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Influence of Minimum Processing Procedures on the Quality of Sweet Cassava

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Abstract – **The objective is to adjust procedures such as the immersion in cold water, cutting, turning and centrifugation to obtain shaped cassava named 'minicassavas'. For this purpose, roots of Recife and Rosinha cultivars were harvested when 8 and 12 months old, weighed, washed and cooled during 24 hours. Subsequently, these roots were cut in pieces; immerged during 0.5 and 30 minutes; peeled; and cut to obtain 'half piece' and cube shapes. Both shapes were turned during 1, 2 and 3 minutes, obtaining the 'rubiene' and 'cateto' shapes, respectively. After that, 'minitolete', rubiene' and 'cateto' were sanitized; centrifuged at 0, 30, 60, 90 and 120 seconds; packed and stored at 9 ± 2 °C ('minitolete') and 5 ± 2 °C ('rubiene' and 'cateto'). Results indicate that the immersion in cold water for 5 or 30 minutes accelerated the peeling of cv. Rosinha and minimized browning symptoms in both cultivars when maintained at 8 ± 2 °C. The ideal lathing time observed to 1.5 Kg of cassava pieces was 2 minutes, regardless of the shape because it reduced the losses and improved the appearance. In addition, the centrifugation of 800 g of 'minitolete' was 30 second, while to 'cateto' and 'rubine' was 60 seconds. In these times, both shapes showed desirable features for a longer period of time. Thus, was verified that one way to add value to cassava is the development of alternative shapes, because this root can suit innovative formats. Thus, procedures used in minimal processing are specific for each shape and it can influence the quality and conservation.**

Keywords **– *Manihot Esculenta,* Crantz, Browning, Minimally Processed, Agribusiness Yield, Quality.**

I. INTRODUCTION

The root of sweet cassava (*Manihot esculenta* Crantz), known as "cassava" in the Northeast, is consumed by millions of people, both cooked and fried, in the form of various byproducts, such as flour and starch. It is the main food source of a large proportion of the world population, particularly countries in South America, Africa and Asia [1].

The sweet cassava is cultivated in all Brazilian states. It is among the nine agricultural products with greater acreage, about 1.9 million hectares [2]. For the state of Pernambuco it is estimated a production of approximately 655,919 tons per year and harvested area of 59,090 tons per year [3].

Maintaining postharvest quality in cassava is one of the major technological challenges faced. The roots are highly perishable after harvest, observing severe alterations of physiological and microbiological nature [4]. The physiological change is characterized by the appearance of streaks and discoloration, or bluish veins in the root vascular system, causing loss of acceptability of the product 'in natura'[5]-[6]. The microbiological alteration is caused under aeration conditions by bacteria *Pseudomonas* sp. [7]. Under low oxygen tension, bacteria of the genus Bacillus are predominant, causing rot and increased acidity [8].

The difficulty in maintaining fresh roots in shops or homes by some days after harvest has been a major barrier to the culture agroindustrial development in post-harvest. The shops commercialize the root 'in natura', with dirty bark, sometimes peeled, immersed in water or frozen. However, this type of product does not offer consumer food safety and even, it is a fresh product, when it is frozen.

An alternative to extend the shelf life of cassava is the appropriateness of minimal processing technology. Studies have been conducted on sweet cassava evaluating packaging [9]-[10]; sanitization [8]; antioxidants use [7], use of edible coating [11] and centrifugation [7]-[12]-[13]. All the procedures described were performed for shapes like 'oarlock', 'middle oarlock', 'stick' and 'slice'.

Alternative and innovative shapes named 'mini-cassava' have not been studied, being necessary investigations focusing on the minimal processing procedures; immersion in cold water, as cassava is a product that darkens quickly [9]-[11]. Immersion in water before peeling is performed empirically for periderm removal of cassava, facilitating the minimal processing. However, this procedure is not systematic, nor do we know what the real contribution of this procedure in peeling and conservation.

The designation of 'mini-cassava' proposed in this work is called 'minitolete'; 'cateto' and 'rubiene'. The 'minitolete' is derived from the longitudinal section of the 'middle oarlock'. The 'cateto' originates in the hub after passing on the "burnishing" similar to that obtained after carrot burnishing [14], while 'rubiene' originates from the 'minitolete', also after turning. In all cases, these shapes add value to cassava; can make consumer's life easier for: cooking fast and not requiring pressure cooker and besides being different and attractive shapes. Thus, it is necessary to establish appropriate methodologies for each cassava

shape minimally processed, with quality and satisfactory yield.

Thus, developing minimal processing procedures with focus on water immersion, cutting, turning and centrifugation are necessary for filing procedures for different varieties of cassava produced in the Semiarid region of Pernambuco.

Therefore, the objectives of this work were to adequate procedures in the minimal processing, with respect to water immersion, cutting, turning and centrifugation, for two cultivars of cassava, "Rosinha" and "Recife", and alternative shapes called 'mini-cassava'.

II. Material and Methods

A. Immersion time in water before peeling and centrifugation for cassava 'mintolete'; 'cateto' and 'rubiene'.

1. Obtaining the raw material

Cassava of varieties 'Recife' or 'Rosinha' were used, taken from the district Cachoeirinha-Pernambuco at 8 months old. They were transported to the Academic Unit of Serra Talhada (UAST / UFRPE). The roots were weighed, washed in water and refrigerated at 8 ± 2 ºC for 24 hours.

2. Minimal processing and preservation

The oarlocks were immersed in cold water for 0, 5 and 30 minutes; cut in the shape of 'minitolete'; immersed in cold water for 10 seconds, followed by immersion in chlorinated solution to 8 °C (200 mg L^{-1}) (dehydrated sodium dichloroisocyanurate) for 10 minutes and chloride solution of 5 mg L^{-1} for 10 minutes. Subsequently, about 250 g of 'minitolete' and 800 g of 'cateto' or 'rubiene' were centrifuged in domestic centrifuge (model C2A05BBBNA) with average maximum angular velocity of 2800 rpm for 0, 30, 60, 90 and 120 seconds.

Approximately 200 g of each shape were packed in polypropylene bag (PP) 150 x 100 mm and 0.6 µm thick and kept under cold storage at 8 ± 2 °C for 'mini-oarlock' and 5 ± 2 °C for 'cateto' and 'rubiene'.

3. Assessing the level of difficulty and peeling time

Seven hundred grams of cassava cuttings with approximately 6 cm in length were separated and peeled by trained personnel. The following criteria were used to evaluate the difficulty to peeling (periderm shift), being considered:Easy, scores from 1 to 2.9 = removal of the entire periderm with the aid of a blade, intending for up to twice the periderm in the opposite direction of the pulp; Moderate, scores from 3 to 4.9 = removal of the entire periderm with the aid of blade intending for three to four times the periderm in the opposite direction of the pulp and Hard, scores from 5 to 6 = removal of the entire periderm with the aid of a blade, intending more than four times the periderm in the opposite direction to the pulp.

The time for removing the periderm was quantified by strippers, obtaining the mean.

4. Periderm Thickness

It was measured with the aid of a digital caliper after peeling.

5. Fresh mass and temperature evolution

About 250 g of 'minitolete' were weighed in a semi-analytical scale (BEL Engineering) before and after each time of centrifugation.

The temperature was measured using a spray gun with infrared sensor (TS-500 INCOTERM) before and immediately after each time of centrifugation and burnishing to the shapes 'cateto' and 'rubiene', as at each stage of minimal processing.

6. Evaluation of fresh weight loss

During storage, packages were weighed in semi-analytical scale (BEL Engineering) on days 0, 3, 4, 6, and 8 for sweet cassava cultivar Recife and on days 0, 2, 4, 6 and 8 for the cultivar Rosinha. The percentage of fresh weight loss was calculated based on the values of masses obtained at baseline (day 0) and every valuation date.

7. Visual assessment

The visual assessment was performed during the days of conservation, based on a subjective rating scale from 5 to 1. Where score 5 corresponded to pieces/shapes with quality for marketing; Score 4 - pieces with mild early browning; score 3 - pieces with moderate intensity of browning; score 2 - pieces with the greenish-yellow coloring on the surface, characteristic of *Pseudomonas* sp. , and score 1- pieces with whitening on the surface, possibly caused by the starch deposition with dehydration.

8. Qualitative evaluation of 'Pseudomonas sp.'

To evaluate the presence of *Pseudomonas* sp. was used the cultivate Rosinha, only peeled and cut into 'minitolete' and packaged in polypropylene bag (150 x 100 mm and 0.1 µm thick) called unprocessed sweet cassava; harvested, immersed for 30 minutes or not in cold water before peeling and; peeled cut into 'minitolete'; sanitized; centrifuged for 30 seconds and packed. In all cases the preservation was 8 ± 2 °C. Images were captured by using: digital camera without using "flash", darkroom chamber and ultraviolet lamp (366 nm) to detect fluorescence, characteristic of *Pseudomonas* sp.

9. Statistical Analysis

The test was conducted in a factorial design that evaluated three times of immersion in water (0, 5 and 30 minutes) in 5 days of analysis (days 0, 2, 4, 6 and 8 for Cultivar 'Rosinha' and days 0, 3, 4, 6, and 8 for Cv. 'Recife').

In assessing the degree of difficulty and time for peeling, it was performed mean Tukey test at 5% probability.In the assessment of yield and periderm thickness, descriptive data analyses were used.

B. Adequacy of turning to 'rubiene' and 'cateto' cassava

1. Obtaining the raw material

Cassava of cultivar Rosinha were used, agroecologically cultivated, harvested in Triunfo - PE at 12 months of age. They were transported to the Unidade Acadêmica de Serra Talhada (UAST / UFRPE). The roots were weighed, washed in water and refrigerated at 8 ± 2 ºC for 24 hours.

2. Minimal processing and preservation

The roots were cut; immersed in cold water for 5 minutes and periderm was removed. Approximately 1.5 kg

of pieces (3-cm edge cubes or half cuttings with 3 cm thickness) was machined for 1, 2 and 3 min using burnishing machine (SKYMSEN model, DB-10). Then, they were immersed into cold water for 10 seconds, followed by immersion in chlorinated solution at 8 °C (200 mg L^{-1}) (dehydrated sodium dichloroisocyanurate) for 10 minutes and chlorinated solution of 5 mg L^{-1} for 10 minutes and centrifuged for 30 seconds.

Approximately 200 g of "cateto" and "rubiene" were packed in polypropylene bags (PP) 150 x 200 mm and 0.6 µm thick and kept in cold chamber storage at 5 ± 2 ºC for 8 days..

3. Temperature evolution

The external temperature was measured before and after each burnishing time.

4. Experimental Yield

It was obtained through the mass of raw material and mass in the different stages of minimal processing. After cutting/peeling, burnishing and after product had been finished (total yield).

5. Volume lost in turning

The lost volume was obtained by the indirect method from water displacement after immersion of pieces before and after burnishing in beaker of known volume.

6. Visual assessment

The visual assessment was performed by means of a subjective rating scale as previously described.

7. Cooking time

Cooking tests were made with pieces of 'rubiene' and 'cateto at the beginning (day zero); four and eight days. In stainless steel container with 1500 mL of water previously boiled, 100 g 'cateto' or 'rubiene' were added. The container was kept closed until baking. Every 10 minutes, the container was opened for tissue penetration with a kitchen fork. When the tissue was soft the firing stopped.

8. Statistical Analysis

The test was conducted in a factorial design evaluating three times of burnishing (1, 2 and 3 minutes) on 5 days of analysis (days 0, 2, 4, 6 and 8 days).

In the evaluation of fresh weight, measure of edges and yield, the descriptive data analysis was used.

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III. Results and Discussion

A. Immersion in cold water can facilitate the peeling and minimize browning and incidence of 'Pseudomonas sp.' in 'minitolete'

It was found that the average time to peeling the Rosinha cultivar was 3 minutes 43 seconds for sweet cassava not immersed; one minute and 11 seconds for sweet cassava immersed for 5 minutes and, 2 minutes and 27 seconds for cassava immersed for 30 minutes (Fig.1). To Recife cultivar, the average time was 2 minutes and 21 seconds for cassava not immersed; 2 minutes and 36 seconds for sweet cassava immersed for 5 minutes and; 2 minutes and 41 seconds for sweet cassava immersed for 30 minutes (Fig.1).

In addition, the Recife cultivar obtained scores between 3 and 4, considered as moderate difficulty to peeling (Fig.1). While cultivar Rosinha, "oarlock" not immersed had scores of 4.7 considered as moderate easily, and for "oarlock" immersed for 5 or 30 minutes, scores were between 1 and 2, characterized as easy to peeling (Fig.1).

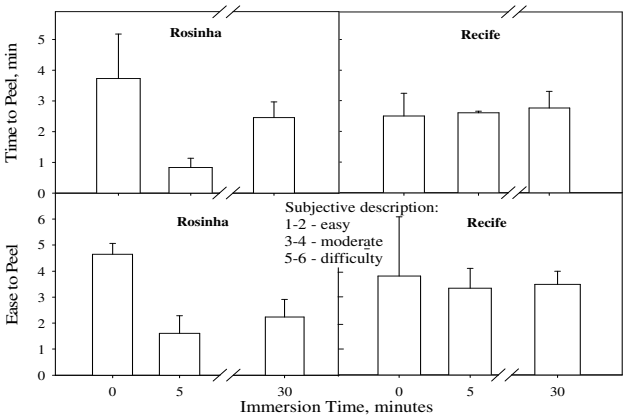

Fig.1. Time for peeling and difficulty to peeling (easy peel) 700 g of oarlock of cassava of Recife and Rosinha cultivars and immersed in water at 9 ± 2 °C for 0, 5 and 30 minutes. The vertical bar means the standard deviation. Serra Talhada-PE, UFRPE/UAST, 2012.

It is believed that these results may be explained partly by the shorter periderm thickness of Recife cultivar (2 ± 0.3 mm). Furthermore, washing in water and maintenance in cold chamber for 24 hours might have been sufficient to keep hydrated the surface of sweet cassava cultivating, needing no additional hydration. As the cultivar Rosinha had thicker periderm (2.5 ± 0.5 mm), during its withdrawal the pieces were taken whole without the need for additional power, which did not happen to the cultivar Recife, in which the periderm was breaking constantly.

The evaluation of mass loss during the storage of 'minitolete' from both cultivars was similar (data not shown). Moreover, until the eighth day, 'minitolete' immersed for 5 or 30 minutes derived from cv. Rosinha or Recife had scores equal to or greater than 3, which means that 'minitolete' had better appearance with regard to darkening (Fig. 2A and B). Unlike 'minitolete' not immersed, in which from the third or fourth day scores were close to 3, regarded with intense browning (Fig.2A and B).

When assessing the effect of *Pseudomonas* sp. The surface fluorescence increased from four (4) days in unprocessed 'minitolete' (Fig.3). While in sweet cassava immersed and minimally processed the fluorescence did not increase until six (6) days (Fig. 3). The fluorescence is indicative of incidence of *Pseudomonas* sp. [12].

Thus, immersion in cold water for 5 or 30 minutes resulted in agility to peeling just for cultivar Rosinha and minimized the incidence of *Pseudomonas* sp.. Moreover, this management minimized symptoms of darkening in conservation for both cultivars minimally processed. This indicates that the immersion procedure should also be adopted for the purpose of quality in conservation.

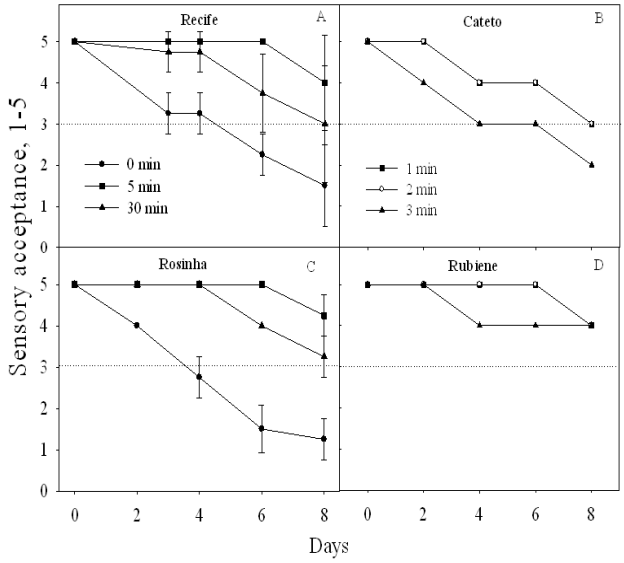

Fig.2. Scores on Appearance of cassava cv. Recife (A) and cv. Rosinha (B) subjected to immersion for 0, 5 and 30 minutes and minimally processed in 'minitolete'. Figure C and D represent time of turning (1, 2 and 3 minutes) of shapes 'cateto' (C) and 'rubiene' (D). The cvs. Recife and Rosinha (A and B) were maintained at 8 ± 2 ºC. While 'cateto' and 'rubiene' shapes (C and D) were kept at 8 ± 2 °C. Serra Talhada-PE, UFRPE/UAST, 2012.

B. Adequacy of cutting and turning to 'mini-cassava' processed in the shapes 'rubiene' and 'cateto'

It was found that in the process of cutting/peeling in cubes in order to obtain the 'cateto' resulted in average yield around 40% (Figure 4), different from cuts to obtain the 'rubiene', with average yield exceeding 60% (Figure 4). The low yield obtained in the process of cutting/peeling in cubes is due to removal of the periderm and part of parenchymal tissue. That has not happened when obtaining 'rubiene', in which only the periderm was removed.

It was observed that with increasing turning time, there was a gradual decrease in yield proportional in both shapes (Figure 4 B). The decreased yield was due to the contribution of the burnishing machine to remove the outermost tissue by abrasion. When measured indirectly the volume of pieces, it was observed that the longer the time, the greater the removal of outer tissue for the next cateto 400, 800 and 1000 cm^3 in times of 1, 2 and 3 minutes, respectively. For 'rubiene "the volume removed was approximately 200, 700, and 900 cm^3 in times of 1, 2 and 3 minutes, respectively.

It was also found that the total yield of the shape 'minitolete' was close to 70%. In the shape 'cateto' total income was close to 20% and while in 'rubiene' it was 45% in the time of one (1) minute of burnishing (Figure 4 C).

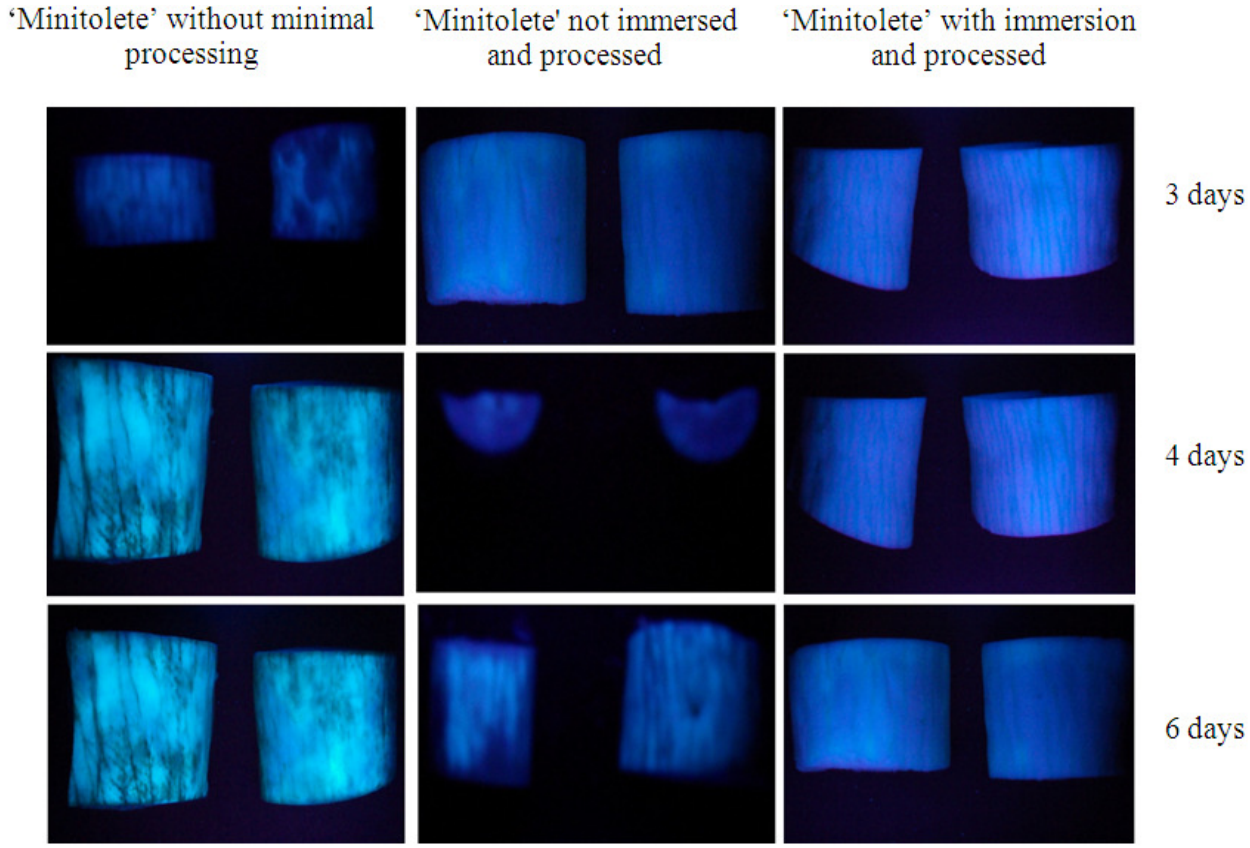

Fig.3. Incidence of *Pseudomonas* sp. per fluorescence in cassava of ' minitolete' shape cv. Rosinha with no minimal processing, not immersed in water and processed and with immersion in water and processed, stored over 8 days at 8 ± 2 °C. Serra Talhada-PE, UFRPE / UAST, 2012.

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The turning studied for sweet cassava aims at causing rounding of the edges, getting a more sensible shape. For other roots such as carrots and potatoes, burnishing beyond rounding, also aims at removing the periderm [15], so for 'baby carrots' two burnishing machines are used and a total time greater than 2 minutes [16]. In the present work, the time of 2 minutes was the most suitable, due to its higher yield over three minutes burnishing. Furthermore, it provided appropriate rounding of the edges, which was not obtained with 1 minute burnishing, even with higher yield (Figure 4 C).

In general, the shape cateto presented lower yield burnishing in the end, enhanced by burnishing for 3 minutes. However, the shape in which the pieces were more uniform, smaller and possibly more attractive, hence the need for analysis of acceptance.

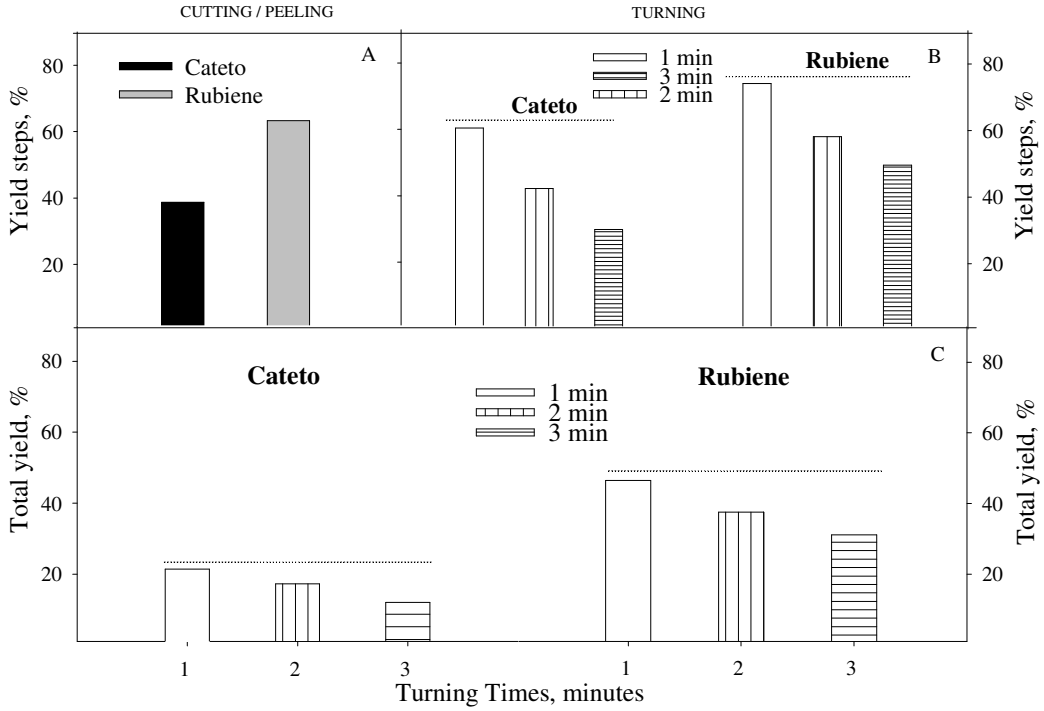

Fig.4. Yields resulting from the step of cutting/peeling(A) and turning(B).Totalyieldafterturningby1, 2 and3 minutes to the formats 'cateto' and 'rubiene' (C). Serra Talhada-PE, UFRPE/UAST, 2012.

In the cooking test, it was found that the shape 'cateto' cooked faster than 'rubiene' at the beginning and after 4 days of conservation (data not shown). This is due to a smaller volume of 'cateto' close to 340 cm^3, different from 'rubiene' close to 460 cm^3. On the other hand, the 'cateto' from 6 days was tough and fibrous, especially when burnishing for 3 minutes, this resulted possibly at higher cooking time on 8 days compared to 'rubiene' (data not shown). Moreover, even after 30 minutes, 'cateto' had not been cooked, remaining very firm, apparently inappropriate for consumption. This may be due to a higher proportion of fibers, secondary xylem, compared to the non-fibrous tissue present in the 'cateto', since the cube was originated from the center of cassava. Adding to this, it is suggested the synthesis of fibers.

Associating with the preservation quality, the shape 'rubiene' retained good general characteristics for consumption until eight days at 5 °C, regardless of the time of turning (Figure 2 D). While the shape 'cateto' had higher more browning symptoms after four days of conservation, especially the pieces burnished for 3 minutes (Fig. 2 C). This may be due to major injuries being caused to the cubes as they suffer mechanical damage and injuries with the sandpaper of the burnishing machine. In addition, the 'cateto' and 'rubiene' from 6 days showed yellowish spots, sticky consistency and odor fermentation compromising the quality (Fig. 2C and D). It is believed that 30 seconds of centrifugation was not sufficient to remove the water absorbed/adsorbed on the minimal processing.

C. Centrifugation time for minimally processed cassava in 'minitolete'; 'rubiene' and 'cateto' shape.

There was sharp decline in ratio of final (after centrifugation) to initial mass (post-turning or before sanitization) in the first 30 seconds of centrifugation for the 'minitolete' shape (Figure 5). For 'cateto' and 'rubiene' shapes, the sharpest drop occurred within until the first 60 seconds (Figure 5). After these times, 30 seconds (minitolete) and 60 seconds (cateto and rubiene), the decrease occurred more smoothly (Figure 5). These curves are usually characteristics for minimally processed products under different centrifugation times [7]-[12]-[17]. The centrifugation time of 30 seconds for 'minitolete', 'cateto' and 'rubiene' was sufficient to remove excess water adsorbed/absorbed into the sanitizing and rinsing, because the ratio was very close to 1 (Figure 5). However, in either 'cateto' and 'rubiene' centrifuged for 30 seconds, associating with the product appearance of after 6 days of storage, both shapes had sticky consistency, characteristic odor of sour and yellowish spots, typical of *Pseudomonas*

sp. Moreover, these shapes centrifuged for 60 seconds showed no symptoms described above, even if the final/initial mass ratio had been below 1 (Figure 5).

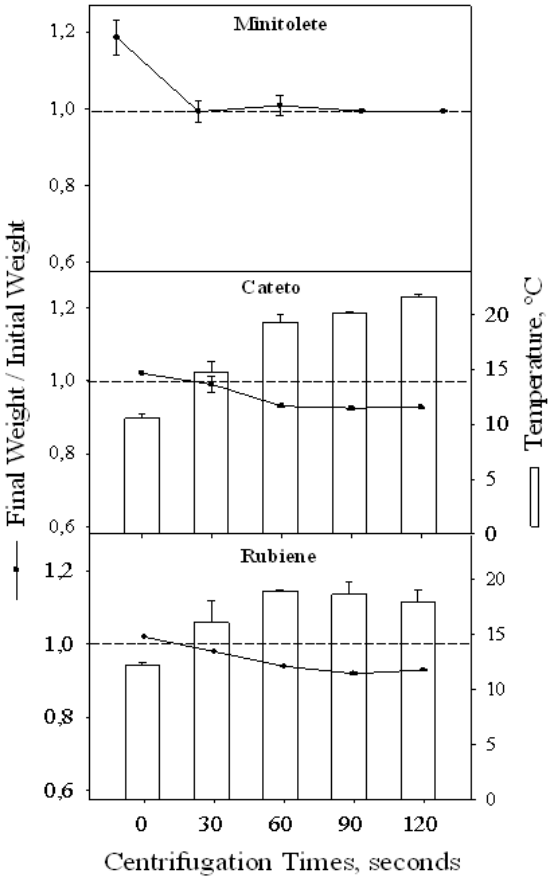

Fig.5. Final mass ratio (after centrifugation)/initial mass (after turning or before sanitizing) (—●—)and temperature (▭) after increasing centrifugation times for cassava 'minitolete', cateto' and 'rubiene'. The vertical bars represent the standard deviation of the mean. Serra Talhada-Pernambuco, UFRPE/UAST, 2012.

It is believed that this behavior is due to the initial mass used as a reference, which was the mass before sanitizing or after turning. It is known that during turning, running water is added to the system to reduce the friction. Therefore, the water can be absorbed/adsorbed by the tissue so that, overall, it is believed that the most appropriate time exceeds 30 seconds, even though the water difference was minimal between 30 and 60 seconds (Figure 5), but enough to alter the organoleptic characteristics of the product.

Thus, it is suggested that for products undergoing burnishing, proper centrifugation time can be used superior to the ratio of mass before and after centrifugation, with the exception of carrots that whitens and the dehydrates under minimal water loss [18].

Observing the appearance of sweet cassava submitted to 120 centrifugation, especially in the early days, resulted in dried and brittle product, besides the intense darkness. Such problems singly or in combination contributed to the product depreciation (data not shown). Between the first and eighth days of storage, it was found for all shapes, a slight tilt in the characteristic curve of mass loss (Figure 6). However, for non-centrifuged pieces, the speed of mass loss was subtly greater showing 0.9, 0.6, and 0.5% for 'minitolete', 'cateto' and 'rubiene' shapes at the end of eight days, respectively (Figure 6). While in earlier times, the mean values did not differ significantly, being close to 0.1% for 'minitolete' and about 0.3% for 'cateto' and 'rubiene' (Figure 6). Possibly, these differences between centrifuged and those not centrifuged pieces were due to accumulation of water absorbed/adsorbed by tissue that remained inside the packaging. This generated a high moisture gradient between the external (outside the package) and internal (inside the package) environments, favoring the water diffusion out of the package, being faster in pieces not centrifuged than in packs containing pieces centrifuged. With the present results, it was found that the minimum processing of cassava is of utmost importance immerging in water prior to peeling for a minimum of 5 minutes to facilitate periderm removal in some varieties, minimize browning and reduce the incidence of *Pseudomonas* sp. in conservation.

IV. Conclusions

The optimal burnishing time for 1.5-kg sweet cassava peices was 2 minutes, regardless of the shape studied, reducing losses and improving the appearance. Centrifugation of 200 g of 'minitolete' was 30 seconds while 800 g of 'cateto' or 'rubiene' it was 60 seconds. In those times the shapes presented desirable characteristics along the cold storage.

Thus, it was found that one way to add value to cassava is the development of alternative shapes, once this root adapted well to innovative shapes. This can result in a breakthrough in culture agribusiness. Furthermore, it was found that some procedures adopted in the minimal processing are specific for each format and may change the quality in conservation.

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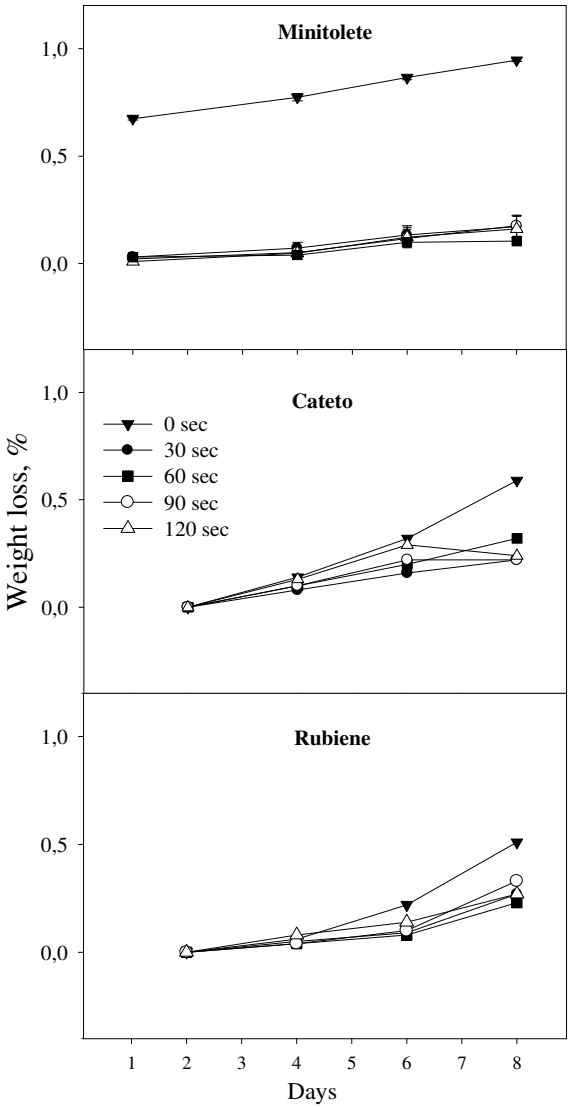

Fig.6. Weight Loss Fresh sweet cassava cultivar Recife, minimally processed informat 'Minitolete' , 'Cateto' and 'Rubiene' cassava, both centrifuged for0, 30,60, 90 and120 seconds. The'minitolete' was maintained at8± 2 ° C, while the 'Cateto' and 'Rubiene' to 5± 2 ° C. Serra Talhada-Pernambuco, UFRPE/UAST, 2012.

REFERENCES

[1] Otsubo A.A. & Aguiar E.B. (2001). Avaliação da produtividade, tempo de cozimento e padrão de massa cozida de cinco cultivares de mandioca de mesa, em Dourados-MS. *Ensaios eCiência*, Campo Grande, v. 5, n. 2. p. 11 – 26.

[2] Empresa Brasileira de Pesquisa Agropecuária –EMBRAPA *Mandioca e Fruticultura Tropical* (2009) [Online]. Available: http://www.cnpmf.embrapa.br.

[3] *Instituto Brasileiro de Geografia e Estatística* (December 2011) Indicadores IBGE: Estatística da Produção Agrícola, [Online]. Available: http://www.ibge.gov.br/home/estatistica/indicadores/agropecuaria/lspa/estProdAgr_2011, 12.pdf.

[4] Ingram JS & Humphries JRO. (1972) Storage of cassava. A review. *Tropical Science*, London, v.9, p. 277-350.

[5] Beeching JR, Dodge AD, Moore KG, Philips HM &Whenhan JE. (1994). Physiological deterioration in cassava: possibilities for control. *Tropical Science*. 34; 335-343.

[6] Cereda MP &Vilpoux O. (2003) Conservação de raízes. In: *Tecnologia, usos e potencialidades de tuberosas amiláceas latino americanas*. São Paulo, Fundação Cargill. p. 13-29; 711p.

[7] Medeiros EAA. *Deterioração pós-colheita da mandioca minimamente processada*. (2009) Dr. Thesis. Universidade Federal de Viçosa, Viçosa-MG. 101p.

[8] Lund DG, Petrini LA, Aleixo JAG &Rombaldi CV. (2005). Uso de sanitizantes na redução da carga microbiana de mandioca minimamente processada. *Ciência Rural*. 35(6):1431-1435.

[9] Alves A, Cansian RL, Stuart G & Valduga E. (2005). Alterações na qualidade de raízes de mandioca (*Manihotesculenta*Crantz) minimamente processadas. *CiênciaAgrotécnica.*29(2): 330-337.

[10] Silva JBC, Lana MM & Vieira JV. (2007). Equipamentos para agroindústria de minicenouras Cenourete e Catetinho. *Horticultura Brasileira,*27: 109-113.

[11] Sousa AED, Paula DA, Melo AAM, Fonseca KS & Puschmann R. (2011). Avaliação do uso de embalagens associado ao uso de revestimento com quitosana em mandioca minimamente processada. In: VI Encontro Nacional sobre Processamento Mínimo de Frutas e Hortaliças, Nova Friburgo, RJ. *Anais*. CD-ROM.

[12] Junqueira MS. (2009). *Conservação de mandioca minimamente processada no formato "palito"*. Universidade Federal de Viçosa, Viçosa-MG. 62p. (Dr. thesis).

[13] Marques CS, Simões NA, Melo AAM & Puschmann R. (2009). Rendimento e análise de mandioca (*Manihot Esculenta Crantz.*) minimamente processada em diversos formatos. In: *Simpósios da UFV: XIX de Iniciação Científica – SIC; IX Mostra Científica da Pós Graduação – SIMPOS; VII de Extensão Universitária – SEU e III de Ensino* – SEM, 21 to 24 octubre 2009.

[14] Lana MM, Vieira JV & Silva JBC. (2001). Cenourete e Catetinho: minicenouras brasileiras. *Horticultura Brasileira*, Brasília. v. 19, n. 3, p. 376-379,

[15] Silva JBC, Lana MM & Vieira JV. (2009). Equipamentos para agroindústria de minicenouras Cenourete e Catetinho. *Horticultura Brasileira,* 27: 109-113.

[16] Diniz Lt, Puschmann R, Simões NA, Costa FB, Moraes FFF, Takayama AA & Freitas MA. (2007). Tempo de Torneamento de cenoura para obtenção de minicenoura. In: XVI *Simpósio de Iniciação Científica*, VI SIMPÓS-Mostra Científica da Pós-Graduação, IV Simpósio de Extensão Rural, Viçosa, MG.

[17] Simões ADN, Costa FBC, Carnelossi MAG, Silva EO & Puschmann R. (2007). Estratégias para reduzir o estresse do processamento mínimo. *Visão Agrícola*, 7, p. 92 – 97.

[18] Simões AN, Ventrella MC, Moretti CL, Carnelossi MAG & Puschmann R. (2010). Anatomical and physiological evidence of white blush on baby carrot surfaces. *Postharvest Biology and Technology,* 55; 45–52.

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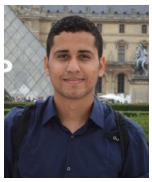

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