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OPTIMIZATION OF DIFFERENT PARAMETERS FOR DRIED SOURSOP SLICES

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ABSTRACT

Soursop is a typical fruit with high nutritonal value. Its high perishability of soursop and the short shelf life after harvesting are the main difficulties in enhancing its potential market for fresh fruit consumption. The soursop (*Annona muricata*) fruit is usually transformed into juice, pulp and concentrate. In order to accelerate its valuable characteristics, present investigation was carried out to optimiz different parameters for processing of dried soursop slices An investigation of maturity of soursop fruit, soaking time with $CaCl_2$, blanching time and temperature, sugar concentration and time of soaking, drying temperature to the dried soursop slice quality was conducted. We also monitored product shelf-life during preservation. Results of present study revealed that maturity of soursop material at 15 ^{o}Brix, 10 mm in depth of soursop slice, deep soaking in $CaCl_2$ 0.5% in 6 hours; blanching at 90^{o}C in 2 minutes; sugar concentration in 50 ^{o}Brix and soaking additives in 4 hours; drying its slice at 65 ^{o}C to get 14% moisture content in the dried soursop slice. Shelf-life of this product could be extended to 6 months without deterioration in PA bag.

KEYWORDS: ***Dried soursop slice, maturity, blanching, soaking, drying, shelf-life***

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INTRODUCTION

Soursop (also graviola, custard apple, and in Latin America, guanábana) is the fruit of *Annona muricata*, a broadleaf, flowering, evergreen tree. The exact origin is unknown; it is native to the tropical regions of the Americas and the Caribbean and is widely propagated**.** It is in the same genus, *Annona*, as cherimoya and is in the Annonaceae family. Annona muricata is a small, upright, evergreen tree that can grow to about 30 feet (9.1 m) tall. The fruits are dark green and prickly. They are ovoid and can be up to 30 centimetres (12 in) long, with a moderately firm texture. Their flesh is juicy, acid, whitish and aromatic. Soursop (*Annona muricata*) fruit is also rich in carbohydrates, particularly fructose. Soursop has many therapeutic properties. The juice is diuretic while the other parts are antibacterial, anticancer, astringent, sedative, and houses other properties too.[1] There were several researches mentioned to soursop production. The processing and quality evaluation of soursop nectar was identified.[2] The soursop is consumed to obtain its pulp, juice, nectar, canned goods and other processed products.[3] The soursop fruit is usually transformed into juice, pulp and concentrate.[4] A fermented beverage from soursop fruit was produced.[5] The effect of various dehydration techniques such as sun drying, solar drying, drying after freezing, vacuum drying and drying using lab scale air oven on physicochemical and retention of antioxidant in different fruit powder prepared from SourSop *(Annona muricata)* was assessed.[6] Soursop liquors were prepared by varying the concentrations of pulp and sucrose syrup with different contents of total soluble solids and evaluated the effects of these on the physical and chemical characteristics of the beverages.[7] A good quality soursop vinegar as an innovative method to preserve and utilise the soursop fruit was produced.[8] A production of probiotic soursop juice and determination of properties of the juice samples was carried out.[9] The commercial utilization of this fruit is hindered by the lack of adequate processing techniques. The objectives of present research were to optimize various parameters for processing of dried soursop slices. This study focused on the investigation of maturity of soursop fruit, soaking time with $CaCl_2$ 0.5%, blanching time and temperature, sugar concentration and time o soaking, and drying temperature to the dried soursop slice quality. Further, shelf-life were also monitored during preservation of product.

MATERIAL & METHODS

Material

Figure 1
Soursop fruit

We cultivated soursop from Soc Trang province, Vietnam. Soursop fruits should be cultivated following Vietnamese Good Agriculture Practices (VietGAP) to ensure food safety. After harvesting, fruits were stored and carried in laboratory within 4 hours of harvesting. Besides soursop fruit laboratory grade chemicals such as sugar, $CaCl_2$ and ascorbic acid was also used in present study. Lab utensils and equipments included pH meter, weight balance, thermometer, refractometer, cooker, drying oven. During study various physicochemical characteristics such as moisture content (weighing sample before drying → drying sample to basic weight → weighing sample after drying), total sugar (using Betrand method), soluble dry matter (using hand-held refractometer) and sensory evaluation (score, 1-5 from organoleptic specialists) was evaluated.

Research method

Determination of soursop maturity for processing

To get the best quality of dried soursop slice, appropriate mature fruit ready for processing was

selected. By examing four groups of soursop fruits having different dry matters (11, 13, 15, 17 ^{o}Brix) in raw material, the sliced soursop would be dried at 65^{o}C to 14% moisture content. In order to select the right fruit maturity; pH, total acidity, vitamin C, sensory characteristics of raw soursop pulp were analyzed.

Determination of primary treatment time with $CaCl_2$

The soursop pulp having 15 ^{o}Brix (sliced in 10mm) must be deeply soaked in 0.5% $CaCl_2$ in wide range of time (2, 4, 6, 8 hours). Then the sliced soursop dried at 65^{o}C to 14% moisture content. In order to select the right time of primary treatment with $CaCl_2$, sensory characteristics of dried soursop slices was evaluated

Determination of blanching time and temperature

After selecting the right fruit maturity (15 ^{o}Brix), soursop pulp would be peeled, sliced in 10mm depth, soaked in 0.5% $CaCl_2$ for 6 hours and blanched 80, 85, 90, 95^{o}C in 1, 2, 3, 4 minutes. The sliced soursop would be dried at 65^{o}C to 14% moisture content. In order to select the right time and temperature of blanching; the effectiveness of enzymatic inactivation via color characteristic was examined.

Determination of sugar concentration and time of soaking

The soursop pulp having 15 ^{o}Brix was sliced 10 mm, soaked in 0.5% $CaCl_2$ for6 hours, blanched at 90^{o}C in 2 minutes, the treated piece would deep soaked in different sugar concentration (46, 48, 50, 52 ^{o}Brix) in different time (2, 4, 6, 8 hours) with the present of ascorbic acid 0.2%. The sliced soursop would be dried at 65^{o}C to 14% moisture content. In order to select the right sugar concentration and time of soaking; sensory characteristic of dried soursop slices were analyzed

Determination of drying temperature

The soursop pulp having 15 ^{o}Brix which was sliced 10 mm, soaked $CaCl_2$ 0.5% in 6 hours, blanched at 90^{o}C in 2 minutes, the treated piece would be then deep soaked in sugar concentration of 50 ^{o}Brix) in 4 hours with the present of ascorbic acid 0.2%. The sliced soursop would be dried at (55, 60, 65, 70^{o}C) to 14% moisture content. In order to select the right drying temperature; we analyzed the weight change and sensory characteristic of dried soursop slices

Observation the shelf-life of finished products

The dried soursop slice must be monitored in terms of the changes of a_w, color and moisture in finished product by time (2, 4, 6, 8 months) in PA bag to evaluate the product shelf-life.

STATISTICAL ANALYSIS

Data were statistically summarized by Statgraphics Centurion XVII.

RESULT & DISCUSSION

Effect of soursop maturity for processing of dried soursop slices

Fruit maturity is a very important criterion for product quality. Soursop pulp was strongly affected by the maturity. The soursop fruits were nornally all collected at 16 weeks after floral bud formation.[10] In this research, we measured soursop maturity via soluble dry matter inside material. 4 samples having different soluble dry matter contents (11, 13, 15, 17 ^{o}Brix) were examined. Among these values, optimal soursop maturity was reported at 15 ^{o}Brix (Table 1) so this value was choosen for further studies

Table 1
Different soursop pulp maturity for processing

Soluble dry matter (^{o}Brix)	pH	Total acidity (%)	Vitamin C (%mg)	Sensory score (1-5)
11	2.6±0.04^{c}	0.91±0.00^{a}	29.11±0.02^{c}	3.17±0.01^{c}
13	2.9±0.02^{c}	0.75±0.01^{b}	32.43±0.03^{b}	3.94±0.02^{b}
15	3.6±0.03^{b}	0.43±0.00^{c}	35.07±0.04^{a}	4.58±0.00^{a}
17	4.0±0.02^{a}	0.39±0.01^{d}	28.22±0.03^{d}	3.15±0.01^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and c was the lowest

The moisture content of different samples ranged from 18.33 to 24.53%, with an average of 21.43% was shown. The pH was between 4.1 and 4.8 with a mean acidity of 1.75%. The soursop pulps were rich in nutrients such as carbohydrates (23.05%), proteins (7.41%), ash (2.22%) and fiber (24.73%).[11]

Effectiveness of primary treatment time with $CaCl_2$ to sensory characteristics of dried soursop slices

During processing, some insoluble pectins are lost, and there is an increase of water soluble pectins which cause changes in physical properties, such as texture, leading to tissue softening.[12] $CaCl_2$ (0.5%) treatments strongly affected to sensory characteristics of soursop fruit, especially color and firmness. By 6 hours of treatment with $CaCl_2$ (0.5%), optimal sensory score of soursop was reported during the study (Table 2), so this duration was selected for next level study

Table 2
Effectiveness of treatment time with $CaCl_2$ 0.5% to sensory characteristics of soursop pulp

Time of soaking (hour)	Texture score	Color score	Flavor score	Aroma score
2	2.22±0.01^c	2.94±0.00^c	2.74±0.01^c	2.69±0.03^c
4	3.18±0.01^b	3.45±0.01^b	3.28±0.02^b	3.33±0.01^b
6	4.25±0.03^a	4.36±0.02^a	4.29±0.02^a	4.41±0.02^a
8	4.27±0.02^a	3.51±0.04^b	3.21±0.01^b	4.43±0.02^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and c was the lowest

This result was similarl to another research. They demonstrated effect of stepwise blanching with calcium chloride solution on firmness, calcium absorption and microstructural changes of jalapeno peppers.[12]

Effectiveness of blanching time and temperature

Blanching strongly affected to pigment formation (discoloration), heat treatment help prevent the enzymatic browning reaction. Among different temperature (80, 85, 90, 95^{o}C) and time duration (1, 2, 3, 4 minutes), it was reported that treatment having 90^{o}C temperature for 2 minutes effectively prevent the formation of browing while it maintaining fruit firmness

Table 3
Effectiveness of blanching time and temperature to enzymatic browning reaction of dried soursop slices

Blanching temperature (^{o}C)	Blanching time (minutes) to soursop discoloration (a value)			
	1	**2**	3	4
80	65.26±0.06^c	66.24±0.03^c	67.02±0.05^c	68.01±0.01^c
85	66.74±0.02^b	68.13±0.01^b	68.85±0.02^b	69.15±0.03^b
90	68.13±0.03^a	70.24±0.01^a	70.29±0.04^a	70.31±0.04^a
95	68.20±0.01^a	70.29±0.04^a	70.31±0.07^a	70.34±0.02^a

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and c was the lowest

This result was quite different with data from another research. They used first blanching at 65°C for 4 min with calcium chloride solutions. Then the samples were subjected to the second blanching in acidified water with 2% citric acid at 96°C for 3 min, to completely stop all enzyme activity and attain a balance between tissue and brine acidity.[12]

Effectiveness of sugar concentration and time of soaking

Sugar supplementation via soaking would contribute to product sensory acceptance. Different sugar concentration (46, 48, 50, 52 ^{o}Brix) with different time duration (2, 4, 6, 8 hours) in the presence of 0.2% ascorbic acid was evaluated. Result of study revealed that sliced soursop dried at 65^{o}C to 15% moisture content. Further, it was reported that 50 ^{o}Brix of sugar in 4 hours soaking was adequate to get a pleasant sensory acceptance. This values was selected for the next studies

Table 4
Effectiveness of sugar concentration (^{o}Brix) in soaking to sensory characteristics of dried soursop slices

Sugar concentration (^{o}Brix)	Sensory score of dried soursop slices by different soaking time (hours)			
	2	**4**	6	8
46	3.78±0.01^{b}	3.82±0.02^{c}	3.94±0.02^{c}	4.01±0.04^{d}
48	3.82±0.04^{b}	4.13±0.02^{b}	4.20±0.01^{b}	4.38±0.02^{b}
50	4.03±0.02^{a}	4.65±0.01^{a}	4.67±0.01^{a}	4.70±0.01^{a}
52	4.06±0.03^{a}	4.09±0.03^{b}	4.11±0.03^{b}	4.23±0.03^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and d was the lowest

Treatment of fruit with sugars prevents/ reduces the loss of nutrient during drying, facilitates drying and enhances the organoleptic properties of the dried fruit samples. The results showed that sucrose should be recommended in the drying of fruits as it helps to prevent the loss of fruit nutrient during drying, as well as increase the organoleptic properties of the fruit treated with it.[13]

Effectiveness of drying temperature

The increasing consumption of dried fruits requires further attention on the quality parameters. Drying has become necessary because most fruits are highly perishable owing to their high moisture content and the need to make them available all year round and at locations where they are not produced.[14] The hot-air drying method could result in a quality product that is characterized by uniform, hygienic, and attractive color of dried fruit and vegetable products.[15] The sliced soursop dried at different temperature (55, 60, 65, 70^{o}C) to get down to 15% moisture content. Among the tested temperatures, best results and appearance were obtained at 65 ^{o}C, while at 70^{o}C, minor browing discoloration owing to caramel was reported.

Table 5
Sensory score of dried soursop slices by different drying temperature

Drying temperature (^{o}C)	Texture score	Color score	Flavor score	Aroma score
55	3.21±0.04^{d}	3.11±0.02^{d}	3.19±0.01^{d}	3.15±0.02^{c}
60	3.79±0.03^{c}	3.85±0.01^{c}	3.90±0.03^{c}	3.94±0.01^{b}
65	4.45±0.02^{a}	4.39±0.01^{a}	4.52±0.01^{a}	4.40±0.01^{a}
70	4.01±0.02^{b}	4.08±0.02^{b}	4.12±0.03^{b}	4.05±0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and d was the lowest

Drying process can cause changes in food surface characteristics which lead to color changes. Changes attributed to carotenoids and other pigments can also be caused by heat and oxidation during drying. In particular, higher drying temperatures and longer drying times were seen to facilitate greater pigment losses.[16]

Shelf-life of finished product

We monitored the changes of a_w, color and moisture in finished product by time (2, 4, 6, 8 months) to evaluate the product shelf-life. After 6 months, we didn't see any change of water activity, color and moisture. However, a little bit of color change at the 8th month, results of study strongly suggested that products could be intact within 6 months of preservation.

Table 6
Physico-chemical and sensory characteristics of dried soursop slice by preservation time

Preservation time (months)	Water activity (a_w)	Color (a value)	Moisture (%)
2	0.68±0.01[a]	70.25±0.02[a]	14.01±0.01[a]
4	0.68±0.01[a]	70.23±0.03[a]	14.01±0.03[a]
6	0.69±0.00[a]	70.22±0.01[a]	14.02±0.01[a]
8	0.70±0.03[a]	68.01±0.04[b]	14.03±0.04[a]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%), a was the highest and b was the lowest

Present study doesn't use any additive to prolong dried soursop product shelf life. In addition to preservation, the reduced weight and bulk of dehydrated products decreases packaging, handling and transportation costs. Quality changes associated with drying of fruit products include physical, sensory, nutritional, and microbiological. Drying gives rise to low or moderate glycemic index (GI) products with high calorie, vitamin and mineral contents (Adewale O. Omolola et al., 2017).[14]

AUTHOR CONTRIBUTION STATEMENT

This study focused on the investigation of maturity of soursop fruit, soaking time with $CaCl_2$ 0.5%, blanching time and temperature, sugar concentration and time o soaking, and drying temperature to the dried soursop slice quality. Further, shelf-life was also monitored during preservation of product.

CONCLUSION

owing to its pleasant taste and aroma. However, soursop fruit are highly perishable, being very susceptible to bruising and decay. A wide range of studies can be found on fruit processing for soursop fruit. Present study successfully optimized some technical drying parameters for dried soursop slices. By applying different treatment processes, soursop could be preserved with high a product shelf-life.

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CONFLICT OF INTEREST

Conflict of interest declared none.

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