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POSTHARVEST DETERIORATION OF SWEET POTATO ROOTS CV. BRS CUIA DURING STORAGE AT ROOM TEMPERATURE

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ABSTRACT

The objective of this work was to evaluate physiological changes related to deterioration of sweet potato roots cv. BRS Cuia during storage at room temperature, identifying the major problem during postharvest. It was determined weight loss, sprouts number, sprouts length, water potential, peroxidase and polyphenoloxidase enzymes activities, and fraction of soluble phenols. The evaluated variables showed increases, except for skin fraction of soluble phenols that decreased during storage. Our results indicate that sprouting is the major problem during storage at room temperature; therefore, to optimize this type of storage and to reduce losses, it is necessary to control sprouting.

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INTRODUCTION

Sweet potato taproots have wide adaptability to the tropical environment, where Brazil stands out as the main producer in the Latin American continent, with emphasis on human nutrition, industrialization, animal feed and fuel alcohol production (Cavalcante *et al*., 2009; Foloni *et al*., 2013). Among the available cultivars, BRS Cuia shows vigorous plants, the roots have flesh and skin cream color, with average yield 40 tons/ hectare^{-1}, and can reach 60 tons/ hectare^{-1} (Castro and Becker, 2011).

Despite the growing importance due to increased consumption and market value, sweet potato roots have a short postharvest shelf life, of about two to four weeks at room temperature. The economic losses of sweet potato during the postharvest chain are estimated from 35% to 95% in most developing countries (Cheema *et al*., 2013; Amoah and Terry, 2018).

Sweet potatoes have been described as having thin, delicate skin that is easily damaged by cuts and abrasion during harvesting, transportation or distribution (Rupsa *et al*., 2017). And during storage, the roots are very perishable because they contain high moisture content (60-75%) hence low mechanical strength as well as high susceptible to decay.

Postharvest quality deterioration emanates from respiration, weight loss, microbial attack, weevil damage and sprouting. Respiration and sprouting result in loss of nutritive value of organs (Campbell *et al*., 2012; Sila *et al*., 2017). In most regions of Brazil, the storage and distribution of sweet potato roots occurs at room temperature and these conditions accelerate sprouting and root decay considerably, compromising the marketing value of the roots (Lima *et al*., 2019). Therefore, the objective of this work was to evaluate physiological changes related to deterioration of sweet potato roots cv. BRS Cuia during storage at room temperature, identifying the major problem during postharvest.

MATERIALS AND METHODS

Sweet potato seedlings cultivar BRS Cuia were acquired from Frutplan (Pelotas, Rio Grande do Sul, Brazil). They were cultivated following standard commercial practices and irrigation was performed using sprinkler system when needed during six months in the experimental field of Federal University of Viçosa (UFV), Viçosa, Minas Gerais, Brazil (20°45'20''S and 42°52'40''W, 651 m of altitude).

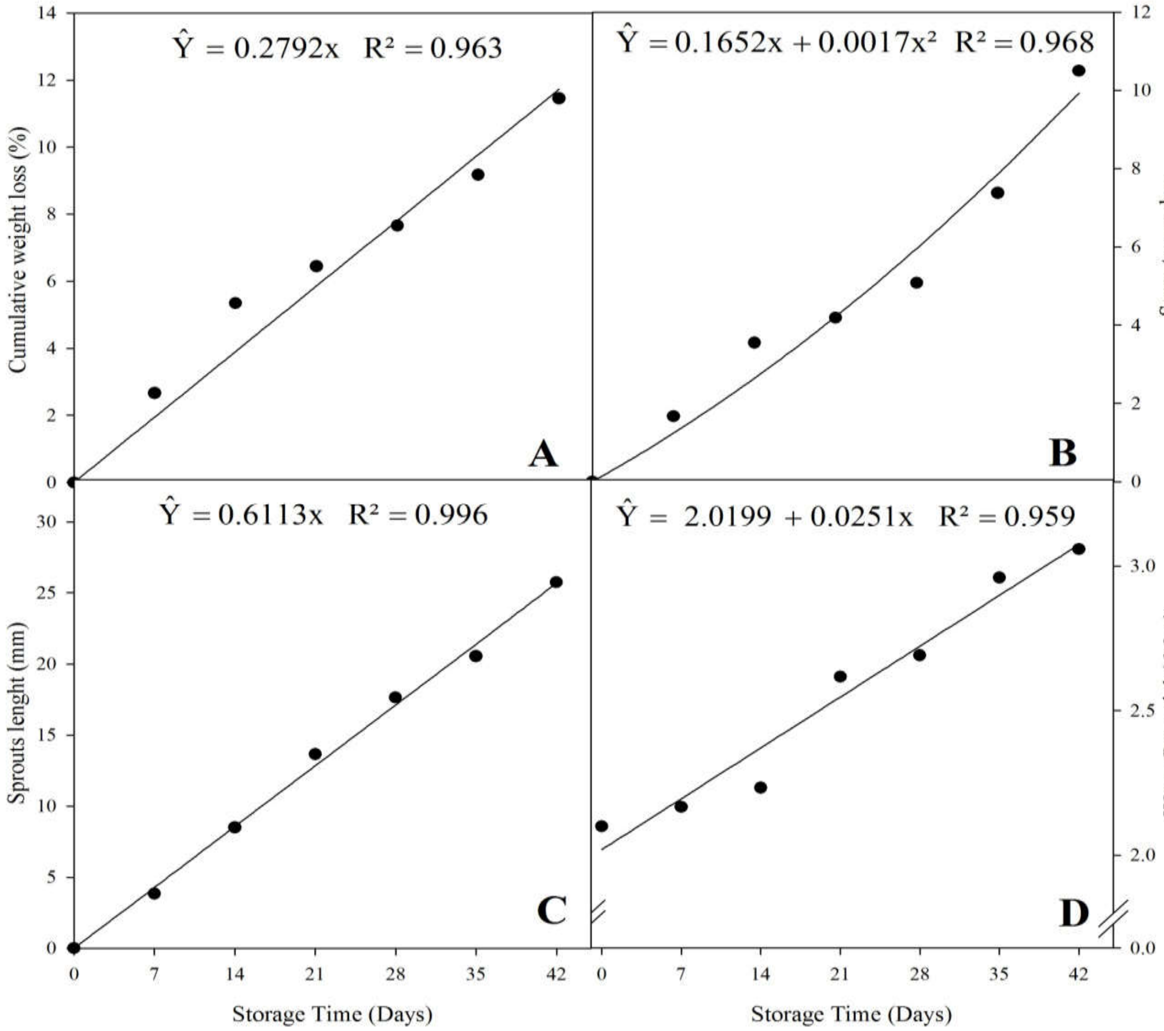

Figure 1. Cumulative weight loss (A), sprouts number (B), sprouts lenght (C) and water potential (D) of sweet potato roots (BRS Cuia) stored for 42 days at 25 °C

The harvest was manual and roots free of apparent damage and disease were standardized by mass between 300-700 g. Root curing was done in B.O.D incubators at 30 °C and 90% relative humidity for 7 days (Amoah *et al*., 2016). The taproots were stored in B.O.D incubators at 25 °C and 90% relative humidity by 42 days.

The cumulated weight loss was determined in an analytical balance of 1200g with 0.1g accuracy (Bel Engineering M1003), with the results expressed as percentage. The sprouts number was determined considering sprouts larger than 1 mm and the results expressed as number of sprouts per root. Sprouts length was measured with a digital caliper and the results expressed as mm root^{-1}. The hydric potential potential was determined using the gravimetric method described by Martin and Nuñez (2007) for massive tissues, and the results are expressed in negative Mega Paschal (-MPa).

Peroxidase activity of flesh and skin was based on a modified method described by Khan and Robinson (1994), wherein 0.1 ml of enzyme extract was added to the reaction medium containing 0.5 ml of hydrogen peroxide (1.80%), 0.5 mL of guaiacol (1.68%), 0.4 ml of deionized water and 1.5 ml of 0.1 M phosphate buffer (pH 6.0). Polyphenol oxidase activity of flesh and skin was based on a modified method described by Benjamin and Montgomery (1973), where in 0.1 ml of enzyme extract was added to the reaction medium containing 0.5 ml of catechin (5 mM), 0.9 mL of deionized water and 1.5 mL of 0.1 M phosphate buffer (pH 4.5). The reactions were quantified based on the alteration of the absorbance in UV-1601 spectrophotometer (Shimadzu, Kyoto, Japan), at wavelength of 470 nm (peroxidase) and 420 nm (polyphenoloxidase) at 25 °C, for 3 minutes. The activity was expressed as absorbance units (AU) min^{-1} mg^{-1} protein. The total protein was determined in the crude extract using bovine serum albumin as standard (Bradford, 1976).

Fraction of soluble phenols of flesh and skin was determined from 3 g of plant material homogenized in a 50: 3.7: 46.3 (v/v) methanol - acetic acid - water mixture, the homogenate was filtered into 4 layers of gauze and centrifuged at 14,000 g for 30 minutes at 4 °C. The Follin-Ciocalteu method was used for quantitation (Fu *et al*., 2010) using 0.0125% gallic acid as the standard solution. The reading was taken on a Genesys 10S UV-VIS spectrophotometer (Thermo Scientific, Massachusetts, USA) at 760 nm and the results were expressed as mg g^{-1} MF gallic acid.

The experiment was performed in a completely randomized design, with four replicates. The results were submitted to regression analysis, where the models were chosen based on the significance of the regression coefficients and the biological phenomenon. Statistical analyzes were carried out using statistical Sisvar 5.6 software (Ferreira, 2011) and the graph design was made in Sigma Plot 10.0 software.

RESULTS AND DISCUSSION

Cumulative weight loss showed linear increase reaching 11% at 42 days of storage (Figure 1A). There was also progressive increase in root sprouting, showing values 10.5 sprouts/root for sprouts number and 25.74 mm/root for sprouts length at 42 days of storage (Figures 1B and 1C). Water potential also showed linear increase of 45% during storage, as the plots are negative, this indicates that there was an increase in water loss by sweet potato taproots (Figure 1D).

Storage losses are mainly caused by the processes like respiration, weevil incidence, sprouting, and evaporation of water from the tubers, spread of diseases, changes in the chemical composition and physical properties of the tuber and damage by extreme temperatures (Prathiksha and Naik, 2017).

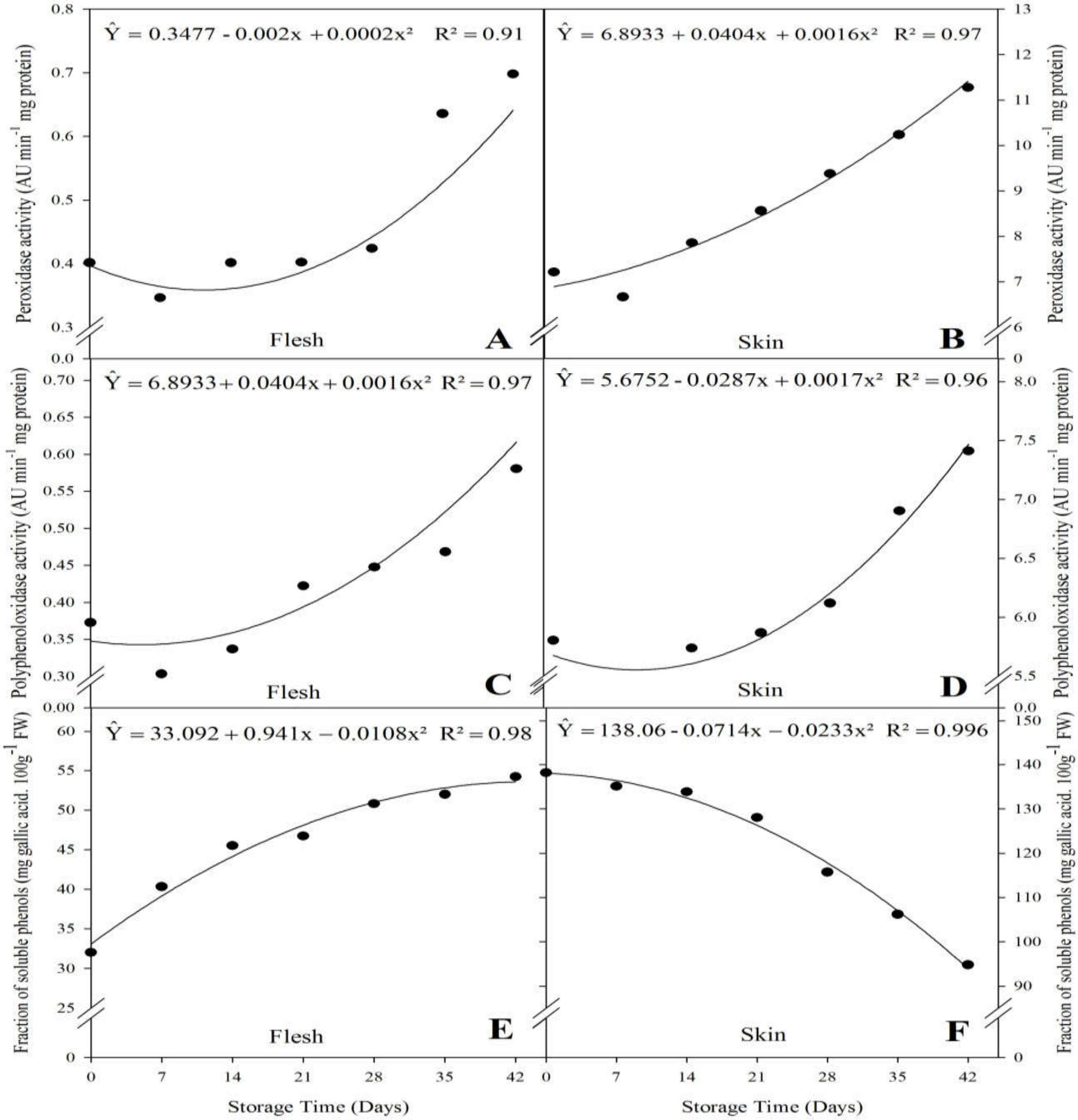

Figure 2. Peroxidase activity in flesh (A) and skin (B), polyphenoloxidase activity in flesh (C) and skin (D) and fraction of soluble phenols in flesh (E) and skin (F) of sweet potato roots (BRS Cuia) stored for 42 days at 25 °C

The cumulated weight loss and water potential was related to sprouting incidence, since respiration and evaporation increase rapidly with the onset of sprouting and continuous sprout growth, resulting in a rapid mass loss increase on stored roots and impairing the nutritional status and quality aspects of products (Mani *et al*., 2014). Cheema *et al*. (2013) also observed relation between mass loss and sprouting when evaluating sweet potato roots of cultivars ‘Bushbuck’ and ‘Ibees’, having higher weight losses and number of sprouts in the control and lower in 1-MCP treatment.

The activities of peroxidase (POD) and polyphenoloxidase (PPO) showed increases during storage. In Figures 2A and 2B, the POD activity showed increase of 72% in the flesh (0.4 to 0.69 AU min^{-1} mg protein) and 62% in skin (7.2 to 11.7 AU min^{-1} mg protein). And in Figures 2C and 2D, the PPO activity showed increase of 56% in the flesh (0.4 to 0.69 AU min^{-1} mg protein) and 27% in skin (5.8 to 7.4 AU min^{-1} mg protein). Regarding the total soluble phenols, there were increase of the flesh and decrease of 32% in skin showing values of 0.32 to 0.54 and 1.38 to 0.94mg gallic acid.g^{-1} FW, respectively. PODcatalyse peroxidation, oxidation-catalytic, and hydroxylation reactions and PPOs catalyse oxidation reactions of phenolic compounds, producing dark pigments from cutting or on the surface of fruits and vegetables (Minibayeva *et al*., 2015; Mishra *et al*., 2013). They are involved in ripening and senescence, plant defence, and darkening reactions (Minibayeva *et al*., 2015). Increases in POD and PPO activities are due to biodegradation reactions related to the senescence and decay processes of sweet potatoes roots (Tang *et al*., 2014), besides being related to the sprouting process (Lima *et al*., 2019; Santos *et al*., 2019). The higher enzyme activities in skin are due phenolic compound tended to be highest in the skin, followed by the pulp (Sun *et al*., 2018). And the decreases in the fraction of soluble phenols in skin may be related to the higher oxidation of phenolic compounds, due to the greater susceptibility to mechanical damage.

The roots did not show considerable decay during storage. However, sprouting in particular leads to weight loss, reduction of nutritional, processing and marketable quality of roots (Chagonda *et al.*, 2014). Visible sprouts on sweet potato are unacceptable to consumers. Therefore, for producers, suppression of sprout growth during storage is absolutely necessary to maintain market quality of the processed products (El-Sayed *et al*., 2013).

Conclusions

Our results indicate that sprouting is the major problem during storage at room temperature; therefore, to optimize storage at room temperature and to reduce losses, it is necessary to control sprouting by chemical suppressors.

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