TEMPERATURE EFFECT ON STORED TOMATO (*LYCOPERSICUM ESCULENTUM L.*) QUALITY PARAMETERS

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Abstract:

The effect of temperature and storage time on tomatoes (*Lycopersicum esculentum* L.) quality attributes, such as colour (CIELab parameters, hue), texture (maximum force, N), weight loss (%), titratable acidity (g citric acid.100 g^{-1}) and total phenolics content (mGAE.100 g^{-1}), were evaluated at 2º, 5º, 10º, 15º and 20 ºC. The results revealed that all parameters changed significantly ($p<0.05$) during storage. Firmness, hue and titratable acidity of stored tomatoes followed a decreasing tendency during storage. On the other hand, the a*, weight loss and total phenolic content showed an increase with temperature and storage time. Temperature and storage time affects tomatoes quality attributes and, in agreement with our results, the best storage temperature for quality maintenance and delaying fruit senescence is between 5ºC to 10ºC.

1. INTRODUCTION

Tomatoes are a relevant fruit in Mediterranean diet with potential benefits to human health and well-being, due to their richness in antioxidants compounds, namely carotenoids (especially lycopene), phenolic composition and vitamin C [1]. The nutritional composition of tomato depends on factors such as cultivar, maturity and growing conditions [2]. Ripening is a complex process of fruit development, which can be described as a result of biochemical and physiological changes leading to a ripe stage that culminates in dramatic changes in texture, colour and flavour [3]. To slow fruits and vegetables respiratory metabolism, biochemical changes, microbial development and hence extending their shelf life, storage at low-temperatures are applied. However, limited information is available about overall implications of different storage conditions on tomato quality.

The aim of the present work was to evaluate temperature (2º, 5º, 10º, 15º, 20 ºC) effects on tomato quality attributes, such as colour (CIELab parameters, hue (^{o}h)), firmness (maximum force, N), weight loss (%), titratable acidity (g citric acid.100 g^{-1}) and total phenolics content (mGAE.100 g^{-1}) during storage, and determine the optimal storage conditions.

2. MATERIALS AND METHODS

Tomatoes were obtained from a commercial greenhouse (Carmo & Silvério) in centre west of Portugal. Fruits were harvested at mature-green stage and their classification was performed through external colour according to USDA standard tomato colour classification [4]. Fruits were divided in five groups of 120 fruits each (~ 22 kg) and stored at 2º, 5º, 10º, 15º, 20 ºC and 90% RH during 39 days.

Colour was evaluated with a tristimulus colorimeter (Minolta chroma Meter, CR-300, Osaka, Japan). Four determinations for each fruit were made in the equatorial zone. The instrument

was calibrated against a standard white colour tile (L*=97.10, a*=0.19, b*=1.95), using the illuminate C. A CIE colour space co-ordinates, L*a*b* values, was determined. From these the hue (^{o}h, Eq.1) colour was calculated. Sixteen measurements were determined for each sample.

$$^{o}h = arctg\left(\frac{b^*}{a^*}\right) \quad \text{(Eq.1)}$$

Texture was determined by 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 test was performed at 3 $mm.s^{-1}$ of speed and at 7.5 mm of distance penetration. Sixteen measurements were determined for each sample.

Loss in weight of three fruits was evaluated at analysis day, as a percentage of the original weight during storage:

$$Weight\ loss\ = \frac{(initial\ weight - final\ weight)}{initial\ weight} \times 100 \quad \text{(Eq.2)}$$

Titratable acidity was measured according to [5]. The results were expressed as g citric acid per 100g of tomato, as follows in equation 3. Six measurements were determined for each sample.

$$Titratable\ \ acidity\ (g\ citric\ acid.100g^{-1}) = \left(\frac{ml\ \ NaOH}{g\ sample}\ x\ 100\right)\ x\ 0.067 \quad \text{(Eq.3)}$$

Total phenolics were determined using the Folin-Ciocalteau reagent [6]. Results were expressed as milligram gallic acid equivalents (GAE).$100g^{-1}$ of tomatoes and were recorded as means of six measurements for each sample.

Data were subjected to analyses of variance (one way ANOVA) using a Statistic v.7.0 Software [7] to determine the effect of temperature and storage time on tomatoes quality. Significant differences between samples were detected using Scheffé test (significant at $p < 0.05$).

3. RESULTS AND DISCUSSION

Figure 1 shows a* and ^{o}h evaluation of stored tomatoes at five temperatures.

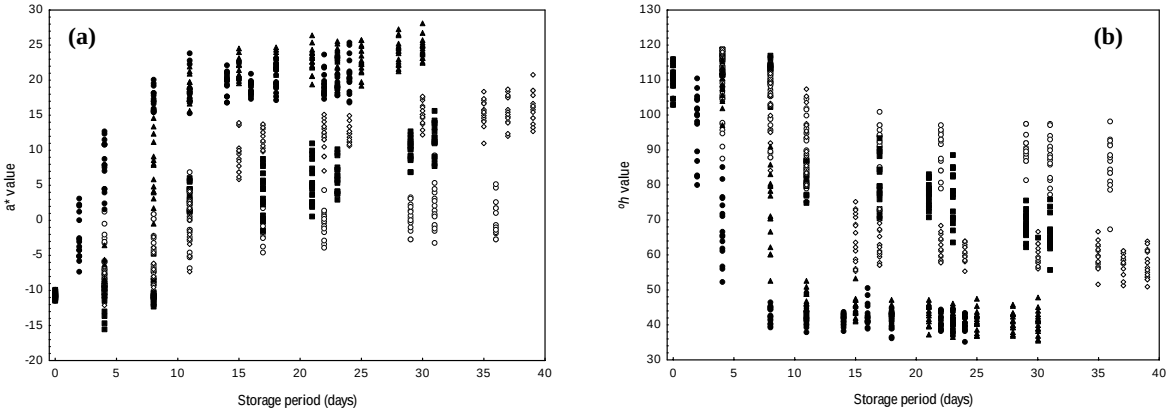

Figure 1 – Tomatoes a* (a) and ^{o}h (b) colour parameters as a function of temperature and storage time: (o) 2ºC, (■) 5ºC, (◇) 10ºC, (▲) 15ºC, (●) 20ºC.

Tomatoes a* and ^{o}h average value (±standard deviation) at day 0 were -10.71±0.42 and 110.67±3.36, respectively. During storage, a* value increased (≈ 10, 20, 26, 34 and 30 units) and ^{o}h decreased (≈ 25, 45, 53, 70 and 70 units) significantly ($p<0.05$), respectively at 2º, 5º, 10º, 15º and 20 ºC. This behaviour was expected because of tomatoes red colour development.

However, a delay of red colour was observed on tomatoes stored at low temperature (2º, 5º and 10 ºC).

Figure 2 and 3 show tomatoes firmness and weight loss, respectively.

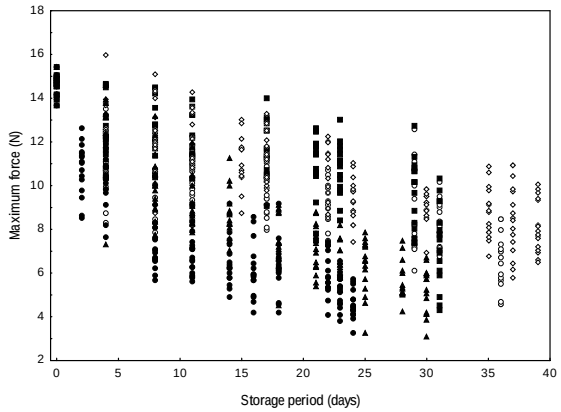

Figure 2 – Tomatoes firmness (maximum force, N) as a function of temperature and storage time: (o) 2ºC, (■) 5ºC, (◇) 10ºC, (▲) 15ºC, (●) 20ºC.

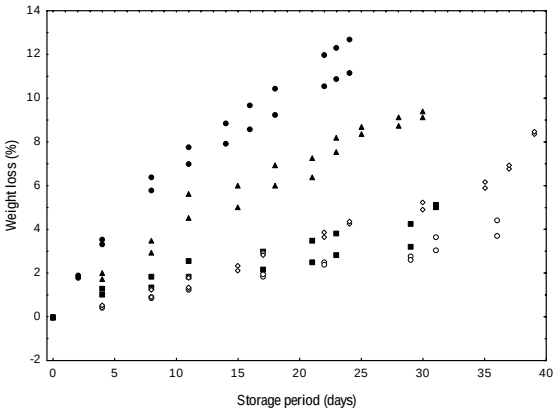

Figure 3 – Tomatoes weight loss (%) as a function of temperature and storage time: (o) 2ºC, (■) 5ºC, (◇) 10ºC, (▲) 15ºC, (●) 20ºC.

Tomatoes firmness average value (±standard deviation) at day 0 was 10.98±1.47 N. Firmness decreased significantly ($p<0.05$) during storage at all temperatures, but the highest decrease was verified at 20ºC (reduction of 70%). On the contrary, the lowest decrease was observed at 5ºC and 10ºC (reduction of 27% and 36%, respectively).
In terms of weight loss, an increase during storage at all temperature was observed, being more accentuated at higher temperatures (≈12% at 20ºC).

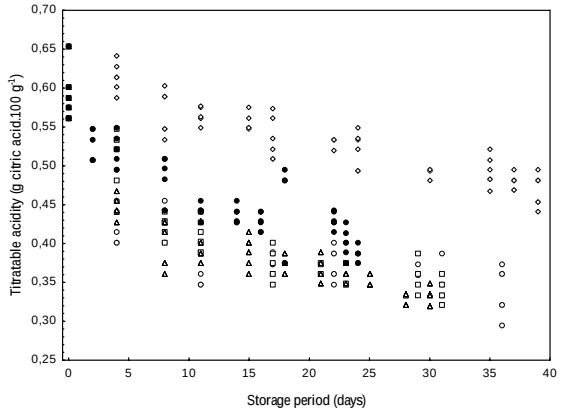

Figure 4 – Tomatoes titratable acidity (g citric acid.100 g^{-1}) as a function of temperature and storage time: (o) 2ºC, (■) 5ºC, (◇) 10ºC, (▲) 15ºC, (●) 20ºC.

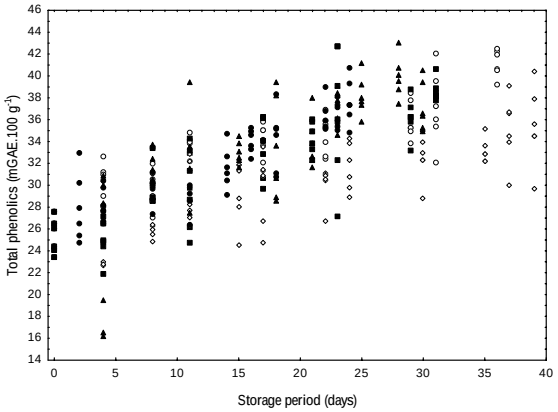

Figure 5 – Tomatoes total phenolics content (mGAE.100 g^{-1}) as a function of temperature and storage time: (o) 2ºC, (■) 5ºC, (◇) 10ºC, (▲) 15ºC, (●) 20ºC.

Figure 4 shows tomatoes titratable acidity at five storage temperatures. Tomatoes titratable acidity average value (±standard deviation) at day 0 was 0.59±0.03 (g citric acid.100 g^{-1}). A decrease in titratable acidity of stored tomatoes was denoted (≈ 0.25, 0.25, 0.12, 0.26 and 0.20 g citric acid.100 g^{-1} for 2º, 5º, 10º, 15º and 20 ºC, respectively). Decrease of tomatoes titratable acidity occurs because citric acid was used as substrate for respiration [8].

Tomatoes total phenolics content average value (±standard deviation) at day 0 was 25.36±1.59 (mGAE.100g $^{-1}$). Total phenolics content increased with temperature and storage time about 62%, 52%, 40%, 60% and 50% at 2º, 5º, 10º, 15º and 20 ºC, respectively (Figure 5). Some authors [9, 10] associate the increase of total phenolics content with the augment of enzymatic activity, especially phenylalanine ammonia-lyase (PAL), which plays an important role in phenolic compounds synthesis.
In terms of overall quality, at lowest temperature (2ºC) stored tomatoes revealed injury disorders and at highest temperature (20ºC) a rapidly senescence was observed.

4. CONCLUSIONS

Temperature and storage time affects tomatoes quality in terms of physical-chemical properties, as well its shelf-life and, accordingly, the best storage temperature for quality maintenance and delaying fruit senescence is between 5ºC to 10ºC.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] Leonardi, C., Ambrosina, P., Esposito, F., Fogliaco, V. (2000). Antioxidant activity and carotenoid and formatine content in different typology of fresh consumption tomato. J. Agric. Food Chem., 48: 4723-4727.

[2] Thompson, K. A., Marshall, M. R., Sims, C.A., Wei, C.I., Sargent, S.A., Scott, J. W. (2000). Cultivar, maturity and heat treatment on lycopene content in tomatoes. J. Food Sci., 65 (5): 791-795.

[3] Javanmardi, J., Kubota, C. (2006). Variation of lycopene, antioxidant activity, total soluble solids and weight loss of tomato during postharvest storage. Postharv. Biol. Tech., 41: 151-155.

[4] USDA. (1991). United States Standard for grades of fresh tomatoes. United States Department of Agriculture, Agricultural marketing Service, Washington DC, USDA.

[5] NP 1421 (1977) – Géneros alimentícios derivados de frutos e de produtos hortícolas – Determinação de acidez. Instituto Português da Qualidade.

[6] Singleton, V.L. & Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdicphosphotungstic acid reagents. American Journal of Enology and Viticulture, 16(3): 144

[7] StatSoft, Inc. (2004). STATISTICA (data analysis software system), version 7. www.statsoft.com.

[8] Tucker, G.A. (1993). Introduction. In: Seymour G.B., Taylor J.E., Tucker G.A. (Eds.). Biochemistry of fruit ripening. London: Chapman & Hall, pp.01-51.

[9] Hunt, G.M., Baker, E.A. (1980). Phenolic constituents of tomato fruit cuticles. Phytochemistry, 19: 1415-1419.

[10] Smith, H. (1973). Regulatory mechanisms in the photocontrol of flavonoid biosynthesis. In: Milborrow, B.V. (Ed.), Biosynthesis and its control in plants. New York: Academic Press, pp. 303-320.