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PROCESSING AND QUALITY EVALUATION OF A CARAMBOLA DRINK (*AVERRHOA CARAMBOLA*)

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ABSTRACT: The objective of the study was to utilise carambola fruits in drinks and to investigate the quality changes on storage at 10 °C and 25 °C for 5 weeks. A survey was conducted by 125 questionnaires to guide the objectives of the research. Carambola drinks of 4 treatments (9 % and 12% sucrose with or without 3% orange juice) were processed with 0.2% xanthum gum, 0.125% citric acid, 0.1% sodium benzoate and 0.125% ascorbic acid and pasteurised at 90 °C for 5min. From survey, 86.4% of respondents have eaten carambola fruits, while 26.9% have consumed carambola drinks. Some respondents (51.9%) disliked the acid taste and short shelf-life of the fruits. A carambola/orange drink (12 °Brix) was most preferred (66.4%) by un-trained panelists and was liked moderately to like very much. On storage, there were no changes ($P>0.05$) in °Brix of drinks but products darken more at 25 °C than at 10 °C as indicated by 'L' values.

INTRODUCTION

Carambola is an attractive tropical fruit belonging to the Oxalidaceae family (Morton, 1987). There are two species of Averrhoa belonging to the family Oxalidaceae : *Averrhoa carambola* and *Averrhoa bilimbi.* In Trinidad, there are no named varieties (Andrews and Ragoonath, 1990), but are classified as being 'sour' /tart or 'sweet.' Morton (1987) reported that there are two main classes – the smaller, very sour type, richly flavoured with more oxalic acid and the larger so-called 'sweet' type, mild flavoured with less oxalic acid. Tropical carambola is golden yellow with a touch of brown along the edges when ripe. Fruits are acutely five-angled and distinctly star shaped when cut across. The skin is thin, tender, translucent, crisp and very juicy (Morton 1987). The fruit is waxy in skin texture and deeply ribbed, containing 5-7 ribs. It may range from sour to semi-sweet to sweet in taste. In Trinidad, W.I. Carambola trees are non-seasonal plants, which generally begin production within first 12 to 18 months of planting. It can yield three to five crops per year (Campbell and Marte 1990). Fruit development can take form 61-70 days, depending on the variety type and the weather conditions.The largest crops of fruits mature during May-June, September-October and December-January (Andrews and Ragoonath, 1990), albeit local citizens indicate that their trees bear continuously throughout the year, or with three or four crops per year.

The carambola fruits are easily damaged and thus proper harvesting techniques are critical to the successful storage and marketing of the fruits (Campbell and Marte, 1990). The fruit has a short shelf life and is rapidly oxidised as the slices become brown on exposure to air. This browning effect is related to the oxidation of phenolic compounds by enzymes, particularly the poly-phenoloxidase (PPO) enzyme (Weller *et al.*, 1997). At 10 °C, fruits harvested at the first signs of yellowing can be stored for a maximum of 7 weeks without decay or qualitative losses (Balkissoon 1990). Andrews and Ragoonath (1990) indicated that carambola can be stored at 5 °C for at least 3 weeks or at 7.2 °C for 6 weeks.

Approximately, 25% of the carambola fruit due to its size, shape and appearance do not meet the desired market standards. Hence, they are utilised for process products to decrease waste and improve returns to farmers and growers (Lamberts and Schaffer, 1990). When the fruit is sliced, the pieces are star-shaped, sweet, crisp and juicy, simultaneously making them a tasty garnish on salads and desserts. Carambola provides flavour to stir-fried entrees, puddings, tarts, stews and curries. The fruit can also be cut in cross – sections and dried as sometimes is done in Jamaica with the ripe fruits (Morton, 1987). Our

objective was to utilise carambola fruits to produce acceptable drinks. Various levels of xanthum gum and were added to the drinks and the quality changes on storage at 10 °C or 25 °C for 5 weeks were investigated. A questionnaire was conducted prior to practical investigation to identify the specific objectives of the research.

METHODS

Questionnaire

A questionnaire was conducted prior to the practical investigation on the production of an acceptable carambola drink. The questionnaire was conducted via personal interview/communication with 125 individuals to gain an insight as to the likes and dislikes for carambola, different uses of the fruit among the population and to guide the objective of the research. Only those students at the University of the West Indies, St. Augustine campus were interviewed.

Processing

Carambola, *Averrhoa carambola* of the Chinaseng variety was obtained form Citrus Grower's Limited, Laventille and from Ambrosia farms, Arima. The mature, yellow fruits (13 cm x 6 cm) were stored at 10 °C. The average weight of the fruit was 192.0 g. Fruits were selected to be free of bruises and blemishes and washed in 10 % chlorinated water (sodium hypochlorite). Fruits were peeled length-wise to separate the ribs and the seeds, slimy membranes and the center of the ribs were removed and juiced in an electrical juice processor and filtered. Xanthum gum at varying levels was mixed with the sugar and incorporated into diluted carambola juice. The formulation consisted of the following ing: carambola juice (35 %) and water (65 %) with additions of ascorbic acid (0.125 %), citric acid ().5 %), sodium benzoate (0.1 %) and sugar (9 % or 11 %).The drink was pasteurised at 90 °C for 5 min. After the first minute, citric acid, ascorbic acid, sodum benzoate and orange juice were added and stirred. The carambola drink was hot – filled in 300 ml bottles.

Experimental Design

The first stage of the study was to investigate the effects of adding different levels of xanthum gum (0.02 %, 0.05 %, 0.2 %, 0.3 %, 0.4 %, 0.5 %, 0.6 %) to the carambola drink of formulation: carambola juice (35 %), water (65 %), ascorbic acid (0.125 %), citric acid (0.5 %), sodium benzoate (0.1 %) and sugar (12 %). The products were stored at 20 °C for 1 month and observed for settling of sediments, and the level of consistency. In the second stage of experimental work, the carambola juice with 0.2 % xanthum gum was selected from the first stage of the experiment as having the least separation of sediments. To the base formulation, sugar was added at 9 % and 11 %, mixed with 3 % orange juice or without added orange juice. Bottles were stored at 10 °C or 25 °C for 5 weeks.. Analyses on the products were done at weekly intervals for sedimentation settling, colour analysis, pH, and ° Brix.

Statistical analysis

Data from questionnaire, physico-chemical analyses (colour, pH, total soluble solids as ° Brix) due to treatments (second stage of processing) storage, and sensory evaluation at 5 % level of significance were analysed using the Statistical Package for Social Sciences (SPSS) version 9.0 for Windows.

Physico-chemical analyses

Colour of the carambola drink was measured as 'L' 'a' 'b' using a Minolta Chroma meter. The pH of the carambola fruit and drink was measured on a pH meter at weekly intervals for 5 weeks, by immersing the pH probe into the carambola drink. The total soluble solids (TSS) as ° Brix was measured using a refractometer.

Microbiologica

Microbial examination of carambola drinks (second stage of processing) for the presence of lactobacilli (Tomato Juice Agar), yeasts and molds (Potato Dextrose Agar) and was performed on week 3 at 10 °C and 25 °C. Tomato juice agar plates were incubated at 37 °C except Potato Dextrose agar at 25 °C for 48 hours and the number of microorganisms reported as cfu ml^{-1}.

Sensory Evaluation

Sensory evaluation was performed on week 3 after processing on carambola drinks form the second stage of processing. Forty – nine (49) un-trained panelists of ages 20-24 chosen from the student population of the University of the West Indies, Trinidad, W.I. and members of the public participated in the sensory evaluation of the 4 treatments (9 % and 11 % sucrose/ with or without added 3 % orange juice). Sensory evaluation was conducted in the Sensory Evaluation laboratory. Samples were chilled at 5 °C prior to being served. The sensory attributes of the carambola drinks which were evaluated: colour, taste, sweetness, and overall acceptability using a hedonic scale of 9- like extremely; 8-like very much; 7-like moderately; 6-like slightly; 5- neither like nor dislike; 4-dislike slightly; 3-dislike moderately; 2-dislike very much; 1-dislke extremely.

RESULTS AND DISCUSSION

Questionnaire. Most of the respondents (86.4 %) to the questionnaire have eaten carambola as a fruit, 63 % ate only one fruit in a single occasion and 65 % consume the fruit only when available during the season. Some respondents (32. 8 %) were aware of the two types of carambola, (the larger, sweet type for processing and the smaller sour type which is eaten as a fruit) which are available locally. When respondents were asked to select the most desirable quality attributes, 29.6 % indicated taste, 26.9 % selected shape, 23.1 % odour and 8.3 % texture. Some respondents (51. 9 %) indicated that there were several attributes they disliked about the fruit: the acid taste, not being sweet, and the short shelf life of the fruit. Carambola is used to make a variety of products: as wines (27.8%); beverages (26.9 %); jams (16.7%); pepper sauce (15.7%); candied product (13.0%); pickle (11.0%); in baked products (2.8 %); cordial (0.9%). When respondent were asked about the acceptability of using carambola for food products, 31.2 % neither liked nor disliked; 27.2% liked very much; 25.6 % liked a little; 9.6 % liked extremely; 3.2 % disliked a little and 2.4 % disliked extremely the suggestion. Based on the responses of the participants, 27.2 % indicated that the fruit was most suitable to be used as a juice, while 22.4 % indicated as a drink. Most participants (66.4 %) preferred a blended carambola drink with orange juice while 59.2 % favoured a mixed fruit drink.

Effects of xanthum gum on sedimentation. Table 1 shows the effect of adding xanthum (%) on sedimentation (cm) of juices on storage after 4 weeks (first stage of processing). The least amount of settling of sediments was in carambola treatment with 0.2 % addition of xanthum gum (0.9 cm) and the most sedimentation in carambola juice with 0.02 % xanthum gum (2.1 cm). On storage of carambola juices with 0.2 % xanthum gum from the second stage of processing (9% sugar; 12 % sugar with or

without 3 % orange juice) at 25 °C for 5 weeks, there was still some sedimentation (0.8 –1.2 cm). Carambola treatments, which were stored at 5 °C for 5 weeks had negligible sedimentation (< 0.3 cm).

Physico-chemical analysis. Colour differences ($P<0.05$) between different carambola drinks are were shown (Table 2). Carambola drinks darken on storage, as indicated by the lower 'L' values of Table 2 when compared to Table 3, with more darkening on storage at 25 °C than at 10 °C storage after 5 weeks. Comparing the 'a' and 'b' values of Table 2 (day 1 after processing) to Table 3 (after 5 weeks of storage), the products became more red and and more yellow. There was some browning in drinks.The enzyme, polyphenoloxidase (PPO) in the carambola causes oxidation, particularly if the tissues were scarred or bruised, thus resulting in browning of drinks (Weller *et al.* 1987). Browning susceptibility of fruit tissue has been reported to be related to ascorbic acid concentrations, PPO activity and phenolic content (Bauernfeind, 1958; Ponting and Joslyn, 1948). Changes in colour can result in decrease consumer appeal and therefore colour is an important determinant of shelf-life (Nagy and Rouseff, 1986).

Total soluble solids. Carambola drinks with 9 % sugarhad 13.2 °Brix; 9% sugar with 3 % orange juice – 12 °Brix; 11 % sugar – 14 °Brix; 11 % sugar with 3 % orange juice – 20.2 °Brix. The ° Brix content of raw carambola juice was 6.12 °Brix. There were no significant ($P>0.05$) in the total soluble solids on storage at 25 °C and 10 °C.

pH. The pH of the raw fruit juice was 2.88-3.01. Table 4 shows that the pH of the carambola drink decreased ($P<0.05$) on storage time. The increase in acidity could be related to the growth of lactobacilli which as determined after 3 week of storage. Oxalic acid is the principal acid found in the carambola fuit. Ripe carambola contains 9.6 mg/g pf oxalic acid while the green fruit contains about 5.0 mg/g (Lamberts and Schaffer, 1989). Other acids found include fumaric, malic, ketoglutaric, succinic and tartaric acid.

Microorganisms. No yeasts and molds were detected on microbial analysis after week 3 of processing. The decline in pH in carambola drinks on storage (Table 4) can be related to the presence of lactobacilli in the drinks ($9.9 \times 10^3 - 1.1 \times 10^5$ lactobacilli per ml).

Sensory evaluation. Thirty-three (70.2 %) of the panelists were within the age group of 20-24 years and 24 or 51.1% of panelists were males. Forty-six (97.9 %) of the participants were aware of carambola fruits, while 23 panelists or 48.9 % have consumed carambola drinks. Table 5 shows the sensory attribute scores assigned to carambola drinks. Carambola drinks were liked slightly to moderately for colour and taste. Sweetness was the least acceptable of all attributes, particularly for carambola drink of 11 % sugar/ 3 % orange juice, which was given a score of 4.76 indicating that it was disliked slightly to neither like nor dislike. This drink was not acceptable due to its high ° Brix content of 20.2. Similarly a carambola drink with 11 % sugar, which had 14 ° Brix content was disliked very much to disliked moderately (2.49). The overall acceptance of all treatments were liked moderately to liked very much (7.04-7.21) except the carambola with 11 % sugar with 3 % orange juice which was disliked slightly to neither liked nor disliked (4.23). Carambola drinks with 11 % sugar/ 3 % orange juice were considered 'too sweet' by panelists. When asked to choose the most preferred carambola drink treatment, 36.2 % of panelists preferred the 9 % sugar with 3 % orange juice, because of its odour and consistency and 36 % of panelists indicated that they would purchase.

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Table 1. Effects of Xanthum Gum (%) Addition on Sedimentation of Carambola juices* after 4 week Storage.

Xanthum gum, %	Sedimentation, cm
0.02	2.1
0.05	2.0
0.20	0.9
0.30	1.0
0.40	1.3
0.50	1.5
0.60	1.5

* first stage of processing

Table 2. Colour of Carambola Drinks (first stage of processing).

Treatments	'L'	'a'	'b'
9 % sugar	32.63	-0.96	-0.26
11 % sugar	30.10	0.00	0.60
9 % sugar + 3 % orange juice	33.33	-0.56	0.93
11 % sugar + 3 % orange juice	30.65	-0.16	0.00

Colour measurement taken after day 1 of processing

Table 3. Colour of Carambola Drinks on storage at 25 °C and 10 °C (second stage of processing)

Colour	9 % sugar	11 % sugar	9 % sugar/ 3 % orange juice	11 % sugar /3% orange juice
Storage, 25 °C				
'L'	28.05	27.95	28.37	28.23
'a"	0.19	0.26	0.17	0.19
'b'	0.86	0.78	0.93	1.10
		Storage, 10 °C		
'L'	29.02	28.08	28.95	29.15
'a'	1.21	0.58	0.31	0.19
'b'	1.21	0.94	0.70	0.77

Colour readings taken after 5 weeks

Table 4. pH of Carambola drink* on Storage.

Storage, wks	Carambola treatments			
	9 % sugar	11 % sugar	9 % sugar / 3 % orange juice	11 % sugar / 3 % orange juice
1st	4.00±0.01	4.02±0.01	3.98±0.01	4.02±0.01
2nd	3.99±0.01	3.89±0.01	3.92±0.01	3.94±0.02
3rd	3.94±0.01	3.77±0.01	3.88±0.02	3.87±0.01
4th	3.78±0.01	3.79±0.01	3.72±0.01	3.81±0.02
5th	3.76±0.02	2.98±0.01	3.66±0.02	3.74±0.01

* carambola drink from the second stage of processing
±SD

Table 5. Sensory Attributes of Carambola Drinks

Attributes	9 % sugar	11 % sugar	9 % sugar + 3 % orange juice	11 % sugar + 3 % orange juice
Colour	6.83±2.26	6.74±15.67	6.83±0.26	6.77±0.18
Taste	6.72±0.63	6.63±1.21	6.57±0.18	6.26±2.03
Sweetness	4.99±2.95	2.49±14.30	5.98±9.88	4.76±1.47
Overall acceptance	7.04±4.28	7.21±5.46	7.21±4.28	4.23±15.18

±SD