



Environmentally Friendly and
Safe Technologies for Quality
of Fruits and Vegetables

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Authors are responsible for content and accuracy of their papers.

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SECTION 4. ENVIRONMENTALLY FRIENDLY AND SAFE
METHODS TO CONTROL POSTHARVEST LOSSES

29. HEAT TREATMENT EVALUATION ON QUALITY AND SAFETY OF WHOLE TOMATO (*LYCOPERSICUM ESCULENTUM* L.) FRUITS

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Abstract

Quality and safety attributes, like colour (CIELab parameters), texture (Maximum force – MF), total phenolics content (TPC), peroxidase activity (POD), microbial count and moulds & yeasts (Log_{10} cfu g⁻¹) were determined on heat treated mature-green tomatoes at temperature ranging of 40 to 50 °C and different times. Heat treatments (HT) did not affect significantly ($p>0.05$) the tomatoes colour. In terms of texture, a reduction of 10% MF was observed at 50 °C_15min. The enzymatic activity of POD increased at all temperatures during the first 30 min at 40 °C ($\approx 37\%$), 20 min at 45 °C ($\approx 120\%$) and 15 min at 50 °C ($\approx 43\%$). In relation with TPC an increase of ca. 20% at 40 °C_60 min and 50 °C_15 min was observed, when compared to fresh tomatoes. A total elimination of microbial count and moulds & yeasts was successfully found at 50 °C and at 45 °C_20 min. In conclusion, the more effective HT in terms of total elimination of microbial count and moulds and yeasts, without negatively effect on tomatoes quality attributes appears to be at 50 °C. However, more studies are required to conclude about the efficiency of HT on tomatoes quality and safety during shelf life period.

Keywords: Heat treatment, quality, safety, tomato

Introduction

Tomato (*Lycopersicon esculentum* L.) is a climacteric fruit, and during ripening several important changes occur on physical-chemical quality. Treatments, such as heat treatment (HT), have been investigated for controlling postharvest fruits and vegetables quality for example in grapefruit (Porat *et al.* 2000a), peaches (Zhou *et al.* 2002), asparagus (Siomos *et al.* 2005), pomegranates (Palou *et al.* 2007) and citrus (Porat *et al.* 2000b). HT inhibits biochemical pathways involved in ripening, like chilling injury, external skin damage during storage, control of decay and insects (Lurie 1998; Jacobi *et al.* 2001; Yahia *et al.* 2007). This treatment could substitute a non-damaging physical treatment for chemical prevention if a combination of time and temperature could be found to provide the desired control without significant quality loss in the commodity (Lurie 1998).

The main objective of this work was to evaluate the immediate effects on quality and safety attributes, like colour (CIELab parameters), texture [Maximum force – MF, (%)], total phenolics content [TPC, (%)], peroxidase activity [POD, (%)], microbial count and moulds & yeasts (Log_{10} cfu g⁻¹) of HT on mature-green tomatoes at temperature ranging of 40 to 50 °C and different times.

Material & Methods

Heat Treatments

Tomatoes (*Lycopersicon esculentum* L.) were purchased on a commercial greenhouse Carmo & Silvério at west region of Portugal. Fruits were harvested at mature-green stage and their classification was performed through external colour evaluation according to USDA standard tomato colour classification (USDA 1991).

Tomatoes were immersed in a thermostatic bath (50 L of capacity) at 40, 45 and 50 °C during different times. After HT the samples were cooled in ice and water bath for 5 min and dried for removing excess of water.

Colour Evaluation

Colour was evaluated with a tristimulus colorimeter (Minolta chroma Meter, CR-300, Osaka, Japan). The instrument was calibrated against a standard white colour tile ($L^*=97.10$, $a^*=0.19$, $b^*=1.95$), using an illuminant C. A CIE colour space co-ordinates, $L^*a^*b^*$ values, was determined. Sixteen measurements were determined for each sample.

Texture Evaluation

Texture was determined by TPA test / penetration test with a Texture Analyzer (TA.HDi, Stable Microsystem Ltd, Godalming, UK), using a 50 N load cell and a cylinder probe with a diameter of 2 mm. The TPA / penetration test was performed at 3 mm s⁻¹ of speed and at 7.5 mm of distance penetration. Results were expressed as % of maximum force ($MF - 100 \times \frac{MF}{MF_0}$, where MF is maximum force of heat treated tomatoes and MF_0 maximum force of untreated tomatoes). Sixteen measurements were determined for each sample.

Total Phenolics Content

Total phenolics were determined using the Folin-Ciocalteu reagent (Singleton & Rossi 1965). The percentage of total phenolic content was defined as $TPC - 100 \times \frac{TPC}{TPC_0}$, where TPC is total phenolic content of heat treated tomatoes and TPC_0 total phenolic content of untreated tomatoes. Six measurements for each sample were determined.

Peroxidase Activity Determination

Peroxidase (POD) activity was determined as described in Yahia *et al.* (2007) and was expressed as $POD_{activity} - 100 \times \frac{A}{A_0}$, where A is POD activity of heat treated tomatoes and A_0 POD activity of untreated tomatoes. Six replicates were carried out per each sample.

Microbial Evaluation

Plate count agar was used as the media for total mesophilic counts, incubated at 30 °C for 3 days using NP 4405 (IPQ 2002). Yeasts & moulds were determined using Rose Bengal 200 Chloramphenicol Agar, surface inoculation and incubated at 25 °C during 5 days using NP 3277 (IPQ 1987). Mesophilic, moulds and yeasts counts were expressed as log₁₀ colony forming units per g of sample [Log₁₀ (cfu g⁻¹)] and three replicates were determined per each sample.

Data Analysis

Data were subjected to analyses of variance (one way ANOVA) using a Statistic v.7.0 Software (StatSoft, Inc., 2004) to determine the effect of heat treatment on tomatoes quality. Significant differences between samples were detected using Scheffé test (significant at $p < 0.05$).

Results & Discussion

Colour and Texture Evaluation

Figure 1 shows the values of colour parameter a^* tomatoes after heat treatment. Tomatoes a^* average value (\pm standard deviation) at day 0 before treatment was -12.94 ± 0.80 . After HT no significant differences were observed on a^* colour, only at 40 °C_60 min was denoted a decrease ($p < 0.05$) of about 10%. These results indicate that HT used in our studies did not exert any negative effect on colour tomatoes. Similar results were achieved by Nguyen *et al.* (2004) in a study of heat treated cherry tomatoes where the study treatment promoted the delay red colour development without tomato damage.

Tomatoes maximum force (%) was evaluated after heat treatment and results are observed in Fig 2. Maximum force decrease was observed as the intensity of heat treatment increase, nevertheless, firmness of heat treated tomatoes at 40 and 45 °C was not affected significantly ($p>0.05$), while at temperatures of 55 °C the treatment was more aggressive to whole tomatoes firmness. For example, after 45 min at 40 °C and 40 min at 45 °C a reduction of 7% and 3% was denoted, respectively. Firmness loss of fruits and vegetables could be related to enzymatic activity such as pectin methyl esterase (PME) (Ali *et al.* 2004)) and the firmness retention due to heat treatment can be possible due the inhibition of carbonate-soluble pectin fraction (Shalom *et al.* 1996).

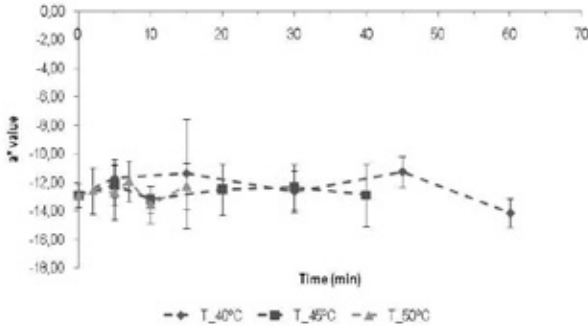


Fig 1. Effect of HT on tomatoes a* colour parameters Bars represent mean \pm standard deviation.

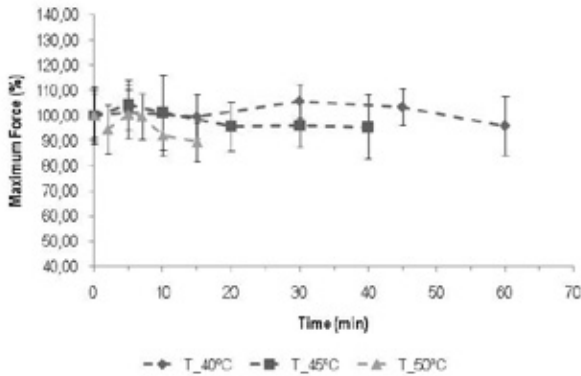


Fig 2. Effect of HT on tomatoes maximum force (%). Bars represent mean \pm standard deviation.

Total Phenolics Content and Peroxidase Activity

Figure 3 shows the results of total phenolics content (TPC) of heat treated tomatoes. On the first 15 min of treatment at 40 and at 45 °C a decrease of this parameter was denoted. On the other hand, after 30 min at 40 °C an increase ($p<0.05$) of 20% content was observed. During HT at 50 °C a TPC increase was observed. Hunt & Baker (1980) and Smith (1973) associate the increase of TPC with the augment of enzymatic activity, especially phenylalanine ammonia-lyase (PAL), which plays an important role in phenolic compounds synthesis.

Results of POD activity (%) of heat treated tomatoes are presented in Fig 4. POD activity presented an opposite behavior that was observed on total phenolics content.

At high temperature (50 °C) and after 10 and 15 min, an increase of 20 and 40% were observed, respectively. At 45 °C was denoted a significant increase ($p<0.05$) of enzymatic activity. POD activity of heat treated tomatoes at 40 °C increase in the first 30 min but after 40 min an increase was observed. Peroxidases are ubiquitous enzymes that have diverse biochemical functions in higher plants and are involved in the response of plants to stress (Yahia).

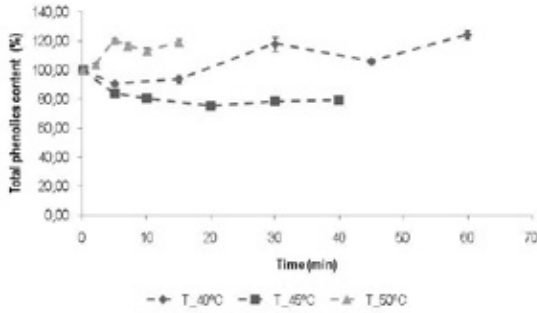


Fig 3. Effect of HT on tomatoes TP content (%). Bars represent mean \pm standard deviation.

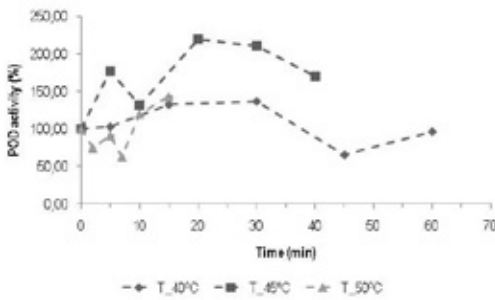


Fig 4. Effect of HT on tomatoes peroxidase activity (POD, %). Bars represent mean \pm standard deviation.

Microbial Evaluation

Figure 5 and 6 show the microbial count and moulds & yeasts of heat treated tomatoes, respectively. The initial load of microbial count of untreated tomatoes was $1.82 \pm 0.45 \text{ Log}_{10} \text{ cfu g}^{-1}$. With heat treatment this value decrease in all temperatures with exception at $40^\circ\text{C}_60 \text{ min}$ when was observed an increase of microbial load ($0.57 \text{ Log}_{10} \text{ cfu g}^{-1}$). In a study by Klaiber *et al.* (2005), carrot treated at $50^\circ\text{C}_10 \text{ s}$ a reduction of 2 Log_{10} in microbial load was observed. The initial value of moulds and yeasts of fresh tomatoes was $1.65 \pm 0.41 \text{ Log}_{10} \text{ cfu g}^{-1}$.

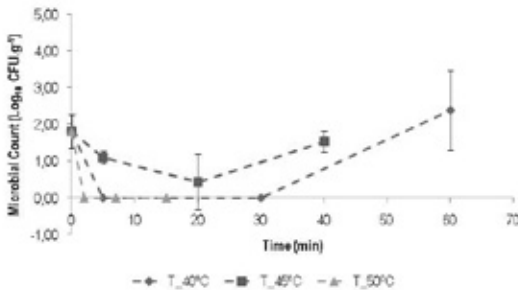


Fig 5. Effect of HT on tomatoes microbial count ($\text{Log}_{10} \text{ cfu g}^{-1}$). Bars represent mean \pm standard deviation.

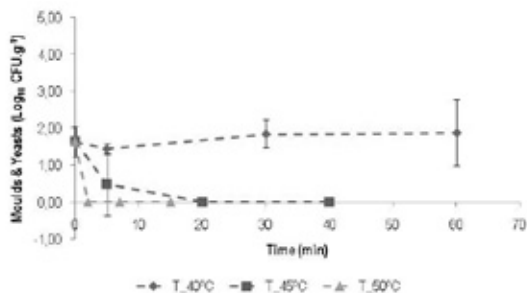


Fig 6. Effect of HT on tomatoes moulds & yeasts ($\text{Log}_{10} \text{cfu g}^{-1}$). Bars represent mean \pm standard deviation.

Moulds and yeasts are more sensitive to higher temperatures than mesophilic microorganism. Tomatoes treated at 45 and 50 °C was revealed a reduction in terms of moulds and yeasts load during treatment, being more effective at high temperature and time. After 2 min at 50 °C a total elimination was denoted in terms of moulds and yeasts on tomatoes treated.

Conclusions

In conclusion, the more effective HT in terms of total elimination of microbial count and moulds and yeasts, without negatively effect on tomatoes quality attributes appears to be at 50 °C. However, more studies are required to conclude about the efficiency of HT on tomatoes quality and safety during shelf life period.

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