EFFECT OF NON-THERMAL METHODS ON THE SAFETY OF STRAWBERRIES (*Fragaria anannassa) AND WATERCRESS (Nasturtium officinale)*

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ABSTRACT

Innovative non-thermal technologies have been studied as an attempt to substitute thermal methods on fruits and vegetables processing. The objective was to study the effect of methods, such as ultrasonication, and its combination with a milder heat treatment (thermosonication), and UV-C irradiation on safety of strawberries and watercress.

Thermosonication studies were carried out at 50ºC, 55ºC, 65ºC and room temperature. Control water washings, at the same temperatures, were also performed. Safety was assessed in terms of total mesophyles and total coliforms, respectively on strawberries and watercress samples.

For total mesophyles, results showed that thermosonication carried out at 65ºC and water washing at 50ºC were the most efficient treatments in microbial reduction. Results from UV-C treatments were not conclusive.

For total coliforms, the most efficient processes were thermosonication and water-washing at 55 ºC. Results from UV-C treatments were identical to the ones obtained by ultrasonication and water washing at room temperature.

1. INTRODUCTION

Non-thermal treatments aiming at reducing microbial content, while retaining products' quality, are promising and alternative technologies in food processing.

Fruits and vegetables often contain a great diversity of microbial flora and are frequently involved in food-borne outbreaks. Mesophilic microorganisms, coliforms, yeasts and molds, are general populations found in those products, which are responsible for quality degradation and safety compromise. Since fruits and vegetables are often consumed uncooked, treatments that ensure microbiological safety and shelf-life extension are required. A number of sanitizing agents may be used to reduce the risk of contamination. Traditionally, fresh fruits and vegetables are rinsed in chlorine and hydrogen peroxide solutions. However, the efficacy of those treatments is often reported to round 2-3 log reduction of microbial content (Sapers *et al.*, 1999; Ukuku *et al.*, 2001). For high contamination, and especially in the case of pathogens, those washing technologies may not be efficient.

More recently, innovative techniques such as ultrasonication and ultraviolet radiation, as minimal food processes, seem a good solution for safety and quality improvements (Piyasena *et al.*, 2003; Allende and Artés, 2003). However, the effectiveness of these technologies depends on the microbial sensitivity to the treatment used, and consequently variable results are commonly reported by researchers.

Ultrasonication in food industry is innovative. Ultrasound is defined as sound waves with a frequency over 20 kHz, which is about the upper limit of human hearing. When applied with convenient intensity, ultrasounds disrupt biological structures (Earnshaw *et al*., 1995). Therefore, ultrasounds have an antimicrobial effect, especially when combined with temperature (i.e. thermosonication; Ordoñez *et al*., 1984). Some recent works reveal 5 to 6 log-reductions in number of microbial cells for liquid foods treated with power ultrasounds combined with mild treatment (Baumann *et al.*, 2005; D'Amico *et al.*, 2006).

Ultraviolet radiation at 200-280 nm (UV-C) has a germicide action. This technology has been used to control post-harvest contaminations in fruits and vegetables, aiming at extending products' shelf-life. This effect was studied in several fruits such as peaches (Stevens *et al.*, 1998), strawberries, cherries (Marquine *et al.*, 2002) and pomegranates (López-Rubira *et al.*, 2005). In relation to vegetables, UV-C light was applied to zucchini (Erkan *et al*., 2001) and lettuce (Allende *et al.*, 2006).

The main objective of this work was to study the influence of ultrasonication, and its combination with a milder heat treatment (thermosonication), and UV-C radiation on the safety of strawberries and watercress.

2. MATERIAL AND METHODS

2.1. Samples

Strawberries (*Fragaria anannassa*) and watercress (*Nasturtium officinale*) were acquired in a local market. Safety of strawberries and watercress was assessed by total mesophyles and total coliforms counts, respectively. Analyses were carried out in fresh untreated samples and after treatments (see section 2.2).

For ultrasonication treatments, strawberries and watercress were cut in small portions. For UV-C treatments, strawberries were half-cut and only watercress leaves were used in the experiments.

2.2. Ultrasound and UV-C radiation treatments

Ultrasonication (US) and thermosonication treatments were performed in an ultrasound equipment (Bandelin Sonorex RK 100H) at 32 kHz. Samples were treated for 2 minutes at 20 ºC (ultrasonication) and at 50-65 ºC (thermosonication). Control water treatments at the same temperatures were also performed.

Ultraviolet radiation treatments were performed for 2 minutes in an UV-C chamber (conceived by University of Algarve, Portugal) with 4 germicide lamps (average intensity of 12.36 Wm^{-2}; TUV G30T9, 16 W, Philips). The intensity of flux and dose of exposure (time x intensity) were continuously measured by an UV digital photometer (DO 9721 Delta Ohm).

Five true replicates of all these treatments were performed.

2.3. Microbiological analysis

After each treatment, samples were aseptically cut in small pieces and homogenised in a stomacher using 80 mL of Buffered Peptone Water, BPW (Lab M, Lancashire, UK), for 5 minutes. Decimal dilutions were carried out in BPW.
Total mesophyles enumeration was assessed, in duplicate, using Plate Count Agar, PCA (Lab M, Lancashire, UK). Samples were incubated at 30 ºC during 3 days, for posterior counts.
Total coliforms enumeration was assessed, in duplicate, using Violet Red Bile Agar, VRBA (Lab M, Lancashire, UK). Samples were incubated at 30ºC during 1 day, for posterior counts.

2.4. Data analysis

The treatment effects were assessed by calculation of log-reduction of microbial content, in relation to fresh untreated samples.

The reduction of total mesophyles and total coliforms by non-thermal technologies action was compared by analyses of variance (one-way ANOVA, significance level of 5%), using SPSS® 14.0 FOR Windows® (2006 SPSS Inc., Chicago, USA). Duncan's test, for means comparison, was also performed.

3. RESULTS AND DISCUSSION

3.1. Total mesophyles in strawberries

Treatment effects (i.e. water-washings; ultrasonication – US; thermosonication – US 50 ºC and US 65 ºC; UV-C radiation) in total mesophyles reduction of strawberries can be seen in Figure 1.

Ultrasonication at 20 ºC (US) and thermosonication at 50 ºC were equivalent to a water-washing, reducing in average 0.5 log-cycles. Thermosonication at 65 ºC reduced approximately 2.5 log-cycles. The treatment was more efficient than a water-washing at the same temperature.

For water-washings at 50 and 65 ºC, reductions in total mesophyles counts were higher at the lowest temperature. This can be explained by different thermal resistances of the microoganisms included in mesophyles enumeration.

Ultraviolet-C radiation did not inactivate mesophyles in strawberries. Further investigation is required for validation of these results.

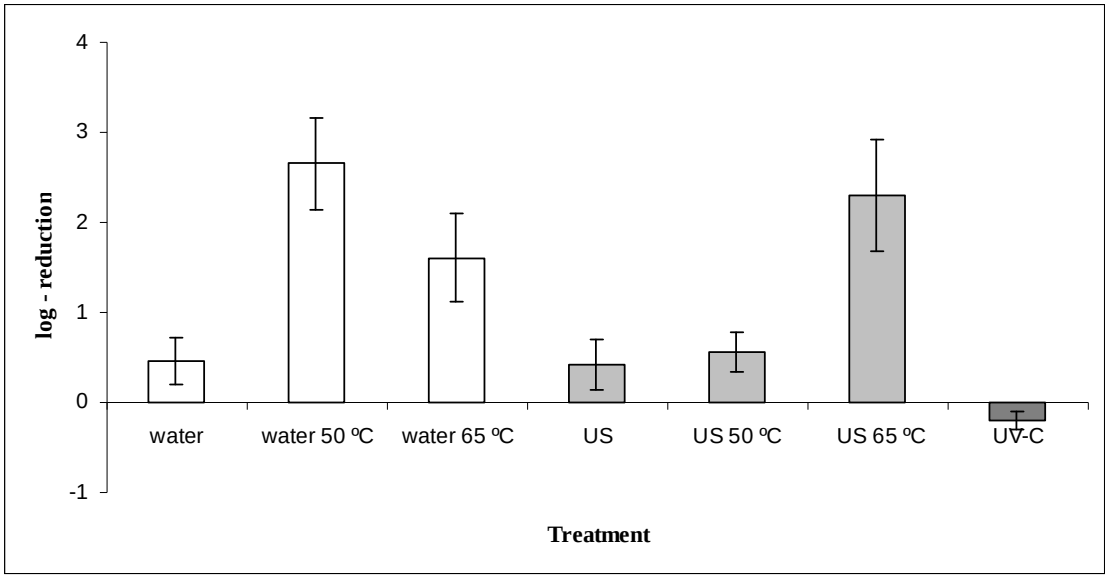

Figure 1. Treatment effects (water-washing, ultrasonication, thermosonication and UV-C radiation) in total mesophyles reduction of strawberries. *The bars indicate standard deviation of values.*

3.2. Total coliforms in watercress

The treatments' impact in total coliforms reduction of watercress can be seen in Figure 2. Ultrasonication treatments (at 20 ºC) and UV-C were equivalent to a water-washing, reducing in average 0.3 log-cycles. No significant differences were detected between water-washings and thermosonication at the same temperatures (50, 55 and 65 ºC).

The most efficient processes were water-washing and thermosonication at 55 ºC, reducing approximately 6 log-cycles.

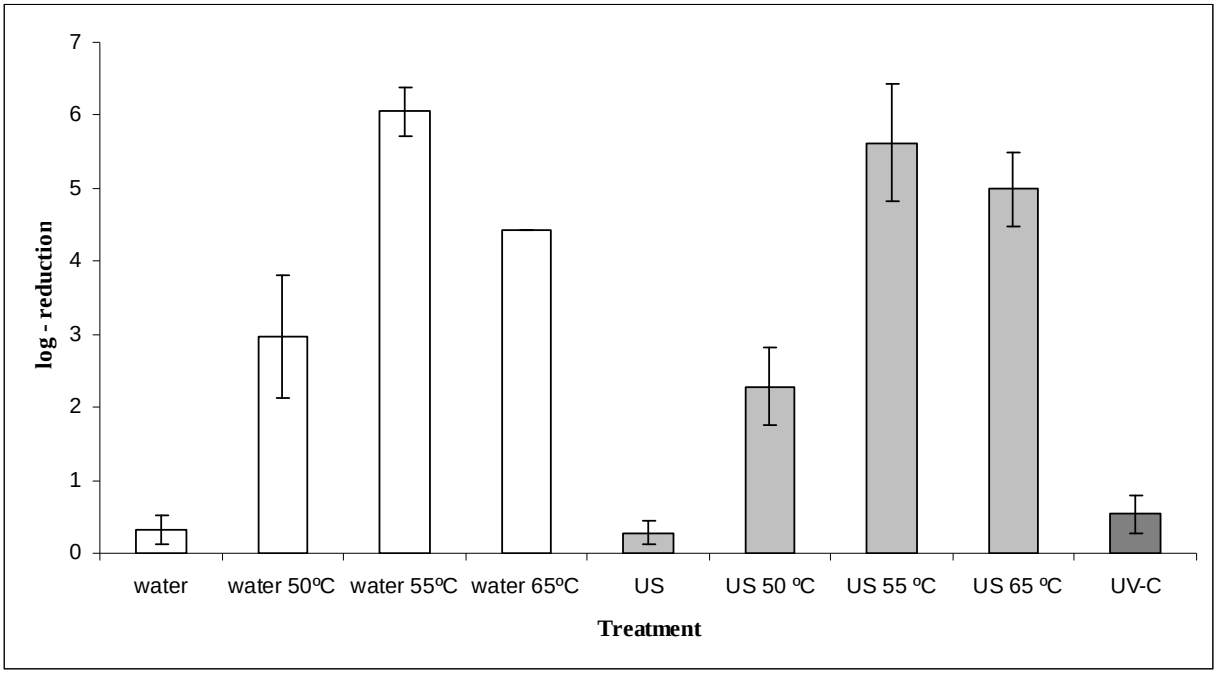

Figure 2. Treatment effects (water-washing, ultrasonication, thermosonication and UV-C radiation) in total coliforms reduction of watercress. *The bars indicate standard deviation of values.*

4. CONCLUSIONS

For total mesophyles reduction in strawberries, ultrasonication was only efficient when carried out at 65 ºC. However, results were equivalent to the ones obtained by water-washings at 50 ºC. Results of ultraviolet-C radiation were not conclusive.

For total coliforms reduction in watercress, thermosonication at 55 ºC was the most efficient process. However, this treatment was equivalent to a water-washing at the same temperature. Ultraviolet-C action was equivalent to a water-washing at 20 ºC.

For the same ultrasonication conditions, greater reductions were obtained in watercress coliforms than in strawberries mesophyles.

5. ACKNOWLEDGEMENTS

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