__Original Research Article__

Effect of Mechanical Damages and Storage Conditions on Quality of Markies cv. Potatoes for Processing

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ABSTRACT

Aims: Evaluate whether mechanical damage and storage conditions affect the quality of the 'Markies' potato for processing.

Study design: The experimental design was the completely randomized, in the scheme of split-plots. The plots were composed of treatments with and without mechanical damage and the subplots were made up by the evaluation times, with 5 replicates, where the experimental unit was composed of 2 tubers.

Place and Duration of Study: Tubers of the 'Markies' cultivar from the producing region of Perdizes, state of Minas Gerais, were planted in June 2016 and harvested in October 2016.

Methodology: The tubers were stored for 2 months at 8 °C, and further divided into treatment with damage, in which the tubers were subjected to impact and abrasion; and control treatment, in which the tubers were not damaged. After that, they were stored at 28 °C and evaluated for their loss of loss of accumulated fresh mass (FML), total soluble sugar (TSS), reducing sugar (RS), non-reducing sugar (NRS) and color after frying in the periods of 0, 12, 24, 36 and 48 h after being placed at room temperature.

Results: The mechanical damage in the tubers increased FML, however, it did not affect the content of TSS, NRS, RS and color after frying. Increases were observed in the content of TSS and NRS after 12 h of evaluation. Grade 2 was assigned to the coloring scale after frying for the tubers regardless of treatment or evaluation period.

Conclusion: Mechanical damage increases the FML and the 'Markies' cultivar is suitable for the industry of pre-fried potato processing even under the occurrence of mechanical damage and exposure to high temperatures.

Key-words: color; FML; sugars; Solanum tuberosum L.; acrylamide.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is the third most important and consumed crop in the world [1]. The consumption of processed potatoes has been increasing as a result in the changes in the diets, the increase in fast food chains and the need for semi-finished foods. To meet the market for processed potatoes, it is necessary cultivars suitable for the industry, and the execution of refrigerated storage for quality maintenance and constant supply.

Cultivar 'Markies' is destined to the processing industry and with qualities for cooking and frying. It has high quality for the pre-fried potato market because it presents high content of dry matter, low sugar content and high levels of starch, obtaining a product with desirable flavor and coloration after frying [2].

The refrigerated storage allows the maintenance of the quality by the reduction of the sprouting, respiratory activity and incidence of diseases. However, when stored at low temperatures, the tubers can accumulate reducing sugars, which, when reacting with amino acids, forms melanoidine pigments by non-enzymatic reaction called Maillard reaction during frying [3]. This reaction promotes darkening of sticks and make them unsuitable for consumption. In addition, in a secondary route, there is the formation of acrylamide, a substance considered neurotoxic and carcinogenic with several studies proving a positive association with human cancer [3].

The process of unloading in the cold chambers and postharvest handling of the tubers results in the occurrence of mechanical damages. The wounds develop a depreciation of the product by physiological changes, entry of pathogenic microorganisms and increase in the water loss [4]. In addition, between the storage and processing stages, the tubers stay for about 48 hours at room temperature, which reduces even more the quality of the products.

Therefore, the objective of this study was to evaluate whether mechanical damage and storage conditions affect the quality of the 'Markies' potato for processing.

2. MATERIAL AND METHODS

Plant material and treatments

Tubers of the 'Markies' cultivar from the producing region of Perdizes, state of Minas Gerais, were planted in June 2016 and harvested in October 2016. They were selected according to their size and lack of damage. Curing of the tubers was carried out at 14 ^{o}C ± 95% Relative Humidity (RH) for 10 days. After this period, the temperature was reduced by 1 °C per day until reaching the storage temperature of 8 °C (± 90% RH).

The tubers were stored for 2 months and later divided into control treatment, where the tubers were not harmed; and treatment with damage caused by impact and abrasion caused by the fall of the tubers from 1 meter of height on rough surface. This process was repeated 10 times for each tuber. After application of the treatments, the tubers were kept on benches at room conditions (28 °C and ± 54% RH). The analysis of loss of FML, TSS, RS, NRS and color of the sticks after frying were carried out. The analyses started two hours after the treatments, with a 12-h interval between the evaluations, following the times 0, 12, 24, 36 and 48 h.

Methodology

The FML was calculated in relation to the initial mass of the tubers and expressed in percent. The quantification of TSS and RS followed the Phenol-sulfuric method [5] and the dinitrosalicylic acid (DNS) method [6], respectively. The NRS were calculated by difference between TSS and RS concentrations and the results expressed in percent. The color of the post-fry potatoes was visually determined based on the grading scale recommended by the 'United States Standards for Grades of Frozen French Fried Potatoes' [7] and the fast food industry color grading chart from 1 to 5.

Statistical analysis

The experimental design was the completely randomized, in the scheme of split-plots. The plots were composed of treatments with and without mechanical damage and the subplots were made up by the evaluation times, with 5 replications, where the experimental unit was composed of 2 tubers. Data were analyzed through analysis of variance and regression, using the SAEG 9.1 [8]. The regression model was chosen based on the regression coefficients by using the t-test at the P = 0,05 probability level, at the coefficient of determination (R^2 = SQReg / SQtrat) and the biological behavior under study.

3. RESULTS AND DISCUSSION

The loss of FML in 'Markies' cultivar of potato tubers with and without damage was increasing in relation to the evaluation time (Fig. 1). The highest increase in the FML in tubers occurred 48 h after the application of the damage, with values of 3.7% in relation to tubers without damage (0.55% FML), representing an increase of 6.5 times. Mechanical damage increases respiratory activity and loss of water because of the exposition of the tissues to the environment, facilitating gas exchange, contributing to the reduction of mass loss. Observed a 1.3-fold increase in the respiratory rate of tubers of damaged potatoes in comparison to the undamaged potatoes when kept at 33 °C [9].

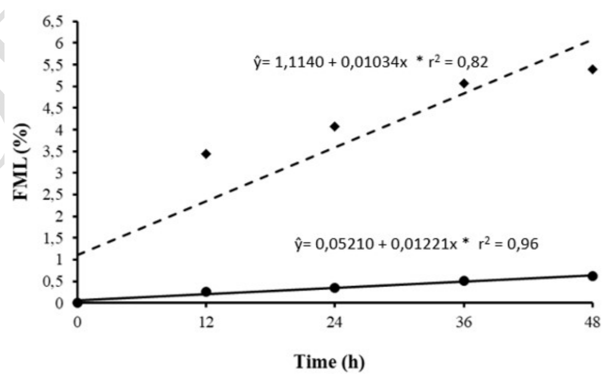

Figure 1. FML in potato tubers cv. 'Markies' without damage (●) and mechanical damage (♦) after 2 months of storage.

The occurrence of tuber damage did not interfere with the contents of TSS and NRS. However, an influence was observed in the evaluation time (Fig. 2). Transfer of tubers from refrigerated storage at 8 °C to room temperature of 28 °C may have resulted in the increment in respiratory activity, leading to the conversion of starch into sucrose, which caused the increase in NRS and consequently of TSS. Storage of potatoes at temperatures higher than 15 °C culminating in the increment in the respiration [10]. The TSS and NRS showed a minimum point at 12 h of evaluation (Fig. 2), indicating that it took 12 h at room temperature to begin the conversion of starch to sucrose. The increase in TSS and NRS contents from the 12 h of evaluation did not affect the quality of the potato for processing; the highest levels of NRS were 48 h with 0.14%. For the processing industry, the NRSs should remain below 0.33% of the fresh mass [11].

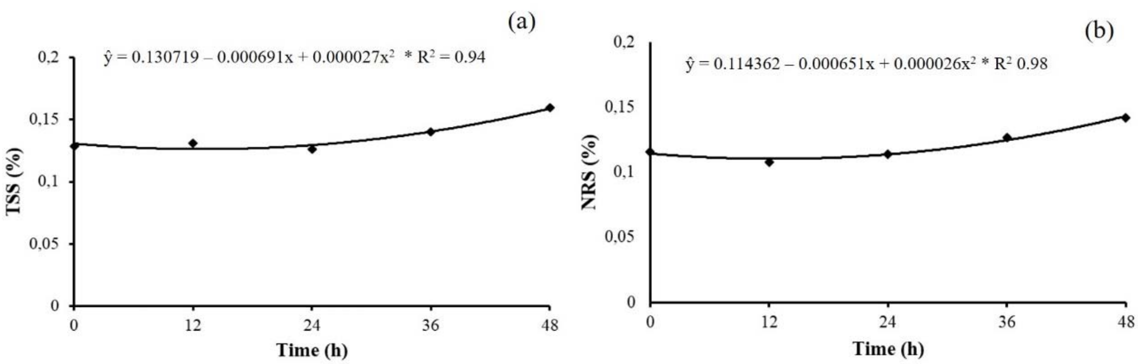

Figure 2. TSS (A) and NRS (B) in potato tubers cv. 'Markies' with and without mechanical damage after 2 months of storage.

No effect of the mechanical damage and the evaluation period were observed on the contents of RS and the color of the sticks after frying, and all the fried sticks were given score 2 according to the standards recommended by the USDA (fig. 3).

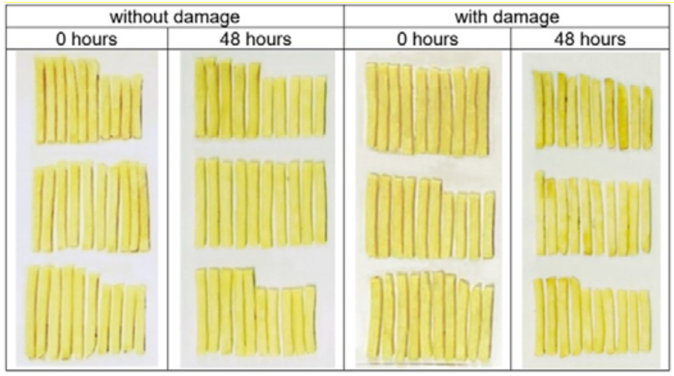

Figure 3. Post-frying coloration of cv. ‘Markies’ with and without mechanical damage after 2 months of storage and 48 hours after the mechanical damage was determined based on the grading scale recommended by the ‘United States Standards for Grades of Frozen French Fried Potatoes’ (USDA, 1967) and the fast food industry color grading chart from 1 to 5.

Darkening is related to the increase in the contents of RS induced by refrigerated storage, in which the carbonyl or ketone group of the RS molecule react with the amino group of the amino acids, like asparagine, resulting in the formation of the melanoidine pigments by non-enzymatic reaction called Maillard reaction at the time of frying. Cultivar ‘Markies’ presents low sugar content [2], which justifies the non-darkening observed in the experiment.

The acceptable content of RS for the pre-fried potato processing industry should be below 0.12% of fresh mass [12] to obtain a good quality product with light yellow coloration. The average RS content was 0.016%, indicating that ‘Markies’ cultivar is suitable for industrial processing even after mechanical injury and exposure to high temperature.

4. CONCLUSION

Mechanical damage increases the FML and the ‘Markies’ is suitable for the industry of pre-fried potato processing even under the occurrence of mechanical damage and exposure to high temperatures.

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