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Stem cutting size and biofilm in longevity of ornamental ginger

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ABSTRACT: The ornamental Ginger is a tropical plant widely used in gardens or as a cut flower in floral arrangements; however, there are no studies on its post-harvest conservation associated with the stem cutting size and the use of cassava starch. Thus, this study aims to determine the optimal stem cutting size and the effect of cassava starch biofilms in order to increase shelf life. The stems were collected in three sizes: 10, 15 and 20 cm and subjected to five treatments with cassava starch: control, 2, 4, 6 and 8%. Authors evaluated every four days fresh weight loss and quality of inflorescences. The cutting size, when associated with the different cassava starch concentrations, showed different values over the storage time. The stems harvested with 10 cm had a lower percentage of weight loss and higher quality score. The concentration of 4% starch reduced weight loss and preserved the quality of stems regardless of the cutting size and it is, therefore, the recommended concentration for the conservation of ornamental ginger by favoring commercial life of up to 16 days.

Keywords: *Zingiber spectabile*, cassava starch, tropical flowers, post-harvest.

Tamanho do corte da haste e do biofilme na longevidade de gengibre ornamental

RESUMO: O gengibre ornamental é uma planta tropical muito utilizada em jardins ou como flor de corte em arranjos florais, todavia, não se tem estudos sobre sua conservação pós-colheita associada ao tamanho de corte da haste e o uso da fécula de mandioca. Assim, o presente trabalho tem por objetivo determinar o tamanho ideal de corte das hastes e o efeito do biofilme de fécula de mandioca visando o aumento da vida de prateleira. As hastes foram colhidas em três tamanhos: 10, 15 e 20 cm e submetidas a cinco tratamentos com fécula de mandioca: Controle, 2, 4, 6 e 8%. Avaliou-se a cada quatro dias a perda de massa fresca e a qualidade das inflorescências. O tamanho do corte quando associado as diferentes concentrações de fécula de mandioca apresentaram valores diferentes ao longo do tempo de armazenamento. As hastes colhidas com 10 cm apresentaram menor percentual de perda de massa e maior índice de qualidade. A concentração de fécula a 4% reduziu a perda de massa e preservou a qualidade das hastes independente do tamanho de corte avaliado sendo, portanto a recomendada para a conservação de gengibre ornamental por favorecer vida útil comercial de até 16 dias.

Palavras-chave: *Zingiber spectabile*, fécula de mandioca, flores tropicais, pós-colheita.

1. INTRODUCTION

There has been growing commercialization of tropical plants in the domestic and international markets and the characteristics that favor their acceptance by consumers are beauty, exoticism and high post-harvest longevity (SANTOS et al., 2015). The genus *Zingiber* belongs to the Zingiberaceae family and comprises 141 species accepted according to the Kew Botanic Garden, most with ornamental potential. Among the various species, the *Zingiber spectabile*, popularly known in Brazil as big ice cream, ornamental ginger, maraca or shampoo, has stood out in crops and trade. It is an Asian plant and its group is one of the most important among the genera of tropical ornamental perennials herbaceous. It is used as a garden plant or cut flowers intended for floral arrangements (GONÇALVES et al., 2015). In general, ornamental gingers have great potential to be marketed as cut flower; however, it is necessary to generate information regarding its post-harvest conservation, mainly in the use of post-harvest technologies that provide increased marketing period, quality maintenance and loss reduction.

The use of cassava starch as biofilm emerges as a sustainable alternative and easy access to increase useful life of ornamental ginger stems as it improves the visual aspect of the product, gives more brightness and color maintenance, and increases the conservation period by reducing respiratory activity and delaying senescence (LUVIELMO; LAMAS, 2012). Its application has already been used in the conservation of fruit and vegetables such as papaya (PEGO et al., 2015), avocado

(COUTINHO et al., 2015), banana (SILVA et al., 2015), tomato (MORH et al., 2014) and etc.

However, there is no information in the literature on the use of cassava starch in increasing the useful life and in post-harvest quality of cut flowers. Thus, the aim of this study was to evaluate the stem cutting size associated with the use of cassava starch in the durability of ornamental ginger flower stems.

2. MATERIAL AND METHODS

Flower stems of ornamental ginger were harvested in July 2015 in the early morning hours in a commercial plantation area in the municipality of Brasil Novo, PA, Brazil, located in the geographical coordinate 03°18'17" south latitude and 53°32'08" west longitude. The climate, according to Koppen classification, is Am and Aw type, characterized as hot and humid; the average temperature and rainfall in the stems harvest period were on average 25° C and 900 mm respectively, and humidity around 81 % (IDESP, 2015)

The stems were conducted to the packing house of the center of cultivation, where they were sanitized in 5ppm hypochlorite solution, packed in cardboard boxes wrapped with newspaper and transported in a dry place in horizontal position to the Product Technology Laboratory of the Faculty of Agronomic Engineering at the Federal University of Para, Campus Altamira, PA.

In the laboratory, the stems were immersed in distilled water for hydration while there was the selection of inflorescences, labeling and standardization of height at 30 cm, by cut in the basal portion; then, they were submitted to treatments. The collected stems had a diameter greater than 1.0 cm.

The treatments consisted of five concentrations of cassava starch, in which: control 0; 2; 4; 6 to 8% in three lengths of the stems: 10, 15 and 20 cm.

Concentrations were prepared by heating the suspensions (starch + water) to 70 ° C, so that gel-setting occurs. Thereafter the suspensions remained at rest until cooling to room temperature, and then the flower stems were sprayed to pouring point with use of knapsack sprayer. The control treatment was sprayed with distilled water only.

After drying, stems were weighed and accommodated in plastic containers with 25L capacity and the volume was completed every 4 days, to be later stored at ambient conditions (temperature 23 ± 1 ° C and relative humidity 85%).

The experiment was installed in a completely randomized design, arranged under a factorial scheme 5x3x6, in split plot in time. The plots consisted of 5 cassava starch concentrations (control, 2, 4, 6 and 8%) x 3 lengths of stems (10, 15 and 20 cm) and in subplots of evaluation days (0, 4, 8, 12, 16 and 20 days after harvest). Each treatment consisted of 5 repetitions with three stems per repetition.

The analyzes took place every 4 days for a period of 20 days, in which researchers evaluated: a) relative fresh weight determined by the difference between the initial weight and the weight of the flower stems on the analysis day. Results were expressed in percentage (%); b) quality of the flower stems measured by the scale of subjective scores consisting of five evaluators, in which: 5- Excellent, turgid stems and inflorescences, bracts with brightness and characteristic color; 4- Good, early loss of turgidity (only sensitive to touch); with or without the onset of discoloration and/or wilting of bracts and stems edges ; 3- Average, declining of bracts by visible loss of turgidity and brightness of inflorescence and stem, bracts' edges with soaked appearance; 2 Bad, pronounced loss of turgidity of bracts and/or stems, translucent bracts' edges, central part of inflorescence softened ; 1- Very bad, disposal: soft bracts and/or dried and/or with soaked appearance, with rotting of the central part of the inflorescence and abscission of bracts. Score 3 was considered the limit for the marketing of ornamental ginger stems.

After checking the normality of data, results were submitted to analysis of variance (ANOVA) and the means were compared by Tukey test ($p < 0.05$) by using the statistical software ASSISTAT version 7.7 beta.

3. RESULTS AND DISCUSSION

According to the results, researchers observed effect of stem cutting length factors x cassava starch concentration with storage time for all traits.

The moisture loss in plant products starts with the vapor diffusion between the plant product and the environment which directly affects the respiratory rate, favoring water loss by evaporation and atmospheric gas composition (GUIMARÃES et al., 2010). In this study there was significant loss of fresh weight regardless of stem length and cassava starch biofilm. In evaluating the vessel life of ornamental ginger treated with pulsing solutions, Coelho et al. (2012) noted significant weight loss in all solutions evaluated.

Regarding the stem length at harvest, it was noted that those harvested with 20 cm long had greater weight loss, differing when compared to those cut with 10 and 15 cm of stem, in which there was no significant effect (Figure 1). Barbosa et al. (2006) and Reis (2009), in assessing the harvest stadium of lilies and calla lilies also observed greater weight loss when harvested lately.

Also regarding the flower stems, it is clear that regardless of the stem cutting length, the greatest reductions are observed from the twelfth day of storage, as shown in Figure 2. Similar searches of Unemoto et al. (2011), in a post-harvest study of the torch ginger also observed a reduction in fresh weight over time after harvest.

In relation to treatment with cassava starch, researchers found that concentrations of 4 and 6% had less weight loss in the flower stems of ornamental ginger when compared the

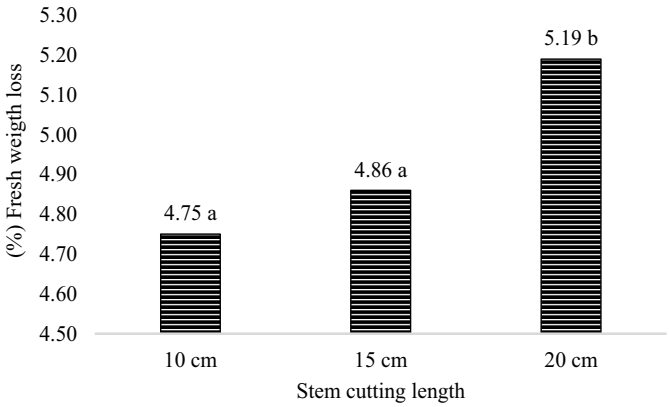

Figure 1. Fresh weight loss percentage in ornamental ginger according to stem cutting length.

Figura 1. Porcentagem de perda de massa fresca em gengibre ornamental em função do comprimento de corte da haste.

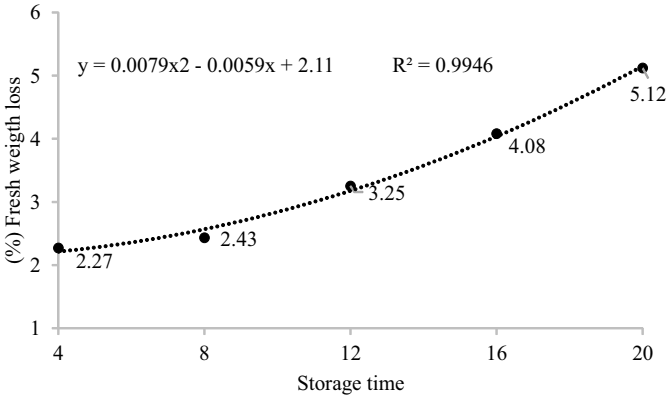

Figure 2. Fresh weight loss percentage in flower stems of ornamental ginger according to storage time.
Figura 2. Porcentagem de perda de massa fresca em hastes florais de gengibre ornamental em função do tempo de armazenamento.

concentrations of 2%, 8% and the control treatment (Figure 3). The smallest variation of fresh weight loss indicates greater conservation of its reserves. So, intermediate concentrations such as 4 and 6% sprayed on the stems provided greater conservation of fresh weight since they kept water balance of the samples, delaying senescence (Figure 3).

Souza (2012) observed reduction in fresh weight loss in Alpinias treated with biofilm of carnauba wax, being more evident in the intermediate concentrations. For Blum et al. (2008) the reduction of water loss should be considered the main benefit of using wax, since it reduces losses by wilt, prolonging life.

As regards the quality of the stems, in general, the use of tapioca starch provided a more glossy appearance to the ornamental ginger stems compared to the control treatment (Figure 4). The concentrations of 6 and 8% favored the appearance of yellowish and necrotic spots on the edge of the stems, which was also observed by Dias and Castro (2009) when evaluating the carnauba wax in conservation of ornamental ginger, where increased biofilm concentration favored darkening of the bracts, causing commercial loss thereof. The concentration of 4% maintained samples with better aspect, regardless of stem cut length (Figure 4).

In analyzing the interaction between the cutting length of the stem x treatments with cassava starch and the evaluation time it

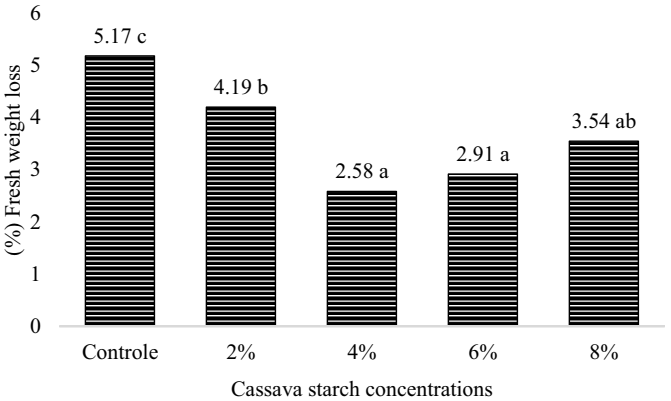

Figure 3. Fresh weight loss percentage in flower stems of ornamental ginger according to treatments with cassava starch.
Figura 3. Porcentagem de perda de massa fresca em hastes florais de gengibre ornamental em função dos tratamentos com fécula de mandioca.

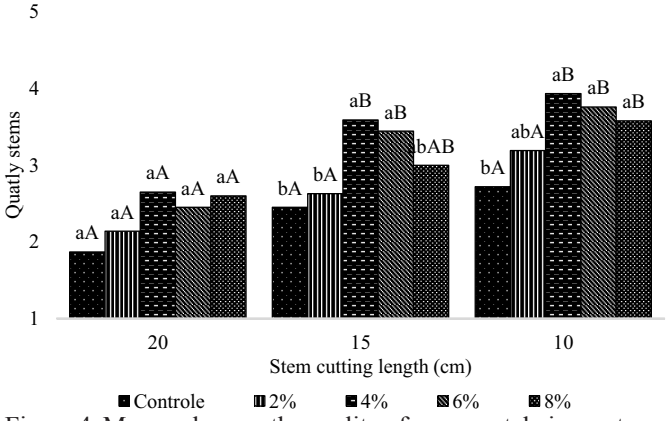

Figure 4. Mean values on the quality of ornamental ginger stems harvested in different sizes and treated with cassava starch. Means followed by the same letter (lowercase) compare the cassava starch concentrations and (uppercase) the stem length.
Figura 4. Valores médios sobre a qualidade das hastes de gengibre ornamental colhidas em diferentes tamanhos e tratadas com fécula de mandioca. Médias seguidas pela mesma letra (minúsculas) comparam as concentrações de fécula de mandioca e (maiúsculas) o comprimento da haste.

was observed that the stems harvested with 20 cm were affected by the concentration of 4% by ensuring greater commercial durability, keeping score equal to 3 until the twelfth day of evaluation. The concentration of 2% showed no difference when compared to the control treatment, reaching marketing average of 3 in the fourth day of storage. On the sixteenth day of evaluation stems harvested with 20 cm were discarded in their entirety (Figure 5).

Regarding the quality of the stems harvested with 10 cm, it was found that the use of biofilm, regardless of concentration, provided improved quality until the sixteenth day of evaluation, when the lowest score was 3, differing only of untreated samples. On the twentieth day, the loss of quality was evident in the treatments with control, 2% and 8% with averages of

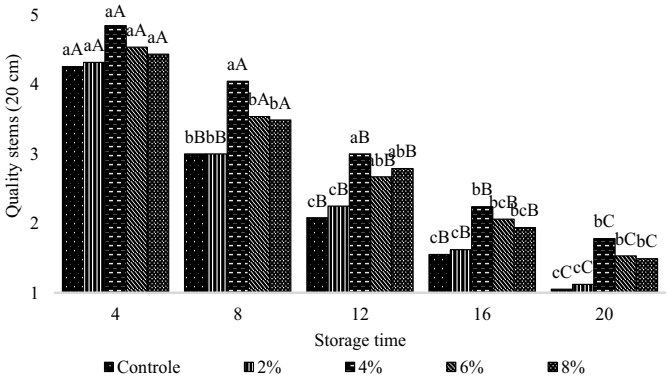

Figure 5. Quality of ornamental ginger stems harvested with 20 cm in length and stored according to the treatments with cassava starch and throughout the storage time. Means followed by the same letter (lowercase) compare cassava starch concentrations and (uppercase) the stem length.
Figura 5. Qualidade das hastes de gengibre ornamental colhidas com 20 cm de comprimento e armazenadas em função dos tratamentos com fécula de mandioca e ao longo do tempo de armazenamento. Médias seguidas pela mesma letra (minúsculas) comparam as concentrações de fécula de mandioca e (maiúsculas) o comprimento da haste.

2.05; 2.17 and 2.31, respectively (Figure 6). The behavior of stems harvested with 15 cm was similar to that seen when cut with 10 cm, and the commercial point was also affected on the sixteenth day of evaluation, when the highest average presented was 3 when treated with 4 and 6% of cassava starch (Figure 7).

Still according to Figure 7, it is observed that loss of quality is more noticeable in the stems of control treatment that presented score 3 in the eighth day of evaluation. The coatings in concentrations of 2 to 8% whose means 2.84 and 2.89, respectively, presented commercial limit on the twelfth day, when the averages were below 3.

At the end of twenty days of storage, all samples had score lower than 2, regardless of treatment with biofilm, not differing

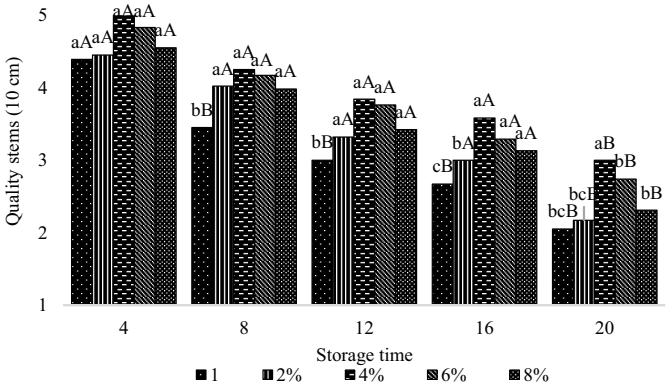

Figure 6. Quality of ornamental ginger stems harvested with 10 cm in length and stored according to the treatments with cassava starch and throughout the storage time. Means followed by the same letter (lowercase) compare cassava starch concentrations and (uppercase) the stem length.

Figura 6. Qualidade das hastes de gengibre ornamental colhidas com 10 cm de comprimento e armazenadas em função dos tratamentos com fécula de mandioca e ao longo do tempo de armazenamento. Médias seguidas pela mesma letra (minúsculas) comparam as concentrações de fécula de mandioca e (maiúsculas) o comprimento da haste.

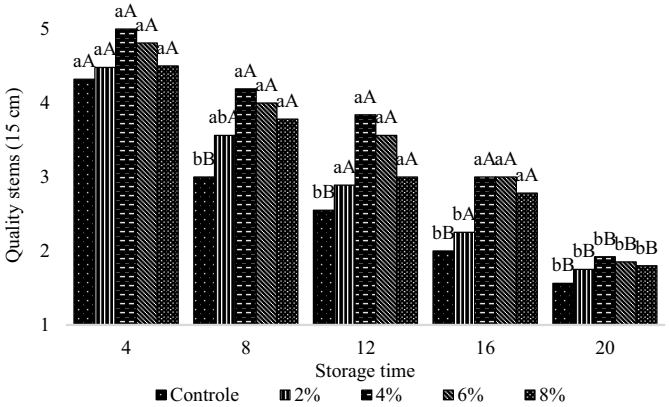

Figure 7. Quality of ornamental ginger stems harvested with 17 cm in length and stored according to the treatments with cassava starch and throughout the storage time. Means followed by the same letter (lowercase) compare cassava starch concentrations and (uppercase) the stem length.

Figura 7. Qualidade das hastes de gengibre ornamental colhidas com 17 cm de comprimento e armazenadas em função dos tratamentos com fécula de mandioca e ao longo do tempo de armazenamento. Médias seguidas pela mesma letra (minúsculas) comparam as concentrações de fécula de mandioca e (maiúsculas) o comprimento da haste.

from each other and presenting as senescence as feature and high loss of turgor and browning of the stems (Figure 7).

Carneiro (2013), evaluating the effect of carnauba wax biofilm according to the floral opening stadium of torch ginger noted that the samples harvested earlier had higher lifetime compared to those at a more advanced stage of development.

4. CONCLUSIONS

The best cut-off size for the maintenance of ornamental ginger quality is between 10 and 15 cm, in which the cutting length of 10 cm associated with concentration of 4% allowed a commercial durability of up to 16 days.

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