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Original paper

Quality of three cowpea green-grains cultivars refrigerated

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Abstract

The objective of this study was to evaluate the quality of green-grains from three cultivars of cowpea kept in refrigeration. The experiment was conducted at the Universidade Federal Rural de Pernambuco - Unidade Acadêmica de Serra Talhada. The experimental design was completely randomized with 6 replicates within a 3 x 4 factorial arrangement. The first factor consisted of three cultivars of cowpea (BRS-Guariba, BRS-Tumucumaque and BRS-Potengi) and the second factor consisted of four storage periods: 0, 7, 14 and 21 days. Packages consisted of 200 g of green beans of each cultivar, placed in 15 x 10 cm polypropylene bags of 15 μm thickness. After sealed, samples were kept at 5 °C ± 2 and 90 ± 5 % of relative humidity. There was an intense drop in total acidity in chlorophyll and carotenoids, that was visually perceived by a change in the tone of green and increased content of soluble solids during cold storage. The maximum conservation time for the conditions studied was 14 days. After this period, a slight darkening of the beans was noticed. This conservation time is longer than the packages currently found in the market. The BRS-Guariba and BRS-Potengi cultivars showed the smallest variations in pH, titratable acidity (TA), chlorophylls (CLT) and carotenoids (CRT). These two cultivars were more suitable for storage at refrigeration.

Key-words: *Vigna unguiculata*, Packaging, Postharvest, Chlorophylls

Introduction

Cowpea (*Vigna unguiculata* L. Walp.) is a food item widely consumed in Brazil. "Baião-de-dois" and "feijão tropeiro" are examples of regional dishes (Embrapa, 2011). What drives the marketing and consumption is its nutritional value, which is higher than the bean *Phaseolus vulgaris* L. (Silva et al., 2002), and the low-fat and low cholesterol contents (Granjeiro et al., 2005).

The cowpea is mainly commercialized in the form of dried beans. Consumers can also find green grains in their own pod, threshed in bulk or bags (Freire Filho et al., 2005). The demand for green-shelled beans has increased in the recent years. However, they are packaged in inadequate polyethylene bags (1Kg) and often kept at room temperature, resulting in a short shelf life.

In the market, the factors that limit the shelf life and increase lost of most vegetables are senescence, deterioration by microorganisms and transpiration (Maharaj et al., 1999). The post-harvest losses can reach high levels depending on the plant species, the form of harvest, storage conditions and product marketing (Allende and Artés, 2003).

The green-grain cowpea has a short shelf life, and can be depleted within in a few days. This fact is due to the high humidity inside the grains, around 50-70 % (Oliveira et al., 2001), which results from the high respiratory rates of the product (Pinto and Morais, 2000). The result of this physiological reaction decrease the quality of green-grains over the storage time. The visual changes occurring in the green cowpea are associated with the loss of green color caused mainly by chlorophyll degradation; on

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the other hand, there can be accumulation of carotenoids. Besides providing the appropriate color to beans, chlorophyll may be associated with anticarcinogenic, antitumor and antimutagenic actions (Morita et al., 2001). The maintaining the quality of green-grains of cowpea harvest and to reducing post-harvest loss are challenges in their comercialization. Currently, some materials are used for production of containers for storage of food, in order to decrease these losses. Polypropylene packaging (PP) has a considerably lower cost when compared to other materials, such as multi-layered nylon. Its main characteristics classifies it as a suitable polymer for cooling: lightness, strength, transparency, good chemical resistance, and low toxicity. It is believed that the use of this packaging associated with new cultivars could increase the product's shelf life for, at least, seven days longer than what is generally expected in traditional marketing.

Maintaining the quality of green-grains of cowpea similar to the time of harvest and reducing post-harvest loss are challenges in their marketing . In order to reduce loss, some materials are currently used for producing containers for storing food. Polypropylene packaging (PP) has a considerably lower cost when compared to other materials, such as Multi-Layered Nylon. Its main characteristics classifies it as a suitable polymer for cooling: lightness, strength, gloss, transparency, good chemical resistance, and low toxicity. It is believed that the use of this packaging associated with new cultivars could increase the product's shelf life for, at least, seven days longer than what is generally expected in traditional marketing.

The Embrapa Meio-Norte developed the cultivars BRS-Guariba, BRS-Tumucumaque and BRS-Potengi for production of green and dry beans. Studies comparing these cultivars associated with post-harvest technologies such as refrigeration and packaging are scarce. Therefore, the objective of this study was to evaluate the physicochemical changes associated with quality in the green and the grains of three cowpea cultivars kept under refrigerated and modified atmosphere.

Material and methods

The experiment was conducted in the laboratory of the Universidade Federal Rural de Pernambuco/Unidade Acadêmica de Serra Talhada (UFRPE/UAST), from October to November 2011. The experimental design was completely randomized with 6 replicates within a 3 x 4 factorial arrangement. The first factor consisted of green grains of three cultivars of cowpea originated from Embrapa Meio-Norte: BRS-Guariba, BRS-Tumucumaque and BRS-Potengi, The second factor consisted of four storage times: 0, 7, 14 and 21 days.

After being harvested manually at day 70th, the cowpeas were threshed, separated in portions of 200 grams of green beans (each cowpea cultivar) and kept in polypropylene containers (15 x 10 cm and 0.8 mm thick). Subsequently, the containers were sealed and stored at 5 °C ± 2 and 90 ± 5 % of relative humidity.

The pH was measured with digital phmetermodel LS 300-HH (Aoac, 1990). Titratable acidity (TA) was measured from 2 g of green bean, macerated, material which was homogenized in a mortar with 50 mL of distilled water, using phenolphthaleinhe as indicator and NaOH (0.1 N) as titrant. Soluble solids (SS) were determined in digital refractometer model Atago PAL-1 (Atago Co., LTD., Japan) with automatic temperature compensation, expressing the results in %, according to standards of Aoac (1990). Total chlorophyll and carotenoids were measured through destructive analysis by extraction with acetone (80 %), in which 2 g were mixed in a mortar with 0.2 g of $CaCO_3$ in the final volume of 10 mL. The readings were taken on a spectrophotometer at 470, 646 and 663 nm wavelengths. The levels of total chlorophyll (CLT) and carotenoids (CRT) were obtained from the equations established by Lichtenthaler (1987).

All analyses were conducted four times in triplicates. The results were analyzed by F test to determine the variance analysis. The means of quality factor (cultivars of cowpea) were compared by Tukey test at 5 % probability using the program Sisvar v. 4.6 (Ferreira, 2003). Quantitative factor (storage times) was performed using regression analysis (Jandel, 1992).

Results and discussion

There was a significant interaction between the factors cultivar and storage time for pH and titratable acidity (TA). Only BRS-Potengi did not fit the regression equation for this feature (Fig. 1B). Unfolding the interaction of cultivars factor on the storage time for pH, there was significant differenceat

14 days, and BRS-Potengihad the highest mean (Table 1).

Table 1. pH and titratable acidity of three cowpea green-grains cultivars (*Vigna unguiculata* L. Walp.) refrigerated.

	pH			
Cultivars	0 Day	7 Days	14 Days	21 Days
BRS-Guariba	6.55a*	7.02a	7.10b	6.87a
BRS-Potengi	6.65a	7.03a	8.02a	6.69a
BRS-Tucumaque	6.61a	7.55a	7.04b	6.49a
Mean	6.60	7.20	7.39	6.68
CV (%)	7.85			

Titrable Acidity (% citric acid)				
Cultivars	0 Day	7 Days	14 Days	21 Days
BRS-Guariba	1.51a	1.25a	1,00a	0,88b
BRS-Potengi	1.33b	1.19a	1,13a	1,14a
BRS-Tucumaque	1.35b	1.21a	1,12a	0,93b
Mean	1.40	1,22	1,08	0,98
CV (%)	8.03			

*Means with different letters indicate significant differences ($p \leq 0.05$).

Performing the unfolding of the interaction between time and cultivars for pH, BRS-Guariba obtained a minimum value of approximately 6.55 near the initial time (0 days), and maximum value of 7.12 at day 14 (Fig. 1A). BRS-Potengi had the greatest variation for this parameter ranging from an estimated value of 6.54 near the initial time (time 0) to 7.93 at day 14 (Fig. 1A).

After 21 days of storage, the pH values of the green cowpea beans were between 6.64 to 7.39, which classify them as low-acidity or weakly acid food. This is a drawback in postharvest food preservation, especially regarding the occurrence of microorganisms such as *Clostridium botulinum* that grow well in this pH range (Germer et al., l995). However, the used container was a polypropylene that allows exchanging O_2 and CO_2, not enabling anaerobiosis, conditions for the development of this microorganism. Loey et al. (1994) claim that food within this pH range requires cold storage for prolonging their shelf life.

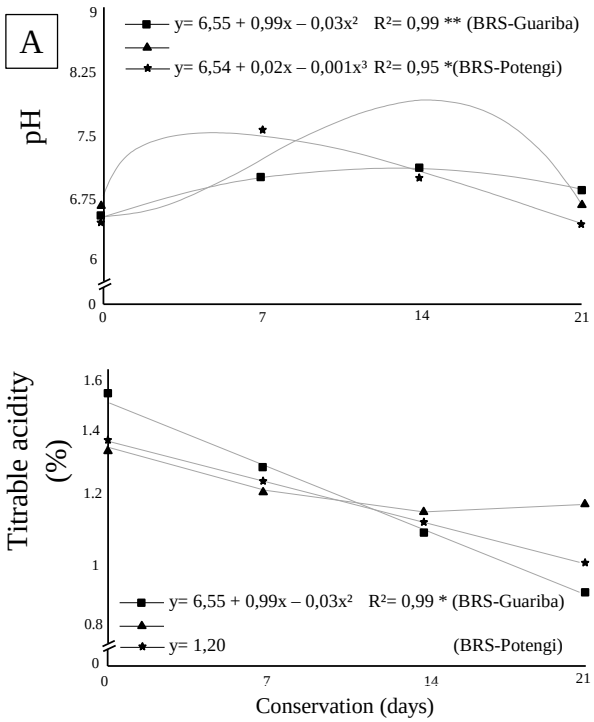

Fig. 1. pH (A) and titratable acidity (B) contents of three cowpea green-grains cultivars (*Vigna unguiculata* L. Walp) kept under refrigeration (5 °C ± 2).

Unfolding the interaction between cultivars for ARR showed a significant difference among the three cultivars at days 0 and 21; BRS-Guariba showed the highest mean at day 0 (1.5 % citric acid), while BRS-Potengi showed the highest mean at day 21 (1.14 % citric acid) (Table 1). Unfolding the inverse of the interaction between cultivars for ATT, there was maximum approximate value of 1.48 % citric acid (0 day) and a minimum value of 0.84 % citric acid after 21 days of storage (Fig. 1B).

There was a similar decrease behavior for titratable acidity over conservation time for the three cultivars, but the lowest range over conservation time was observed for BRS-Potengi. This behavior may be related to the fact that citric acid is an organic acid that serves as substrate for the respiratory reactions occurring in the cowpea green-grains. Watada and Morris (1967) state that respiratory reactions in common green-grains intensify after harvest even when exposed to low temperatures; therefore, this behavior can occur with grains of cowpea under the same conditions. Chitarra and Chitarra (2005) state that some food products have a higher buffering

capacity, allowing wide variations in acidity without exerting significant variations in pH.

The soluble solids (SS), total chlorophyll (CLT) and carotenoids (CRT), there were no interactions between time and cultivars (Fig. 2 and Table 2).

There was a significant effect for isolated factors, except for soluble solids that showed no difference between cultivars, with 30.59 % overall average value (Table 2).

Table 2. TSS, CLT and CRT of three cowpea green-grains cultivars (*Vigna unguiculata* L. Walp.) refrigerated. SS: Soluble Solids; CLT: total chlorophyll e CRT: carotenoids.

Cultivars	TSS (%)	CLT (mg g^{-1})	CRT (mg g^{-1})
BRS-Guariba	31,10a	3,00b	5,32b
BRS-Potengi	30,66a	3,12ab	5,62b
BRS-Tucumaque	30,01a	3,26a	6,91a
Mean	30,59	3,13	6,85
CV (%)	6,94	9,37	23,82

*Means with different letters indicate significant differences ($p \leq 0.05$).

Considering time for percentage of TS, there was an estimated minimum value of 29.68 % close to the initial time (0 days) and the maximum value of 32.02 % at day 21 (Fig. 2A). This increase was observed for the green-grains of the three cultivars of cowpea. This increase may be due to hydrolysis of starch into sugar, which is a component soluble solids. Thus, the metabolic activity in bean remains very high, even under refrigeration.

The CLT contents in BRS-Tumucumaque recorded the highest mean of fresh matter, 3.26 mg g-1, and did not differ significantly from the BRS-Potengi with 3.12 mg g-1. The cultivar with lowest mean in CLT content was BRS-Guariba (Table 2). On the other hand, the total chlorophyll content in the three cultivars decreased approximately 85% during storage, comparing the beginning and the end of storage (Fig. 2B).

It is believed that this drop is, in part, due to the intense metabolic activity of the green beans. The packaging used might also contribute to chlorophyll degradation by allowing the diffusion of oxygen into the interior (Matile et al., 1996). In addition, ethylene and high water content in seeds can induce total chlorophyll degradation (Heaton and Marangoni 1996). Thus, in this study, it was evident that the grains of green beans continue their high metabolic activity, even while packaged at 5 °C.

Total carotenoids content decreased intensely during the 21 days of storage, starting with fresh weight values of 7.04 mg g^{-1} decresing for 5 mg g^{-1} fresh weight (Fig. 2C). In addition, BRS-Tumucumaque (6.91 mg g^{-1}) was statistically higher (Table 2).

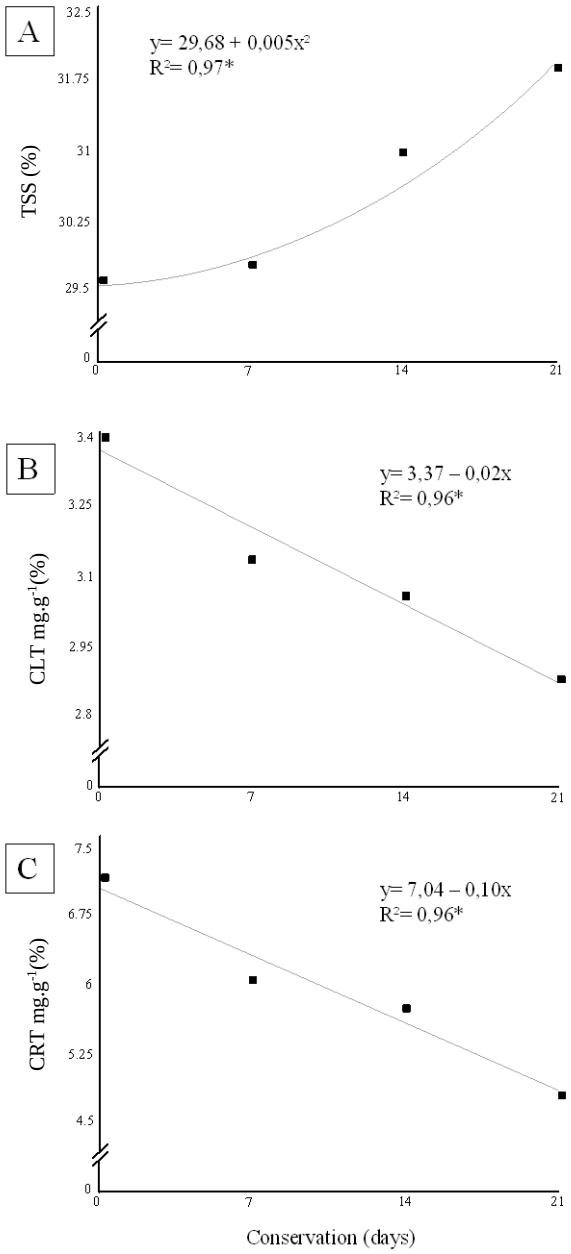

Fig. 2. Soluble Solids (SS, A), total chlorophyll (CLT, B) and carotenoids (CRT, C) contents of three cowpea green-grains cultivars (*Vigna unguiculata* L. Walp.) kept under refrigeration (5 °C ± 2).

In addition to the change of green color, characteristic of chlorophyll degradation (Fig. 2A),

presenting dark-colored beans, which was more intense after 14 days, which may be associated with the synthesis of phenolic compounds. Thus, 14 days was the maximum appropriate storage time under studied the conditions, depending on the visual changes. This conservation time is longer than the packages currently found in the market.

Overall, the results of this study showed that green beans have high metabolic activity, evidentiated by the sharp drop in total acidity, chlorophyll and carotenoids and increased content of soluble solids.

The refrigeration at 5 °C combined with the use of alternative packaging provided conservation of quality green beans for 14 days. This shows that the conservation of green beans under refrigeration associated with packaging can slow the physicochemical changes associated with quality, and thus increase the shelf life and marketing of green beans.

Conclusion

BRS-Guariba and BRS-Potengi had the smallest variations over conservation time for pH, TA, CLT and CRT, and they are the most suitable of the three cultivars evaluated for storage in modified atmosphere at 5 °C ± 2.

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