultrasound as an emerging technology to preserve fresh juice

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Fruit and vegetable juices

- A diet rich in fruit and vegetable has been linked with protection against cardiovascular disease and several types of cancer.

Said diet contains:

- ✔ Soluble and insoluble fibre
- ✔ Beta-carotene
- ✔ Ascorbic acid
- ✔ Vitamin E
- ✔ Phenol compounds
- ✔ A wide range of minerals

Ruxton et al. (2006)

Carrot juice

- Carrot juice is a popular beverage consumed throughout the world and widely accepted as an important source of healthy components, such as:

✔ Carotenoids

✔ Vitamins

✔ Phenolics

That promote antioxidant activity in human beings as they scavenge free radicals (Aadil et al., 2013)

Shelf-life of carrot juice

- This is short, because its characteristic low acidity and high moisture content lead to microbial spoilage that limit storage.

- Thermal treatment is applied to reduce microbial growth in carrot juice, for example, 105 to 121 ºC.

- Nevertheless, this high thermal processing used to extend shelf-life of juices also decreases the nutrient content and alters flavour in the products (Gomez et al., 2011).

Emerging Technology

Thermal

- Microwave
- Radiofrequency
- Ohmic heating

Nonthermal

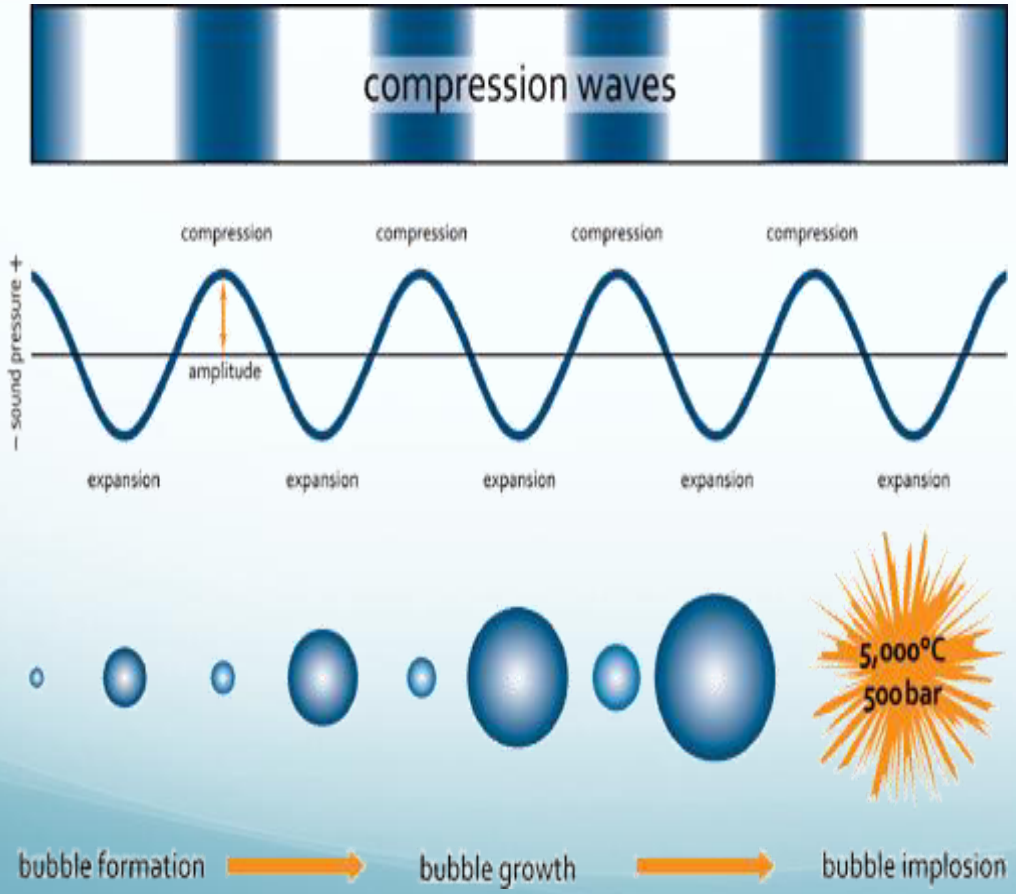
- High Hydrostatic Pressure
- Pulsed Electric Fields
- Ultraviolet
- Irradiation
- Cold Plasma
- Chemicals
- **Ultrasound**

Ultrasound

- Ultrasound has been identified as a potential technology to meet the FDA requirement of a 5 log-reduction for juice pasteurization (Patil et al., 2009).

- Ultrasonic waves cause cell rupture attributed to intracellular cavitation.

The cavitation requires extreme alterations in temperature and pressure conducive to bubble generation. The bubbles grow and burst forcefully in the succeeding compression cycles of a propagated sonic wave. The strong energy and high pressure cause a localized sterilization effect.



Taken from Ultrawaves - Wasser & Umwelttechnologien GmbH
http://www.ultrawaves.de/en/technology.htm

- However, ultrasound alone is not very effective for microbial inactivation.

- Ultrasound combined with medium-range temperatures (thermo-sonication) or pressure (mano-sonication) could be an efficient technology to enhance the lethal effect on microorganisms.

Objective

- To evaluate the combined effect of sonication at temperatures of 50, 54 and 58 °C on: *E. coli*, coliforms, yeasts and moulds, of carrot juice - after processing and during storage at 4 °C.

MATERIAL & METHODS

Processing of carrot juice

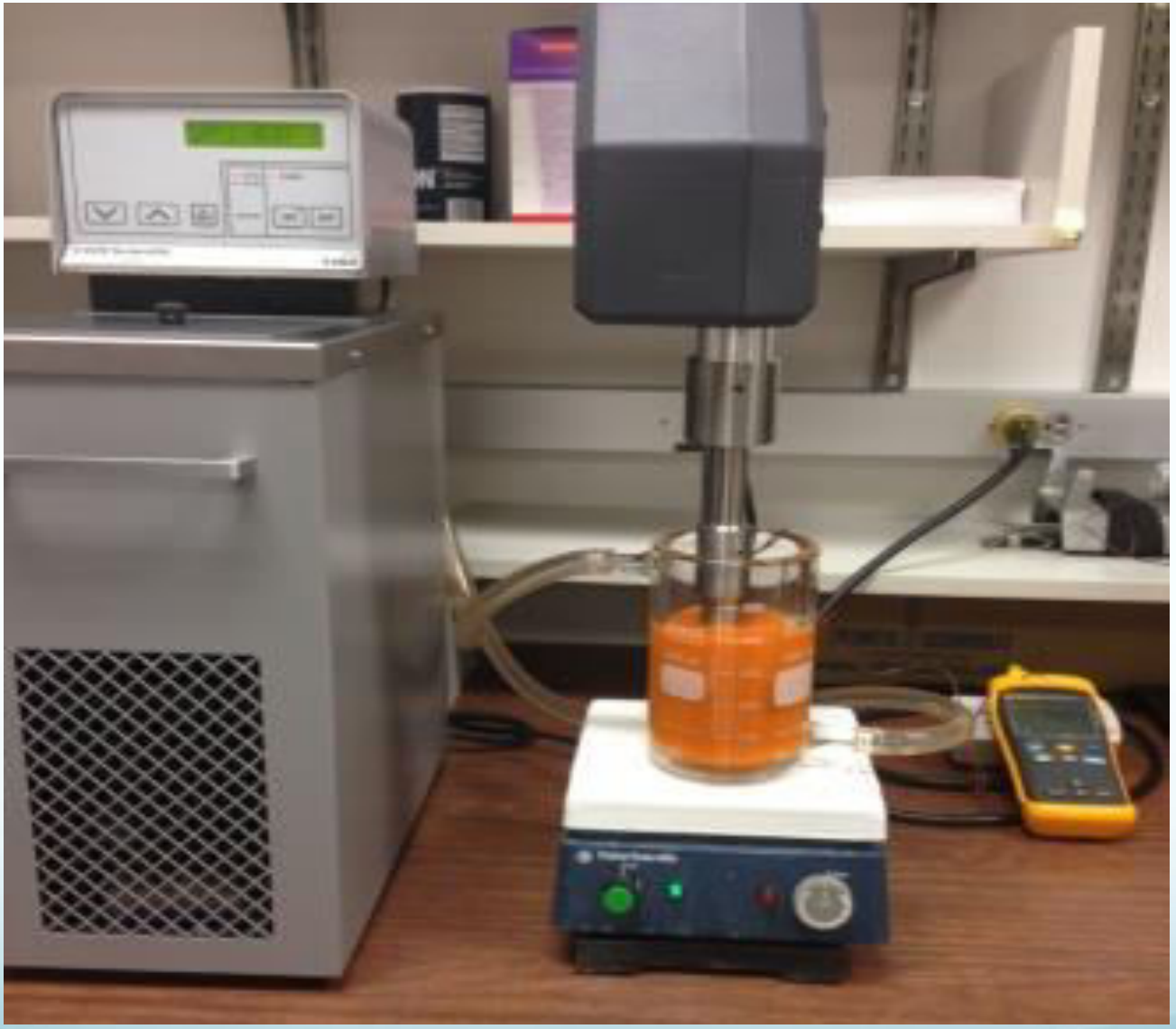
- Fresh carrots were purchased from a local market in Pullman, WA, USA.
- The carrots were washed, peeled and sliced manually with a sterile stainless-steel knife. The sliced carrots were then pressed with a juice extractor (Hamilton Beach model 67608Z).
- Said carrot juice was adjusted by filtration until a solid concentration of 11°Brix was obtained (similar to the commercial product).

Ultrasound treatments

- The carrot juice was treated at a frequency of 24 kHz and amplitude of 120 µm by means of ultrasonic equipment (Hielscher® model UP400S).

- For the tests, juices were placed in a double-wall beaker of 500 ml, maintained under agitation and processed at 50 °C, 54 °C and 58 °C.

- Fresh carrot juice with no treatment was used as a control.



- Carrot juice treated by ultrasound together with the control samples were poured - after sonication - into 25 ml sterile plastic bags and stored at 4 ˚C for 20 days.

- Every other day, one sample of each treatment was analyzed and subsequently discarded.

Analysis in shelf-life studies

- ✔ mesophiles,
- ✔ yeasts and moulds,
- ✔ enterobacteria

RESULTS

The control had the highest mesophiles growth compared to C that showed the lowest growth and was therefore the best treatment.

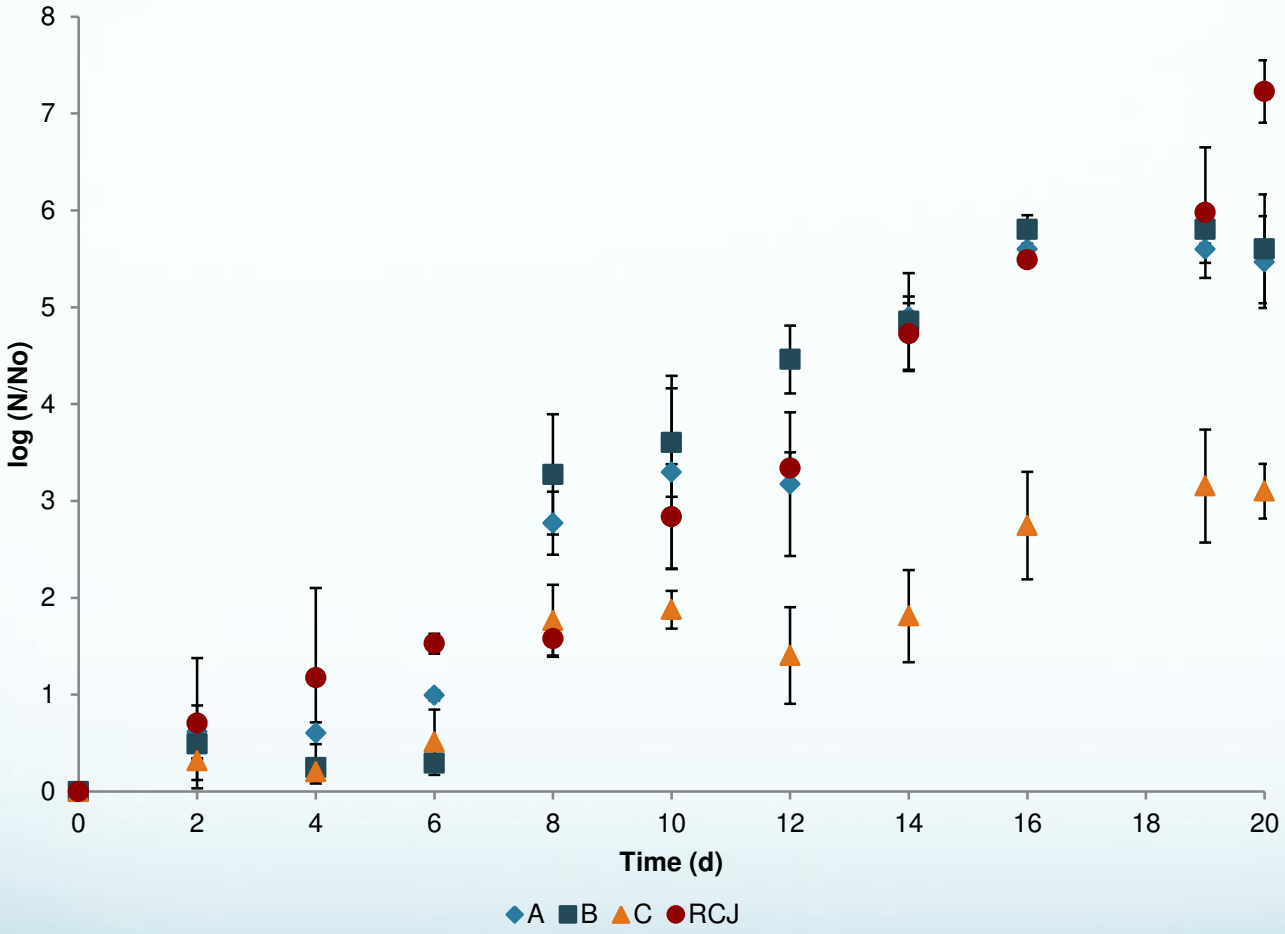


Figure 1. Growth of mesophiles during shelf-life on thermo-sonicated carrot juice processed at (A) 50°C, (B) 54°C, (C) 58°C during 10 min plus a control sample (RCJ).

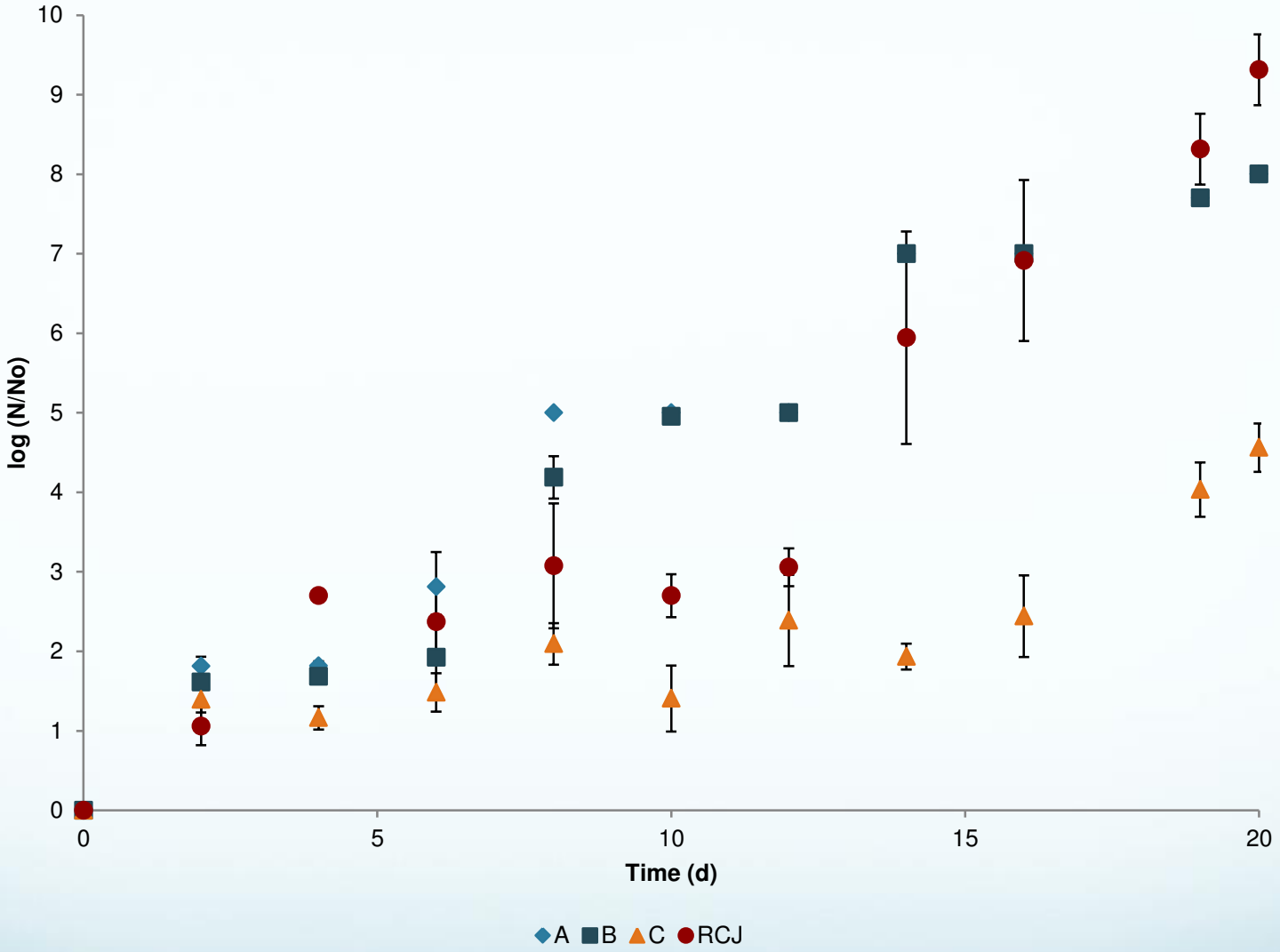


Figure 2. Growth of yeasts and moulds during shelf-life on thermo-sonicated carrot juice processed at (A) 50°C, (B) 54°C, (C) 58°C during 10 min plus a control sample (RCJ).

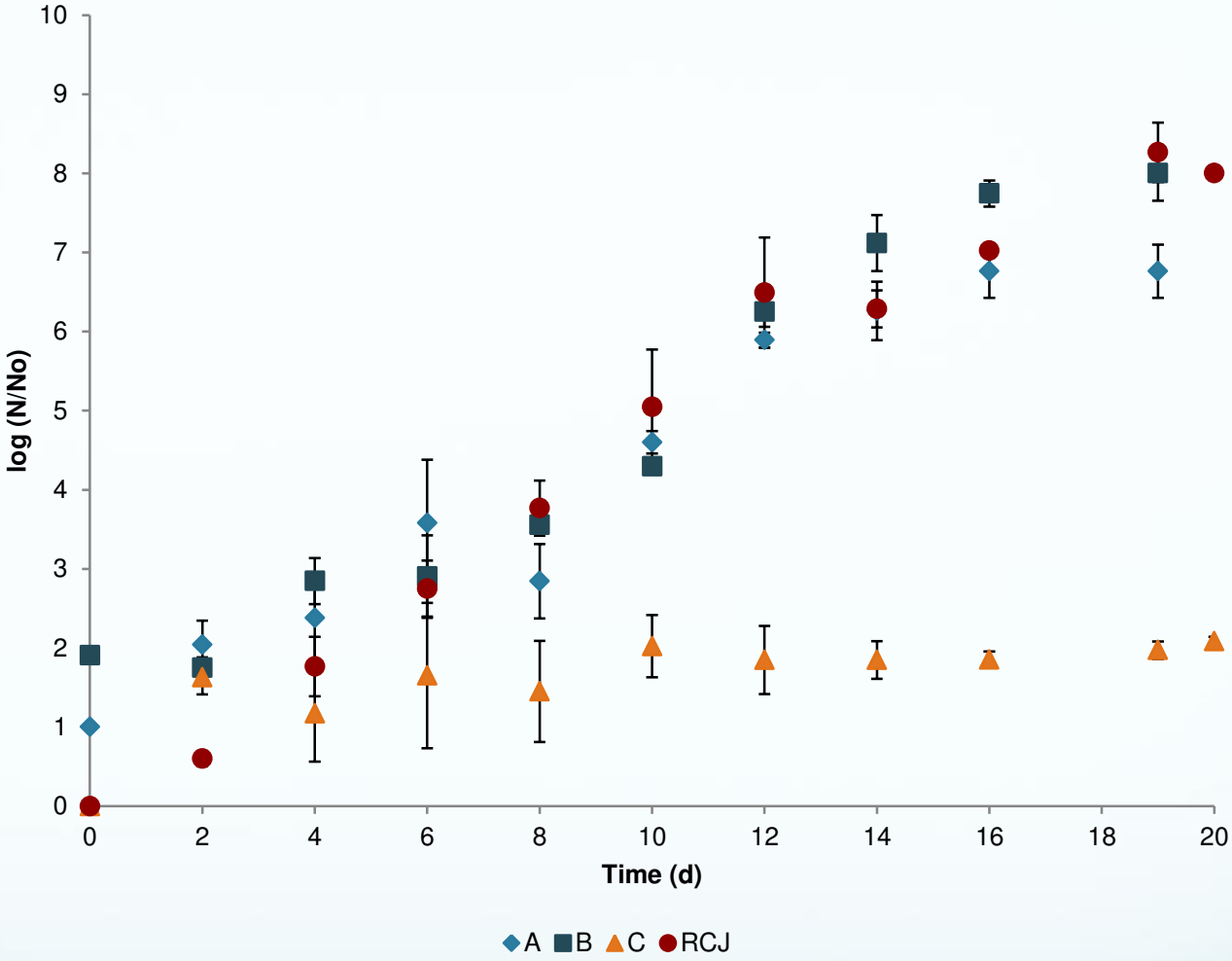


Figure 3. Growth of enterobacteria during shelf-life on thermo-sonicated carrot juice processed at (A) 50°C, (B) 54°C, (C) 58°C during 10 min plus a control sample (RCJ).

Notes

All samples were evaluated for microbial growth during the estimated shelf-life (20 d of storage) but discarded when visible signs of spoilage were observed.

Summary of results

- After 10 d of storage, when spoilage was noted the control sample was eliminated. The growth of enterobacteria was 5.04-log.

- After 12 and 14 d, samples sonicated at 50 and 54 ºC reached 5.89-log and 6.25-log of enterobacteria, respectively. These treated samples were also discarded due to visible spoilage.

- Samples sonicated at 58 ºC had the best quality; microbial growth remained low at around 3-log for mesophiles, 4.5-log yeasts and moulds and 2-log for enterobacteria after 20 d of storage

Conclusion

- Ultrasound increased the shelf-life of products at a rate of 100% when combined with medium range of temperatures of 58°C compared with the control sample.

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