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HIGH PRESSURE TREATMENTS AS AN ALTERNATIVE TO CONVENTIONAL THERMAL BLANCHING – A CASE STUDY ON SWEET GREEN AND RED BELL PEPPERS FRUITS (*Capsicum annuum* L.)

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Abstract: The effect of pressure treatments of 100 and 200MPa (10 and 20min) and thermal blanching at 70°C, 80°C and 98°C (1 and 2.5min), on green and red sweet bell peppers was compared. Pressure treated peppers showed a lower reduction on soluble protein and ascorbic acid contents (red peppers presented even an increased content of ascorbic acid of about 15–20%). Peroxidase (POD) and pectin methylesterase (PME) (whose activity was only quantifiable in green peppers) showed a higher stability to pressure treatments, particularly the latter enzyme, while polyphenol oxidase (PPO) was inactivated to the same final level by the thermal blanching and pressure treatments. Pressure treatments resulted in similar (in green pepper) to slightly higher (in red pepper) microbial loads compared to blanching. Pressure treated presented similar to better firmness before and after tunnel freezing at -30°C, compared to thermally blanched peppers. Overall, pressure treated peppers present similar to better levels of the quality parameters studied, pointing to the possible use of pressure treatments as an alternative to the conventional thermal blanching of sweet bell peppers.

1. INTRODUCTION

Bell peppers (*Capsicum annuum* L.) are used to produce dehydrated products (such as paprika), pickled peppers, and frozen peppers to be used in pizzas or to be eaten raw as salads. The demand for frozen raw peppers has been increasing considerably in the last years, due to consumers' willingness to eat raw, minimally processed vegetable products, as part of healthier food habits. Prior to freezing, foods of vegetable origin are submitted to thermal blanching to reduce the microbial load and inactivate deleterious enzymes, since many of the quality changes that occur during distribution and storage of these foods, are due to detrimental reactions catalyzed by enzymes, such as peroxidase (POD), polyphenol oxidase (PPO), and pectin methylesterase (PME). However, heating causes also losses of sensorial and nutritional quality attributes, such as reduction of ascorbic acid content. This is particularly relevant for frozen sweet bell peppers intended to be stored frozen and eaten raw after thawing, since thermal blanching can cause considerable deleterious effects on texture, which is particularly important for this product due to its characteristic texture properties. In the last 15-20 years, high pressure processing has been increasingly explored and used to process foods, to destroy microorganisms and inactivate enzymes, with minimal deleterious effects on quality [1-3], with a considerable number of high pressure pasteurized food products already commercially available worldwide.

The aim of this work was to study the effect of pressure treatments and conventional thermal blanching on green and red sweet bell pepper fruits in several quality parameters (soluble protein and ascorbic acid contents, activity of PPO, PME, and POD, texture, and microbial load). The effect of freezing, carried out at an industrial plant, using the usual processing

conditions to produce commercial frozen peppers, on firmness, was also evaluated for both thermal and pressure treated peppers.

2. MATERIALS AND METHODS

The ascorbic acid (AsA) content (mg.100 g fresh weight^{-1}) was quantified by HPLC [4]. All enzyme activity determinations (PPO, PME, POD) were done spectrophotometrically. Texture was measured from the skin side using a texture analyser (TA-HDplus, Stable Micro System). For the blanching treatments, the pepper samples were cut in slices of 15×75 mm and placed in a plastic bag that was heat sealed. At pre-set temperature (70, 80 and 98°C), the samples were immersed in a thermostated water bath (1 or 2.5min), and immediately cooled after in a water bath at 4°C for 5min, and then equilibrated at room temperature for the texture measurements. For the pressure treatments the samples were packed in a plastic bag, which was heat sealed under vacuum. The samples were then pressurized using an isostatic press at room temperature, up to 100 or 200MPa during 10 or 20 min, followed by decompression. Peppers samples were coded as: C: unprocessed; BI.1 and BI.2, blanched at 70°C, for 1 and 2.5 min, respectively; BII.1 and BII.2, blanched at 80°C, for 1 and 2.5 min, respectively; BIII.1 and BIII.2, blanched at 98°C, for 1 and 2.5 min, respectively; PI.1 and PI.2, pressurized at 100MPa for 10 and 20 min, respectively; PII.1 and PII.2, pressurized at 200MPa for 10 and 20 min, respectively. To carry out the freezing experiments, thermal and pressure treated peppers were kept at 4°C, before freezing in a tunnel freezer at -30°C, with an air-blast freezing system. The frozen samples were stored at -20°C and prior to the texture measurements the samples were thawed and equilibrated at room temperature. For data analysis, ANOVA and Tukey's test were carried out to determine significant differences ($P < 0.05$).

3. RESULTS AND DISCUSSION

Protein contents were not significantly different ($P > 0.05$) for unprocessed green and red peppers (Fig. 1). Blanching treatments reduced ($P < 0.05$) the protein content by about 15% to 60% of green peppers (except for treatment BI.2) and 15% to 35% in red peppers. Pressure treated green peppers showed a significant lower reduction ($P < 0.05$) in protein content, than green peppers blanched at 80°C (1 min) and 98°C (2 min), and higher ($P < 0.05$) than that blanched at 70°C. Pressure treated red peppers showed no variation ($P > 0.05$) of the protein content compared with the control sample, results that are clearly better than those observed for all the blanching treatments.

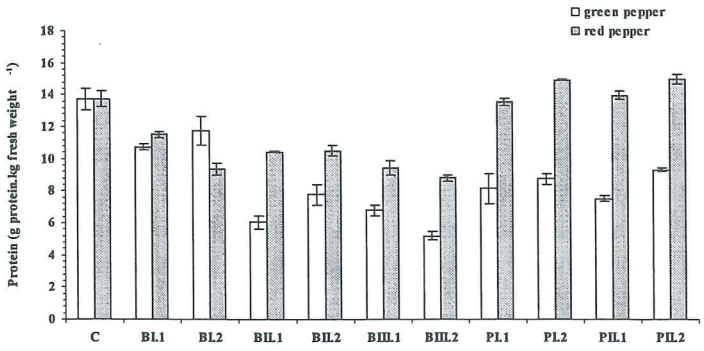

Figure 1 - Protein (g protein.kg fresh weight^{-1}) measured for unprocessed, thermally blanched, and pressure treated green and red peppers. The bars represent the standard deviation ($n = 3$).

Overall, the protein content of red peppers was less affected by both blanching and pressure treatments, indicating an effect of the colour maturation stage. AsA content for both green and red peppers (Fig. 2) are within the range found in other studies [5]. For unprocessed peppers,

AsA content was significantly higher ($P < 0.05$) for red peppers. AsA content decreased progressively as blanching conditions were more severe (higher temperature and longer treatment time duration), to about 45% and 30% of the initial value, for green and red peppers, respectively.

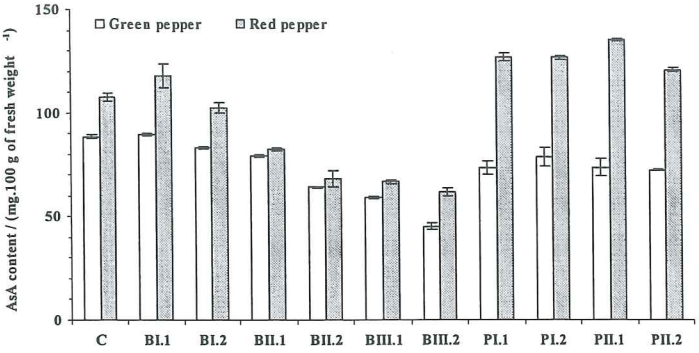

Figure 2 - Effect of thermal blanching and pressure treatments, on AsA content (mg of AsA.100g fresh weight^{-1}) of green and red peppers. The bars represent the standard deviation (n = 3).

Pressurized red bell peppers showed an increase of about 15-20% of AsA content which may be related to an increased extractability that might result from the pressurization process [6] or/and to a higher stability to pressure compared to temperature, of AsA and/or other components, e.g. oxidation inhibitors, which can inhibit the oxidation of ascorbic acid [7]. AsA was clearly better retained in pressurized red peppers than in green peppers, indicating an effect of the colour maturation stage, as already observed for the soluble protein content.

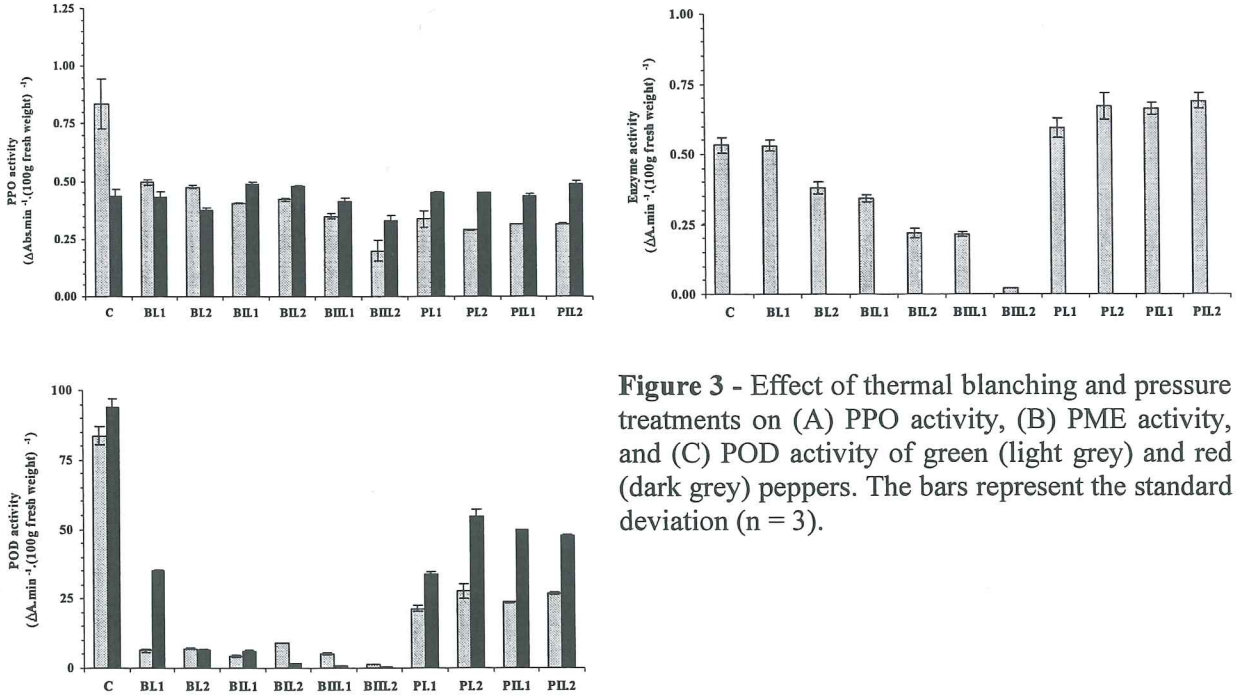

Figure 3 - Effect of thermal blanching and pressure treatments on (A) PPO activity, (B) PME activity, and (C) POD activity of green (light grey) and red (dark grey) peppers. The bars represent the standard deviation (n = 3).

Green and red pressure treated peppers showed a PPO activity level similar or lower to that of thermally blanched peppers, except for the most severe blanching treatment (Fig. 3A). Red pepper PPO was found to be more stable to pressure and temperature than PPO of green peppers, results that indicate also an effect of the colour maturation stage. PME activity was only detected in green peppers (Fig. 3B). Absence of PME activity in red peppers can be due to absence of the enzyme, or to the occurrence of a well known PME inhibitor [8]. PME

activity of thermal treated green peppers declined progressively, as temperature and time increased. Pressure treated peppers showed a slight increase in PME activity, which could be related to a more effective extraction of the enzyme, due to damage of plant cell wall/membrane and changes in cell wall association state of the enzyme. Pepper POD showed a lower stability towards temperature when compared to PPO and PME (Fig. 3C). According to our results (data not shown), pressure treatments caused a lower reduction on microbial counts when compared to thermal blanching treatments, particularly for red peppers, where almost no reduction on microbial counts was verified. Nevertheless, the microbial content of the processed peppers for total mesophilic counts, enterobacteriaceae and total and faecal coliforms were below the maximum acceptable values for consumption [9].

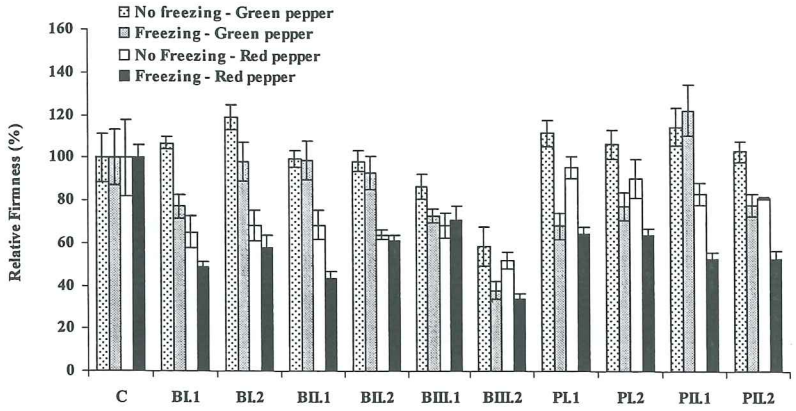

Figure 4 - Effect of thermal blanching and pressure treatments and freezing on the firmness, measured from the skin side, of green and red peppers. The bars represent the standard deviation (n = 5).

Generally, the results showed a trend for firmness of red peppers to be more sensitive to both the thermal blanching and the pressure treatments, than firmness of green peppers (Fig. 4). Also, pressurized peppers showed similar to better values for firmness, compared to thermally blanched peppers. Moreover, freezing caused a higher decrease on firmness for thermally blanched peppers. Globally, thawed peppers that were pressure treated, showed a similar to better texture, compared to the thermally blanched peppers.

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