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Quality and Consumer Acceptability of Santol Candy, *Kamias and Balimbing* Prunes

Emma Ruth V. BAYOGAN[1]
and Anne Catherine T. PADILLA[2]
[1]Professor, University of the Philippines-Mindanao Campus, Davao City 8000
[2]1nstructor, DOSCST, Mati, Davao Oriental 8200

Abstract

This study aimed to determine some physico-chemical characteristics of santol candy, kamias prunes and balimbing prunes; as well as the microbial safety of these dehydrated fruits, and; know the consumer's acceptability of these processed fruits in Mati, Davao Oriental. Santol was plumped for 1, 2, 3 and 4 weeks which served as treatments. These dehydrated fruits were also stored at ambient for about four months for santol and three months for kamias and balimbing. The data gathered were % moisture content, total soluble solids (TSS), % titratable acidity (TA), pH, total plate count (TPC), yeast and mold count (YMC) and consumer preference. Moisture content for santol candy generally increased towards the second month of storage although there was again a decrease on the fourth month. TSS of santol candy generally decreased over time. A significant difference for % Tawas noticeable during the first two months of storage, and on the last two months, results did not vary significantly on all treatments. Significant differences on the pH between treatments were seen before and after four months of storage. An increasing trend in TPC and YMC was noticeable during the 4-month storage at ambient.

Keywords: moisture content, TSS, TA, pH, TPC, YMC, processing: Sandoricum koetjape, Averrhoa bilimbi, Averrhoa carambola

Introduction

The Philippines as a tropical country boasts of a variety of fruit species. Only a few of these contribute directly to the economy of the country. Today, however, many fruits are considered promising in terms of nutritional components and potential economic values (Coronel, 1986). Santol (Sandoricum koetjape), Kamias or Iba (Averrhoa bilimbi) and Balimbing (Averrhoa carambola) are considered underexploited. These are common backyard trees in many tropical countries in Asia. Santol and

Balimbing are often consumed fresh while Kamias is used in some local dishes. These fruits maybe processed into a variety of products (Guzman, 1977). Processing of these fruits into dehydrated candy is a simple way of adding value to the commodity. This is first done by plumping fruits in highly concentrated sugar solution until the latter replaces the natural acids and liquids from the fruit tissues. The plumped fruits are then dehydrated to improve eating quality and storability.

Objectives

1. To determine some physico-chemical characteristics of santol candy, kamias prunes and balimbing prunes,
2. To determine the microbial safety of the dehydrated fruits using total plate count and yeast and mold count before and after storage, and
3. To verify consumer acceptability of santol candy, kamias prunes, and balimbing prunes in Mati, Davao Oriental.

Materials and Methods

Preparation of Fruits

Santol. Ripe, newly-harvested 'native' santol fruits purchased from Madang market in Mati, Davao Oriental were used. The fruits were washed thoroughly to remove surface dirt, peeled thinly, seeds discarded, pulp sliced into wedges, and soaked overnight in lime-cornstarch solution (1/4 c lime and 8tsp cornstarch per 4 L of water). Soaked pulp was rinsed thoroughly in running water for two or three times. Soaking solution was discarded.

Kamias and balimbing. Fruits were selected and prepared following the procedure of Inderio and Marundan (2002). Mature-green and 50% yellow (for kamias and balimbing,) respectively; firm, and medium-sized fruits were sourced out from household backyards in Mati, Davao Oriental. Fruits were washed, cleaned and trimmed by removing the hair-like floral remnants at the pedicel-end of the fruit. The fruits were pricked all over with a fork to facilitate extraction of juice when rolled against a chopping board. Lime solution (ca. 2.7 g lime to 1 L water per kg fruit) was prepared for soaking of the fruits for two hours or overnight. Fruits were rinsed thoroughly to remove traces of lime then drained. The lime solution was discarded after use.

Processing

Santol. For every 3 kg of santol pulp that was soaked and rinsed, 2,25 kg brown sugar was used staggeredly for plumping in 3 days. On the first day, a third of the sugar (0.75 kg) was added to the 3 kg santol pulp. This was boiled for 10 minutes and plumped overnight. On the second day, another third of the sugar (0.75kg) was added to the santol pulp lot followed by boiling for 10 minutes and plumping for a second night. The last third of the sugar was added to the mixture on the third day,

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boiled for 10 minutes and plumped for the third time. Plumping of the santol pulp for 1, 2, 3, and 4 weeks which served as treatments followed. Fruit slices were thoroughly immersed in syrup with the container covered well. The mixture was brought to a boil at the end of each plumping treatment. Fruit pieces were drained of syrup and dried (Fig. 1).

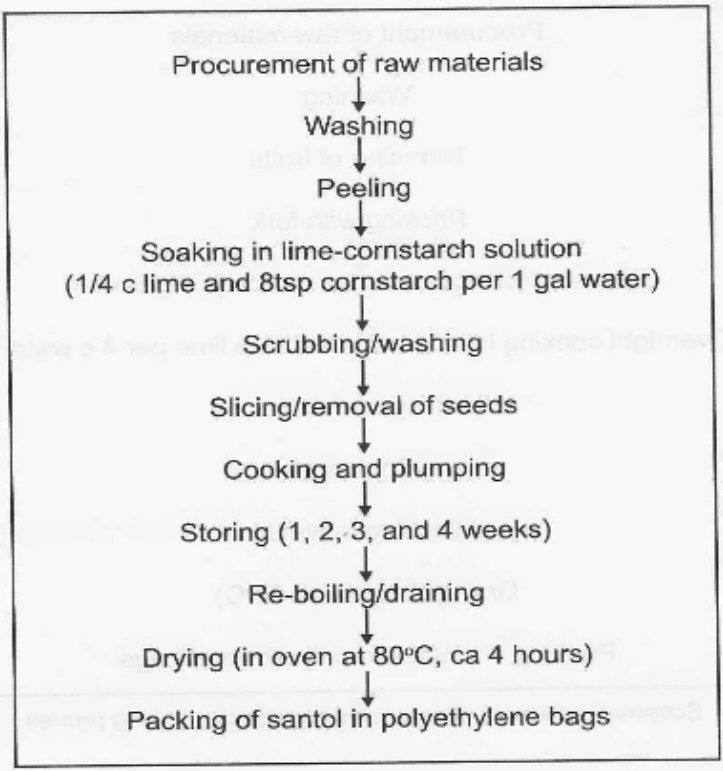

Fig. 1. Schematic diagram of processing santol candy.

Kamias and balimbing. For every kilogram of previously lime-soaked and drained fruits, 500g (2 cups) brown sugar, 4 tbsp soy sauce, 4 pieces bay leaf and 1g citric acid were added. The mixture was heated to boiling until the sugar was dissolved. The fruits were carefully turned over frequently as needed under a low flame till it turned deep brown in color and syrup was almost used up. When done, bay leaves were removed, fruits rinsed lightly in water and drained. The fruits were arranged in single layer on screen trays and oven-dried at 800C for 4 hours (Fig.2, Inderio and Marundan, 2002).

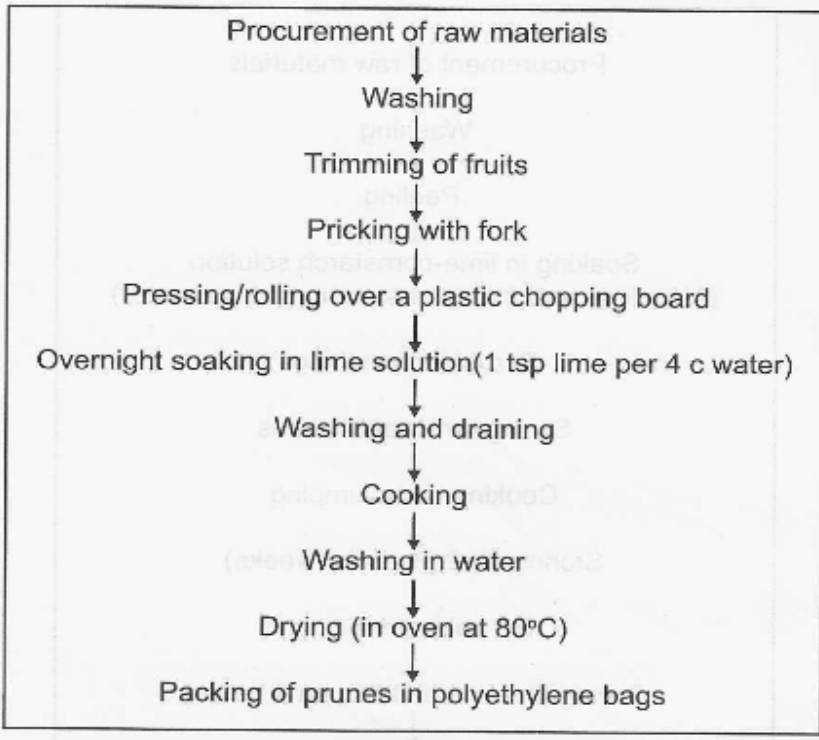

Fig. 2. Schematic diagram of processing kamias/balimbing prunes.

Experimental design

Santol. The experiment consisted of four treatments using four storage periods. Complete randomized design (CRD) was used to compare these treatments with each treatment replicated three times.

Kamias and balimbing. T-test was used to compare results before and after three months of ambient storage. Each analysis was replicated three times.

Data Gathered

% Moisture Content determination. Approximately 5 grams of sample was weighed and dried at 105^{0}C to constant weight.

Total Soluble Solid (TSS) determination. About 10 grams of sample was blended in 20 ml distilled water and filtered. Total soluble solids were determined by putting a drop of the filtrate on the mirror of a digital hand refractometer

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(Atago). Values were read from the refractometer and corrected for dilution.

Titratable Acidity (TA) determination. Fifteen grams of sample was obtained and added with 45 ml distilled water. After filtering, 2.5 ml was obtained and diluted up to 25 ml with distilled water. An indicator was added followed by titration with 0.1 N NaOH.

pH. Blended sample was obtained and pH values were directly read from a pH meter.

Microbiological determination. Microbial tests such as total plate count (TPC) and yeast and mold count (YMC) were determined either at monthly intervals for santol candy while kamias and balimbing prunes were evaluated at initial and after three months of ambient storage.

Consumer acceptability evaluation. Evaluation for general acceptability with the use of the Hedonic scale on 350 respondents from the three most populous barangays in Mati was done for each product from August to September 2002. The survey was done to determine the consumers' preference of dehydrated fruit candies over commercial candies considering purchase of the products at a suggested price and general acceptability.

Results and Discussion

Moisture content

The % moisture content of santol candy, plumped for 1, 2, and 3 weeks before storage differed significantly from each other but not those plumped for 1 or 3 weeks (Table 1). There was generally an increase in the % moisture content as evident towards the second month of storage. Although there was again a decrease on the fourth month.

Total Soluble Solids (TSS)

One, 3 and 4 week-plumped santol candies showed significantly higher TSS than those plumped for 2 weeks (Table 2). Longer plumping of fruits in syrup allowed time for concentration of sugar in the syrup and in the fruit to reach equilibrium. This may also be due to slow penetration of sugar on the fruit tissues. Higher TSS for one week-plumped candy can be attributed to the adhering syrup on the product surface. TSS of santol candy generally decreased over time. When moisture content of dried fruit is not low enough, it caused residual moisture to accumulate on surface known as sweating. Sugar and other soluble solids from the fruit dissolved resulting in a decrease in TSS (Inderio et al., 2002). The decrease in TSS might also be due to microbial utilization and conversion of sugar to acid (Frazier and Westhoff, 1988) which might explain the similarity in TSS of 1 and 4 week-plumped santol candy over storage time.

Table 1. Mean percentage moisture content of santol candy plumped and stored at varying durations.

Storage Duration (month)	Plumping duration (week)			
	1	2	3	4
0	21.67 [a]	21.33 [b]	21.79 [a]	22.27 [c]
1	25.92 [a]	26.07 [a]	23.18 [b]	25.81 [a]
2	30.00 [a]	29.81 [a]	27.09 [a]	29.77 [a]
3	27.62 [a]	27.67 [a]	27.22 [a]	27.32 [a]
4	25.11 [a]	25.91 [b]	24.48 [a]	27.16 [c]

Mean scores within a row with different letter superscripts are significantly different at 5% level (SAS Version 6.12, LSD)

Table 2. Mean total soluble solids (°Brix) of santol candy plumped and stored at varying durations.

Storage Duration (month)	Plumping duration (week)			
	1	2	3	4
0	20.10 [a]	18.53 [b]	20.86 [a]	19.20 [b]
1	19.27 [a]	18.43 [b]	20.30 [c]	19.20 [a]
2	18.90 [a]	18.10 [b]	19.60 [c]	18.90 [a]
3	18.40 [a]	17.90 [a]	18.73 [a]	18.40 [a]
4	18.03 [a]	17.50 [b]	17.66 [c]	18.13 [a]

Mean scores within a row with different letter superscripts are significantly different at 5% level (SAS Version 6.12, LSD)

Titratable Acidity (TA)

A significant difference for percent titratable acidity (Table 3) for santol candy plumped for 2 to 4 weeks and stored 3 -4 months had higher TA- This high percentage of TA in fruits plumped for one week may be due to the short period of plumping, in which sugar has not replaced much of the acid content of santol candy. But on the last two months of storage, titratable acidity in all treatments did not vary significantly. Acid might have been dissolved on the residual moisture that accumulated on the product.

pH

The readings of the pH of the different treatments were done only before storage and after storage. Results (Table 4) showed that there were significant differences between treatments before and after four months storage.

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Table 3. Mean % titratable acidity of santol candy plumped and stored at varying durations.

Storage Duration (month)	Plumping duration			
	1	2	3	4
0	0.030 [a]	0.018 [b]	0.025 [c]	0.022 [c]
1	0.029 [a]	0.020 [b]	0.024 [c]	0.023 [c]
2	0.027 [a]	0.019 [b]	0.023 [c]	0.022 [c]
3	0.025 [a]	0.020 [a]	0.023 [a]	0.021 [a]
4	0.023 [a]	0.021 [a]	0.027 [a]	0.020 [a]

Mean scores within a row with different letter superscripts are significantly different at 5% level (SAS Version 6.12, LSD)

Table 4. Mean pH of santol candy plumped and stored at varying durations.

Duration	Plumping duration (week)			
	1	2	3	4
before storage	2.85[a]	3.00 [b]	3.08 [c]	2.91 [a]
after storage	2.88 [a]	3.01 [b]	2.89 [a]	2.95 [c]

Mean scores within a row with different letter superscripts are significantly different at 5% level (SAS Version 6.12, LSD)

Microbiological analysis

There was an increase in Total Plate Count (TPC) of microbes as the santol candies were stored longer (Table 5). The increasing trend in TPC was consistent in santol candy plumped for one week. The candies plumped for2t04 weeks had higher initial TPC compared with the TPC after one month of storage. TPC was highest at 4 months of storage. On the other hand, the YMC (Table 6) increased consistently in santol pulp plumped for 3 and 4 weeks. The increase in YMC was observed in santol plumped for one and two weeks starting at one month of storage. A high TPC and YMC may be due to the length of time the santol was plumped.

Contamination may also have occurred during handling subsequent to drying and during packaging (Frazier and Westhoff 1988). Similarly, microorganisms

that are resistant to drying may have survived thus, the increase in TPC. The spores of bacteria and molds are especially resistant to storage under dry conditions.

Table 5. Mean total plate count (TPC) (cfu/g sample) from santol candy plumped and stored at varying durations.

Storage Duration (month)	Plumping duration (weeks)			
	1	2	3	4
0	$1.0x10^0$	$4.2x10^2$	$3.3x10^2$	$1.7x10^2$
1	$4.7x10^1$	$2.7x10^1$	$2.2x10^1$	$1.1x10^1$
2	$5.2x10^2$	$6.7x10^1$	$1.7x10^2$	$1.7x10^1$
3	$5.6x10^2$	$1.2x10^2$	$2.4x10^2$	$5.6x10^2$
4	$9.0x10^2$	$1.9x10^3$	$4.9x10^2$	$2.4x10^3$

Table 6. Mean scores for yeast and mold count (cfu/g sample) of santol candy.

Storage Duration (month)	Plumping duration (weeks)			
	1	2	3	4
0	$1.3x10^3$	$1.7x10^2$	$0.0x10^0$	$0.0x10^0$
1	$3.3x10^0$	$2.2x10^1$	$1.7x10^1$	$1.8x10^1$
2	$3.5x10^1$	$1.7x10^2$	$5.0x10^1$	$2.3x10^1$
3	$1.5x10^2$	$3.3x10^2$	$9.0x10^1$	$3.2x10^2$
4	$1.2x10^3$	$8.5x10^3$	$2.2x10^2$	$1.4x10^3$

Kamias and Balimbing prunes

The moisture content of kamias prunes did not have significant increase during 3 months of storage while that of balimbing prunes increased significantly (Tables 7 and 8). TSS significantly decreased while TA and pH significantly increased after storage in both kamias and balimbing. TSS, TA, and pH increased significantly after three months of storing both kamias and balimbing prunes. The low pH of the kamias prunes showed that some degrees of acidity or sourness was retained even after processing.

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Table 7. Mean scores for moisture content (%), TSS (°Brix), TA (%) and pH of *kamias* prunes before and after storage.

	MC, %[1]	TSS, °Brix	TA (%)	pH
Before storage	34.91[a]	26.50[a]	0.033[a]	2.6[a]
After 3 months' storage	34.45[a]	18.10[b]	0.078[b]	2.7[b]

[1]Mean scores within a column with different letter superscripts are significantly different at 5% level using T-test.

Table 8. Mean scores for moisture content (%), TSS (°Brix), TA (%) and pH of *balimbing* prunes before and after storage.

	MC, %[1]	TSS, °Brix	TA	pH
Before storage	23.23[a]	26.30[a]	1.0[a]	4.4[a]
After 3 months' storage	25.72[b]	17.50[b]	1.9[b]	4.6[b]

[1]Mean scores within a column with different letter superscripts are significantly different at 5% level using T-test.

Table 9. Mean scores for TPC (cfu/g) and YMC (cfu/g) of kamias and balimbing prunes before and after storage.

	***Kamias* prunes**		***Balimbing* prunes**	
	TPC, cfu/g sample	YMC cfu/ g sample	TPC, cfu/g sample	YMC, cfu/g sample
Before storage	$0.0x10^0$	$3.3x10^2$	$4.4x10^2$	$1.8x10^2$
After 3 months' storage	$2.2x10^1$	$0.0x10^0$	$3.3x10^1$	$6.7x10^2$

respondents although these have been produced in limited scale at the Davao Oriental State College of Science and Technology for about two years before the Survey (Table 10). Most expressed appreciation to process the fruit and therefore add some value to such neglected fruit crops. After a taste test of the specific product which was individually packed and devoid of labels (Wansink, 2003), over 69% responded that if the products were available, they would prefer these over the common commercial candies. They were even willing to purchase the products provided they are affordable. Majority had expressed good general acceptability of tie products. These favorable taste ratings may or may not however. directly translate into purchase, consumption or market success (Wansink, 2003).

Table 10. Preference and general acceptability by potential consumers of santol candy and kamias/balimbing prunes (n=350)

Response, % Item	Santol Candy	*Kamias* Prunes	*Balimbing* Prunes
Preference of buying dehydrated fruit over commercial candies (should dehydrated fruit be available)			
Yes	72.22	82.19	69.50
No	27.78	17.81	30.50
Willingness to purchase santol candy, bilimbi/starfruit prunes at P5.00 a pack			
Yes	83.12	86.50	82.59
No	16.88	13.50	17.41
General Acceptability			
like extremely	16.13	29.18	23.08
like very much	26.45	18.54	25.85
like moderately	21.94	20.97	16.62
like slightly	27.74	20.97	23.38
neither like nor dislike	5.16	6.69	8.92
dislike slightly	2.26	1.52	1.23
dislike moderately	0.00	0.61	0.31
dislike very much	0.00	1.22	0.31
dislike extremely	0.32	0.30	0.31

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Conclusions and Recommendations

The percent moisture content of santol candy before storage tend to be significantly different from each other. Moisture content increased during the two-month storage but decreased towards the fourth month. TSS of santol candy generally decreased over time. When moisture content of dried fruit was not low enough, it caused residual moisture to accumulate on surface known as "sweating." Sugar and other soluble solids from the fruit become dissolved resulting in a decrease in TSS. Titratable acidity on all treatments did not vary significantly. Acid might have been dissolved on the residual moisture that accumulated on the product. Significant differences on the pH between treatments were noticeable before and after storage.

The increasing trend in TPC was consistent in santol candy plumped for one week. The remaining treatments all had higher initial T PC relative to the TPC after one month of storage. TPC was highest at 4 months of storage. Yeast and mold count increased consistently in santol pulp plumped for 3 and 4 weeks. The increase in YMC was observed in santol plumped for one and two weeks starting at one month of storage. A high TPC and YMC may be due to the length of time the santol is plumped. Contamination may also have occurred during handling.

Percent moisture content of kamias prunes did not differ significantly during the storage period. The TSS, TA and pH had significant difference before and after storage. There were also significant differences on % MC, TSS, TA and pH for balimbing prunes before and after storage. There was an increase in the TPC of the kamias prunes after storage but not balimbing prunes. YMC was increased in balimbing prunes but not the TPC.

Most of the respondents in the taste test had expressed appreciation on the dehydrated products and even considered buying these should these be available commercially.

Further verification of these results is recommended to get the real picture of the trends provided by the study. Commercial feasibility and viability should also scale.

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